

Pollination and food production in a changing world

Dr. Danny Minahan

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Course format

3 academic credits: One 3 hour meeting each week.

Grading

Attendance and participation: 15%

Teamwork assignments and presentations 20%

Presentation of scientific paper 20%

Kibbutz walk reflection 5%

Field trip reflection 10%

Final exam 30%

Course description

Plants and pollinators have co-evolved together for nearly 200 million years, resulting in the diversity of flowering plants and pollinating animals that we see today. Animal pollinators visit flowers to collect resources, and this visitation is necessary for the survival and reproduction of the flowering plants they visit. The resources produced by flowering plants are collected and used by pollinators for nutrition, defense, and nesting. However, the stability of plant-pollinator interactions is rapidly being undermined in the face of climate change, habitat loss, pollution, and exposure to agrochemicals, among other drivers. Considering that nearly 80% of the food we consume as humans relies on pollination services, there is a direct and urgent need to better understand these interactions, and the threats undermining them, and to explore novel approaches aimed at plant-pollinator conservation and sustainability.

Course structure

In this course we will explore the field of ecology, which is the study of interactions between organisms and their environment, but specifically that of plant-pollinator interactions. These interactions will be examined through the lens of pollinator behavior to better understand the ecosystem services of food production and biodiversity conservation. This course will be divided into three sections. Early in the course, we will take a global perspective to

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understand the big- picture challenges facing pollinators, and the implications for food security. We will then dive deeper into the mechanisms that threaten pollinators, with an emphasis on pollinator behavior and pollination. And the final part of this course will examine the expected consequences of a warmer planet on pollinators and food production and consider the next steps towards preserving this invaluable ecosystem service.

This course will consist of lectures, including some guest lecturers, along with nature walks around the kibbutz and one field trip. In addition, students will engage in small group activities during class, complete 2 reflections from the walk and field trip, and in pairs will present a scientific paper to the class.

Books referenced in this course (see full reading list at end of syllabus)

Ollerton, J. (2021). *Pollinators and pollination: nature and society*. Pelagic Publishing Ltd.

Purdy, J. (2023) *The foraging ecology of honey bees*. Elsevier.

Seeley, T. D. (2011). *Honeybee democracy*. Princeton University Press

Course schedule

Week 1 Course introduction

- Part I: Introduce the structure and content of the course.
- Part II: Explore the range of biology sub-disciplines and the scales at which they are studied. With an emphasis on ecology, and population and community scales.

Week 2: Biodiversity and ecosystem services

- Part I: Ecology unit 1: Fundamentals - Population dynamics and community biodiversity
- Part II: Ecology unit 2: Interactions - Mutualisms and ecosystem services
- Part III: Pollination as an ecosystem service.

Week 3: Behavioral ecology of pollination

- Part I: Ecology unit 3: Behavioral ecology - Resource limitation and behavioral strategies
- Part II: Movement rules and decision making by pollinators and the implications for pollination.
- Part III: Walk around the Kibbutz to locate pollinators and characterize their behavior
- *Pre-class readings: (a) and (b)* ○ Ollerton (2021) Chapter 1, pages 4-7
- Purdy (2023) Chapter 6, first four sections (~6 pages)

Week 4: Global challenges threatening food security.

- Part I: Ecology unit 4: Community ecology - Connectedness in ecological systems
- Part II: Scale and economics of food production of global food production
- Part III: Balancing economic and food security with pollinator conservation efforts
- *Pre-class reading: (c) Ollerton 2021 Chapter 7 pages 108-123*

Week 5: Honey bees and beekeeping for agriculture

- Field trip to Porat Farm in Moshav Ein Yahav
- Pre-class reading: (d) Egerer and Kowarik (2020)

Week 6: Habitat use by pollinators and their response to change

- Part I: Introduce the scales of habitat use by pollinators. Local to landscape.
- Part II: Foraging strategies of pollinators and resilience to change.
- *Pre-class reading: (e) Seeley 2010: (e) Introduction. pages 3-19*

Week 7: The study of pollinator behavior, pollination, and food production

- Part I: How do scientists study pollinators and pollination around the world?
- Part II: Introduce research paper presentation assignment.
- *Pre-class reading: (f) Carey et al. (2020)*

Week 8: Midterm exam

- Part I: Last minute questions and review about exam
- Part II: Midterm exam

Week 9: Global initiatives to protect pollinators.

- Part I: Successful approaches to pollinator conservation and protection in an increasingly interconnected world
- Part II: Guest lecture: TBA
- *Pre-class reading: (g) Klein et al. 2007*

Week 10: Sub-lethal stressors and pollinator health

- Part I: Agricultural inputs at the local and ecosystem scale
- Part II: Unbalanced nutrition and bee health
- Part III: Guest lecture: Avi Eliyahu. Honey bees, wild bees, and disease
- *Pre-class reading: (h) Wright et al. 2018*

Week 11: Wild and domesticated pollinators in Arava agriculture. The flower strip project.

- Guest lecture: Dr. Jessica Schaeckermann
- *Pre-class reading: (i) To be determined*

Week 12: The future of pollination and food security in a changing world

- Part I: Responses by pollinators to a changing climate
- Part II: Predictions for the future of pollination and food production

- Part III: Steps taken to mitigate the challenges predicted into the future
- *Pre-class reading: (j) Erenler et al. (2020)*

Week 13: Research paper presentations

- Student research paper presentations

Week 14: Final exam

Reading list

- Ollerton (2021). Chapter 1, pages 4-7
- Purdy (2023). Chapter 6, pages TBD
- Ollerton (2021). Chapter 7, pages 108-123
- Egerer, M., & Kowarik, I. (2020). Confronting the modern gordian knot of urban beekeeping. *Trends in Ecology & Evolution*, 35(11), 956-959.
- Seeley (2011). Introduction.
- Carey, M. A., Steiner, K. L., & Petri Jr, W. A. (2020). Ten simple rules for reading a scientific paper. *PLoS computational biology*, 16(7).
- Klein, A. M., Vaissière, B. E., Cane, J. H., Steffan-Dewenter, I., Cunningham, S. A., Kremen, C., & Tscharntke, T. (2007). Importance of pollinators in changing landscapes for world crops. *Proc. of the royal society B: biological sciences*, 274(1608), 303-313.
- Wright, G. A., Nicolson, S. W., & Shafir, S. (2018). Nutritional physiology and ecology of honey bees. *Annual review of entomology*, 63, 327-344.
- Week 11: Dr. Jessica TBD
- Erenler, H. E., Gillman, M. P., & Ollerton, J. (2020). Impact of extreme events on pollinator assemblages. *Current Opinion in Insect Science*, 38, 34-39