Chemical Ecology – Spring Workshop

Course number: 001.2.2079

Lecturer: Dr. Vered Tzin

Course credits: 2

Students: Master and Ph.D. and third-year undergrads

Requirements: Basic chemistry, molecular biology, and basic ecology is recommended.

Format: Sequential three days in the field and in the lab during Spring (February 2022)

Grading: 15% class presence, 15% field trip, and 70% final report (submission two weeks after workshop is over).

Course description:

The research field of Chemical Ecology promotes an ecological understanding of the origin, function, and significance of natural chemicals that mediate interactions within and between organisms. This workshop examines the chemical basis of interactions between species and is intended for students with a basic knowledge of chemistry and biology. The workshop will focus on the ecology and chemistry of desert plants and animals, especially herbivores and pollinators. The overall aim of the course is to demonstrate the current use of chemical ecology approaches from the field into the lab. The students will be exposed to the future potential of chemical ecology in the development of tools for use in sustainable insect monitoring and elucidating the plant responses to insects.

On completion of the course, students will be able to:

- Categorize ecological interactions and potential mechanisms by which they are mediated.
- Discuss these mechanisms in light of evolutionary theory and draw conclusions about potential agricultural applications.
- Become familiar with the general structures of metabolites and the relationship between structure and function.
- Become familiar with a number of analytical, behavioral, and experimental techniques used to analyze chemical compounds that mediate ecological interactions.

- Plan and design an experiment and implement methods relevant for plant-insect interaction.
- Read and synthesize findings from original scientific research in chemical ecology by studying and discussing the primary literature.
- Formulate and write a scientific report based on newly generated data collected in the workshop

Synopsis

Day 1:

1) Classroom 1: Basic concepts in chemical ecology (mutulism, herbivory, Darwinian natural selection; optinmal defesne theory) (4 hr)
2) Experiment: Field visit – pick a plot and plants (1 hr)
3) Classroom 2: Define the research question, and experimental design (methods, setup replicates, time of sampling, statistics, potantial pitfalls) (4 hr)

Day 2:

4) Experiment: Setup (1 hr)
5) Classroom 3: Principle in analytical chemistry (SPEM, HD, GC/MS) (2 hr)
6) Experiment: Plant sampling and insect observation (herbivores and pollinators scouting)(3 hr)
7) Laboratory: Setting the HD system and Y-tube olfactometry bioassay (3 hr)

Day 3:

8) Laboratory: GC/MS extraction and run (2 hr)
9) Classroom 4: Data analysis (MassHunter, XCMS,Metaboanalyst) (4 hr)
10) Classroom 5: Discussion (data (3 hr)

Day 4: (not in a sequential time) – via Zoom or in person

11) Classroom 6: Final report prentession, peer evalution,critical thinking, improvemt for next year (5 hr)

Reading material before the workshop:

Chapter Six - A practical guide to implementing metabolomics in plant ecology and biodiversity research

Author: Uthe et al., 2021

Chemical convergence between plants and insects: biosynthetic origins and functions of common secondary metabolites
Author: Franziska Beran, Tobias G. Köllner, Jonathan Gershenzon and Dorothea Tholl

Herbivore-induced plant volatiles in natural and agricultural ecosystems: open questions and future prospects
Author: Gish et al., 2015

The chemical ecology of plant-pollinator interactions: recent advances and future directions
Author: Parachnowitsch and Manson, 2015

Videos:

Baldwin (Max Planck Inst.) 1: Studying a plant's ecological interactions in the genomics era (introduction min 01:46-12:17)(plant-insect interaction dogma 18:15-26:10; N. atenuta background 30:10-37:30, N. gene slinsing 37:30: end)
https://www.youtube.com/watch?v=VIq664HaNFU&t=208s&ab_channel=iBiology

Baldwin (Max Planck Inst.) 2: Nicotiana attenuata's responses to attack from the moth's caterpillar
https://www.youtube.com/watch?v=GIruik14ht4&t=1364s&ab_channel=iBiology

Baldwin (Max Planck Inst.) 3: Plant's perspective on seeds, sex, and microbes
https://www.youtube.com/watch?v=nb0mZBnlgc8&t=6s&ab_channel=iBiology