

Chemical Ecology

BSPM 570

Spring 2012

Instructor: Louis B. Bjostad
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Lecture: 11 MWF
Room E8, Plant Sciences Building

Calendar:

Lectures	
18 Jan (Wednesday)	First class
10-18 March	No classes, Spring break
4 May (Friday)	Last class

Assignments	
22 Feb (Wednesday)	Exam One (30% of grade)
7 March (Wednesday)	Abstract of review article due (5% of grade)
4 April (Wednesday)	Review article due (30% of grade)
7 May (Monday)	Exam Two (30% of grade), 7:30 AM -9:30 PM
Every Friday	Class discussions (5% of grade)

PLEASE NOTE THAT THIS CLASS USES PLUS AND MINUS LETTER GRADES.

Optional Textbook: *Introduction to Ecological Biochemistry*, J. B. Harborne

Optional Laboratory (BSPM571):

Feb 24	Friday	1 pm – 5 pm	Gas-liquid chromatography
Mar 23	Friday	1 pm – 5 pm	Thin layer chromatography
Apr 13	Friday	1 pm – 5 pm	Solid phase extraction
May 4	Friday	1 pm – 5 pm	Derivatization

Topic 1. Overview of chemical ecology: design and significance of bioassays, chemical techniques in studying ecological interactions.

Lectures:

Introduction	Jan 18 Wed
Seven Postulates	Jan 20 Fri
Chromatography	Jan 23 Mon

Lecture (Jan 25 Wednesday):

Cha Dong H.; Powell Thomas H. Q.; Feder Jeffrey L.; et al. Identification of Host Fruit Volatiles from Three Mayhaw Species (*Crataegus* Series *Aestivales*) Attractive to Mayhaw-Origin *Rhagoletis pomonella* Flies in the Southern United States. JOURNAL OF CHEMICAL ECOLOGY Volume: 37 Issue: 9 Pages: 961-973 DOI: 10.1007/s10886-011-0013-6 Published: SEP 2011.

Class discussion (Jan 27 Friday):

Zhang Dong; Terschak John A.; Harley Maggy A.; et al. Simultaneously Hermaphroditic Shrimp Use Lipophilic Cuticular Hydrocarbons as Contact Sex Pheromones. PLOS ONE Volume: 6 Issue: 4 Article Number: e17720 DOI: 10.1371/journal.pone.0017720 Published: APR 20 2011.

Topic 2. Major chemical groups of natural products and their structural features, plant, biosynthetic origins of secondary compounds

Lecture (Jan 30 Monday):

Chemical classes

Lecture (Feb 1 Wednesday):

Salminen Juha-Pekka; Karonen Maarit; Sinkkonen Jari. Chemical Ecology of Tannins: Recent Developments in Tannin Chemistry Reveal New Structures and Structure-Activity Patterns. CHEMISTRY-A EUROPEAN JOURNAL Volume: 17 Issue: 10 Pages: 2806-2816 DOI: 10.1002/chem.201002662 Published: MAR 2011.

Class discussion (Feb 3 Friday):

Chen Feng; Tholl Dorothea; Bohlmann Joerg; et al. The family of terpene synthases in plants: a mid-size family of genes for specialized metabolism that is highly diversified throughout the kingdom. PLANT JOURNAL Volume: 66 Issue: 1 Pages: 212-229 DOI: 10.1111/j.1365-313X.2011.04520.x Published: APR 2011.

Topic 3. Theories of the roles of plant allelochemicals

Lecture (Feb 6 Monday):

Theories of chemical defense

Lecture (Feb 8 Wednesday):

Salminen Juha-Pekka; Karonen Maarit. Chemical ecology of tannins and other phenolics: we need a change in approach. FUNCTIONAL ECOLOGY Volume: 25 Issue: 2 Pages: 325-338 DOI: 10.1111/j.1365-2435.2010.01826.x Published: APR 2011.

Class discussion (Feb 10 Friday):

Endara Maria-Jose; Coley Phyllis D. The resource availability hypothesis revisited: a meta-analysis. FUNCTIONAL ECOLOGY Volume: 25 Issue: 2 Pages: 389-398 DOI: 10.1111/j.1365-2435.2010.01803.x Published: APR 2011.

Also of interest (NOT required reading):

Stamp N. Out of the quagmire of plant defense hypotheses. QUARTERLY REVIEW OF BIOLOGY Volume: 78 Issue: 1 Pages: 23-55 DOI: 10.1086/367580 Published: MAR 2003.

Hadacek Franz; Bachmann Gert; Engelmeier Doris; et al. HORMESIS AND A CHEMICAL RAISON D'ETRE FOR SECONDARY PLANT METABOLITES. DOSE-RESPONSE Volume: 9 Issue: 1 Pages: 79-116 DOI: 10.2203/dose-response.09-028.Hadacek Published: 2011.

Topic 4. Herbivory and the chemical defenses of plants

Lecture (Feb 13 Monday):

Web of Science

Lecture (Feb 15 Wednesday):

Lampert Evan C.; Zangerl Arthur R.; Berenbaum May R.; et al. Generalist and specialist host-parasitoid associations respond differently to wild parsnip (*Pastinaca sativa*) defensive chemistry.

ECOLOGICAL ENTOMOLOGY Volume: 36 Issue: 1 Pages: 52-61 DOI: 10.1111/j.1365-2311.2010.01244.x Published: FEB 2011.

Class discussion (Feb 17 Friday):

Today is the last course material that will be covered on Exam One on Feb 22 Wednesday.

Konno Kotaro. Plant latex and other exudates as plant defense systems: Roles of various defense chemicals and proteins contained therein. PHYTOCHEMISTRY Volume: 72 Issue: 13 Special Issue: SI Pages: 1510-1530 DOI: 10.1016/j.phytochem.2011.02.016 Published: SEP 2011.

Topic 4. Herbivory and the chemical defenses of plants (continued)

Lecture (Feb 20 Monday):

Today is the first course material that will be covered on Exam Two on May 7 Monday.

Detailed examples for tannins, terpenes, cyanogens, cardenolides, toxic amino acids and proteins (no readings).

EXAM ONE (Feb 22 Wednesday):

THIS EXAM IS 30% OF YOUR FINAL GRADE.

Lecture (Feb 24 Friday):

More detailed examples for tannins, terpenes, cyanogens, cardenolides, toxic amino acids and proteins (no readings).

Topic 5. Coevolution of herbivores and plant allelochemicals

Lecture (Feb 27 Monday):

Berenbaum M. 1983. Coumarins and caterpillars: a case for coevolution. Evolution 37: 163-179.

Lecture (Feb 29 Wednesday):

Becerra JX, Noge K, Venable DL. Macroevolutionary chemical escalation in an ancient plant-herbivore arms race. PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA Volume: 106 Issue: 43 Pages: 18062-18066 Published: OCT 27 2009.

Class discussion (Mar 2 Friday):

Iason Glenn R.; O'Reilly-Wapstra Julianne M.; Brewer Mark J.; et al. Do multiple herbivores maintain chemical diversity of Scots pine monoterpenes?. PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B-BIOLOGICAL SCIENCES Volume: 366 Issue: 1569 Pages: 1337-1345 DOI: 10.1098/rstb.2010.0236 Published: MAY 12 2011.

Topic 6. Chemical recognition: chemosensory and neurophysiological basis, behavioral mechanisms

Lecture (Mar 5 Monday):

Chemical recognition

Lecture (Mar 7 Wednesday):

ABSTRACT (300 words) OF YOUR REVIEW ARTICLE DUE TODAY (5% OF FINAL GRADE)

Tanaka K, Uda Y, Ono Y, et al. Highly Selective Tuning of a Silkworm Olfactory Receptor to a Key Mulberry Leaf Volatile. CURRENT BIOLOGY Volume: 19 Issue: 11 Pages: 881-890 Published: JUN 9 2009.

Class discussion (Mar 9 Friday):

Swarup S.; Williams T. I.; Anholt R. R. H. Functional dissection of Odorant binding protein genes in *Drosophila melanogaster*. GENES BRAIN AND BEHAVIOR Volume: 10 Issue: 6 Pages: 648-657 DOI: 10.1111/j.1601-183X.2011.00704.x Published: AUG 2011.

SPRING BREAK IS MARCH 10 – MARCH 18

Topic 7. Circumvention of defenses: detoxification, mixed function oxidases, group transfer

Lecture (Mar 19 Monday):

Circumvention of defenses

Lecture (Mar 21 Wednesday):

Langel Dorothee; Ober Dietrich. Evolutionary recruitment of a flavin-dependent monooxygenase for stabilization of sequestered pyrrolizidine alkaloids in arctiids. *PHYTOCHEMISTRY* Volume: 72 Issue: 13 Special Issue: SI Pages: 1576-1584 DOI: 10.1016/j.phytochem.2010.12.014 Published: SEP 2011.

Class discussion (Mar 23 Friday):

Ahn Seung-Joon; Badenes-Perez Francisco R.; Reichelt Michael; et al. METABOLIC DETOXIFICATION OF CAPSAICIN BY UDP-GLYCOSYLTRANSFERASE IN THREE *Helicoverpa* SPECIES. *ARCHIVES OF INSECT BIOCHEMISTRY AND PHYSIOLOGY* Volume: 78 Issue: 2 Pages: 104-118 DOI: 10.1002/arch.20444 Published: OCT 2011.

Topic 8. Chemical interactions among plants: allelopathy, higher plant parasites, chemical communication

Lecture (Mar 26 Monday):

Allelopathy

Lecture (Mar 28 Wednesday):

Inderjit; Evans Heather; Crocoll Christoph; et al. Volatile chemicals from leaf litter are associated with invasiveness of a Neotropical weed in Asia. *ECOLOGY* Volume: 92 Issue: 2 Pages: 316-324 DOI: 10.1890/10-0400.1 Published: FEB 2011.

Class discussion (Mar 30 Friday):

Kato-Noguchi Hisashi; Salam Md Abdus; Suenaga Kiyotake. Isolation and Identification of Potent Allelopathic Substances in a Traditional Bangladeshi Rice Cultivar Kartikshail. *PLANT PRODUCTION SCIENCE* Volume: 14 Issue: 2 Pages: 128-134 Published: APR 2011.

Topic 9. Pollination biology: floral pigments, floral scent and floral rewards, toxic nectar

Lecture (April 2 Monday):

Pollination

Lecture (April 4 Wednesday):

YOUR REVIEW ARTICLE IS DUE TODAY (30% OF FINAL GRADE)

Galen Candace; Kaczorowski Rainee; Todd Sadie L.; et al. Dosage-Dependent Impacts of a Floral Volatile Compound on Pollinators, Larcenists, and the Potential for Floral Evolution in the Alpine Skypilot *Polemonium viscosum*. *AMERICAN NATURALIST* Volume: 177 Issue: 2 Pages: 258-272 DOI: 10.1086/657993 Published: FEB 2011.

Class discussion (April 6 Friday):

Ayasse Manfred; Stoekl Johannes; Francke Wittko. Chemical ecology and pollinator-driven speciation in sexually deceptive orchids. *PHYTOCHEMISTRY* Volume: 72 Issue: 13 Special Issue: SI Pages: 1667-1677 DOI: 10.1016/j.phytochem.2011.03.023 Published: SEP 2011.

Topic 10. Microbial interactions: phytotoxins, phytoalexins and lectins

Lecture (April 9 Monday):

Microbial Interactions

Lecture (April 11 Wednesday):

Splivallo Richard; Ottonello Simone; Mello Antonietta; et al. Truffle volatiles: from chemical ecology to aroma biosynthesis. *NEW PHYTOLOGIST* Volume: 189 Issue: 3 Pages: 688-699 DOI: 10.1111/j.1469-8137.2010.03523.x Published: 2011.

Class discussion (April 13 Friday):

Schoenian Ilka; Spiteller Michael; Ghaste Manoj; et al. Chemical basis of the synergism and antagonism in microbial communities in the nests of leaf-cutting ants. *PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA* Volume: 108 Issue: 5 Pages: 1955-1960 DOI: 10.1073/pnas.1008441108 Published: FEB 1 2011.

Also of interest (NOT required reading):

Murray Shauna A.; Mihali Troco K.; Neilan Brett A. Extraordinary Conservation, Gene Loss, and Positive Selection in the Evolution of an Ancient Neurotoxin. *MOLECULAR BIOLOGY AND EVOLUTION* Volume: 28 Issue: 3 Pages: 1173-1182 DOI: 10.1093/molbev/msq295 Published: MAR 2011.

Topic 11. Chemical attack and defense in animals: toxins, venoms, phytotoxemia

Lecture (April 16 Monday):

Toxins

Lecture (April 18 Wednesday):

Bohlen Christopher J.; Chesler Alexander T.; Sharif-Naeini Reza; et al. A heteromeric Texas coral snake toxin targets acid-sensing ion channels to produce pain. *NATURE* Volume: 479 Issue: 7373 Pages: 410-U167 DOI: 10.1038/nature10607 Published: NOV 17 2011.

Class discussion (April 20 Friday):

Van Dyck Severine; Caulier Guillaume; Todesco Maite; et al. The triterpene glycosides of *Holothuria forskali*: usefulness and efficiency as a chemical defense mechanism against predatory fish. *JOURNAL OF EXPERIMENTAL BIOLOGY* Volume: 214 Issue: 8 Pages: 1347-1356 DOI: 10.1242/jeb.050930 Published: APR 2011.

Topic 12. Infochemicals: semiochemicals, pheromones, allomones, kairomones

Lecture (April 23 Monday):

Infochemicals

Lecture (April 25 Wednesday):

Hiltpold Ivan; Erb Matthias; Robert Christelle A. M.; et al. Systemic root signalling in a belowground, volatile-mediated tritrophic interaction. *PLANT CELL AND ENVIRONMENT* Volume: 34 Issue: 8 Pages: 1267-1275 DOI: 10.1111/j.1365-3040.2011.02327.x Published: AUG 2011.

Class discussion (April 27 Friday):

Gols Rieta; Bullock James M.; Dicke Marcel; et al. Smelling the Wood from the Trees: Non-Linear Parasitoid Responses to Volatile Attractants Produced by Wild and Cultivated Cabbage. *JOURNAL OF CHEMICAL ECOLOGY* Volume: 37 Issue: 8 Pages: 795-807 DOI: 10.1007/s10886-011-9993-5 Published: AUG 2011.

Topic 13. Case studies: ongoing research in chemical ecology

Lecture (April 30 Monday):

David James Lecture

Sitosterol as a feeding stimulant for termites: chemistry and ecological rationale

Lecture (May 2 Wednesday):

Elisa Bernklau Lecture

Host selection in corn rootworms: chemistry and ecological rationale

Lecture (May 4 Friday):

Powner Matthew W.; Gerland Beatrice; Sutherland John D. Synthesis of activated pyrimidine ribonucleotides in prebiotically plausible conditions. NATURE Volume: 459 Issue: 7244 Pages: 239-242 DOI: 10.1038/nature08013 Published: MAY 14 2009.

GRADING CRITERIA

A. Written examination (30% of grade).

First exam will include all material from the first class until the day of the exam.

B. Abstract of review article (5% of grade).

Abstract should have **300 words**, along with a preliminary reference list of **5 principal references** in an appropriate format of your choice. Your abstract should summarize the topic that will be covered in your full-length review article.

C. Review article (30% of grade).

Review article must be on a research topic of current interest in chemical ecology in scientific format, including title, abstract (same one you turned in before), introduction, discussion (preferably in subsections), and references. You may insert photocopies of tables or figures from other publications, if you like. The paper should have **3000 words** (this is usually about 10 double-spaced pages), and **10-20** references.

You must turn in:

- one **printed copy**, and also
- one **electronic file** in any of the following ways you prefer:
 - **email** me your review article as a **PDF file**, or a **Microsoft Word file**, or a **text file** (to louis.bjostad@colostate.edu)
 - give me a **CD** with your review article as a **PDF file**, or a **Microsoft Word file**, or a **text file**

Other comments about the **printed copy** you turn in:

- Double-space all pages, so that I have room to write comments between the lines
- Number the pages
- Staple the pages together
- Do not put your article in a binder (manuscripts submitted to journals never are)
- Include your email address at the top of your review article

D. Final examination (30% of grade).

Second exam will include only the material not covered on the first exam.

E. Class discussions (5% of grade).

Your performance in the discussions will **NOT** be graded, but 5% of your final grade will depend on your active participation in the discussions.