Spring 2012

BIOL 4620/6620
AQUATIC CHEMICAL ECOLOGY

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Course summary: The course focuses on understanding how chemical signals and cues (especially in aquatic systems) produce cascading effects on population regulation, community organization, and ecosystem function. Think of this as the "ecological biochemistry" of how individuals, populations, communities, and ecosystems function.

Class meets on Tuesdays and Thursdays from 1:35 to 2:55 pm in Mason 311 There is no textbook. Required and recommended readings will be made available on T-square (https://t-square.gatech.edu/portal), and students are encouraged to use library databases and the scientific literature to pursue topics in more detail. Since there is no textbook and many of the sessions involve class discussion as well as formal lecture, **attendance and class participation are required**.

Evaluation:	**UG students**	**Grad students**
Surprise quizzes	**5%**	**5%**
Primary literature critique	**10%**	**10%**
Midterm test #1	**15%**	**15%**
Midterm test #2	**20%**	**20%**
Oral presentation and discussion leading		**20%**
Final paper	**20%**	**20%**
Class participation	**10%**	**10%**
Final	**20%**	

Surprise quizzes can come anytime, and usually involve trivial questions about the day's readings that you should always get full points for if you read the paper and show up to class on time. I'll drop one quiz grade, but if you miss or do badly on more than one, then it will affect your grade. There will be no make-up exams for pop quizzes. I give these in the first 2-3 min of class. BE HERE.

The **primary literature critique** will be a short paper written by each student (maximum 2 pages single spaced, 12 point font), reporting on a recent article from the scientific literature (not a review; I want you to cover a paper reporting an experiment so you can comments on its strengths and weaknesses of approach and interpretation) that you choose by conducting your own literature search. The chosen article should not have been used in a writing assignment for another course and cannot come from the reading list for this course. It should be one that you found particularly interesting and important, and can focus on any area of chemical ecology. In this paper, you should present a brief overview of the field, report the important findings of the chosen article, argue why this article represents an important contribution, and critically evaluate its strengths and weaknesses. For both this and the final paper, please submit by email, and *remember to put your name and email address on the paper itself*. **You can turn this in anytime before 5 April.**

The **midterms and final tests** will be based on material covered in lectures, class discussions, and readings up to the date of that test (the final is not cumulative).

For the **final paper,** you will write a proposal to get funding to conduct research related to a new idea that you want to test dealing with chemical ecology (no – don't put in budgets, or worry about justifying costs, just write a compelling proposal on the ideas, why they are important, and how you can address them). The paper is to be no more than 5 single-spaced pages (not including references, which should be used extensively, in the format of the journal *Ecology*), 12 point font. **Due at the latest by April 19 (before may be better as you will be approaching finals by this date)**

FOR GRADUATE STUDENTS - Your **oral presentation and discussion leading** works like this: everyone in the class reads the assigned paper(s) and comes prepared to ask questions, discuss the ideas presented, and to play a significant role in class discussion on the assigned paper(s). On the day you lead the discussion, you read all papers assigned for that day PLUS OTHERS ON THAT TOPIC SO YOU ARE A RELATIVE EXPERT IN THIS FIELD, and bring a short (~20 minute) **powerpoint presentation** to deliver as you lead the discussion, interspersed with questions and comments from the class. Expect the discussion to run for about one hour including the time required to deliver your slides.

Class participation will be judged by the degree to which each student participates in discussions (by asking questions during others' presentations, answering questions, offering ideas, opinions, critiques of readings, and by connecting the current discussion to previous class discussions). If you sit like a lump and never make a mistake because you never open your mouth, you get 0 points. If you say enough and it is always insightful and brilliant, you get 10 points. If you participate fully, asking insightful questions when you have them but also ones you think may be stupid (if you have it, others may as well – someone has to ask….), that's also worth 10 points. If you talk incessantly until you think of something worth saying… well, none of us value that very much….

Please see www.honor.gatech.edu for Georgia Tech's Academic Honor Code, which you are required to uphold.

Class calendar:

Week	Date	Topic		Reading assignment (read BEFORE class)
1	Jan 10	Introduction to the instructor, course, and expectations for student success		-
	Jan 12	Chemical ecology: From molecules to ecosystems (part 1)		Hay (2009)
2	Jan 17	Chemical ecology: From molecules to ecosystems (part 2)		Hay (2009)
	Jan 19	Chemically-mediated competition: Allelopathy	Doug Rasher	Rasher et al. (2011);
3	Jan 24	Chemically-mediated foraging (large-scale tracking) Discussion leader: Hunter Clasen		Nivette (2011)
	Jan 26	Chemically-mediated foraging (small-scale tracking and prey responses) Discussion leader:		Weissburg et al. (2002)
4	Jan 31	Ecology and evolution of taste Discussion leader:		Krebs (2009); Villalba and Provenza (2009)
	Feb 2	Chemically-mediated gamete and mate recognition Discussion leader:		Zimmer and Riffell (2011); Wyatt (2011)
5	Feb 7	Microbes as competitors: Why fish stink		Burkepile et al. (2006) for fun, google "NPR stinky fish"
	Feb 9	TEST		
6	Feb 14	Microbes as pathogens and host chemical defenses against them Discussion leader: Natasha Fedan		Stow et al (2007); Ritchie (2006)
	Feb 16	Bacterial chemotaxis for virulence, habitat selection, and food tracking Discussion leader:		Thar & Kuhl (2003); Stocker et al (2008)
7	Feb 21	Microbes as accomplices: Chemically-mediated host-microbe symbioses Discussion leader: Troy Alexander		Gil-Turnes et al (1989); Hane (2008)
	Feb 23	Quorum sensing as a mechanism for regulating social interaction Discussion leader: Larisa Pender-Healy		Higgins et al (2007);Rumbaugh et al (2009)
8	Feb 28	Chemically-mediated kin recognition, mate attraction and repulsion – sex pheromones Discussion leader: Sarah Singh		Queller et al (2003); Lize et al (2006); Bagoien & Kiorbe (2005)
	Mar 1	Natural toxins interacting with receptors and toxin-mediated prey capture Discussion leader:		Sheng et al. (2010); Remigio & Duda (2008)
9	Mar 6	Larval habitat selection settlement		Hadfield (2011); Dixson et

		Discussion leader: David Gibbs		al. (2008)
	Mar 8	Global change effects on chemical cuing and signaling Discussion leader: Cody Clements		Munday et al. (2010); Ferrari et al (2011)
10	Mar 13	TEST		
	Mar 15	Chemically-mediated competition: Fouling and dominance Discussion leader: Jessie Roy		Schmitt et al (1995); Bergman and Moore (2005)
11	Mar 20	Spring Break		
	Mar 22	Spring Break		
12	Mar 27	Getting lunch without becoming lunch: why small herbivores prefer toxic plants		Sotka and Hay (2002)
	Mar 29	Chemical defense theories: Useful or not?? Discussion leader: Lauren Connolly		Stamp (2003)
13	Apr 3	Consumer-prey interactions: Induction, activation, geography & costs of defenses Discussion leader:		Baldwin (1998); Morrison and Hay (in press)
	Apr 5	Come to as much as you can of the Teasley workshop on seaweed-coral interactions (9 world-authorities here all day giving talks)		No reading
14	Apr 10	Integrating chemical defense with mobility and behavior Discussion leader:		Kicklighter and Hay (2005)
	Apr 12	The smell of fear and its cascading effects on populations, communities, and ecosystems (part 1) Discussion leader: Tiffany Andras		Peckarsky et al. (2008)
15	Apr 17	The smell of fear and its cascading effects on populations, communities, and ecosystems (part 2) Discussion leader:		Schoeppner & Relyea (2009); Peacor et al (2012)
	Apr 19	Those lower species….like us? Human sex pheromones? And the ecology of sex appeal (part 1)		Gelstein et al. (2011)
16	Apr 24	The science of sex appeal (part 2)		-
	Apr 26	Overview discussion		-
	May 1	Final test (2:50-4:00)		-

Reading list – articles available on T-square

January 10: none

January 12:

Hay ME (2009) Marine chemical ecology: chemical signals and cues structure marine populations, communities, and ecosystems. Annu Rev Mar Sci 1:193-212

January 17:

No additional reading today. We'll still be covering the Hay (2009) reading

January 19:

Rasher DB, S Engel, EP Stout, J Kubanek and ME Hay. 2011. Macroalgal terpenes function as allelopathic agents against reef corals. Proc Nat Acad Sci 108(43) 17726-17731

January 24:

Nevitt GA (2011) the neuroecology of dimethyl sulfide: a global-climate regulator turned mairne infochemical. Int Comp Biol 51: 819-825

January 26:

Weissburg MJ, Ferner MC, Pisut DP, Smee DL (2002) Ecological consequences of chemically mediated prey perception J Chem Ecol 28: 1953-1970

January 31:

Krebs JR.(2009) The gourmet ape: evolution of human food preferences. Am J Clin Nutr 90(s) 707s-711s

Villalba JJ, Provenza FD (2009) learning and dietary choice in herbivores. Rangeland Ecol Mgt 62:399-406.

February 2:

Remigio EA, Duda TF (2008) Evolution of ecological specialization and venom of a predatory marine gastropod. Molecular Ecol 17:1156-1162

Sheng J, et al. (2010) A dinoflagellate exploits toxins to immobilize prey prior to ingestion. Proc Nat Acad Sci 107(5): 2082-2087

February 7:

Burkepile, DE, JD Parker, CB Woodson, HJ Mills, J Kubanek, PA Sobecky, and ME Hay. 2006. Chemically-mediated competition between microbes and animals: microbes as consumers in food webs. Ecology 87:2821-2831

February 9: TEST – no reading

February 14:

Stow A, Briscoe D, Gillings M, Holley M, Smith S, Leys R, Silberbauer T, Turnbull C, Beattie A (2007) Antimicrobial defences increase with sociality in bees. Biol Lett 3:422-424

Ritchie KB (2006) Regulation of microbial populations by coral surface mucus and mucus- associated bacteria. Mar Ecol Prog Ser 322:1-14

February 16:

Thar R, Kuhl M (2003) Bacteria are not too small for spatial sensing of chemical gradients: an experimental evidence. Proc Natl Acad Sci 100:5748-4753

Stocker et al. (2008) Rapid chemotactic response enables marine bacteria to exploit ephemeral microscale nutrient patches. Proc Nat Acad sci 105(11): 4209-4214

February 21:

Gil-Turnes MS, Hay ME, Fenical W (1989) Symbiotic marine bacteria chemically defend crustacean embryos from a pathogenic fungus. Science 246:116-118

Hane ER (2008) Symbiont-mediated protection. Proc R soc B 275: 353-361.

February 23:

Higgins DA, Pomianek ME, Kraml CM, Taylor RK, Semmelhack MF, Bassler BL (2007) The major *Vibrio cholerae* autoinducer and its role in virulence factor production. Nature 450:883-886

Rumbaugh KP, Diggle SP, Watters CM, Ross-Gillespie A, Griffin AS, West SA (2009) Quorum sensing and the social evolution of bacterial virulence. Current Biol 19:341-345

February 28:

Bagoien E, Kiorboe T (2005) Blind dating – mate finding in planktonic copepods. I. Tracking the pheromone trail of *Centropages typicus*. Mar Ecol Prog Ser 300:105-115

Queller DC, Ponte E, Bozzaro S, Strassmann JE (2003) Single-gene greenbeard effects in the social amoeba *Dictyostelium discoideum*. Science 299:105-106

Lize A, Carval D, Cortesero AM, Fournet S, Poinsot D (2009) Kin discrimination and altruism in the larvae of a solitary insect. Proc Roy Soc B 273:2381-2386

March 1:

Zimmer RK, Riffell JA (2011) Sperm chemotaxis, fluid shear, and the evolution of sexual reproduction. Proc Nat Acad Sci 108(32): 13200-13205

Wyatt TD (2011) Pheromones and behavior. Pages 23-38 IN Breithaupt T, and Thiel M (Eds.) Chemical Communication in crustaceans. Springer,New York

March 6:

Hadfield MG (2011) Biofilms and marine invertebrate larvae: what bacteria produce that larvae use to choose settlement sites. Annu Rev Mar Sci 3:453-470

Dixson DL, et al. (2008) Coral reef fish smell leaves to find island home. Proc R soc B 275: 2831-2839

March 8:

Munday PL et al (2010) Replinishment of fish populations is threatened by ocean acidification. Proc Nat Acad Sci 107:12930-12934

Ferrari MCO et al. (2011) Putting predator and prey into the CO_2 equation: qualitative and quantitative effects of ocean acidification on predator-prey interactions. Eco Lett 14:1143-1148

March 13: TEST – no reading

March 15:

Schmitt, T.M., M.E. Hay, and N. Lindquist. 1995. Constraints on chemically-mediated coevolution: multiple functions for seaweed secondary metabolites. Ecology 76: 107-123.

Bergman DA, Moore PA (2005) Prolonged exposure to social odours alters subsequent social interactions in crayfish (*Orconectes rusticus*). Animal Behaviour 70:311-318

March 27:

Sotka, E.E. and M.E. Hay. 2002. Geographic variation among herbivore populations in tolerance for a chemically-rich seaweed. Ecology 83: 2721-2735

March 29:

Stamp N (2003) Out of the quagmire of plant defense hypotheses. Quart Rev Biol 78(1):23-55.

April 3:

Baldwin, IT. 1998. Jasmonate-induced responses are costly but benefit plants under attack in native populations. Proc. Nat. Acad. Sci. USA 95 (14): 8113-8118

Morrison WE and ME Hay. (in press) Are lower latitude plants better defended?: Palatability of freshwater macrophytes. Ecology

April 5:

NO READING

April 10:

Kicklighter CE and Hay ME (2006) Defenses of mobile marine invertebrates are integrated with life-style, mobility, and distribution. Ecol. Monogr 76:195-215.

April 12:

Peckarsky et al. (2008) Considering non-consumptive effects in textbook examples of predator-prey interactions. Ecology 89:2416-2425.

April 17:

Schoeppner NM, Relyea RA (2009) Interpreting the smells of predation: how alarm cues and kairomones influence different prey defenses. Funct Ecol 23:1114-1121.

April 19:

Gelstein et al. (2011) Human tears contain a chemosignal. Science 331:226-230.

April 24:

April 26: discussion/review – no reading

May 1: TEST – no reading