Evolutionary Ecology BSPM526/BZ526
Fall 2007 – Tuesday and Thursday 11:00 – 12:15 Yates 206

Instructors:
Cameron Ghalambor
Office: E338 Anatomy/Zoology
Office Hours: Wed 10-11am
Phone: 491-2759
Email: cameron1@lamar.colostate.edu

John McKay
Office: C129 Plant Sciences
Office Hours – Thursday 2-3pm
Phone: 491-5730
Email: jkmckay@colostate.edu

Lectures: Tuesday, Thursday

Credits: 3

Introduction:
Evolutionary ecology, as the name implies, lies at the interface of ecology and evolution. In general, Evolutionary Ecology considers how organisms have evolved to become adapted to their abiotic and biotic environments and how current ecological processes interact with evolutionary history. The field requires an understanding of both evolutionary and ecological theory and incorporates an array of approaches and techniques depending on the question being pursued. These techniques may range from the application of molecular tools in natural populations, theoretical and mathematical modeling, manipulative field studies, and laboratory or field based common garden experiments. Thus, a common goal in many evolutionary ecology studies is to understand the adaptive significance and evolutionary potential of phenotypic variation in natural populations.

Overview:
This course is designed for graduate students and advanced undergraduates. The format of the course will be a combination of lecture and discussion. Instructors will give background lectures, and students will lead discussion sessions on a variety of topics covered each week. Lectures and assigned readings are designed to provide a foundation in evolutionary ecology and provide a sampling of specific topics.

Reading/Discussion:
Readings will be primarily based on a combination of classic and recent papers that reflect both historic and current progress in the field; most will be drawn from the primary literature.

Learning Objectives for Students:
Students will be able to apply theory and methods used for studying why and how traits evolve.

1) Students will be able to explain the historical background of some of the major questions in evolutionary ecology as well as read and discuss the most current research.
2) Students will learn to shape their ideas into formal proposals, learn the skills of grant writing, and develop independent thinking.

Final project:
Students will identify an area of interest and propose research to answer an outstanding question in that area. Undergraduates taking the class will turn in a 2 page NSF pre-doc style proposal. Graduate students will have an 8-page limit, styled after the NSF Dissertation Improvement Grant proposal.

Lecture Schedule:
Date Topic

Week 1
21 Aug Introductions and Course Overview
23 Aug Evolutionary Ecology: A Historical Perspective – McKay & Ghalambor

Orians, G.H. 1962. Natural Selection and ecological theory. The American Naturalist 96:257-263.
Lack, D. 1965. Evolutionary ecology. Journal of Animal Ecology 34: 223-231.
McIntosh, RP. 1970. Community, competition, and adaptation. Quarterly Review of Biology 45: 259-280.
Loehle, C. & JHK Pechmann. 1988. Evolution- The missing ingredient in systems ecology The American Naturalist 132: 884-899.

Week 2
28 Aug Ecology, Natural Selection, and Genetic Basis of Evolutionary Change - McKay
Fisher, R. A. 1930. Chapter 1: The nature of inheritance. In: The genetical theory of natural selection. pp. 1-21.
Harlan HV, Martini ML (1938) The effects of natural selection in a mixture of barley varieties *J. Agricultural Research* **57**, 189-199
Haldane, J. B. S. 1957. The cost of natural selection. *Journal of Genetics* 55:511-524.
Gingerich, P. D. 1983. Rates of evolution: effects of time and temporal scaling. Science **222**:159-161.
Barton and Turelli. 1989. Evolutionary Quantitative Genetics: How little do we know? Annual Review of Genetics 23: 337-370
Orr, H.A. (1998) The population genetics of adaptation: The distribution of factors fixed during adaptive evolution. Evolution 52, 935-949.

30 Aug How Evolution Works and How It Applies to Ecology – Ghalambor
Reznick DN & Ghalambor CK. 2001. The population ecology of contemporary adaptations: what empirical studies reveal about the conditions that promote adaptive evolution. Genetica 112: 183-198.
*Reznick, D. N. and J. Travis. 1996. The empirical study of adaptation in natural populations. Pp 243-289. in M. R. Rose and G. V. Lauder, eds. Adaptation. Academic Press, San Diego.
Urban MC & Skelly DK. 2006. Evolving meta-communities: toward an evolutionary perspective on metacommunities. Ecology 87: 1616-1626.
*Franks, SJ et al. 2007. Rapid evolution of flowering time by an annual plant in response to climate fluctuation. PNAS 104: 1278-1282.

Week 3
4 Sept Adaptation and Constraint I: Trade-offs and the "Programme" - Ghalambor
6 Sept Discuss Readings
*Gould, S.J. and R.C. Lewontin. 1979. The spandrels of San Marco and the Panglossian paradigm: a critique of the adaptationist programme. *Proc. R. Soc. Lond. B.* 205:581-598.
Mayr, E. 1983. How to carry out the adaptationist program. American Naturalist 121: 324-334.
*Ghalambor, CK. et al. 2003. Multi-trait selection, adaptation, and constraints on the evolution of burst swimming performance. Integrative and Comparative Biology 43: 431-438.
Schemske, D. W. and P. Bierzychudek. 2001. Evolution of flower color in the desert annual *Linanthus parryae*: Wright revisited. Evolution 55:1269-1282.
O'Hara, R. B. 2005. Comparing the effects of genetic drift and fluctuating selection on genotype frequency changes in the scarlet tiger moth. *Proc. R. Soc. B* 272:211-217.

Week 4
11 Sept Adaptation and Constraint II: Does the G-Matrix Matter? -McKay
13 Sept Discuss Readings
*Berg RL (1960) The ecological significance of correlation pleiades *Evolution **14,*** 171-180
Jordan N (1991) Multivariate analysis of selection in experimental populations derived from hybridization of two ecotypes of the annual plant *Diodia teres* W. (Rubiaceae) *Evolution **45,*** 1760-1772.
*Schluter D (1996) Adaptive radiation along genetic lines of least resistance *Evolution **50***, 1766-1774.

Week 5

18 Sept Life History Evolution I: Trade-offs and Fitness - Ghalambor

20 Sept Discuss Readings

Ghalambor, CK & Martin TE. 2001. Fecundity-survival trade-offs and parental risk taking in birds. Science 292: 494-497.
*Reznick, DN et al. 2002. r- and k- selection revisited: The role of population regulation in life history evolution. Ecology 83: 1509-1520.
*Reznick, DN et al. 2000. Big houses, big cars, superfleas and the cost of reproduction. TREE 15: 421-425.
Reznick, DN et al. 1990. Experimentally induced life history evolution in a natural population. Nature 346: 357-359.
Smith CC & Fretwell SD. 1974. Optimal balance between size and number of offspring. American Naturalist 108: 499-506.
Einum S. & Fleming IA. 2000. Highly fecund mothers sacrifice offspring survival to maximize fitness. Nature 405: 565-567.
Sinervo B & Huey R. 1990. Allometric engineering- an experimental test of the causes of interpopulational differences in performance. Science 248: 1106-1109.

Week 6

25 Sept Life History Evolution II: Fitness and Demography - McKay

27 Sept **Exam 1**

*Kawecki, T.J. 1995. Demography of source-sink populations and the evolution of ecological niches. Evolutionary Ecology 9: 38-44.
*Holt, R.D. 1996. Demographic constraints in evolution: Towards unifying the evolutionary theories of senescence and niche conservatism. Evolutionary Ecology 10:1-11.
Van Tienderen, P. H. 2000. Elasticities and the link between demographic and evolutionary dynamics. Ecology 81:666-679

Week 7

2 Oct Phenotypic Plasticity I: Ecological Genetics and Genotype x Environment - McKay

4 Oct Discuss Readings

Via, S. and Lande, R. (1985) Genotype—environment interaction and the evolution of phenotypic plasticity.*Evolution* **39**, 505–22.
*Falconer, D. S. 1990. Selection in different environments: effects on environmental sensitivity (reaction norm) and on mean performance. Genetical Research, Cambridge **56**:57-70
Fry, J. D. 1992. The mixed-model analysis of variance applied to quantitative genetics: biological meaning of the parameters. Evolution **46**:540-550.
*Campbell, D. & Waser, N. 2001. Genotype by environment interaction and the fitness of plant hybrids in the wild. Evolution 55: 669-676.

Week 8

9 Oct Phenotypic Plasticity II: Selection and Adaptation - Ghalambor

11 Oct Discuss Readings

Bradshaw A.D. (1965) Evolutionary significance of phenotypic plasticity in plants. Advances in Genetics 13, 115–155.
*Gotthard, K. & Nylin, S. (1995) Adaptive plasticity and plasticity as an adaptation: A selective review of plasticity in animal morphology and life-history. Oikos 74, 3-17.
Dudley, S.A. & Schmitt, J. (1996) Testing the adaptive plasticity hypothesis: Density-dependent selection on manipulated stem length in Impatiens capensis. American Naturalist 147, 445-465
DeWitt, T.J., Sih, A. & Wilson, D.S. (1998) Costs and limits of phenotypic plasticity. Trends in Ecology and Evolution 13, 77-81.
Pigliucci, M. & Murren, C.J. (2003) Genetic assimilation and a possible evolutionary paradox: Can macroevolution sometimes be so fast as to pass us by? Evolution 57, 1455-1464.
*Price, T.D., Qvarnstrom, A. & Irwin, D.E. (2003). The role of phenotypic plasticity in driving genetic evolution. Proceedings of the Royal Society of London, Series B. 270,1433-1440.
Reylea, R.A. (2002) Costs of phenotypic plasticity. American Naturalist 159, 272–282.
Ghalambor, CK. McKay, JK, et al. 2007. Adaptive versus non-adaptive plasticity and the potential for contemporary adaptation in new environments. Functional Ecology 21: 394-407.

Week 9

16 Oct Dispersal and Gene Flow: Molecular vs. Quantitative Perspectives - McKay

18 Oct Discuss Readings

Slatkin and Barton 1989 A comparison of three indirect methods for estimating average levels of gene flow. Evolution 43: 1349 - 1368
*Whitlock and McCauley 1999. Indirect measures of gene flow and migration. Heredity 82: 117-125
Barton, N. H. 2001. The role of hybridization in evolution. *Molecular Ecology* **10**: 551-568.

*McKay and Latta. 2002 Adaptive population divergence: markers, QTL and traits. Trends Ecol. Evol. **17**:285-291**.**
Jordan, M.A. *et al*. Phenotypic divergence despite high levels of gene flow in Galápagos lava lizards (*Microlophus albemarlensis*). *Molecular Ecology* 14:859-867

Week 10

23 Oct Sexual Selection and Mating Systems - Ghalambor

25 Oct Discuss Readings

Barrett, SP. & Harder LD. 1996. Ecology and evolution of plant mating. TREE 11: 73-79.
*Emlen, ST & Oring LW. 1977. Ecology, sexual selection, and evolution of mating systems. Science 197: 215-223.
Rowe, L. et al. 1994. Sexual conflict and the evolutionary ecology of mating patterns- water striders as a model system. TREE 9: 289-293.
Barrett SP et al 1996 The comparative biology of pollination and mating in flowering plants. Philosophical Transactions of the Royal Society of London 351: 1271-1280.
Christy, JH & Salmon M. 1984. Ecology and evolution of mating systems of fiddler crabs. Biological Reviews 59: 483-509.
*Sinervo, B. & Lively CM. 1996. The rock-paper-scissors game and the evolution of alternative mating strategies. Nature 380: 240-243.

Week 11

30 Oct Speciation: Evolution of Reproductive Isolation - McKay

1 Nov Discuss Readings

*Dobzhansky, T. 1940. Speciation as a stage in evolutionary divergence. *American Naturalist* **74**: 312-321.
Orr HA. 2001. The genetics of species differences. TREE 16: 343-350.
*Coyne and Orr 2004 – Chapter 2 "Study Speciation"
Nosil, P. 2005. Perspective: Reproductive isolation caused by natural selection against immigrants from divergent habitats. Evolution 59: 705-719.

Week 12

6 Nov Speciation: Ecological Speciation - McKay

8 Nov **Exam 2**

Schluter D. 2001. Ecology and the origin of species. TREE 16: 372-380.
Rundle, HD & Nosil, P. 2005. Ecological speciation. Ecology Letters 8: 336-352.
*Ramsey J. et al 2003. Components of reproductive isolation between monkeyflowers. Evolution 57: 1520-1534.
*Coyne and Orr 2004 – Chapter 5 "Ecological Isolation"
Hendry, AP et al. 2007. The speed of ecological speciation. Functional Ecology 21: 434-443.

Week 13

13 Nov Evolutionary Consequences of Species Interactions - Ghalambor

15 Nov Discuss Readings

*Martin, M. M., and J. Harding. 1980. Evidence for the evolution of competition between two species of annual plants. Evolution **35**:975-987.
Yoshida T. et al. 2003. Rapid evolution drives ecological dynamics in a predator-prey system. Nature 424: 303-306.
*Pfennig, DW et al. 2007. Field and experimental evidence for competition's role in phenotypic divergence. Evolution 61: 257-271.
Carroll, SP et al. 1998. Rapidly evolving adaptations to host ecology and nutrition in the soapberry bug. Evolutionary Ecology 12: 955-968.
Fenchel, T. 1975. Character displacement and coexistence in mud snails. Oecologia 20: 19-32.
Brodie, ED et al. 2002. The evolutionary response of predators to dangerous prey: hotspots and coldspots in the geographic mosaic of coevolution between garter snakes and newts. Evolution 56: 2067-2082.
McPeek, MA et al. 1996. Adaptation to predators in a new community: swimming performance and predator avoidance in damselflies. Ecology 77: 617-629.

20 & 22 Nov – No Class, Thanksgiving Week

Week 14

27 Nov Applied Evolutionary Ecology and Evolutionary Conservation Biology - Ghalambor

29 Nov Discuss Readings

*Coltman, DW et al. 2003 Undesirable evolutionary consequences of trophy hunting. Nature 426: 655-658.
Hogg, JT. et al. 2006. Genetic rescue of an insular population of large mammals. Proceedings of the Royal Society of London B 273: 1491-1499.
Epps, CW et al. 2005. Highways block gene flow and cause a rapid decline in genetic diversity of desert big horn sheep. Ecology Letters 8: 1029-1038.
Conover, DO et al. 2005. Darwinian fishery science: lessons from Atlantic silverside. Canadian Journal of Fisheries and Aquatic Sciences 62: 730-737.
Reznick, DN & Ghalambor, CK. 2005. Can commercial fishing cause evolution? Answers from guppies. Canadian Journal of Fisheries and Aquatic Sciences 62: 791-801.
Conover, DO & Munch SB. 2002. Sustaining fisheries yields over evolutionary time scales. Science 297: 94-96.
*Kinnison, M. & Hairston NG. 2007. Eco-evolutionary conservation biology: contemporary evolution and the dynamics of persistence. Functional Ecology 21: 444-454.
Stockwell, CA. 2003. Contemporary evolution meets conservation biology. TREE 18: 94-101.

Week 15

4 Dec Specialization vs. Generalization: Evolutionary Community Ecology

6 Dec Discuss Readings

Futuyma, D. & Moreno G. 1988. The evolution of ecological specialization. Annual Review of Ecology and Systematics 19: 207-233.

Fry JD (1996) The evolution of host specialization: are trade-offs overrated? *American Naturalist **148,*** S84-S107.

States, J.B. 1976. Local Adaptations in Chipmunk (Eutamias amoenus) Populations and Evolutionary Potential at Species' Borders Ecological Monographs 46; 221-256.

*Dyer et al. 2007. Host specificity of Lepidoptera in tropical and temperate forests. Nature 448: 696-700.

Johnson, MTJ & Stinchcombe, JR. 2007 An emerging synthesis between community ecology and evolutionary biology. TREE 22: 250-257.

*Hairston NG et al. 2005. Rapid evolution and the convergence of ecological and evolutionary time. Ecology Letters 8: 1114-1127.

Fussman et al. 2005 Ecological and evolutionary dynamics of experimental plankton communities. Advances in Ecological Research 37: 221-243.

Week 16

11 Dec Final Discussion, Class Evaluation, and **Final Research Proposals Deadline**

Assessment:

Student performance will be evaluated based on in class participation and discussion, two exams and a final paper in the form of a grant proposal. Each week 2-4 papers from the primary literature will be assigned as background reading and students will be expected to actively participate in discussion in class. To facilitate discussions, all students are required to turn in a one-page summary, including some questions for discussion and the beginning of each class prior to lecture. Most of your grade is based on the final research proposal, written in the form of a NSF grant, which is due at the end of the semester.

Class Participation and discussion	150 points
Mid-term exam 1	200 points
Mid-term exam 2	200 points
1 page Paper summaries	100 points
Final Research Proposal	300 points
Total	1000 points