Assignments

Bio373 – Mechanisms of Evolution – Spring 2005

Mon Jan. 24

Class goals: Discuss format and expectations of class. Discuss role of evolutionary thinking in biology as a whole by considering case study of HIV/AIDS.
Reading: Chapter 1 of *Evolutionary Analysis*
Focus questions:

1. Outline how "adaptive thinking" and historical perspective have influenced the understanding of HIV's interactions with human populations.
2. What are the implications (if any) of an evolutionary perspective of HIV for treatment and/or public health policy?
3. Consider questions 3-7 at the end of the chapter.
4. Consider a central theory of the subject of the biology class you took last semester. How are people testing hypotheses derived from this theory? How are these hypotheses informed by an evolutionary perspective? If not, how might they be?

Wed Jan. 26

Class goals: Analyze Darwin's arguments for "descent through modification."
Readings: Chapter 2 of text
Paley, *Natural Theology* excerpts
Wallace, A.R., (1858) On the Tendency of Varieties to Depart from the Original Type
Darwin, C. (1859) *Origin of Species* excerpts

Please submit a question for discussion via the Blackboard discussion board

Focus questions:

1. Chapter 2 of the text should be a review of many basic concepts. Bring in any questions you have on the themes or examples from this chapter.
2. What is the goal of the "Introduction" to the Origin of Species? How does Darwin structure this short chapter to achieve these goals?
3. How does Darwin address Paley's "argument from design?" To what extent do his arguments rely on evidence vs. logic?
4. Note Darwin's use of metaphor throughout the excerpted sections. Are the metaphors effective? Are there any dangers to the use of metaphor to make scientific arguments?
5. As you read the Wallace paper, compare his arguments and metaphors to those of Darwin. On page 9 of the Wallace handout, Reiss argues Wallace's conception of the mechanism of adaptation can be distinguished from Darwin's. Do you agree? Are the distinctions important?

Fri Jan 28

Class goals: To explore how natural selection is studied in nature and experimentally; to use basic statistical tools to measure selection.
Reading: Chapter 3 of text (focusing on pp. 69-86)
Handout: "Studying Selection"
Focus questions:

1. Pay attention to the text's use of the terms "adaptation" and "fitness." Do you agree with their definitions? What are the differences between the kinds of "fitness" described?

2. Consider questions 2, 3 and 4 at the end of the chapter.

Assignments
Bio373 – Mechanisms of Evolution – Spring 2005

Monday Jan 31

Class goals: To understand the various mechanisms by which mutations occur, the methods of estimating rates of mutation, the significance of different types of mutation for adaptive and non-adaptive evolution, and the methods of measuring genetic variation in populations. Discussion of local ecotype hypothesis.

Reading: Chapter 4 of the textbook.
Local Ecotype Websites:
http://www.iowaprairienetwork.org/FAQ/ecotype_importance.htm
http://www.for-wild.org/land/ecotype.html

Focus questions:

1. Consider study questions 9-14 at the end of the chapter.
2. Consider the reasoning and language from the two "local ecotype" websites. What specific assumptions are made regarding evolutionary processes. Develop a list of specific hypotheses to test these assumptions. How would you test these hypotheses? (This should be an exhaustive list, rather than just ones that could be done in the greenhouse in the next months).

Wednesday Feb 2

Class goals: To review the "null model" of population genetics (the Hardy-Weinberg principle). To understand the effect of natural selection on allele frequencies in populations.

Reading: Pp. 140-166 in the textbook

1. Why is the Hardy-Weinberg theorum considered a 'null model?" How is it used to generate hypotheses of selection?
2. Using the data in question 2 at the end of the chapter, determine whether the alleles are in Hardy-Weinberg equilibrium.

Assignment: Each research group should bring a draft of your experimental design for a greenhouse local ecotype experiment. Include details of justification, design, and analysis.

Friday Feb 4

Class Goals: To understand the how ecologically realistic forms of selection can maintain variation within single populations. To apply consideration of mutation-selection balance to the persistence of inherited disease in humans.

Reading: Remainder of Chapter 5

1. With respect to fitness, how is *dominance* defined? What is *overdominance?* What effects can overdominance and frequency-dependent selection have on allelic variation in populations?

2. Explain in words why, for deleterious alleles, mutation and selection "balance" to produce equilibrium frequencies of such alleles. How might we explain allele frequencies of such "deleterious" alleles that are *above* the predicted equilibrium point?

3. Review questions 2, 4, 6, and 7.

Assignments

Bio373 – Mechanisms of Evolution – Spring 2005

Monday February 7

No class scheduled (but I will be available). Plant your ecotype experiment during this time or over the previous weekend.

Wednesday February 9

Class goals: To understand how migration and genetic drift affect allele frequencies among populations. To understand how population structure is measured.

Reading: Pp. 195-223 in the textbook.

1. What are the predicted effects of genetic drift on the levels of heterozygosity (i.e., the average heterozygote frequency across all loci) in a population? If alleles at a locus are under selection, what are the possible effects of genetic drift on the equilibrium?
2. What factors besides population size affect the rate of genetic drift?
3. How might one measure the *net* effect of gene flow and drift on population structure (hint: consider what measure both forces affect)?
4. Consider question 2 at the end of the chapter (you don't need to look up the paper).

Friday February 11

Class goals: To understand the application of drift and selection principles to the analysis of molecular evolution.

Reading: pp. 223-236

Focus questions:

1. Study questions 9-12 on page 249.
2. A colleague of mine who studies genetic variation in species of *Drosophila* has found a few species which (unlike most species) exhibit *no* variation at synonymous sites in their mitochondrial genes. What could explain this unusual situation?

Assignments
Bio373 – Mechanisms of Evolution – Spring 2005

Monday Feb 14

Class goals: Case studies of molecular evolution and population structure.

Readings:

- Pp. 236-248 in textbook
- Friar et al. (2001) Population structure in the endangered Mauna Loa silversword, *Argyroxiphium kauense* (Asteraceae), and its bearing on reintroduction. *Molecular Ecology 1657-1563*.
- Martin and Pulumbi (1993). Body size, metabolic rate, generation time and the molecular clock. PNAS 90:4087-4091.

Paper are available from class website. Please submit one discussion question for each paper via Blackboard.

1. If both drift and random mating affect levels of heterozygosity, how could one tell which was responsible?
2. What techniques are used to measure inbreeding coefficients in populations? How is inbreeding depression measured? What are some of the challenges of measuring it?
3. Consider questions 4, 7 and 8 at the end of the chapter.

Wednesday Feb 16

Class goals: Demonstration of your exquisite understandings of the subject matter so far. (Exam I)

Friday February 18

Class goals: Learning to play around with molecular genetic data in order to explore questions about population structure, selection and phylogeny.

Reading: TBA

Assignments
Bio373 – Mechanisms of Evolution – Spring 2005

Monday Feb 21

Goals: To understand the logic and methodology of phylogenetic inference.

Reading: pp. 549-566

1. How is the principle of parsimony related to the principles of homology and analogy? Is 'simplicity' a good philosophical basis for accepting hypotheses? What other principles might we use?

2. What are the advantages and disadvantages to using different types of characters (e.g. molecular, morphological, biochemical, behavioral) in phylogenetic inference?

3. Distinguish between the approaches of maximum likelihood, distance and parsimony.

Wednesday Feb 23

Goals: To explore real data sets and the use of phylogenetic analysis in hypothesis testing.

Reading: pp. 556-582 and 345-349

1. How are disputes over phylogeny estimation resolved?

2. Consider questions 20, 22, and 23 at the end of the chapter.

Friday Feb 25

Class visit by George Weiblen, University of Minnesota.

Reading:

•Weiblen, G. D. 2004. Correlated evolution in fig pollination. Systematic Biology 128, 128-139.

Assignments
Bio373 – Mechanisms of Evolution – Spring 2005

Monday Feb 28th

Class goals: Discussion of species concepts and modes of speciation. Check/discussion of local ecotype experiment.

Reading: pp. 583-602

1. Why is having a species concept important in evolutionary biology? Is it important to have a single one? Compare the advantages and disadvantages of each of the three species concepts described by the authors. How do the case studies illustrate the complications of working with different species concepts? Can you think of other examples?

2. How can hypotheses of isolation via vicariance be weighed against hypotheses of isolation via dispersal? Does it matter which is the mechanism?

3. What evidence might be gathered to support the role of genetic drift via founder effect in producing divergence during speciation?

4. Selection has long been assumed to contribute to divergence during geographic isolation. Why do proponents of sympatric speciation presume selection can be strong enough to produce divergence without geographic isolation? What kinds of evidence could support this idea?

5. How can sexual selection produce divergence during isolation? Should this be considered an adaptive mode of speciation?

Wednesday March 2 Class goals: To consider how genetic studies inform debates on speciation mechanisms. Data gathering/analysis of local ecotype experiment.

Reading: pp. 603-611

1. For what reasons could reproductive isolation evolve before secondary contact? How could one determine whether pre-mating isolation evolves before or after secondary contact? Consider Coyne and Orr's study as a test of theories of *reinforcement*. In what other ways can hybridization contribute to speciation or adaptation?

2.. Consider Reiseberg’s studies of speciation in sunflowers. What approaches are they using to test hypotheses regarding the causes of this speciation event?

4. To practice applying the ideas from this chapter, consider questions 16-18 and 20-21 at the end of the chapter.

Friday March 4

Note: **We will make this a 1-hour class – please plan to attend Dr. Porterfield’s noon time seminar in 2021, which will address similar issues in her studies of N. American fish. Please let me know if you are available at 1 pm to go to (free) lunch with her after her seminar.**

Class goals: Discussion genetic studies of species and speciation with visiting scientist Jean Porterfield (St. Olaf College):

Assignments
Bio373 – Mechanisms of Evolution – Spring 2005

Reading:

Alves, P.C., et al. 2003. Ancient introgression of *Lepus timidus* mtDNA into *L. granatensis* and *L. europaeus* in the Iberian Peninsula. Molecular Phylogenetics and Evolution 27:70-80.

Please submit 2 questions for discussion via Blackboard.

Directions for the formal oral presentation:

Find a paper from the scientific literature that uses phylogenetic analysis to address a more comprehensive issue about evolution (i.e., the point of the paper is not just to publish the phylogeny of some group or to debate a methodological point). It would naturally be good if the questions and/or organisms were of interest to you. Please email me as soon as you have identified a paper – I'd like it if people didn't choose the same papers.

In your oral presentation, you should convey clearly the authors' questions, methods, results and interpretations. In addition, you should criticize the paper: what did the authors do well or poorly? Here are some points to consider:

- Describe the questions that the authors addressed. Are they of interest *generally?*
- Describe the organisms and their biology, particularly if they are not familiar. What makes them an interesting or appropriate group to study in order to address these questions?
- Describe the methods of phylogenetic analysis. What types of characters did they use? What types of analyses did they use? Was the resulting phylogenetic hypothesis robust, or were their any ambiguities?
- Describe how the results of the phylogenetic analysis were used to understand a larger evolutionary problem. Was a phylogenetic approach critical to answering the question? Could a non-phylogenetic approach be used equally well?
- What additional questions (including ones raised by the authors) are the most interesting in your view? What would you like to see done next? How would you go about it?

Your presentation should take approximately 10 minutes, with time left for questions. Prepare a Powerpoint (or analogous) file with your presentation images and place it in the class Projects folder, so we can access it quickly. **Contrary to what I said in class, we will do eight of these on Wednesday March 9th, and the remaining three on Friday March 11th. The lucky winners of the Friday slots are Dave, Meg and Elizabeth.**

Assignments
Bio373 – Mechanisms of Evolution – Spring 2005

Monday March 7

Class goals: To understand how interactions of multiple alleles at a locus and multiple loci complicate predictions of population genetics.

Reading:. Pp.253-274

1. How is linkage disequilibrium (LD) defined and measured?
2. How can selection cause linkage disequilibrium? How can drift or population admixture cause it?
3. Why does sexual reproduction reduce LD? What influences that rate at which this happens?
4. Test your understanding of these concepts by completing problems 1 and 2 at the chapter's end.
5. What logic did Stephens' et al. use to argue for the recent origin of the CCR5 Δ32 allele? What did they need to find out to estimate the age of the allele?

Wednesday March 9

Oral presentations: Applying phylogenetic analyses to evolutionary problems.

Please place your presentation on the project folder before class begins.

Friday February 21

Oral presentations (Dave, Meg and Elizabeth)

Class goals: To consider why sexual reproduction exists and persists.

Reading: pp. 274-285

1. In what way is Maynard Smith's model a *null model* for the evolution of sexual reproduction?
2. Evaluate Dunbrack et al.'s test of the model in light of the question 5 at the end of the chapter.
3. How do evolutionary biologists evaluate which of two competing theories, in this case "Muller's ratchet" vs. "arms race" explanations for the maintenance of sex, have more support? Do the studies described here convincingly discriminate between the two hypotheses?

Assignments
Bio373 – Mechanisms of Evolution – Spring 2005

Monday March 14

Quiz # 2

Wednesday March 16

Field trip to Krumm preserve – meet at 9 am at the greenhouse entrance to the science building.

Readings:

Beye et al. 1998. Nestmate recognition and the genetic relatedness of nests in the ant *Formica pratensis*. Behav. Ecol. Sociobiol. 43:67-72.

Zhu et al. 2003. Highly variable social organization of colonies in the ant *Formica cinerea*.

Friday March 18

Field trip to CERA – meet at 8 am (???) at greenhouse entrance to the science building..

Assignments
Bio373 – Mechanisms of Evolution – Spring 2005

Monday April 4

Monday 9 am -- trip to CERA to observe ant mounds. Meet at greenhouse parking area - leave promptly at 9 am.

Wednesday April 6th

Class goals: To consider why sexual reproduction exists and persists. Discussion of ideas for ant/other projects.

Reading: pp. 274-285; + papers of your choice related to your probable project.

In what way is Maynard Smith's model a *null model* for the evolution of sexual reproduction?
Evaluate Dunbrack et al.'s test of the model in light of the question 5 at the end of the chapter.
How do evolutionary biologists evaluate which of two competing theories, in this case "Muller's ratchet" vs. "arms race" explanations for the maintenance of sex, have more support? Do the studies described here convincingly discriminate between the two hypotheses?

Friday April 8

.
To understand the concepts of heritability, phenotypic selection, the response to selection, modes of selection, and plasticity.

Reading: Chapter 8 and pp. 350-351.

1. Describe the difference between broad-sense and narrow-sense heritability.
2. Consider questions 1-5 at the end of Chapter 8.
3. Define the terms *phenotypic plasticity*, *norm of reaction* and *genotype by environment interaction*. How are these concepts related?
4. Describe the difference between the selection differential and the selection gradient.
5. How do correlations among a group of traits influence selection on each individual trait?
6. Galen predicted that it would only take a few generations of natural selection for timberline sky pilots to evolve flowers as large as tundra sky pilots. What assumptions underlie this prediction?
7. Compare and contrast the three modes of phenotypic selection. What effect does each mode have on the maintenance of genetic variation within populations?

Assignments
Bio373 – Mechanisms of Evolution – Spring 2005

Monday March 3

Class Goal: To understand analysis of variance (ANOVA) of a common garden experiment and its relation to heritability. To understand experimental and observational methods for studying adaptation.

Reading: pp. 251-265; 268-271 (but not Box 8.2); **also bring in data from the fungal experiment to analyze**

1. Consider questions 1-3, 8, 9, 11 at the end of Chapter 8.
2. What are the pros and cons of experimental and observational tests of adaptive hypotheses?

Wednesday March 5

Class goals: To under the role of constraints and trade-offs on adaptation. To understand the developmental basis of plasticity.

Readings: text pp. 271-284 and Brakefield et al. 1996. Development, plasticity and evolution of butterfly eyespot patterns. Nature 384:236-242 (download from Blackboard)

Please submit two discussion questions via Blackboard

Friday March 7 QUIZ II

Class goals: To demonstrate your exquisite understanding of population and quantitative genetics.

I will (once again) be out of town beginning Thursday March 6, so the quiz will be handed out by one of the science secretaries.

Monday March 10

Bring in a 4 copies of a draft group Methods and Results (+ figures and tables) section for your fungal data. We will exchange and critique.

Class goals: To understand Darwin's formulation of sexual selection and modern applications of it.

Reading: pp. 289-319

Focus questions: Questions 5, 7, 8.

Assignments

Bio373 – Mechanisms of Evolution – Spring 2005

Wednesday March 12

Class goals: To evaluate the connections between disease ecology and sexual selection (the Hamilton-Zuk model of sexual selection); to consider feminist critiques of the study of sexual behavior.

Readings: (1) Zuk, M. 1996. Disease, endocrine-immune interactions and sexual selection. Ecology 77: 1037-1042. and (2) Zuk, M. 1993. Feminism and the study of animal behavior. Bioscience 43: 11. (Download from Blackboard)

Submit discussion questions to Blackboard

Thursday March 13

- Convocation lecture by Marlene Zuk: "Sexual Selections: what we can and can't learn about sex from animals" Herrick Chapel 11 am.

- Open discussion with Marlene Zuk: South Lounge of the forum 4:15 pm

Friday March 14

Class will meet from 10-11 am!

Class goals: Responses to Zuk's visit and discussion of paper writing

Assignments

Bio373 – Mechanisms of Evolution – Spring 2005

Monday March 31

Class goals: To consider the role that natural selection may play in DNA sequence evolution

Reading: pp.611-623

(1) Explain why the rate of evolutionary change (or substitution rate) for neutral alleles is **not** dependent on population size. What does it depend upon? What evidence exists that sequences evolve according to this "neutral theory?" What role does selection play in explaining variation among genes in substitution rate?

(2) Explain why the rate (per unit time) of neutral substitution might differ between evolutionary lineages. How does Ohta's "nearly neutral model" account for the appearance of a "molecular clock?

(3) Explain the logic behind the McDonald-Kreitman test for positive selection.

(4) Consider question 5 at the end of the chapter.

(5) Describe the difference between "background selection" and "hitchhiking."

Wednesday April 2

Class goals: To understand mechanisms behind genome evolution;

Reading: pp. 623-635

1. Explain why bacterial transposable elements tend to be found in plasmids, rather than in the genome as they are in eukaryotes.

2. Consider question 8 at the end of the chapter.

3. What features distinguish organelle from nuclear genomes? What is known about how organelle genomes evolve?

Friday April 4 A final draft of your paper is due by 5pm today!

Class goals: Take data from local ecotype experiment samples

Reading: none

Assignments

Bio373 – Mechanisms of Evolution – Spring 2005

Monday April 7

Goals: To understand the logic and methodology of phylogenetic inference.

Reading: pp. 437-447 + Box 13.2

1. How is the principle of parsimony related to the principles of homology and analogy? Is 'simplicity' a good philosophical basis for accepting hypotheses? What other principles might we use?

2. What are the advantages and disadvantages to using different types of characters (e.g. molecular, morphological, biochemical, behavioral) in phylogenetic inference?

3. Distinguish between the approaches of maximum likelihood, distance and parsimony.

Wednesday April 9

Goals: To explore real data sets and the use of phylogenetic analysis in hypothesis testing.

Reading: pp. 449-460

1. How are disputes over phylogeny estimation resolved?

2. Consider questions 4, 5, 8 and 9 at the end of the chapter.

Friday April 11

Continuation of systematics lab and discussion of uses of phylogeny.

Assignments

Bio373 – Mechanisms of Evolution – Spring 2005

Monday April 14

Extraction of DNA from local ecotype experiment. Meet in the lab.

Tuesday April 15 4:15 PM Science 2021

Zoe McKiness '99 -- *Evolution of chemoautotrophic symbioses: implications for biogeography and cospeciation*.

Wednesday April 16

Goals: To understand methods to identify and evaluate the importance of horizontal gene transfer (discussion led by Zoe McKiness).

Readings:

Brown, J.R. 2003. Ancient horizontal gene transfer. Nature Rev. Genet. 4:121-132.
Andersson, J.O. et al. 2003. Phylogenetic analyses of diplomonad genes reveal frequent lateral gene transfers affecting eukaryotes. Current Biology 13:94-104.

Please submit 2 questions for discussion to Blackboard!

Friday April 18

Goals: To understand the uses of phylogenetic comparative methods and their application to tests of adaptive hypotheses. + Quantification of DNA from extractions.

Reading: textbook pp. 265-270

Assignments
Bio373 – Mechanisms of Evolution – Spring 2005

Wed April 30

Class goals: Data analysis of AFLP results.

Friday May 2

Class goals: Last morphological measurements or additional DNA extractions.