Week 1 - Animal structure and function – frog locomotion

This Week's Learning Objectives

1) To study the significance of organism size and scaling
2) To consider a model of animal locomotion ability (frog jumping)
3) To consider the evolutionary origins of organism form and function

Monday Jan 21 (1:15-3:05)

Activity: Course introduction and lecture on animal scaling

Wednesday Jan 23 (1:15-4:05)

Activity: Biomechanics exercise

Readings (some of these will support Monday's lecture):

- Handout – *Anuran locomotor performance*
- Regression analysis (Appendix A in *Investigations*)
- Chapters 1 and 2 of Schmidt-Nielsen "Scaling: Why is animal size so important?"(on electronic reserve)
- Background on the following topics: (animal) locomotion, musculoskeletal systems, natural selection, analogy, homology
-

Focus questions:

1. Explain why organismal needs may change as an organism changes in size.
2. Describe examples of organismal "solutions" (i.e., adaptations) to the challenge of size change that involve
    a. a change in *dimension* (or *shape)*
    b. a change in *materials.*
    c. a change in *design.*

Friday Jan 25 (1:15-2:05)

Activities: Biomechanics and scaling exercises; further discussion

Assignments:

- Gould, SJ. 1974. Size and shape: the immutable laws of design set limits on all organisms. (link on webpage)

Week 2 – Natural selection and adaptation

Learning Objectives:

1) To consider the integration of form and function in studies of adaptation and evolution.
2) To begin an investigation of organismal acclimation

Mon Jan 28 1:15-3:05 –Natural selection, adaptation and phylogenetic trees

Readings:

- Darwin, C. 1859. Excerpts from *On the Origin of Species* [download from class website]
- Background reading from Biology texts on systematics and phylogeny

Assignments:

- Submit a question for discussion of the Darwin reading to me by email **by 11 am on Monday.**
- Regression/allometry problem set due at class time.

Focus questions:

1. 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?
2. Describe the distinction between *monophyletic*, *paraphyletic*, and *polyphyletic* groups.
3. What are the criteria by which *homologous* and *analogous* similarities are distinguished? How do these concepts relate to Darwin's principles of *natural selection* and *descent with modification from common ancestors?*
4. Why is the distinction between *homologous* and *analogous* similarity critical for phylogenetic analysis? In cladistic analysis, why are *shared derived characteristics* so important?

***Wed Jan 30 1:15-4:05 – Acclimation to temperature in C. elegans* – exercise and design**

Activity -- Investigate whether *C. elegans* show acclimation to temperature for movement; design a group experiment to further investigate details acclimation

Reading assignments:

1. *C. elegans* acclimation handout
2. Dusenberry et al. 1978. Thermal acclimation more extensive for behavioral parameters than for oxygen consumption in the nematode *Caenorhabditis elegans. J. Exp. Zool.* 206:191-198. [on electronic reserve].

Fri Feb 1 1:15-2:05 – Discussion of paper from the primary literature locomotion and adaptation

Reading:

Irschick, D.I. & J.B. Losos 1998. A comparative analysis of the ecological significance of maximal locomotor performance in Caribbean Anolis lizards. Evolution 52:219-226.[download from class web page]

Assignment: Submit a question for discussion to me via email – **submit by 11 am on Friday.**

Week 3 – Physiological Ecology

Learning objectives:

- To consider some of the challenges organisms face because of variation in temperature and water availability in the environment
- To understand the distinctions between adaptation, acclimation, and phenotypic plasticity.
- To remind ourselves of the structure of the scientific paper

Monday Feb 4 1:15-3:05 –Lecture on temperature relations

Reading: Chapter 4 of Molles' *Ecology* (Might want to review Ch. 1-3 for background)
Brown et al (ms) – links to text and figures on the website.

Focus questions: Review questions 3 and 7-10 at end of chapter.

Assignment: Fill out the paper rubric (on website) for Brown et al. (ms) – bring to class

Wednesday Feb 6 1:15-4:05 – Organismal performance and acclimation exercise

Readings: ANOVA problem set (see link on website)

Assignments: For each dataset shown on the ANOVA handout:

- Carry out the ANOVA in Minitab (see directions in *Investigations*).
- Make a plot of treatment means with SE error bars by choosing Stat>ANOVA>Interval Plot.
- Write out a short explanation of how the results of the ANOVA (particularly the F and p values) are related to the figure you've made.

Hand in or email me your problem set by 1:15 pm

Friday Feb 8 1:15-4:05 – Lecture on water relations

Readings: Chapter 5 of Molles' *Ecology*

Focus questions: Review questions 1-3, 5-6, 8-9 at the end of the chapter.

Research Group Assignment: Bring a draft of your paper's *Methods* and *Results* sections, including all figures and tables. Email me an electronic copy (YourLastName_Worm_draft.doc or *.rtf) by 1 pm.

Individual assignment: Find an article in the primary literature primary literature that is relevant to your acclimation project. In your own words, describe (1) what questions the study addressed (2) the study's findings, and (3) their relevance to your study. Send as an attached file to me by email. **Include your name in the document name (e.g., BrownLitCit.doc). Please send as a *.doc or *.rtf file.**

Week 4 - Causes and consequences of variation in plant growth

Learning objectives:

- To consider the determinants of plant growth rate (e.g., plant morphology, and the uptake and allocation of energy and materials)
- To understand the concept of relative growth rate
- To demonstrate your understanding of the course material so far

Monday Feb 11 -- 1:15-3:05 – Lecture on water relations and energy acquisition

Readings: Chapters 5 and pp. 134-146 of Molles' *Ecology*
Review of plant growth in general bio text (keywords: organs, meristems)

Focus questions: Review questions 1-3 at end of chapter.

Wednesday Feb 13 -- 1:15-4:05 – Quiz I and Measuring relative growth rate

Readings: Relative growth rate exercise handout

Advice for studying for the Quiz

The best way to prepare for success at performing a task is to practice -- to perform the task repeatedly. Since a quiz requires you to write about your understanding of the ideas we've discussed, *the best way to study for the quizzes is by writing.* If you can write clear answers to the focus questions and discussion questions for papers, and intepret data we've looked at or generated, you will do well on the exam. Old Quizzes are posted to the class website – it wouldn't hurt to practice by answering those questions, too.

Friday Feb 15 1:15-2:05 – Finish lecture/discussion of energy relations (no additional reading)

Upcoming Assignment! Worm acclimation paper due Monday Feb 18

NOTE: The Methods and Results sections may be identical to those of your group partners, but the remainder of the paper must reflect your individual writing efforts. You may, of course, use peer reviewers NOT in Bio 252 or the Writing Lab to provide critical feedback (as long as they are acknowledged).

Attach your paper to an email sent to me – it should be a single electronic file in either *.doc or *.rtf format. **I can't read *.docx or Wordperfect files!** Give your file the following name -- YourLastName_Frog.doc. I should receive the file by email by 5 pm. Paper received later than that will suffer at 10% penalty.

Scientific paper writing requirements for Brown's section of Bio 252:

- Please double-space all parts of your paper. Use a readable font (e.g., 12 pt Times New Roman.)
- You do not need a title page – place the title at the top of your first page.
- Don't forget page numbers!
- You DO need an abstract.
- Figures and Tables may appear in order at the end of the paper (DO NOT imbed them). figure needn't be on a separate page, nor does it need to fill the page as long as it is legible.
- Citations should be in the Biology style described in *Investigations* – avoid frustration and set up a RefWorks account for yourself, since this will automatically produce citation lists in this style!
- If you cite a paper, it means you read the paper, not just the on-line abstract.
- Treat *Investigations* like the source of all wisdom about writing biology papers.

Week 5 – Growth and Reproduction

Learning Goals:

- To understand the mechanisms and consequences of sexual reproduction
- To understand the basic concepts of reproduction and transmission genetics, including independent assortment, segregation of alleles, crossing over, and loci interactions.
- To complete and analyze the RGR data.

Monday Feb 18 – Lecture and discussion of life history, growth and reproduction

Readings:

- General Bio textbook reading (review?) on mitosis, meiosis, and reproduction (e.g., Chapters 12&13 in Campbell's *Biology* 6th ed) and transmission genetics (Chapter 14 of Campbell's *Biology*).
- Mendel, G. 1865. Experiments in Plant Hybridization (download from webpage) -- Come prepared to discuss Mendel's paper – bring your comments on the paper's style and argument.

1. Why should organisms reproduce at all? When should they reproduce?
2. What are the advantages/costs of asexual reproduction? sexual reproduction? Under what conditions might we expect to find each?
3. How do sexual organisms vary in life cycles? What are the consequences?
4. What makes Mendel's approach to understanding inheritance distinct from Darwin's?
5. What elements of the cellular process of meiosis explain Mendel's "rules" of inheritance?

Worm acclimation paper due Monday Feb 18 at 5 pm --- NOTE: The Methods and Results sections may be identical to those of your group partners, but the remainder of the paper must reflect your individual writing efforts. Attach your paper to an email sent to me – it should be a single electronic file in either *.doc or *.rtf format. **I can't read *.docx or Wordperfect files!** Give your file the following name -- YourLastName_Worm.doc.

Wednesday Feb 20 – RGR harvest; discussion of paper and continuation of transmission genetics.

Readings:

- Reich PB, Buschena C, Tjoelker MG, Wrage K, Knops J, Tilman D, Machado JL (2003) Variation in growth rate and ecophysiology among 34 grassland and savanna species under contrasting N supply: a test of functional group differences. *New Phytologist* 157:617-631.

Assignment: Complete the "Analyzing multi-factor investigations" exercise – bring in a copy of your analyses and answers to the questions.

Friday Feb 22th –2nd RGR weighing and data analyses (Margaret and Sue in charge)

Week 6 – Inheritance

Learning Objectives:

- To understand the chromosomal basis of inheritance, and the uses of genetic mapping to understand traits whose genetic basis is unknown
- Planning and setting up long-term competition experiment

Monday Feb 25– Analysis of RGR data and competition project planning

Reading:

- Goldberg DE, Landa K (1991) Competitive effect and response: hierarchies and correlated traits in the early stages of competition. Journal of Ecology 79:1013-1030. (see link on class webpage)

Assignment A: Submit a discussion question by email to [brownj] by 11 am

Assignment B: Email to me a report (*.doc or *.rtf) of your analysis of the RGR data by 1 pm. This should include appropriate statistical analyses, graphs, and a summary paragraph that interprets the patterns seen.

Wednesday Feb 27 – Genetics exercises

Reading: Find a chapter on chromosomal basis of inheritance in general Biology textbooks (e.g., Chapter 15 of Campbell's *Biology*). Keywords: linkage, sex-linkage, genetic mapping, recombination.

Friday March 4 1:15-2:05 QTL analysis and evidence for convergent evolution

Assignment: Submit a discussion question by email to [brownj] by 11 am

Reading: Protas et al. 2006. Genetic analysis of cavefish reveals molecular convergence in the evolution of albinism. Nature Genetics; Jan2006, Vol. 38 Issue 1, p107-111. (see link on class webpage)

Week 7 – Evolution of populations

Learning objectives:

- To understand basic principles of microevolution, including the effects of natural selection, genetic drift, gene flow, and mutation on evolutionary change in populations and sets of populations
- To consider the concept of speciation, and the relationship between microevolution and macroevolution

Monday March 3 – Convergent evolution and evolution within populations

Readings:

- Protas et al. 2006. Genetic analysis of cavefish reveals molecular convergence in the evolution of albinism. Nature Genetics; Jan2006, Vol. 38 Issue 1, p107-111. (see link on class webpage)
- Chapter 8 in Molles' *Ecology*

Assignments:

- Submit a discussion question by email to [brownj] by 11 am
- Mendelian Genetics problem set due at 1:15 pm

Focus questions:

(1) How is *heritability* estimated? What are the challenges in doing so?
(2) Can heritability for the same trait be different in different populations? Why?
(3) If phenotypic variation is found to be heritable within a population, are phenotypic differences between populations due to genetic differences between them? Explain.

Wednesday March 5 – Evolutionary models

Focus questions:

1. What is a null model? How does it apply to the Hardy-Weinberg Law? What does this null model predict about genotype and allele frequencies in populations?
2. What are the assumptions of this null model? Are they realistic ones? How could we detect which (if any) of these assumptions are violated in a real population? [Hint: consider how relaxing each assumption would affect allele and/or genotype frequencies.]
3. What effects can genetic drift, gene flow and non-random mating have on the ability of natural selection to act in populations?
4. How can natural selection lead to lower levels of genetic variation (as measured by heterozygosity)? How can it lead to higher levels?
5. How should the forces of evolution interact? How could we tell when more than force is acting?
6.

Friday March 7 – Quiz II

Week 8 – Linking micro- and macroevolution

Learning objectives:

- To consider the concept of speciation, and the relationship between ecological interactions, microevolution and macroevolution

Monday March 10 – Studying evolution of populations and speciation

Reading assignments:

- Gen. biology textbook reading on Speciation (e.g., Campbell Chapter 24)

Focus questions:

- Why is it important to have a "species concept?"
- What is the "biological species concept"? What problems (practical and theoretical) might arise from this definition?
- What are the various ways that gene exchange can be prevented between populations? In what variety of ways could such barriers evolve? Do you think "isolating mechanisms" is a good term to use for such barriers to gene exchange?

Wednesday March 12– Field trip to CERA for gall selection exercise

Reading:

- Gall selection handout
- Background on the *Solidago-Eurosta* gall system from Warren Abrahamson's site – please also watch the streaming video at http://www.facstaff.bucknell.edu/abrahmsn/solidago/gallfly_video.html (this works best on a PC).

Assemble behind the Crystal Center shortly after 1pm. The vans will be leaving at 1:15 sharp!

Assignment: Wear warm clothes and footwear that can withstand a little mud (i.e. boots). It is always windier at CERA than in town, so dress appropriately.

Friday March 14 – Evolution of genes and form

Reading: Carroll SB (2005) Evolution at two levels: On genes and form. PLoS Biol 3(7): e245.

Submit a discussion question by email to [brownj] by 11 am

Week 9 – Speciation and Population Ecology

Learning objectives:

- The understand how evolutionary forces lead to formation of new species
- To understand basic principles of the study of species distributions and abundance

Monday March 31 – Population distributions

Reading assignments:

- Chapters 9 and 10 in Molles

1. Why are we interested in how individuals of a species are dispersed? Consider both small- and large-scale patterns.
2. Why might dispersion change of over time? What can we learn from these changes?
3. Review questions (Ch. 9) 2, 3, 4, and 7.
4. Review questions (Ch. 10) 2, 3, 5, and 7.
5. What can we learn about mechanisms by which population size is determined by studying expanding populations (or "invasive species")?
6. What is the implication of Soares et al.'s findings that almost half the variation in *r* was caused by variation in genotype or interactions between genotype and environment?

Wednesday April 2 – Population dynamics

Reading: Molles, Chapter 11

Focus questions: Review questions 1,3,4,5, and 7.

Friday April 4 --Continuation of population dynamics

No further reading assignments.

Your gall selection report is due by 1 pm (by email) on this day.

Week 10 – Competition

Learning objectives:

- To learn principles of species interactions in biological communities, especially the population dynamics and distribution consequences of interspecific competition
- To harvest competition experiments and gather and analyze data.

Monday April 7 – Senescence and competition harvest

Readings:

- Chapter 12 in Molles
- Monaghan P and Haussmann MF. 2006. Do telomere dynamics link lifestyle and lifespan? Trends Ecol. Evol. 21:47-53. (download from web page)

Please email a discussion question about the telomere paper by 11 am.

Wednesday April 9 – Competition

Reading: Chapter 13 in Molles

Focus questions: Review questions 5-8 and 10

We will also spend time weighing harvested plants and undertaking data analysis.

Friday April 11 – Quiz 3

Quiz will cover material considered from March 5 through April 7.

Week 11 – Community Ecology

- To learn principles of species interactions in biological communities, especially the population dynamics and distribution consequences of interspecific competition and predation

Monday April 14 – Competition and review of competition experiment results

Readings: Chapter 13 of Molles

Focus questions: Review questions 5-8 and 10

Assignments:
- Bring a rough draft of your group competition presentation, including figures and data analysis.
- Review the principles of scientific oral presentations in *Investigations.*

Wed April 16 – Oral presentations on the Competition experiment

See back side of sheet for presentation rubric. Oral presentations will be 12 minutes maximum, with 3 minutes for questions.

Friday April 18 – Exploitation

Readings: Chapter 14

Focus questions: Review questions 1-5, 10

Evaluation of Oral Presentation

Bio 252 -- J. Brown

I. Introduction. The study's rationale was

Rating	Examples
1. not clearly evident.	Failed to clearly outline question/hypothesis.
2. evident but not developed effectively.	Stated specific hypothesis/question, but motivation for question ignored. Inadequate or inappapropriate background on study organism.
3. stated clearly and developed with appropriate background.	Specific hypothesis/question linked with more general question. Rationale for using study organism included.
4. stated and developed elegantly.	Used previous research.to link hypothesis to larger question. Succinct justification for study species, including necessary details of its biology.

II. Methods. The study's methods and design were

Rating	Examples
1. inadequate and/or inappropriate.	Mistakes made in describing study design. Improper analyses used for study design.
2. adequate.	Design described, but not clearly related to question or hypothesis.
3. clear and efficient.	Study design described, including analysis.
4. elegant.	Level of detail appropriate to understand design and analysis. Clearly related design to question/hypothesis.

III. Results. Data analysis and presentation were

Rating	Examples
1. inadequate and/or inappropriate.	Improper analysis or no presentation of data.
2. adequate.	Date presented, but hard to follow.
3. clear and efficient.	Data presented in clear figures.
4. elegant.	Appealing figures with concise indications of analytical results.

IV. Data interpretation (Discussion & Conclusions)

Rating	Examples
1. was inappropriate and/or inadequate.	Derived conclusions that are not justified by outcome.
2. was explained and justified.	Correctly interpreted meaning of results.
3. was clearly related to the question.	Explained how results addressed the question/hypothesis
4. demonstrated intellectual creativity by placing conclusions in a larger context and proposing very *interesting* directions for further research.	Linked results to other published studies and suggested how further studies could extend or clarify specific conclusions or general relevance of the question.

V. Visual aids were

Rating	Examples
1. not clear and/or helpful.	Spelling errors. Distracting graphics/effects, Text too small.
2. adequate.	Layout of slides clear.
3. clear and efficient.	Good balance between text and graphics.
4. elegant.	Appealing design of slides drew attention to important elements.

VI. Overall quality of speaking (eye-contact, volume, clarity, organization)

Rating	Examples
1. Poor	Unrehearsed. Disorganized. Not understandable or audible.
2. Adequate	Clear, but too dependent on notes. Relied on audience to follow slides.
3. Good.	Explained all slides clearly and confidently.
4. Engaging and entertaining	Poised. Eye-contact with audience. Answered questions confidently.

Week 12 – Community and Ecosystem Ecology

Learning objectives

- To understand how species interactions and disturbance influence variation in diversity in biological communities
- To sample a long-term experiment on effects of fire on woodland plant communities

Monday April 21 – Species diversity

Readings:

- Molles, Chapter 16
- Hutchinson, et al. 2005. Prescribed fire effects on the herbaceous layer of mixed-oak forests. Canadian Journal of Forest Research, 35: 877-890.

Focus questions: Review questions 1, 4, 7 and 9 at end of chapter.

Assignment Please email me a question for discussion of the paper by 11 am.

Wednesday April 25 – Field trip to CERA to sample forest understory experiment

Meet at the Noyce loading dock by 1:05. The vans will leave at 1:15 SHARP!

Reading: Handout on Forest Understory fire experiment.

Friday April 27 – Food webs and community structure

Reading: Molles, Chapter 17

Focus questions: Review questions 2, 3, 4 and 7.

Week 13 – Food webs and Ecosystems

Learning objectives:

- To gather and analyze data on the effects of fire regime on system-level carbon dynamics in reconstructed tallgrass prairie at the Conard Environmental Research Area

Monday May 30– Food web dynamics

Readings:

- Power ME (1992). Habitat heterogeneity and the functional significance of fish in river food webs. Ecology. 73:1675-1688. [download from class web page]
- Chapter 18 of Molles

Focus: Review questions 2, 8 and 9

Assignment: I will email you a compilation of the class's data on the forest burn experiment. You should decide how to analyze it to determine the effects whether burning effects the individual densities of species, as well as the species richness and species diversity.

Write a short paragraph describing the results of your analysis; include a single figure showing some important aspect of the analysis you wish to highlight. (You needn't present ALL the data graphically). Write a second short paragraph discussing the results with reference to those of Hutchinson et al. 2005.

Email this report to me by 1 pm prior to class and come prepared to discuss the results and your interpretation of them.

Wednesday April 30 –Data collection at CERA: carbon dynamics in tallgrass prairie -- Meet at the Noyce loading dock at 1:05 pm – we will leave promptly at 1:10!

Reading: *Carbon Dynamics* handout

Friday April 2

Nutrient cycling

Reading: Chapter 19 of Molles

Focus: Review questions 1, 4, 8.