Anthropological Sciences 155/255: Demography and Life History Theory

Instructor: James Holland Jones

November 9, 2006

Mondays & Wednesdays, 10:00-11:50
Building 320, Room 221
Winter Quarter 2007

1 Course Description

Life history theory is the branch of evolutionary biology that attempts to understand patterns of investment in growth, reproduction, and survival across the life cycle. It is the theory that explains all the major transitions that mark individual organisms' life cycles from conception to death. The diversity of life reflects a tremendous diversity in life histories. Some organisms live very short lives and reproduce in large numbers. Others spread a modest amount of reproduction out over a long lifespan. Still others live an extraordinarily long time and still manage to reproduce in massive numbers. Why do organisms differ so much in traits such as age at maturity, age-specific fertility, life expectancy, or clutch size? How do humans fit into this diversity?

Life history theory lies at the very heart of evolutionary explanation because it deals with the mechanics of natural selection. If you want to argue that a trait – any trait – evolved via natural selection, you need to have at least a rudimentary understanding of life history theory.

In this class, we will focus on the central themes of life history theory and how they relate to specific problems of the human life cycle. Our class reading will focus on classic works that should be in the bibliography of any evolutionary anthropologist or biologist. In addition to the classic questions of life history theory (e.g., evolution of reproductive effort, size vs. quality, etc.), we will discuss some peculiar issues that relate specifically to humans. These include: (1) the evolution of childhood, (2) the evolution of post-reproductive lifespan, (3) the evolution of late age at maturity and low fertility, (4) the evolution of biparental care – and alloparental care more generally.

2 Expectations

This course uses mathematics to describe processes relevant to the study of human biology and social behavior. It is not, however, a course in mathematics. You will not be expected to do mathematical proofs or derive complex formulae. You will be expected to understand the demographic, social, and biological theory contained in the mathematics as described in class lectures and in the readings.

Students enrolled in ANSI 255 will be expected to complete an independent project in lieu of the final exam. This project will involve specifying a state-dependent life history question and solving the dynamic optimization problem. This problem will require some simple computer programming. There are multiple potential platforms through which this can be done. Clark and Mangel (2000) provide a series of programs, written in True Basic and C++, for estimating dynamic state variable models. The pseudo-code provided in this and their previous book (Mangel and Clark 1988) will also allow a student with little prior programming experience to write suitable code in R or MATLAB.

The reading load for this class is comparatively light. I therefore expect that you will do the readings. Problem sets and exams will draw questions from weekly readings.

3 Grading

The breakdown of grading for this class will be as follows:

50% Weekly problem sets designed to reinforce lectures and readings and build confidence in your analytic skills. Problem sets will be due on Monday at the beginning of class each week. Late work will lose a third of a grade per day past due.

15% Take-Home Midterm Exam. This exam must reflect your own work.

25% Final Exam. Before the exam you will receive a list of possible questions from which the actual questions on the exam will be taken. You are encouraged to work in teams to prepare for the exam, but the exam itself must reflect your own work.

10% Class Participation. This is a small class. If you have questions, ask them in class. Show me that you are actually working to understand the material.

4 Prerequisites

I expect that you have a basic understanding of ecology and evolution and, specifically, natural selection. We will employ mathematical tools in developing the theory discussed in this class. Mathematical preparation at the level of calculus is necessary to understand the material presented. While we will use some techniques from linear algebra, students should be able to acquire an instrumental understanding sufficient for this class without having any specific background.

5 Readings

There are no required texts for this class. All readings will be taken from the primary scientific literature. Many of these readings are "classics" – frequently cited and rarely read. I will supplement these readings with fairly extensive course notes.

All readings are available in electronic format, and can be accessed at the secure readings section of the class website.

6 Course Outline (Subject to Change)

Week 1 Introduction: Models of Populations

1. Unstructured populations
2. Discrete vs. overlapping generations
3. The renewal equation
4. Euler-Lotka characteristic equation
5. Optimization

Readings: Lotka (1907), Lotka (1922)

Assignment:

Week 2 Matrix Models for Structured Populations

1. Motivation and model formulation
2. Relationship to other models
3. Eigenvalues, eigenvectors, etc.
4. Sensitivities and elasticities
5. Link to quantitative genetics

Readings: Leslie (1945), Caswell (1978), Lande (1982)

Assignment:

Week 3 Scaling and Allometry

1. The critical role of body mass
2. The Charnov model
3. Invariants and symmetry

Readings: Schmidt-Nielsen (1984, ch. 2), Peters (1983, ch. 8), Charnov (1991)

Week 4 Reproductive Effort I: Semelparity vs. Iteroparity in Unstructured Populations

1. Cole's paradox
2. Reproductive effort
3. Patterns of mortality

Readings: Gadgil and Bossert (1970) Cole (1954), Charnov and Schaffer (1973)

Assignment:

Week 5 Reproductive Effort II: Variable Environments

1. Variable environments in unstructured models
2. Arithmetic means, geometric means, and bet-hedging
3. Variable environments in structured models
4. Caloric restriction and lifespan extension

Readings: Schaffer (1974), Hirshfield and Tinkle (1975), Orzack and Tuljapurkar (1989)

Assignment:

Week 6 Clutch Size, and State-Dependent Life Histories

1. Quality-quantity trade-off
2. Clutch manipulation experiments
3. Variables of state
4. State-dependent life histories

Readings: Smith and Fretwell (1974), McNamara and Houston (1996), Morris (1998)

Assignment:

Week 7 Senescence

1. Gompertz and related curves
2. Mutation accumulation
3. Antagonistic pleiotropy
4. Disposable soma

Readings: Williams (1957), Hamilton (1966), Carey et al. (1992)

Assignment:

Week 8 Growth

1. Determinant vs indeterminant growth
2. Models of growth (e.g., von Bertalanffy, Gompertz)
3. Trade-offs

Readings: Mangel and Stamps (2001), Karkach (2006)

Week 9 Childhood

1. Interspecific evidence for "childhood"
2. Developmental delay

3. Human capital

Readings: Bogin (1997), Tuljapurkar and Wiener (2000), Kaplan and Robson (2002)

Assignment:

Week 10 Post-Reproductive Survival

1. Patterns of post-reproductive survival
2. Grandmother hypothesis
3. Intergenerational transfers

Readings: Hawkes et al. (1998), Lee (2003)

Assignment:

References

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