EXPERIMENTAL STUDIES OF ADAPTATION

Graduate Seminar, OEB697J

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Each week we discuss studies that meet three criteria: 1. evolution occurs during an experimental period, 2. plasticity is ruled out, 3. a particular source of natural selection is reliably inferred.

So, most commonly:

Experimental Evolution: where sources of selection are manipulated, esp. in the lab. (This does not include artificial selection. In experimental evolution you do not control survival or reproduction-- you let the forces you manipulate do that, and the population may or may not adapt.) Endler's book didn't talk about this directly; it's become big since then. Steven Stearns, Linda Partridge, Dick Lenski; E.coli and Drosophila most commonly cited.

"Natural" Experiments: in quotes because often human-induced, sometimes but not usually for the sake of the study.

i. often introductions of species, either the focal species into a new habitat that differs in presumed selection pressures, or a predator or other species into the focal species' environment. Reznick with guppies in streams of different predators most commonly cited.

ii. also, changes in environment, e.g. drought, El Nino, hurricane, watch evolution happen afterwards. Industrial melanism in Biston moths, Grant's work on Darwin's finches, and heavy metal tolerance in plants in polluted habitats, are commonly cited. The inference of a particular source of selection is often less rigorous in such studies, because a whole suite of environmental changes has occurred.

So, in general, we'll be looking at studies that attempt to demonstrate adaptation in progress, in a variety of taxonomic groups. We get to see evolution unfolding in the course of an experiment.

Papers we will read:

WEEK 1: 2/2 Adaptation: methods and concepts

- John A. Endler. 1986. *Natural Selection in the Wild*, ch.3 (Princeton: Princeton UP).
- Hudson Kern Reeve and Paul W. Sherman. 1993. Adaptation and the goals of evolutionary research. *Quarterly Review of Biology* 68:1-32.

WEEK 2: 2/9 Experimental evolution of *Escherichia coli*

- Lenski, R. E. & Travisano, M. 1994. Dynamics of adaptation and diversification: a 10,000-generation experiment with bacterial populations. *Proceedings of the National Academy of Sciences of the U. S. A.* 91:6808-6814.
- Leroi, A. M., Lenski, R. E. & Bennett, A. F. 1994. Evolutionary adaptation to temperature. III. Adaptation of *Escherichia coli* to a temporally varying environment. *Evolution* 48:1222-1229.

WEEK 3: 2/16 *No seminar*

WEEK 4: 2/23 Experimental evolution of viruses

- Burch, C. L. & Chao, L. 1999. Evolution by small steps and rugged landscapes in the RNA virus phi 6. *Genetics* 151:921-927.
- Whatmore, A. M., Cook, N., Hall, G. A., Sharpe, S., Rud, E. W. & Cranage, M. P. 1995. Repair and evolution of *nef* in vivo modulates Simian Immunodeficiency Virus virulence. *Journal of Virology* 69:5117-5123.

WEEK 5: 3/2 Adaptation of plants to pollinators and metals

- Jules, E. S. & Shaw, A. J. 1994. Adaptation to metal-contaminated soils in populations of the moss, *Ceratodon purpureus*: vegetative growth and reproductive expression. *American Journal of Botany* 81:791-797.
- Galen, C. 1996. Rates of floral evolution: adaptation to bumblebee pollination in an alpine wildflower, *Polemonium viscosum*. *Evolution* 50:120-125.

WEEK 6: 3/9 *Drosophila* fruitfly experimental evolution

- Sokolowski, M. B., Pereira, H. S. & Hughes, K. 1997. Evolution of foraging behavior in Drosophila by density- dependent selection. *Proceedings of the National Academy of Sciences of the U. S. A.* 94:7373-7377.
- Stearns, S. C., Ackermann, M., Doebeli, M. & Kaiser, M. 2000. Experimental evolution of aging, growth, and reproduction in fruitflies. *Proceedings of the National Academy of Sciences of the U. S. A.* 97:3309-3313.

WEEK 7: 3/16 *No seminar*

WEEK 8: 3/23 *No seminar*

WEEK 9: 3/30 Rapid evolution of wild invertebrates

- Seeley, R. H. 1986. Intense natural selection caused a rapid morphological transition in a living marine snail. *Proceedings of the National Academy of Sciences of the U. S. A.* 83:6897-6901.
- Gomi, T. & Takeda, M. 1996. Changes in life-history traits in the fall webworm within half a century of introduction to Japan. *Functional Ecology* 10:384-389.

WEEK 10: 4/6 *Poecilia* guppy adaptation to different predator regimes

- Magurran, A. E., Seghers, B. H., Carvalho, G. R. & Shaw, P. W. 1992. Behavioral consequences of an artificial introduction of guppies (*Poecilia*

reticulata) in N. Trinidad: evidence for the evolution of antipredator behavior in the wild. *Proceedings of the Royal Society of London B*, 248:117-122.

- Reznick, D. N., Shaw, F. H., Rodd, F. H. & Shaw, R. G. 1997. Evaluation of the rate of evolution in natural populations of guppies (*Poecilia reticulata*). *Science*, 275:1934-1937.

WEEK 11: 4/13 Salmon evolution following introduction

- Hendry, A. P. 2001. Adaptive divergence and the evolution of reproductive isolation in the wild: an empirical demonstration using introduced sockeye salmon. *Genetica* 112-113:515-534.
- Kinnison, M. T., Unwin, M. J., Hendry, A. P. & Quinn, T. P. 2001. Migratory costs and the evolution of egg size and number in introduced and indigenous salmon populations. *Evolution* 55:1656-1667.

WEEK 12: 4/20 Moor frog local adaptation to acidity

- Räsänen, K., Laurila, A. & Merilä, J. 2003. Geographic variation in acid stress tolerance of the moor frog, Rana arvalis. I. Local adaptation. *Evolution* 57:352-362.
- Räsänen, K., Laurila, A. & Merilä, J. 2003. Geographic variation in acid stress tolerance of the moor frog, Rana arvalis. II. Adaptive maternal effects. *Evolution* 57:363-371.

WEEK 13: 4/27 Adaptation of beaks to seeds in Darwin's finches

- Boag, P. T. & Grant, P. R. 1981. Intense natural selection in a population of Darwin's Finches (Geospizinae) in the Galápagos. *Science* 214:82-85.
- Grant, P. R. & Grant, B. R. 1995. Predicting microevolutionary responses to directional selection on heritable variation. *Evolution* 49:241-251.

WEEK 14: 5/4 Adaptation of soapberry bugs and honeycreepers to food plants

- Carroll, S. P. & Boyd, C. 1992. Host race radiation in the soapberry bug: natural history, with the history. *Evolution* 46:1052-1069.
- Smith, T. B., Freed, L. A., Lepson, J. K. & Carothers, J. H. 1995. Evolutionary consequences of extinctions in populations of a Hawaiian honeycreeper. *Biological Conservation* 9:107-113.

WEEK 15: 5/11