Summary of Introduction to Evolutionary Biology

v0.2

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September 27, 2017

Preface

This document aims to summarize the lecture Introduction to Evolutionary Biology as it was taught in the autumn semester of 2017. Unfortunately I can't guarantee that it is complete and free of errors. You can contact me under **glebert@student.ethz.ch** if you have any suggestions for improvement. The newest version of this summary can always be found here: `https://n.ethz.ch/~glebert/`

1 Introduction

Definition: Evolution means biological change over time
Technical basis: Phenotypes of individuals that are encoded by heritable genotypes vary in a population and their frequencies change

1.1 History

Aristotle: Ladder of nature / perfection
Carl von Linné: Systematic classification of life
James Hutton & Charles Lyell: Gradual long-term processes shaped earth (Uniformitarianism)
Jean-Baptiste de Lamarck: Inheritance of acquired characteristics (Lamarckian evolution)
Charles Darwin: Evolution is descent with modification and results in survival of the fittest

1.2 Microevolution

direct observation: small time-scales → short-term changes

Evidence of Microevolution:

1) Observation from natural populations
   - Bacterial adaptation to antibiotic stress
   - Soapberry bug adaptation to fruit
2) Observation from living anatomy
   Vestigal and rudimentary traits
   - Kiwi wings
   - Human coccyx (Steissbein)
   - Human arrector pili muscle (Haaraufrichter-Muskel)
   - (Appendix might be safe house for good gut bacteria)

1.3 Speciation

Ring species are one species splitting into two. They provide evidence of speciation.

1.4 Macroevolution

indirect observation: long time-scales → long-term changes

Evidence of Macroevolution:

1) Successions & Extinctions
   Law of succession: pattern of correspondence between fossile and recent forms from the same locale
   Comparative anatomy: Georges Cuvier argued that certain species are extinct. Recent macrofauna is only a fraction of all that ever existed
2) Transitional forms
   Darwinian evolution predicts intermediate forms between a species and its ancestor (e.g. *Microraptor gui* and *Archaeopteryx* between dinosaurs and modern birds
3) Homologies (Owen: "the same organ in different animals under every variety of form and function) can be found through comparative anatomy and comparative embryology. The similarity is due to inheritance from a common ancestor. They are phenotypically and genetically defined and enable the use of model organisms.
   Some molecular homologies are
   - the universal genetic code: bases and codons
   - the small-subunit (SSU) ribisomal RNA genes

2 Natural selection

Natural selection is the process underlying adaptive evolution

2.1 Darwins postulates of evolutionary change

Evolutionary change over time is a deductive implication of four postulates.

1) All populations contain variable individuals
2) Variation among individuals is, at least in part, heritable
3) Some individuals are more successful at surviving and reproducing than others
4) Survival and reproduction of individuals are not random; but individuals with the most favorable variation given the environment are those better at surviving.

These postulates can be tested in real world populations (e.g. Darwin's finches from the Galapagos islands). One has to be careful to not misinterpret biasing factors. For example heritability measures can be skewed by misidentified paternity, misidentified maternity, food quality or maternal effects such as egg quality.

2.2 Definition

Natural selection acts on individuals (more specifically, phenotypes), its consequences occur in populations as allele frequency changes.

2.3 Darwinian vs. Lamarckian evolution

Different processes proposed for the same pattern.

1.	No initial variation	Initial variation
2.	Individuals adapt during their lifetime	Selection acts on individuals
3.	Inheritance of aquired changes/characters (IAC)	Inheritance of surviving alleles if environment leads to adaptation
	⇒ individuals and populations evolve	⇒ populations evolve

Epigenetic modifications are attached to the genetic code and can be passed on to the offspring (up to two generations). Thus their evolutionary relevance is short-term.

2.4 Limits

- Natural selection acts on existing traits
- Natural adaptation does not lead to perfection
- Natural selection is non-random, but it is not progressive
- Natural selection is blind to the future, but tells us tales from the past

2.5 “Perfection” in nature

William Paley argued, that the vertebrate eye is too perfect and complicated to have resulted from natural processes. Thus it must be a creation of a conscious designer. By looking closely at eyes from various chordates one can see that there is a lot of variation in the complexity of the eye. Thus Paleys argument is wrong.