Life History Traits

Brief review of strategies we've seen so far:

- •Foraging strategies
- •Territorial behaviors
- •Signalling behaviors
- •Reproductive behaviors
- •Mating systems

We investigated these different behaviors and traits in terms of how they affect fitness of the individual

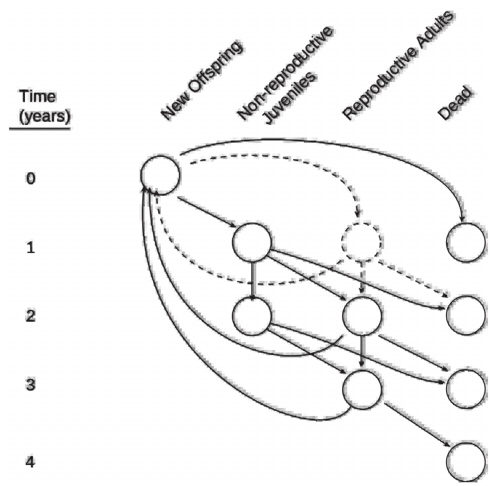
Another class of traits have a clear and direct bearing on fitness. These are the life-history traits. The major life history traits are:

- •Age at first reproduction
- •Number and size of offspring
- •Reproductive lifespan and ageing

All of these affect the so-called "Life Table" of an organism

Relation to the "Life Table"

Imagine following a cohort of individuals in a population



Note, there are more formal representations using matrix algebra

Life History Variation in Pacific Salmon

Fecundity and Age at Maturation, etc.

- •Sockeye
- •Pink
- •Chum
- •Chinook
- •Coho
- •Steelhead

<u>Intra</u>specific Variation in Fecundity in Chum Salmon

Chum salmon from the Amur River Siberia:

Summer run: 39.8 eggs/cm fork length

Autumn run: 53.5 eggs/cm fork length

Goals of life history theory

To Answer, "Why all this variation?"

and

Ultimately wish to construct models which predict what sorts of traits will be favored in what sorts of environments.

Without constraints, the answer is easy, for highest fitness one would. . . .

The CORNERSTONE (as in other optimality models):

Assumption of limited time and resources and the need to *allocate* these to particular traits

Trade-offs

Evidence for Trade-offs

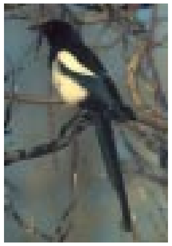
Four main ways people have tried to demonstrate that these trade-off exist:

<u>1. Phenotypic Correlations within or among populations</u>

- •Example: egg size and egg number between salmon populations of the same species
- •Doesn't really demonstrate direct trade-offs

<u>2. Experimental Manipulations</u>

- •Trade-offs between clutch size and offspring survival.
- •Inspired greatly by the "Lack Clutch" hypothesis of the 1940's
  - •Hypothesis regarding latitudinal clutch-size trends
- •Hogsted (1980) Magpie clutch augmentation/ reduction experiments.

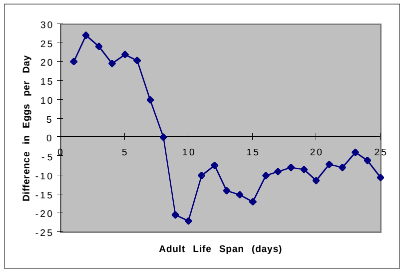


<u>3. Correlation of traits between relatives</u>

- •Quantitative genetics approach
- •Maybe useful for demonstrating short-term constraints and trade-offs
- •Long term selection may not be constrained by genetic correlations detected in such studies

<u>4. Correlated responses to selection</u>

- •Artificially select for a trait and see what else changes along the way.
- •Famous experiments by Rose and Charlesworth
  - •Squashed fruit flies at an unnaturally young age



Selection for both shorter life and higher fecundity

Simple Mathematical Models

Perennial vs. Annual Life Histories:

S_0 = Probability of survival in the first year
S_P= Probability of survival in later years

Ba = Seed production rate of annual plant
Bp = Seed production rate of perennial

L = rate of increase

L (annual) = (Ba)(S_0)
L (perennial) = (Bp)(S_0) + S_P

What values of B and S lead to the annuals increasing faster than the perennials?

Annuals will be favored when S_0 is high relative to S_P

If not, annual seed production must be high to compete with perennials

Another Model

Relationship between reproductive life-span and reproductive investment.

So = Probability of surviving the first year (to reproductive age)
B = number of offspring produced in a season

Sp = probability of surviving adult years
Partitioned into:
Sr = factor of survival probability that is affected by your reproductive investment
S = factor of survival probability unaffected by reproductive investment

L = (S)(Sr) + (So)(B)

Now, imagine changing B (and hence Sr). Our common trade-off assumption would say that Sr would become smaller as B became larger.

ΔL = S(ΔSr) + So(ΔB)

High adult survival favors lower yearly investment in reproduction.

Phenotypic Plasticity

Noted in many other types of traits as well, but has received much attention in the study of life history traits.

Back to our first day:

Genotype ---------Environment---------> Phenotype

Reaction Norms.

Selection for phenotypic plasticity itself

Reaction norms

Genetically determined---may be an item under selective pressure.