Life history traits:
Characteristics which contribute to the pattern of births and deaths

Comparative life histories

Life histories are incredibly varied!

Example: Christmas crabs and albatrosses
How many offspring does each female produce per reproductive episode?

Life histories are incredibly varied!

If you assume that populations of albatross and Christmas crabs tend to stay the same, what do we expect about juvenile mortality of Christmas crabs and albatross?
Why the diversity of life histories?

How much is due to an adaptive response of a population to its environment?

Patterns of birth

a. Timing of reproduction

a. Timing of reproduction

Onset of reproduction - early

Plant-feeding aphids.

• Live birth of nymphs.
• When born contain embryos of their own offspring.

So adult females contain embryos of their grandchildren!
a. Timing of reproduction

Onset of reproduction - late

- Start to reproduce at 8-10 years!
- Very old relative to most birds.

Number of reproductive episodes -

- Semelparity - "one birth"
- Iteroparity - "repeated births"

Most semelparous plants and animals short-lived, reproduce just once at the end. Includes annual plants (plants that live one year), some insects, and cephalopods.

Some semelparous organisms live for many years, then invest all of their resources in a single reproductive episode. This is called:
Big bang reproduction!

Big bang reproducers: Agave
Grow slowly, then send up huge flowering stalk before dying. Often flower in relatively wet years.
Hypothesis: Big bang reproduction an adaptation for a dry environment.

Big bang reproducers: Salmon
Leave freshwater, live several years in ocean.
Then swim upstream to their natal stream, to reproduce
Hypothesis: Salmon are evolutionarily constrained to breed in natal streams. Because of effort, can’t breed more than once

and then to die.
Iteroparous plants and animals reproduce many times throughout their lives. Include perennial plants, many arthropods, many vertebrates.

Other patterns of birth

Number of offspring per reproductive episode (clutch size)

Size of offspring at birth (relative to adult size)

Example of small offspring: Marsupials

Females have several embryos in suspended development in the uterus. They give birth to tiny young (only a few cm long).

Hypothesis: Small size at birth an adaptation for a harsh environment.

The young marsupial then develops in the pouch. If it dies, another embryo starts to develop.

Other patterns of birth

Size of offspring at birth (relative to adult size) large

Example: most placental mammals
2. Patterns of death

a. Survivorship curves

![Graph showing Survivorship curves for Type I organisms with low juvenile mortality.](image)

![Graph showing Survivorship curves for Type I organisms with low juvenile mortality.](image)

What kinds of organisms?
a. Survivorship curves

Type II
Relatively constant rate of mortality throughout life span

Type III
High juvenile mortality
a. Survivorship curves

![Survivorship Curve Diagram]

D. Tradeoffs in life history
1. The ideal organism?
   The organism most favored by natural selection should...
   reproduce shortly after its own birth,
   produce large clutches of offspring to which it devotes a large amount of parental care, and reproduce throughout its long life.

Lastly

the ideal organism wins competitions with other individuals, and has an effective defense against predation and parasitism.

Does such an organism exist?

Why not?

Because organisms have limited resources with which to grow, maintain themselves, and reproduce.

So, often there are compromises - negative relationships between life history characteristics. These are called: life history tradeoffs.
Life history tradeoffs
Example - growth and reproduction in Douglas fir trees

Life history tradeoffs
Example: Clutch size and offspring survivorship in swifts

Researchers added an extra egg to some nests

What does this show?

Life history tradeoffs
Example: Defense and reproduction in water fleas (Daphnia)

In spring - few predators, Daphnia produce about 6 eggs.

In summer - many predators, Daphnia develop spines, and produce fewer (about 3) eggs.

Spring morphology
Summer morphology


The kind of habitat an organism experiences shapes its life history in predictable ways.

What are some short-lived or unpredictable habitats?

Temporary pools, dung (for dung feeders), patches of bare ground in grassy habitat

Unvarying or predictably seasonal habitats lead to K-selected life histories.
What are some short-lived or unpredictable habitats?

Important to characterize the habitat as the organism sees it.

E.g. a fruit fly that develops in rotting mushrooms in an oak forest.
r-selected or K-selected habitat?

How do short-lived, or unpredictable habitats affect the evolution of life histories?

In short-lived, or unpredictable habitats, organisms are predicted to:

Be small (relative to related species)
Have little defense against predation
Have low competitive ability
Reproduce early
Produce many, small offspring
Have good dispersal ability
How do unvarying or predictably seasonal habitats affect the evolution of life histories?

In unvarying, or predictably seasonal habitats, organisms are predicted to:

- Be large (relative to related species)
- Have good defenses against predation
- Have high competitive ability
- Delay reproduction
- Produce few, large offspring
- Have poor dispersal ability

K-selected

Pop. size

time

Populations are usually close to the carrying capacity, so little selection for a large number of offspring. Instead resources are invested in larger body size and competitive ability. So why is it called K-selection?

In the literature, reckless application of the idea.

An example - a text calls insects, bacteria, annual plants all r-strategists, and whales, rhinoceroses, and oak trees K-strategists.

So what’s the evidence for r- and K-selection?

What other factor distinguishes these two groups?
What would be a good test of r- and K-selection theory?

Look at different populations of the same species, or closely related species, in habitats that differ in predictability.

Example: Test of r- and K-selection in cattails

Closely related cattail species in two habitats

<table>
<thead>
<tr>
<th>Plant traits</th>
<th>Texas - long growing season, predictable habitat</th>
<th>N. Dakota - short grow. season, less predictable hab.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Onset of Reproduction</td>
<td>70 days</td>
<td>44 days</td>
</tr>
<tr>
<td>Height of plant (body size)</td>
<td>186 cm</td>
<td>162 cm</td>
</tr>
<tr>
<td>No. of fruits (offspring)/plant</td>
<td>8</td>
<td>41</td>
</tr>
<tr>
<td>Weight of fruits (size of offspring)</td>
<td>21</td>
<td>11</td>
</tr>
</tbody>
</table>

Does the evidence support the hypothesis?

Kinds of experiments

Descriptive experiments - Predict what pattern you would observe if hypothesis was true, then make the observations.

Example - the cattail experiment

Strengths - may be the only way to test some hypotheses. May be able to gather a larger data set, e.g. if some of the observations are published.

Weaknesses - Strictly correlative - because treatment was not randomly assigned, may be other factors responsible for what you observe.
Kinds of experiments
Manipulative experiments - Randomly assign individuals to treatments, then measure the effect
Example coming up
Strengths - The most rigorous means of testing a hypothesis
Weaknesses - May not always be possible
If you were interested in how life history evolves in different environments, what kind of a manipulative experiment might you do?

A recent laboratory evolution experiment - effects of different rates of adult mortality on life history traits in Drosophila (fruit flies)

Question: In environments where there is high adult mortality (e.g. high predation) what happens to other aspects of Drosophila life history?

Experimenters set up selection lines - in some removed adults 2 x weekly (“High adult mortality treatment”), in others didn’t (“Low adult mortality treatment”) kept all other factors constant
Kept selection up from 1993-1998, and continued on for several years!

Some of their predictions: When adult mortality is high, populations should evolve
Higher fecundity early in life
Shorter development times
Smaller adult size
Effect of high adult mortality on amount of early reproduction:
Which treatment reproduces earlier? Do they do it from the start of the experiment?

Effect of high adult mortality on larval development time:
Which treatment has a shorter larval development time?

Effect of high adult mortality on body size:
Which treatments’ adults are smaller?

Summary
The study of life history evolution shows some mechanisms by which animal and plant populations diversify in response to their environment.

Some patterns found are general to many organisms. For example, the manipulative selection experiment in *Drosophila* shows a pattern seen in other descriptive experiments:
High adult mortality leads to earlier reproduction, shorter development time, and smaller body size.