Considerations

- Phenotypic plasticity
- Origin of adaptations
- Trade-offs and constraints

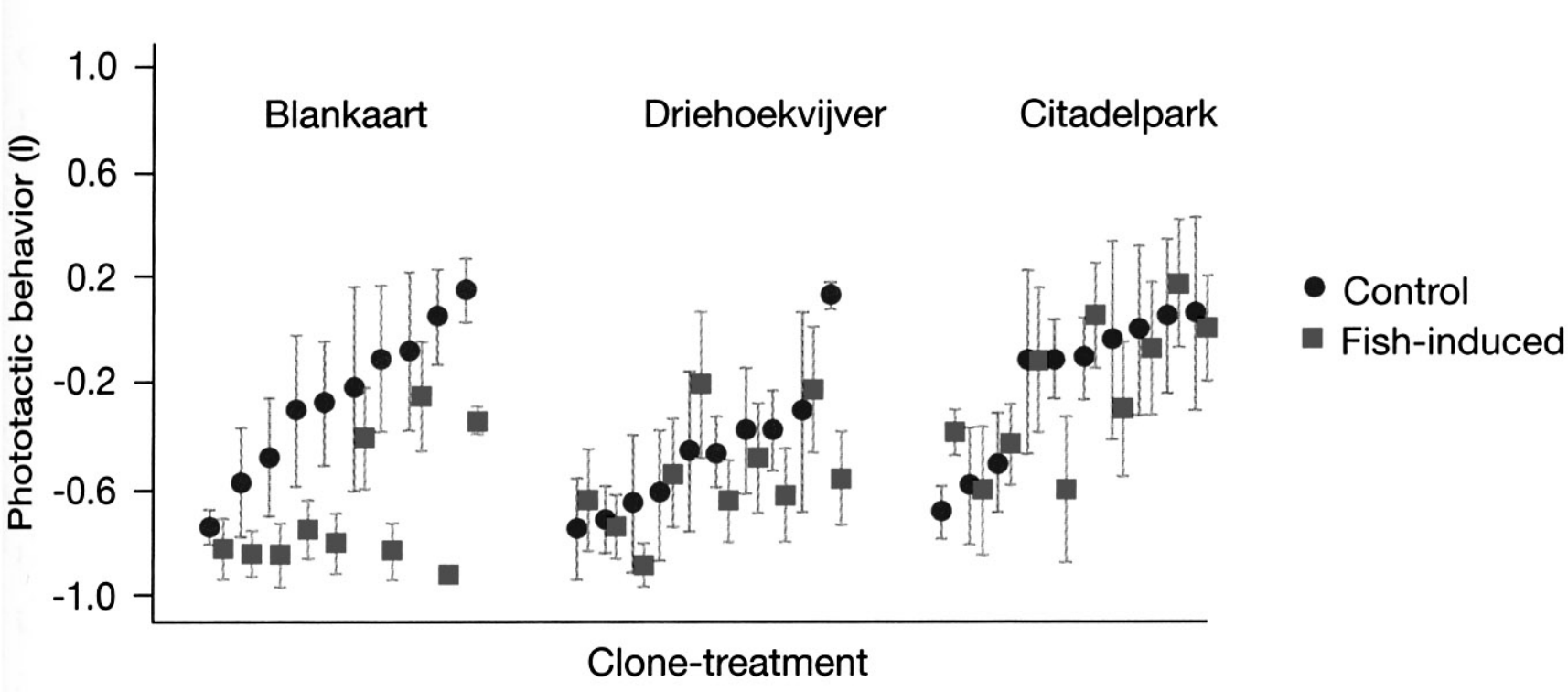
Phenotypic plasticity

- Phenotype partially due to environment and partially due to genes
- Plasticity is changes in phenotype due to environment
- Plasticity of development may itself be a trait that can evolve
  - Opposite of plasticity is ***canalization*** of development; same phenotype across wide range of environments

Meet *Daphnia magna*

- Freshwater crustacean
- Asexual reproduction usually
  - Genetic clones
- Model in experimental evolutionary biology

Daphnia plasticity



Daphnia in 3 lakes in Belgium. Blankaart lots of fish; Driehoekvijver some; Citadelpark none

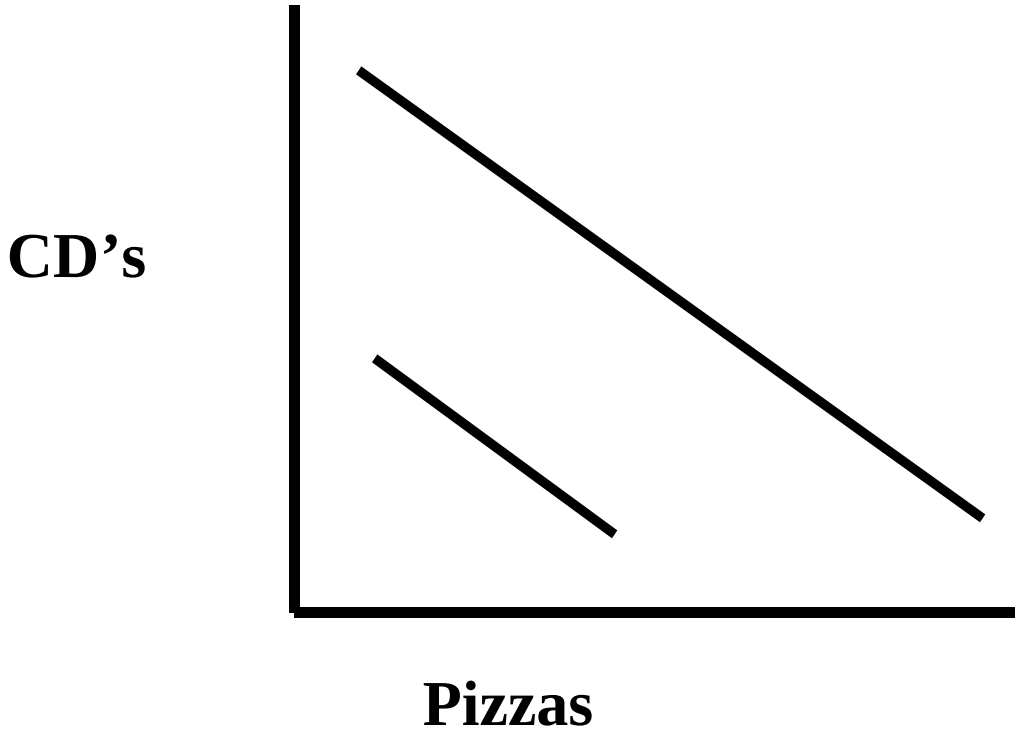
Some genotypes more plastic than others (e.g. var'n within Blankaart); genetic variation in plasticity called ***genotype-by-environment interaction***

Can anything evolve?

- Trade-offs
- Constraints
- Lack of variation

Trade-off

- Money spent on pizza can not be spent on CD’s



Functional trade-offs

- Increased benefit in one context may decrease benefit in another
  - Male peacock feathers may impress female peahens
  - May make males more likely to be caught by a tiger

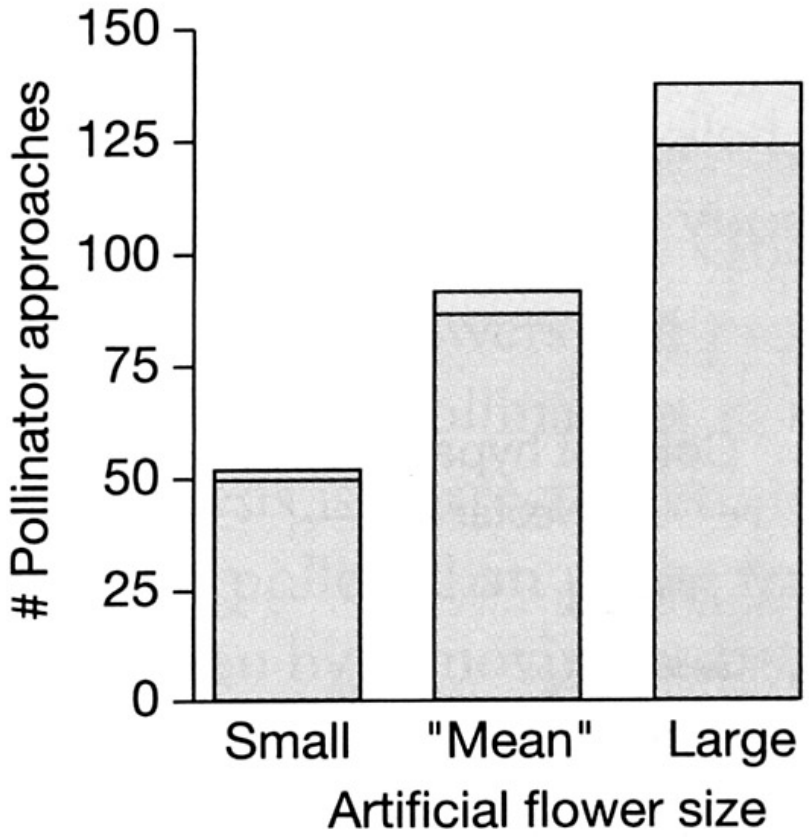
How big are your begonias?

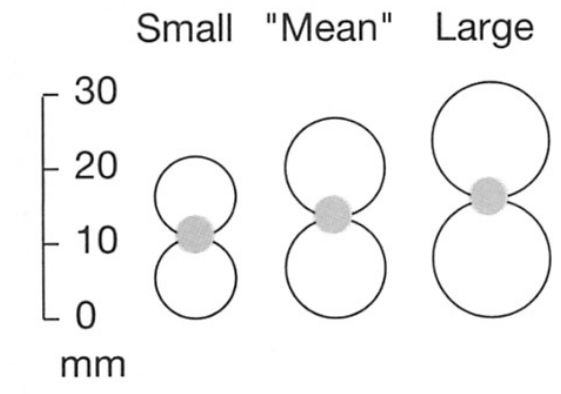
- Begonias have separate male and female flowers, botanists call that ***monoecious***

- Bee pollinated
- Male flowers pay bees with pollen
- Female flowers do not offer bees anything
  - Mimic male flowers

How big should a female flower be?

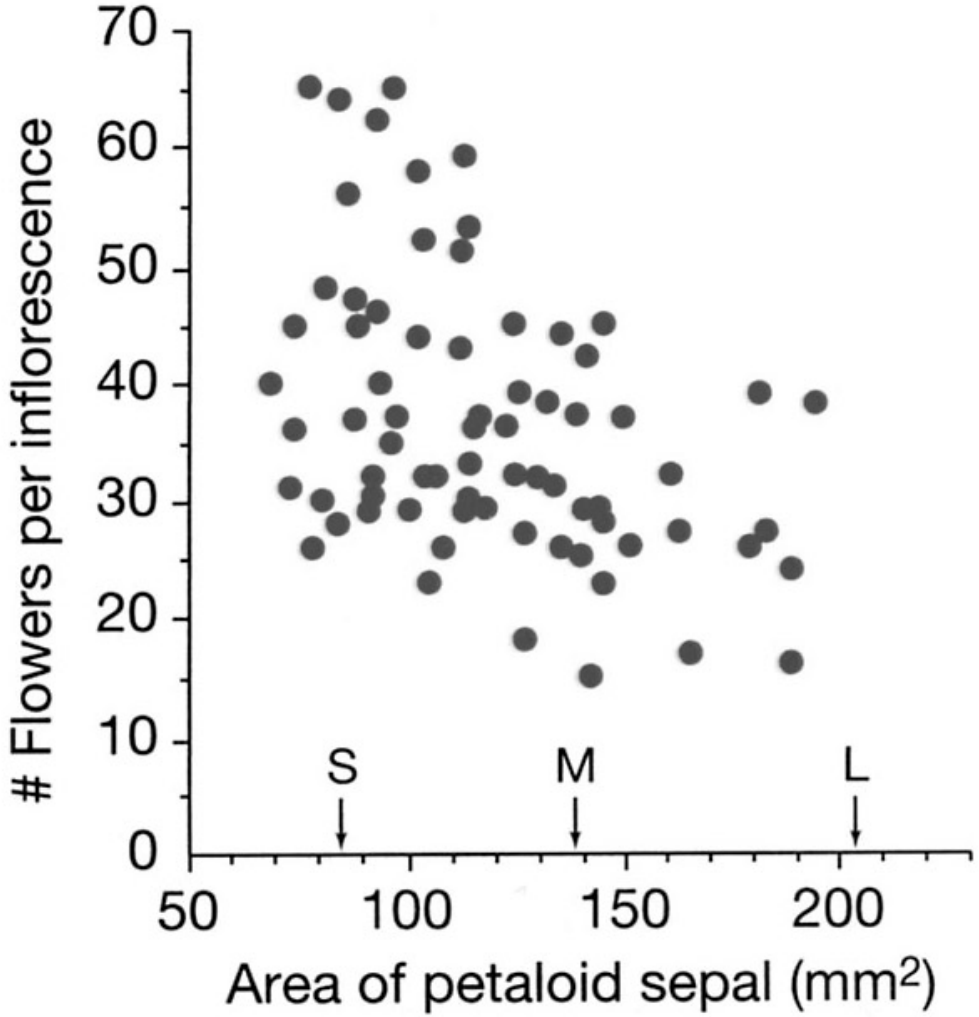
- Bees prefer larger flowers



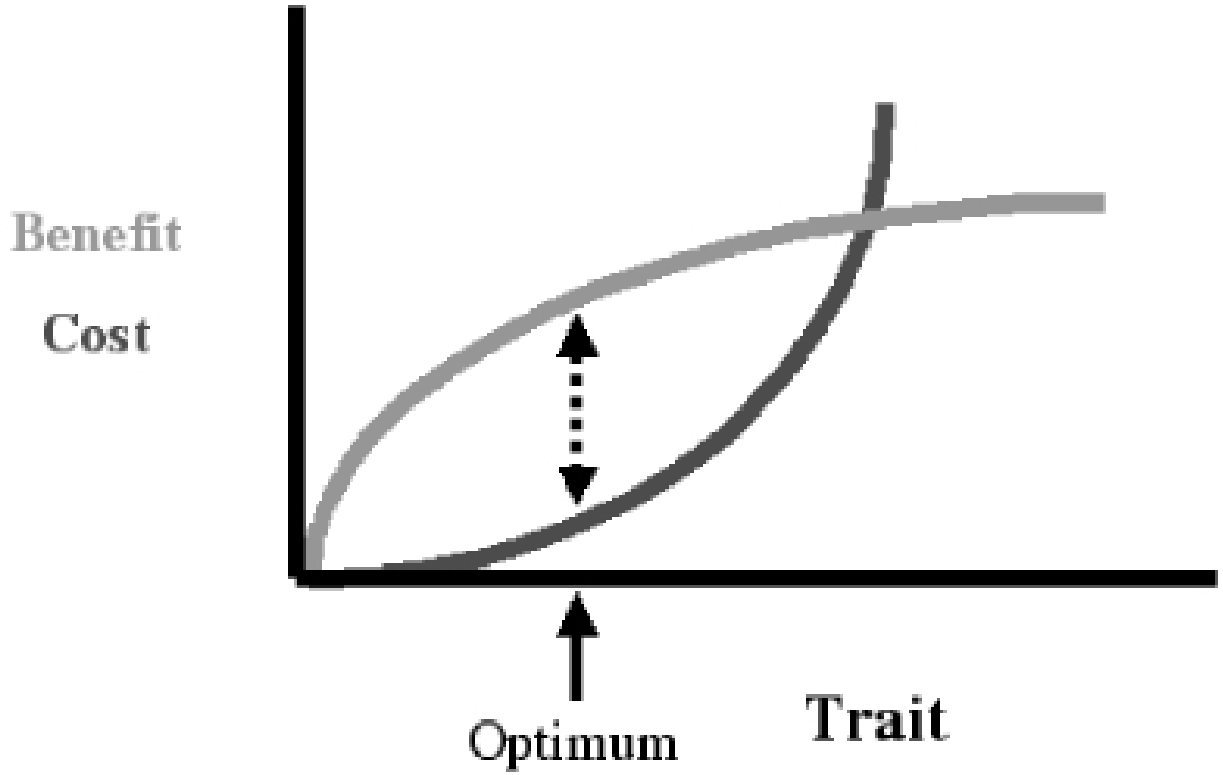


Blue bars pollinator approaches; orange bars pollinator visits

Female flower size trade-off

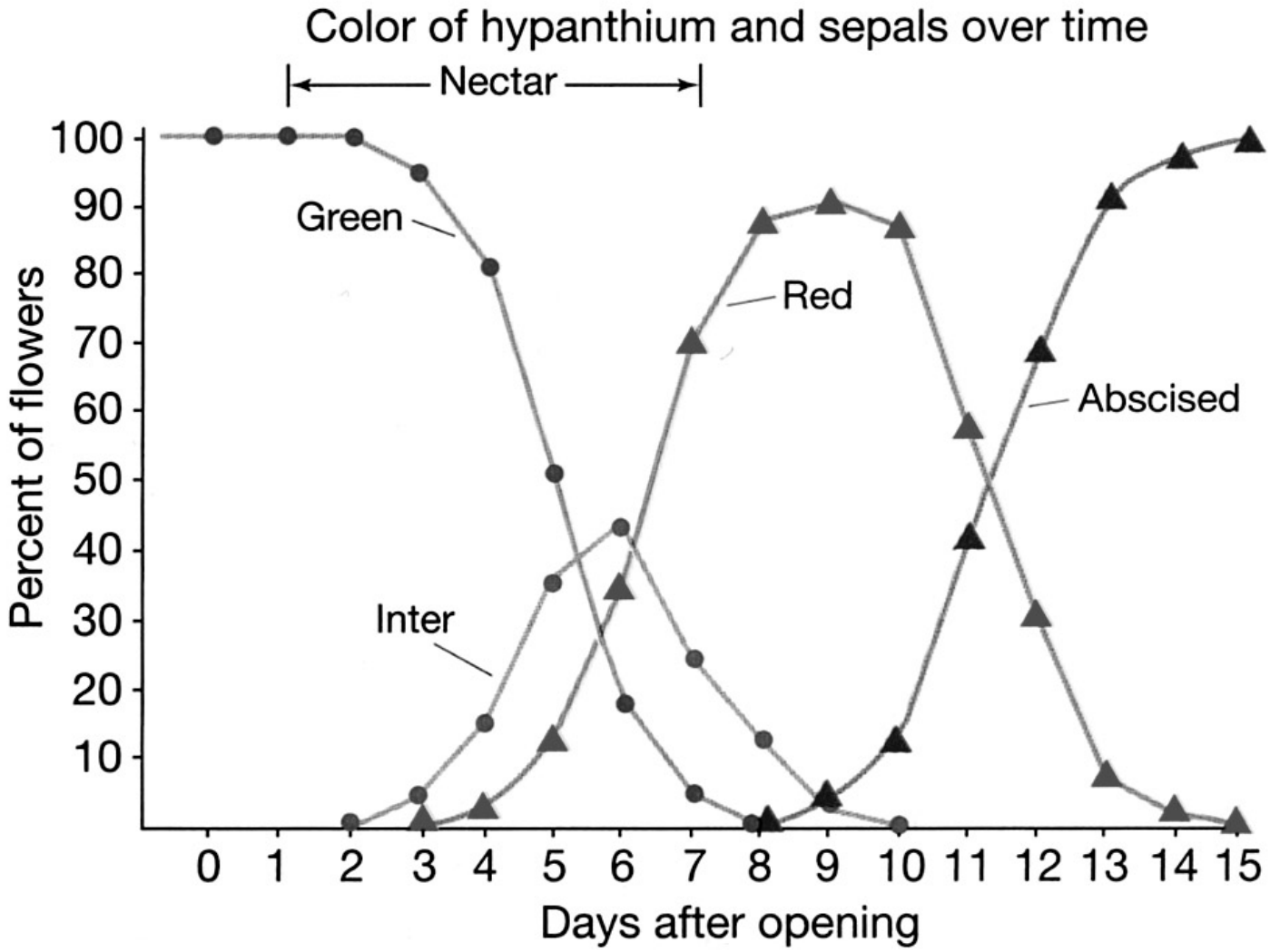


Maximizing fitness with trade-offs



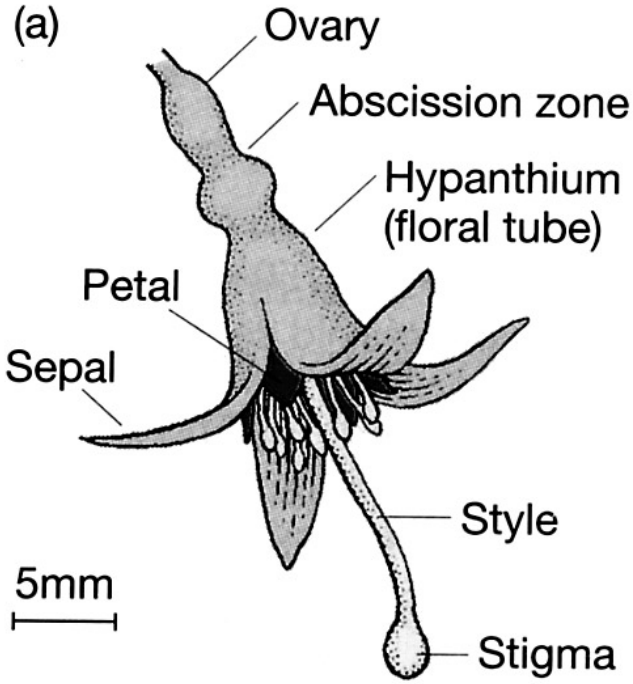
Constraints, *Fuchsia* example

Fuchsia morphology, phenology

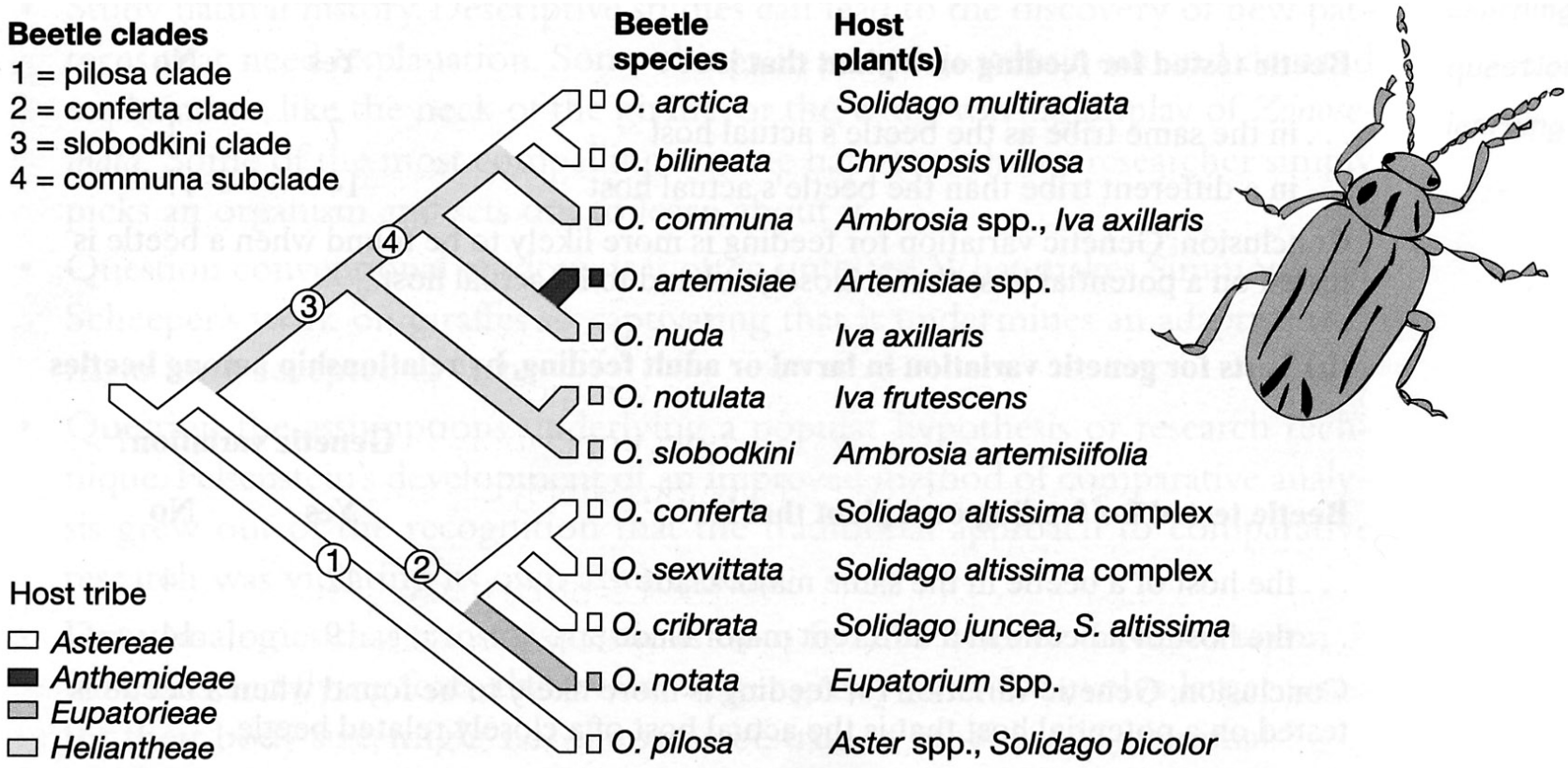


Why do *Fuchsia* turn red?

- Signal to pollinators that flower no longer active
  - Nectar through day 7
- Why turn red instead of just dropping flower?
- Constraint: it takes 3 days for pollen tube to grow to ovary, 1.5 days for abscission zone to form
  - Abscission day 12



Can lack of genetic variation constrain evolution?



Genetic variation for feeding

Table 8.4 Summary of tests for genetic variation in larval or adult feeding on potential host plants

(a) Tests for genetic variation in larval or adult feeding, by relationship among host plants

	Genetic variation?	
Beetle tested for feeding on a plant that is . . .	**Yes**	**No**
. . . in the same tribe as the beetle's actual host	7	1
. . . in a different tribe than the beetle's actual host	14	17

Conclusion: Genetic variation for feeding is more likely to be found when a beetle is tested on a potential host that is closely related to its actual host

(b) Tests for genetic variation in larval or adult feeding, by relationship among beetles

	Genetic variation?	
Beetle tested for feeding on a plant that is . . .	**Yes**	**No**
. . . the host of a beetle in the same major clade	12	4
. . . the host of a beetle in a different major clade	9	14

Conclusion: Genetic variation for feeding is more likely to be found when a beetle is tested on a potential host that is the actual host of a closely related beetle

Levels of Selection

- Species?
- Populations?
- Groups?
- Individuals?
- Genes?

“Selfish” genes

- C value - total amount of DNA per cell
  - Amoeba 670 billion kb
  - Humans 3.4 billion kb
  - Fruit fly 180,000 kb
- Transposons
  - Parasitic DNA sequences
  - Can catalyze their own replication and insertion
    - Human chromosome 22 has about 29% of DNA is transposons (13 % LINES 16% SINES)

Conclusions

- Adaptive evolution is not without limits
- Traits originate from other pre-existing traits
- Trade-offs and constraints important limits to phenotypic evolution