Ward Lecture 6

Exaptation and Functional morphology

Example of an adaptation

- Bat
  Echolocation through sonar -

Qualifying as an Adaptation

1.Heritable: it must be genetically encoded—since natural selection cannot act on traits that don't get passed on to offspring.

2. Functional:

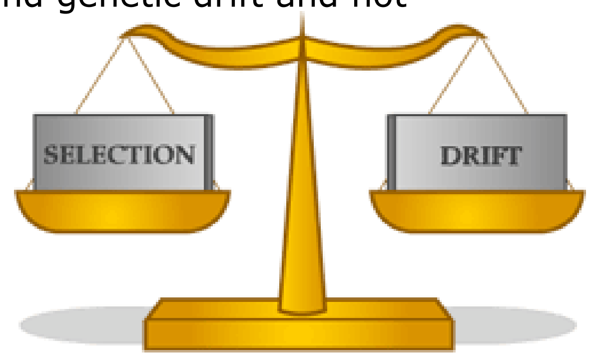
The trait must actually perform that task.

3.Adaptive:

it must increase the fitness of the organisms that have it—since natural selection only increases the frequency of traits that increase fitness.

Neutral Theory: The relative importance of drift and selection

The neutral theory of molecular evolution suggests that most of the genetic variation in populations is the result of mutation and genetic drift and not selection.



The theory suggests that

- if a population carries several different versions of a gene, odds are that each of those versions is equally good at performing its job—in other words, that variation is neutral: whether you carry gene version A or gene version B does not affect your fitness.

The neutral theory is easily misinterpreted. It does NOT suggest:

1. That organisms are not adapted to their environments
2. That all morphological variation is neutral
3. That ALL genetic variation is neutral

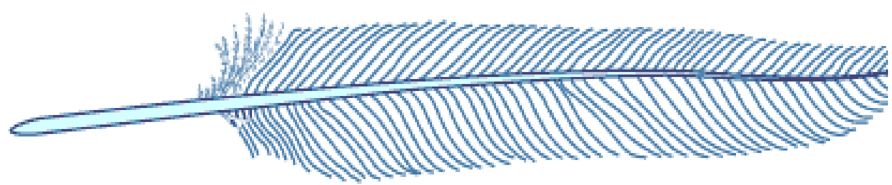
4. That natural selection is unimportant in shaping genomes

An **exaptation**

- is a character evolved for a different purpose for that which it is currently used, or in other words, a character which was appropriated for a new use than that which it was originally developed for.

Examples of Exaptation

- Bird feathers: evolved for thermoregulation



Later co-opted for flight. First feathers (on dinosaurs!) could not have functioned for flight. Wrong engineering. But right structure to evolve into a flying component.

Archaeopteryx, the earliest known bird (Upper Jurassic of Germany)

It is not enough to know that the feature is functional right now. We want to know what was happening when it first evolved, which often involves reconstructing the phylogeny of the organisms we are interested in and determining the likely ancestral states of the characters.

Not Everything is an Adaptation

- 1. The character is the result of history
- 2. The character is just a by-product
- 3. The character is an out-dated adaptation
- 4. The character is the result of genetic drift

Coevolution:

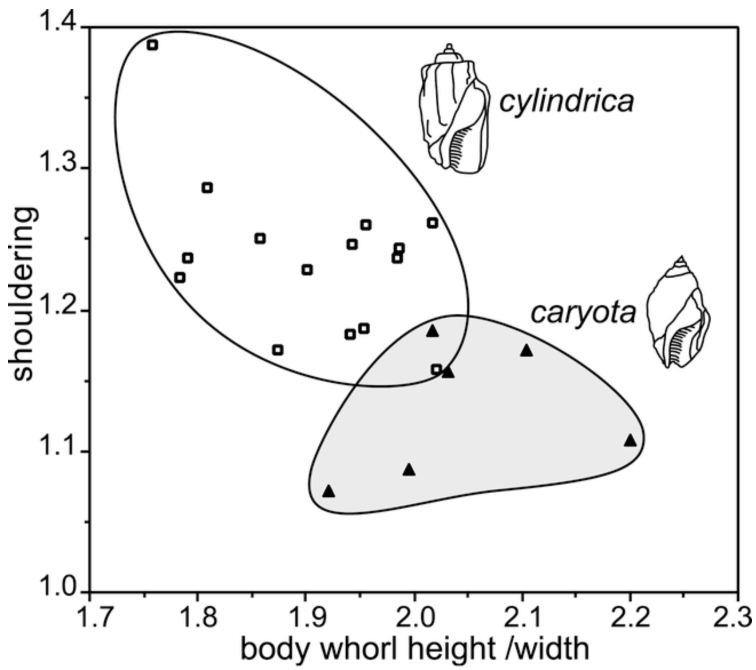
two (or more) species reciprocally affect each other's evolution

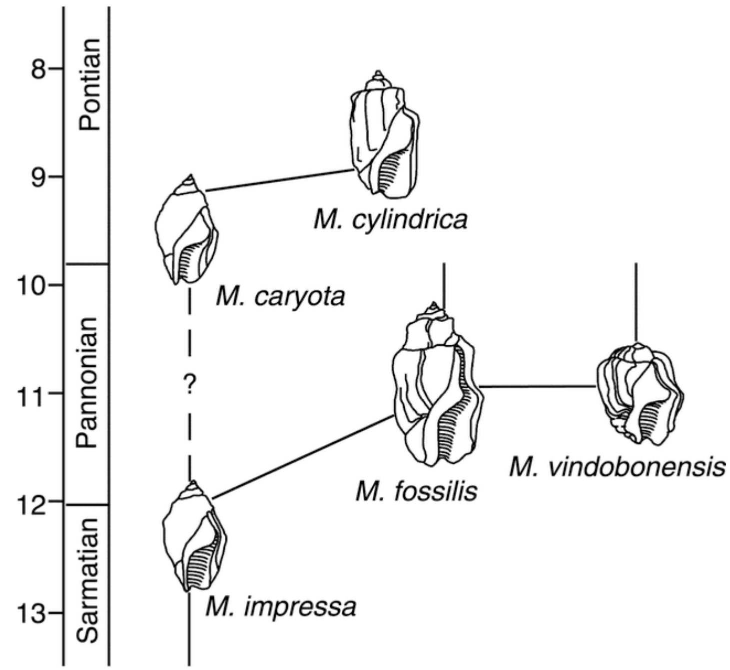
- Co-evolution most likely to occur when species have close ecological intereactions:
- 1. Predator/ prey
- 2. Highly competitive species
- 3. Mutualistic species

The evolution of Melanopsis

- A case history of evolution

A case history of ITERATIVE Evolution: Repeated pattern of evolution





Constructional Morphology

- ***Historical,***
- ***Fabricational,***
- ***And Functional aspects***

How to analyze function

- Engineering principles
- Paradigm method - how could it work best?
- Functional morphospace
- Using the recent to interpret the past
- Experiments on actual material
- Wind tunnels and flume tanks

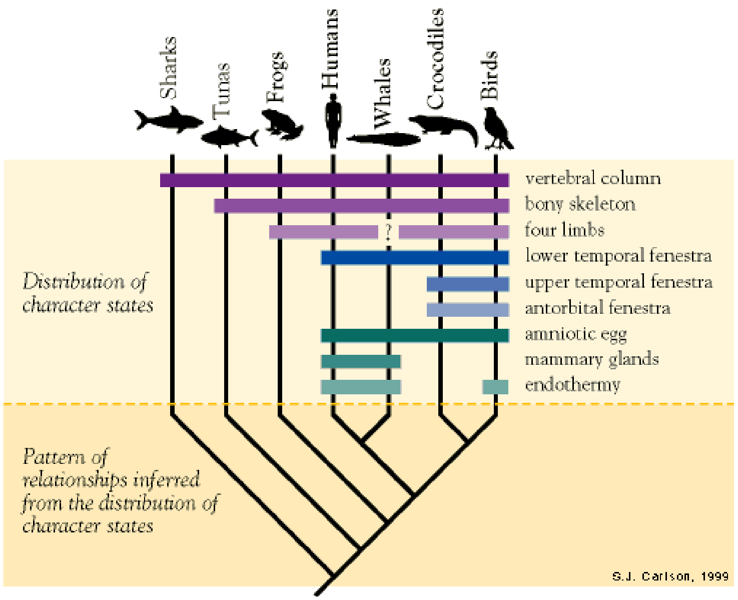
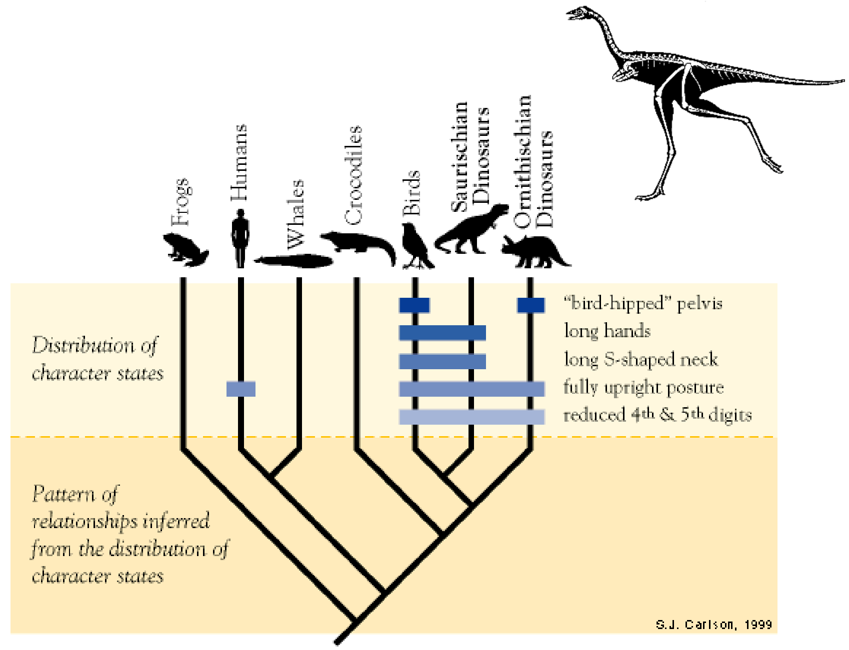
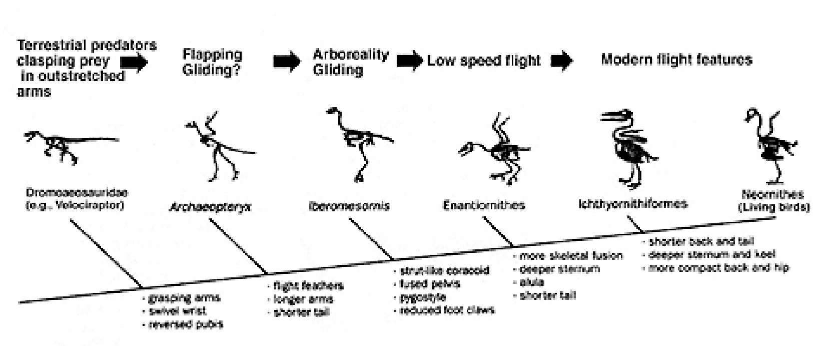
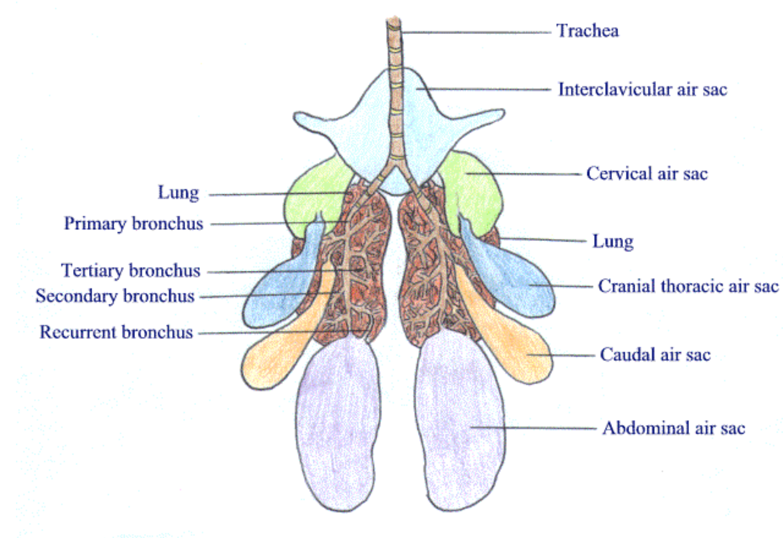


Figure 7. Characters listed in Table 1 mapped on the seven living taxa, as discussed in the text.





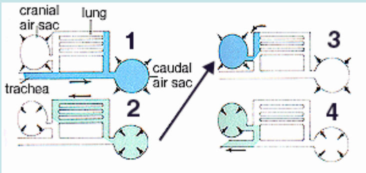


1 - On first inhalation, air flows through the trachea & bronchi & primarily into the posterior (rear) air sacs

2 - On exhalation, air moves from the posterior air sacs & into the lungs

3 - With the second inhalation, air moves from the lungs & into the anterior (front) air sacs

4 - With the second exhalation, air moves from the anterior air sacs back into the trachea & out



Altitudinal limits of taxa (note: Everest is 8.8 km)

		max . height	% of Everest's height	
amphibians	salamander	3	34%	European Alps
	toad	5	57%	Himalayas
reptiles	lizard	5.5	62%	Himalayas
mammals				
	marmot	5.5	62%	Himalayas
	yak	5.8	66%	Asia
	deer (taruca)	6	68%	Andes
	vicuna, guanaco	5.4	61%	Andes
	human "settlement"	5.9	67%	Chile (mine)
Birds	Geese	11	125%	Himalayas