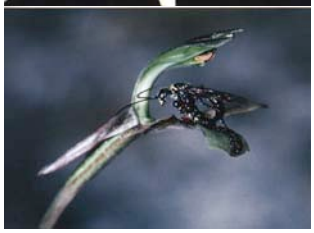
Adaptations:

What they are & how to study them

Orchids



Ad: to, towards Aptus: a fit

Arboreal weaver ants

Hawk moths

Adaptation….

- Physiological adaptation
- Process of becoming adapted
- Features that enhance reproductive success

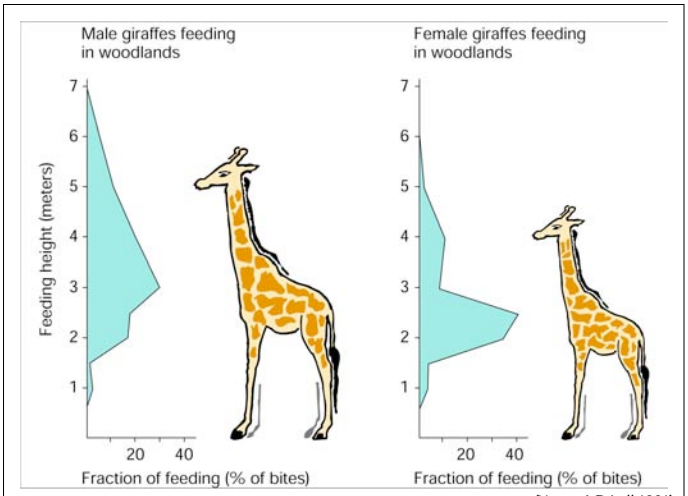
Explanations of Adaptations

- complexity
- evident function (design)

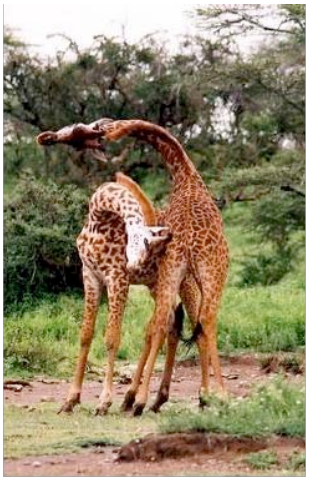
- Teleology (Gk teleos, "end"): does nature have goals?

- Teleonomy: "a process or behavior that owes its goal-directedness to the operation of a program"
e.g. DNA or CNS programs

The Giraffe's neck…..



(Young & Isbell 1991)



…..”Just So” Stories

The Adaptationist Program

Criticized……

Gould & Lewontin (1979) The spandrels of San Marcos and the Panglossian paradigm. Proc R Soc Lond B 205: 581-598

Defining Adaptation …..

Ahistorical

"An adaptation is a phenotypic variant that results in the highest fitness among a specified set of variants in a given environment." (Reeve & Sherman, 1993)

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Preadaptations & Exaptations

- a feature that fortuitously serves a new function
- characters evolved for other functions, or none at all, that have been co-opted for a new use. (Gould and Vrba, 1982)

e.g. exaptation… wolf submission licking from food begging

Definition:

"A feature is an adaptation for some function if it has become prevalent or is maintained in a population (or species, or clade) because of natural selection for that function."

Futuyma, 1998

Caveat! Don't expect…..

- pervasiveness (traits, pop & spp differences)
- perfection

Why?…..

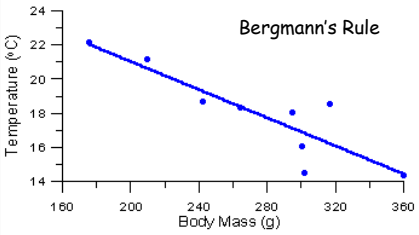
- consequence of physics/chemistry
- evolved by drift
- correlated with another (adaptive) feature
- consequence of phylogenetic history

e.g. exaptation… human hand (tool use) from primate grasping in trees

2. Design

- inferred from correspondence with engineering principles & mathematical models

  - Assume NS has optimized features within specified constraints
  - Controversial (optimality models)



Recognizing Adaptations

1. Complexity
2. Design
3. Experiments
4. Observational studies
5. The Comparative Method

3. Experimentation

Obs: Wing-waving display on disturbance in Zonesemata resembles territorial threat leg-waving of Salticids

Ho[1]: flies do not mimic jumping spiders

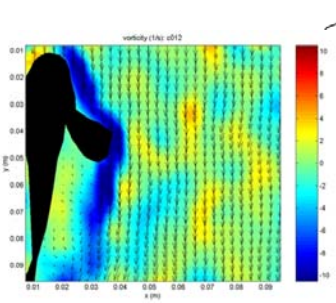
Ho[2]: fly mimicking spider is avoided by range of predators

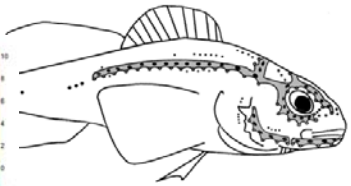
Ho[3]: fly mimicking spider intimidates spiders themselves

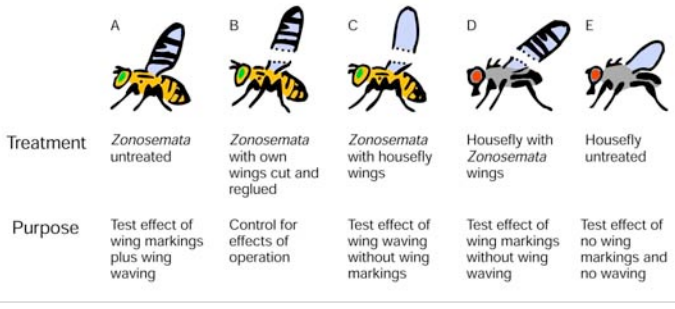
Greene et al 1987

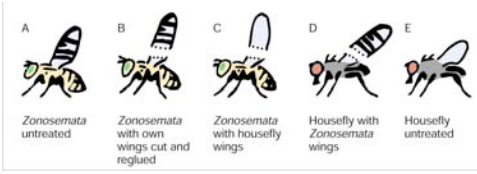
1. Complexity

- suspect adaptive function e.g. fish lateral line
- evolution of morphological novelties e.g. eyes, ears



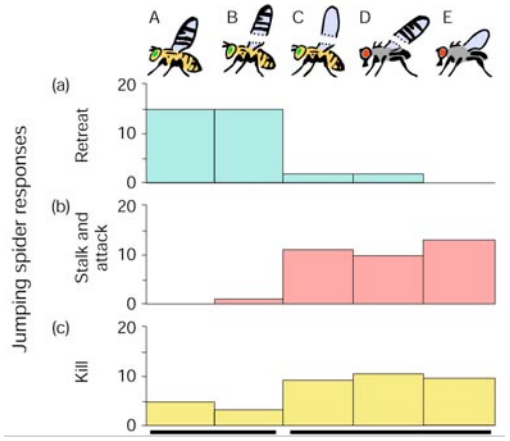






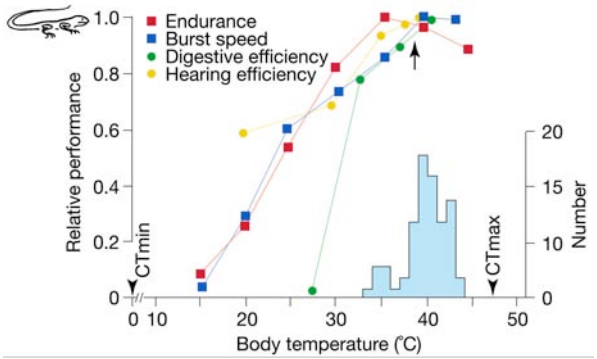
Predictions under Hypothesis 1: No mimicry					
Jumping spider will:	Attack	Attack	Attack	Attack	Attack
Other predator will:	Attack	Attack	Attack	Attack	Attack
Predictions under Hypothesis 2: Mimcry deters other predators					
Jumping spider will:	Attack	Attack	Attack	Attack	Attack
Other predator will:	Retreat	Retreat	Attack	Attack	Attack
Predictions under Hypothesis 3: Mimicry deters jumping spiders					
Jumping spider will:	Retreat	Retreat	Attack	Attack	Attack
Other predator will:	Attack	Attack	Attack	Attack	Attack

Data support Ho[3]



Observational Studies.....

Thermal performance curve - Dipsosaurus dorsalis

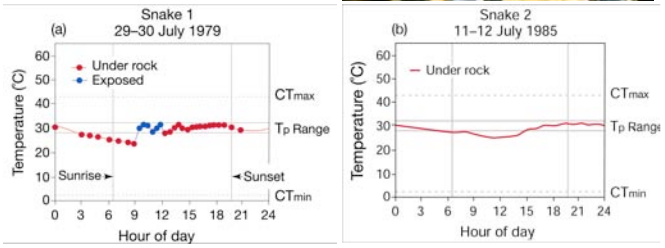


Implies behavioral ecothermy .... in principle

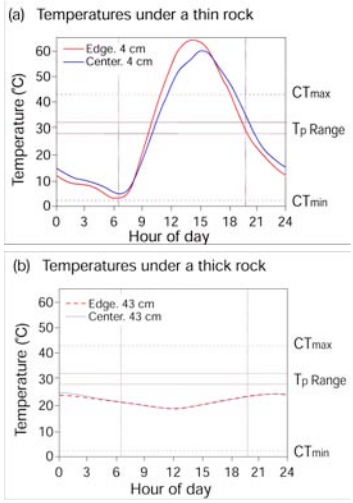
4. Observational Studies

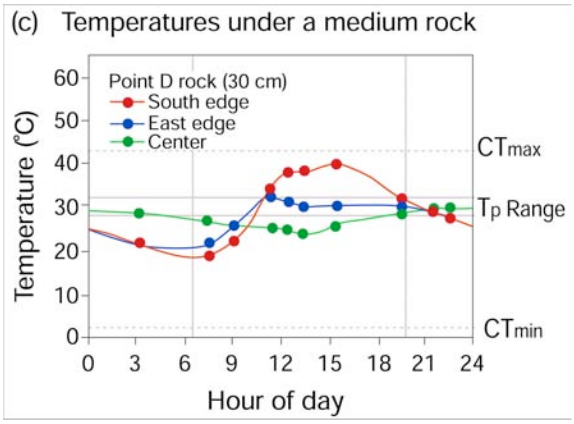
e.g. Do Garter snakes make adaptive choices in nighttime retreat?

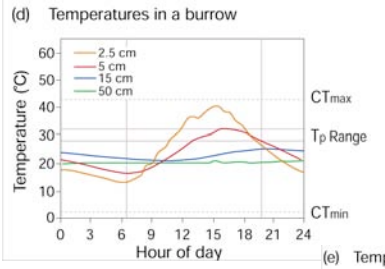
Huey et al 1989

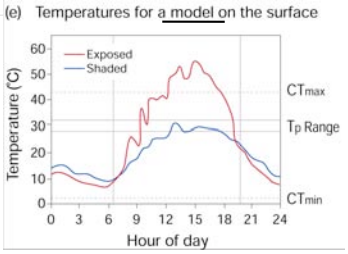


Models & Rock choices





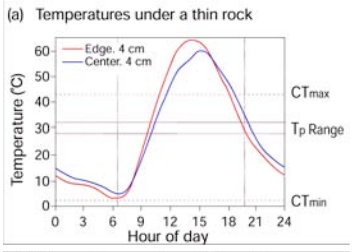


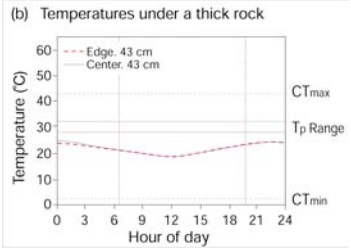


Choices wrt rock availability?

8% 61% 31%

Models & Rock choices





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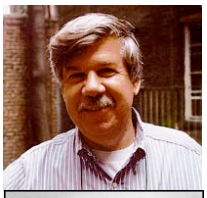

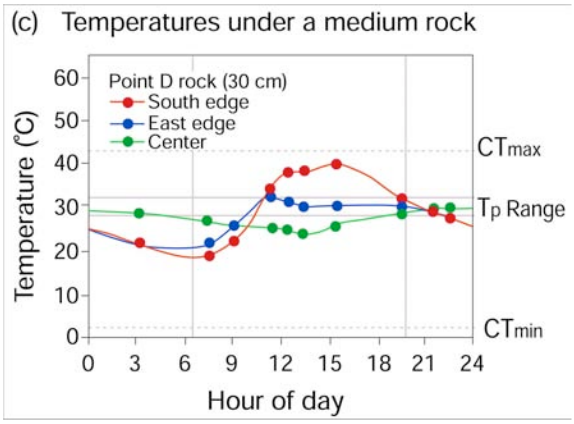

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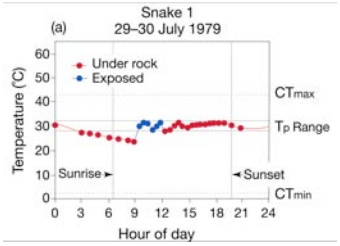

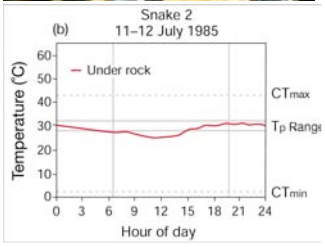

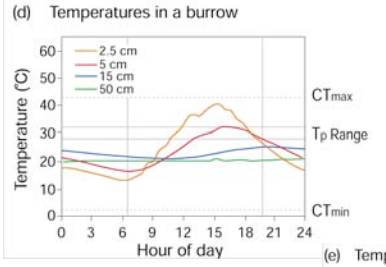

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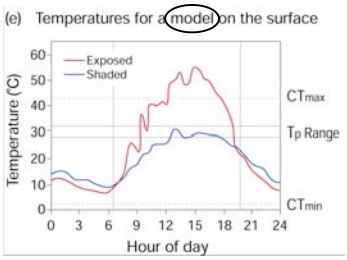

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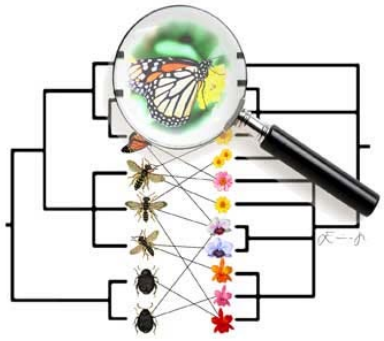
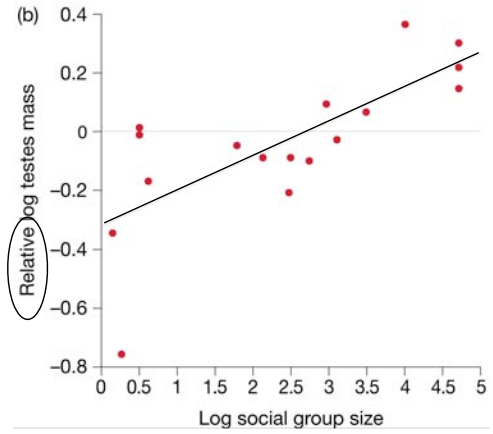


- use of sets of spp to test hypotheses on adaptation & other evolutionary phenomena

Obs: fruit bats & flying foxes

H_o: Testis size evolves (at least partially) as an adaptation for sperm competition



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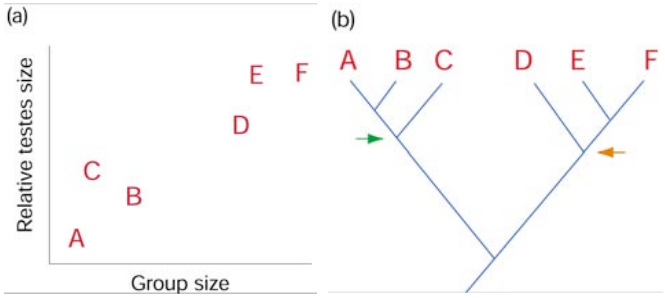
The problem….



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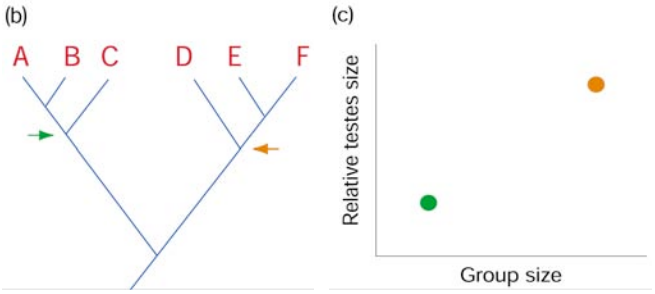
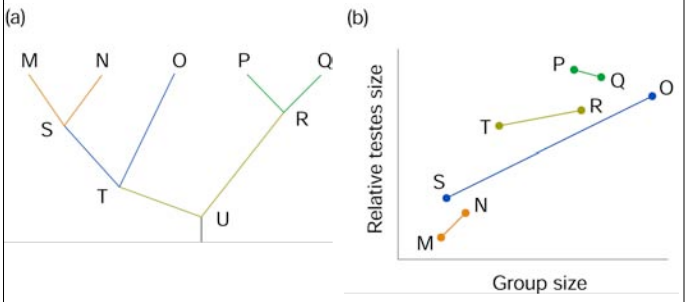
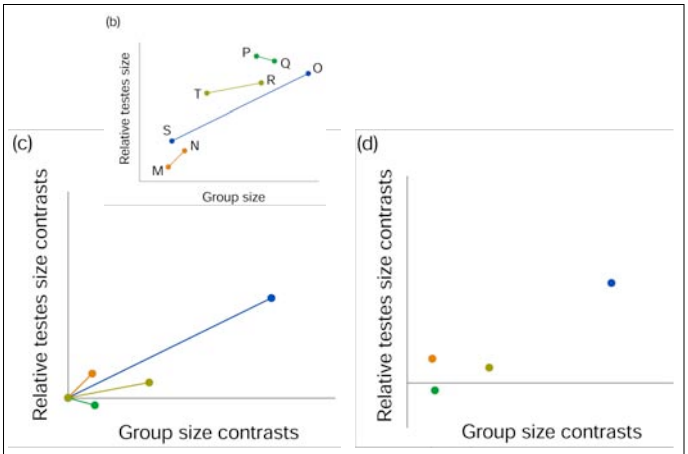


Phylogenetic pseudoreplication

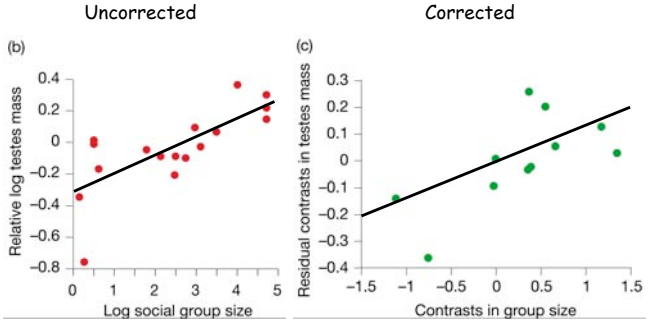
Felsenstein's Independent Contrasts.....





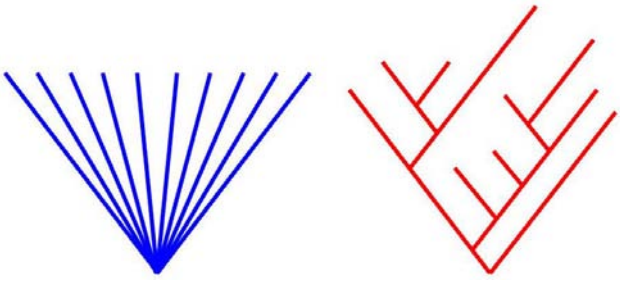
	Group size	Body mass (g)	Testes mass (g)	Species
(a)	325	518	3.25	*Acerodon mackloti*
	900	1021	8.4	*Pteropus giganteus*
	3,020	850	3.8	*Pteropus tonganus*
	50,000	677	6.75	*Pteropus poliocephalus*
	1,200	800	5.1	*Pteropus alecto*
	50,000	400	5.3	*Pteropus scapulatus*
	147.5	224	1.64	*Dobsonia peroni*
	50,000	325	5.5	*Eidolon helvum*
	3,000	142	3.5	*Rousettus aegyptiacus*
	650	91.8	0.74	*Rousettus amplexicaudatus*
	3	15.9	0.287	*Macroglossus minimus*
	3	23	0.317	*Macroglossus sobrinus*
	3,000	60	0.798	*Eonycteris spelaea*
	2	160	0.299	*Epomops buettikoferi*
	65	80	0.9	*Epomophorus anurus*
	1.5	32.5	0.23	*Micropteropus pusillus*
	4	35	0.36	*Cynopterus sphinx*

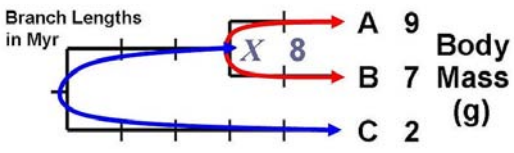
Hoskens 1998



Conventional statistical methods assume...

PCM may not be 'ultrametric' (have tips that are contemporaneous)

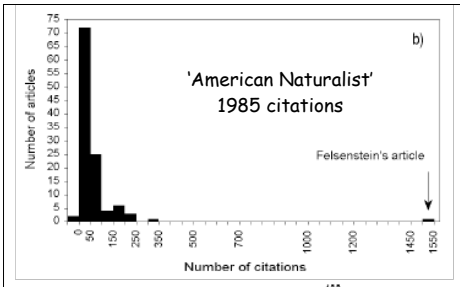




Identify and Compute Independent Contrasts

Compute square roots of sums of (corrected) branch lengths = S.D.

Contrast	Value	S.D.	Standardized Contrast
A-B	2	2	1
X-C	6	3	2

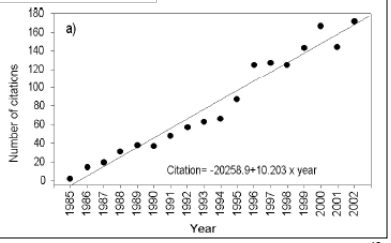


Felsenstein's impact

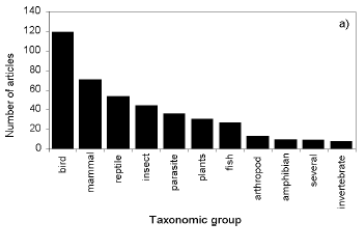
1462 citations
1985-2002

•3rd place from 1945 on

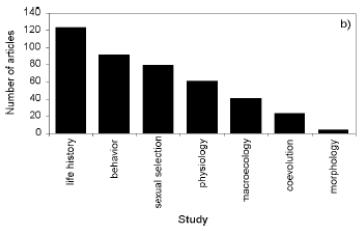
•theoretical articles in high-impact journals



(Carvalho et al 2005)



1462 (1985-2002)

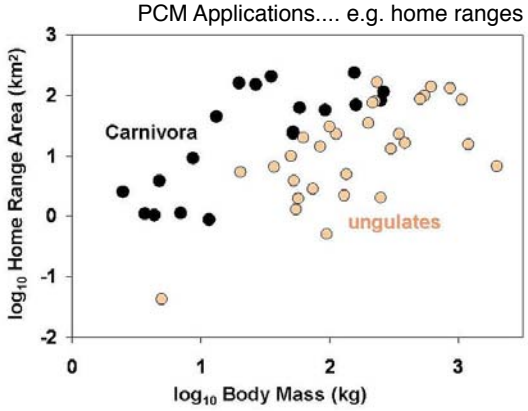


"Adaptation is an inherently comparative idea ..." (Harvey and Pagel, 1991, p. 13)

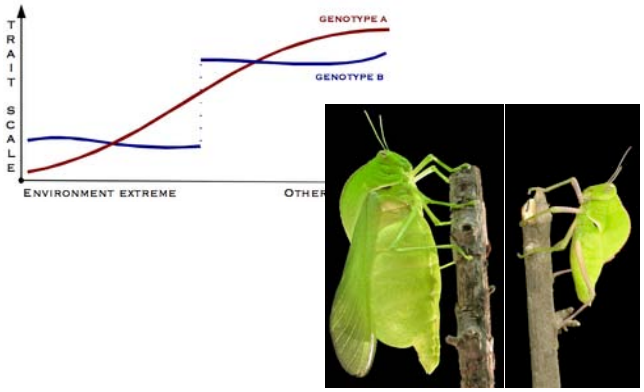
"... we must learn to treat comparative data with the same respect as we would treat experimental results ..." (Maynard Smith and Holliday, 1979, p. vii)

"Naive, prephylogenetic comparative tests should be kept at the other end of a barge pole." (Ridley and Grafen, 1996, p. 87)

PCM Applications.... e.g. home ranges



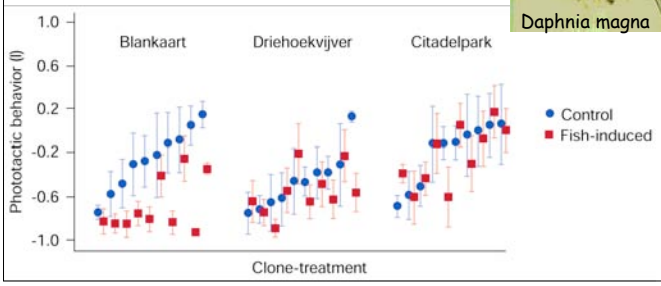
PCM Applications....
e.g. Phenotypic Plasticity as an adaptive trait



Phenotypic Plasticity

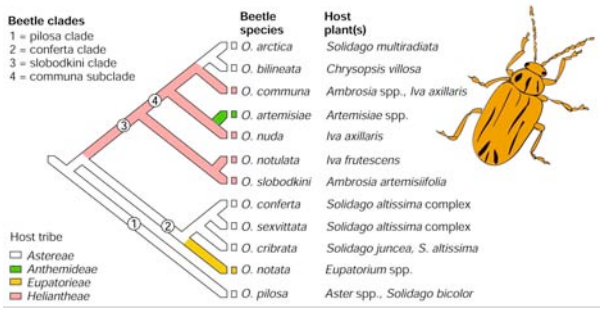
- is adaptive when it allows individuals to adjust their phenotypes so as to increase their fitness in the particular environment in which they find themselves

genotype-by-environment interaction



PCM Applications....

e.g. Testing constraints on adaptation



Host plant use in Ophraella

MacClade - Maddison's

Compare - Emélia Martins

Asking interesting questions

- Study natural history
- Question conventional wisdom
- Question assumptions underlying a method
- Draw analogies transferring questions across fields/taxa
- Ask 'Why not?"