Abstraction and Reification in Biological Theory

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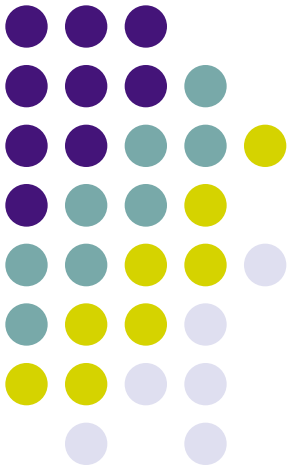
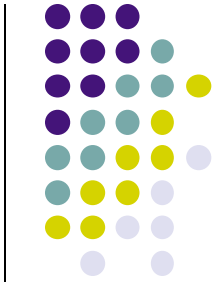


Outline



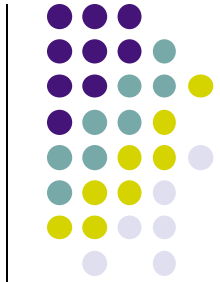
(1) Abstraction and Reification

(2) Character Analysis in Phylogenetics

(3) Fisherian Assumptions in Evolutionary Genetics

(4) Next Stop?

Winther (2006, 2008, 2009)
Winther and Wade (in prep)
Winther and Najmi (in prep)



(1) Abstraction and Reification

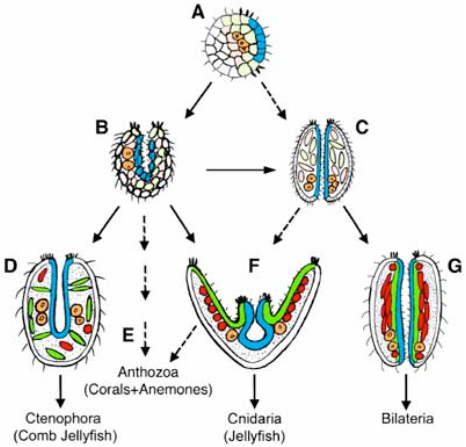
What is Abstraction?

- Generalize from the data

Variation in the seed size

Variation in the Pod length

- Identify natural kinds

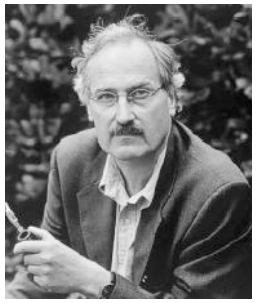


- Formalize mathematically

$$\hat{x}_i(t+1) = \hat{f}_i(\hat{\mathbf{x}}(t)), \text{ where } 1 \le i \le n$$

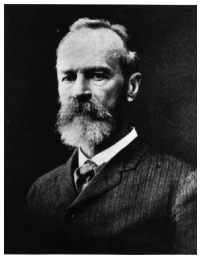
What is Reification?

- Conflating abstractions and concrete world
- Forgetting assumptions and limits of abstractions
- Unjustifiably exporting abstractions from one domain into another domain



What Causes Reification?

- Reification: taking an abstraction too far
  - "vicious abstractionism"



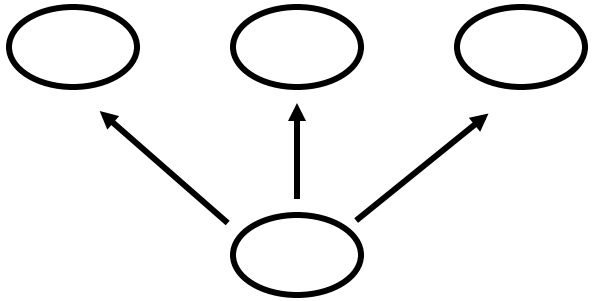
- Causes
  - Rarifying from the data
  - Failure to compare and contrast alternative models, methodologies or theories (i.e., abstractions)
  - Failure to reflect over the historical contingency of our favorite model, methodology or theory

Model-World Relation

Naïve Realism

Model

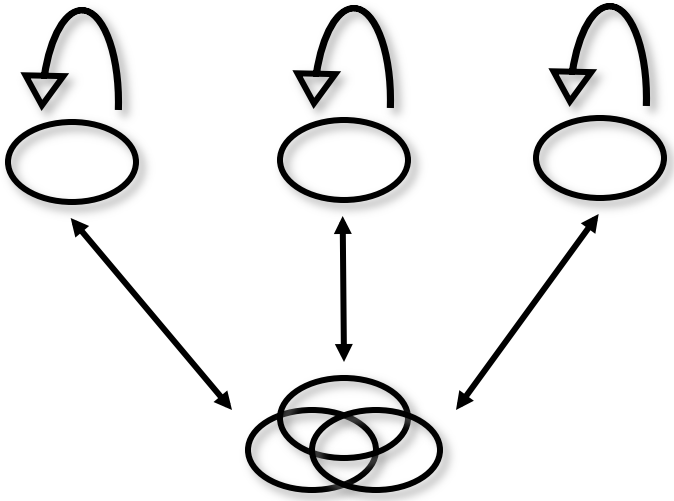
World

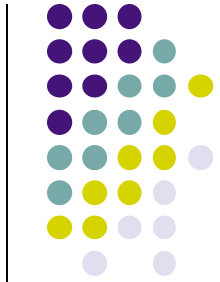


Realist Constructivism

Model

World





(2) Character Analysis in Phylogenetics

What is a Character?

- An abstracted unit
- Are individuated, identified, defined, distinguished, measured, drawn, counted, manipulated

Why are Characters Important?

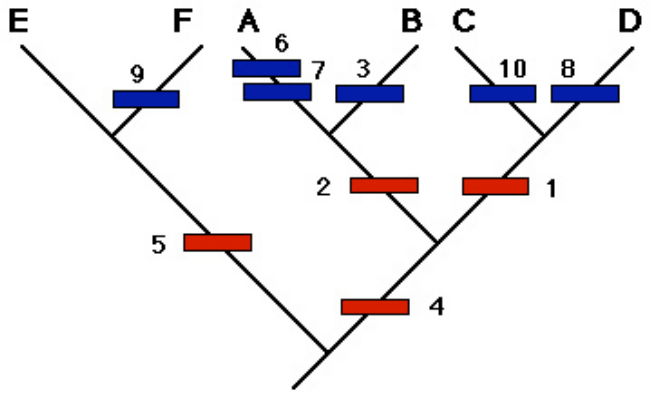
- Basic data for phylogenetic analysis

Character Analysis

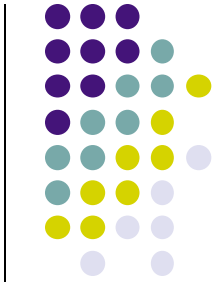
Characters (presence/absence)

	1	2	3	4	5	6	7	8	9	10
A	0	1	0	1	0	1	1	0	0	0
B	0	1	1	1	0	0	0	0	0	0
C	1	0	0	1	0	0	0	0	0	1
D	1	0	0	1	0	0	0	1	0	0
E	0	0	0	0	1	0	0	0	0	0
F	0	0	0	0	1	0	0	0	1	0

Phylogenetic Analysis



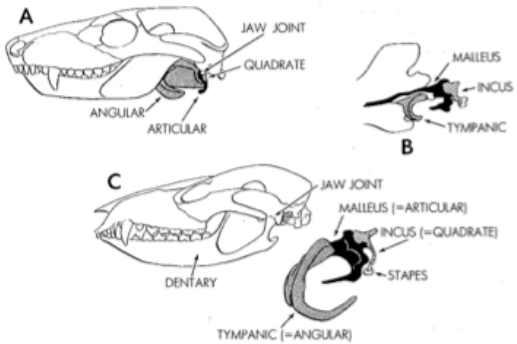
Two Central Problems of Phylogenetics



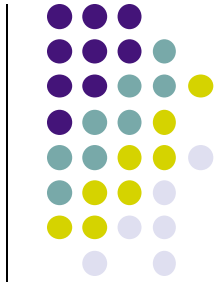
Type of Analysis	Central Problem	Problem Description	Solution
Character Analysis	Bad characters	Abstracting bad, *reified* characters leads to skewed cladograms ("garbage in, garbage out")	1. "The more the merrier" 2. Employ objectivity criteria 3. Both (1) and (2)
Phylogenetic Analysis	Inconsistency of good characters	Sum total of good characters of a data set do not support the same cladogram	1. Congruence 2. Likelihood 3. etc.

Objectivity Criteria for Homology Assessment

Objectivity Criteria	Related to similarity	First Discussed
1. Topological	Yes	Remane, Hennig, Wiley
2. Special similarity	Yes	Remane, Hennig, Wiley
3. Series of intermediate forms	Yes	Remane, Hennig, Wiley
4. Conjunction	Yes	Patterson
5. Causal grounding	Yes, but "deeper"	Rieppel and Kearney
6. Inter-disciplinary communication	No	Rieppel and Kearney

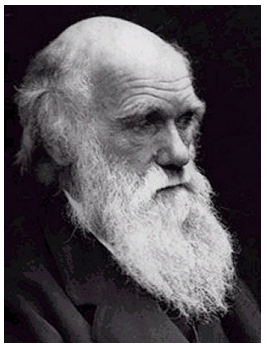


User Manual for How to Avoid Reifying Characters!!

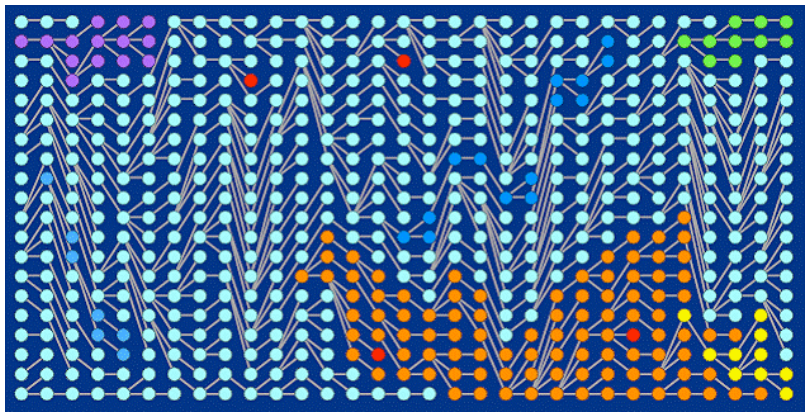


(3) Fisherian Assumptions in Evolutionary Genetics

Levels of Selection



- Evolution by natural selection requires
  - Heritable…
  - Variance…
  - in Fitness.

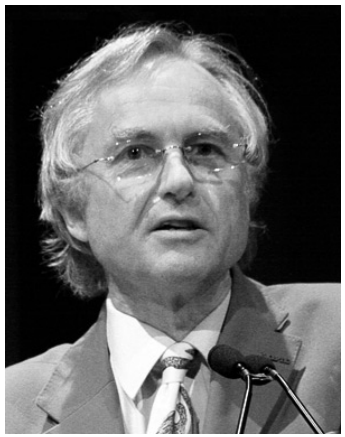


- At which levels are Lewontin's three conditions met?
  - Gene
  - Organism
  - Group…

Richard Dawkins' Program

- Genes act "selfishly"
  - a tale of competition from the gene-eye's view
  - no higher-level selection

- Dawkins adds significant amounts of philosophy, ethics, and ideology. Will focus on the science.



Fisherian Assumptions

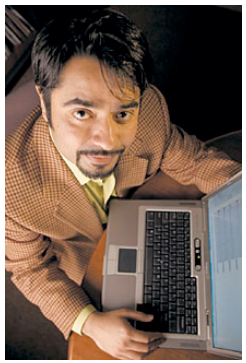
- Infinitely large, unstructured populations
- No fitness interactions among gene loci
- No phenotypic plasticity

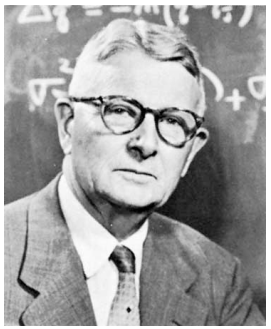
Strong idealizing assumptions
for evolutionary genetic models!

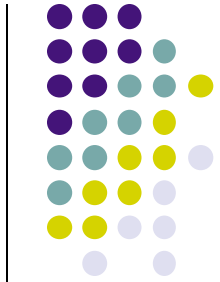
Dawkins reifies these assumptions…

A Hierarchical, Systemic Darwinism Alternative

- Fisherian assumptions rarely hold empirically but are often reified
- Dawkins can be subsumed under a general hierarchical and systems approach
  - many evolutionary forces (…genetic drift, migration)
  - multiple levels of selection (sometimes entwined)
  - selfish gene can fall out as a special case (e.g., Einstein → Newton)

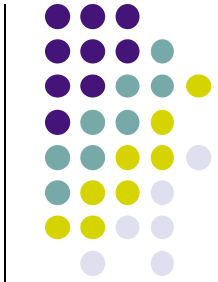






(4) Next Stop?

A Sense of Urgency

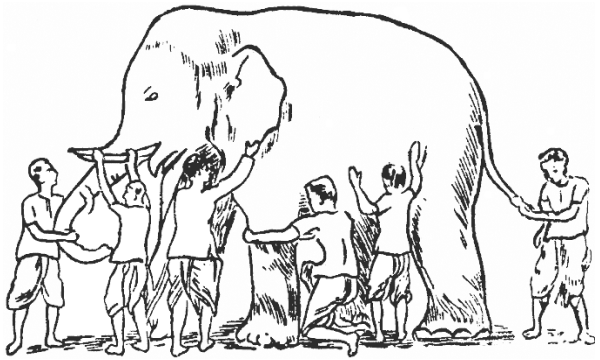


- Many urgent problems: genomic, medical, ecological…

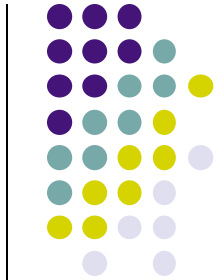
- Abstractions allow us to address such problems
  - the promises/power and limits/weaknesses of abstractions
  - entwinement of ontology (nature) and epistemology (abstractions)
  - beware of reification – need a critical, self-conscious attitude to abstractions (models, methodologies, theories)

Accepting and Overcoming Reification

- The blind men and the elephant…
  …or the wise, dialoguing blind women?



- Reality is complex and difficult to understand
- Abstraction is necessary, but must be understood, critiqued, and guided



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