Aspects of the Philosophy of Systematics

Tasmania
Explore the possibilities

Dr Catherine Byrne – Tasmanian Museum and Art Gallery

“Science depends on judgments of the bearing of evidence on theory.... One of the central aims of the philosophy of science is to give a principled account of those judgments and inferences connecting evidence to theory.”

Peter Lipton (2001: 184, Inference to the best explanation). In: *A Companion to the Philosophy of Science*.

Basic Criteria for Judging Methods in Biological Systematics

- Recognize the goal of Science.
- The goal of biological systematics should be consistent with this goal.
- Does a particular systematics method satisfy the goal of Science?
- Does a particular systematics method accurately represent our perceptions and why-questions?

The Goal of Science: To *Causally Understand* What We Observe

"Broadly speaking, the vocabulary of science has two basic functions: first, to permit an adequate *description* of the things and events that are the objects of scientific investigation; second, to permit the establishment of general laws or theories by means of which particular events may be *explained* and *predicted* and thus *scientifically understood*; for to understand a phenomenon scientifically is to show that it occurs in accordance with general laws or theoretical principles."

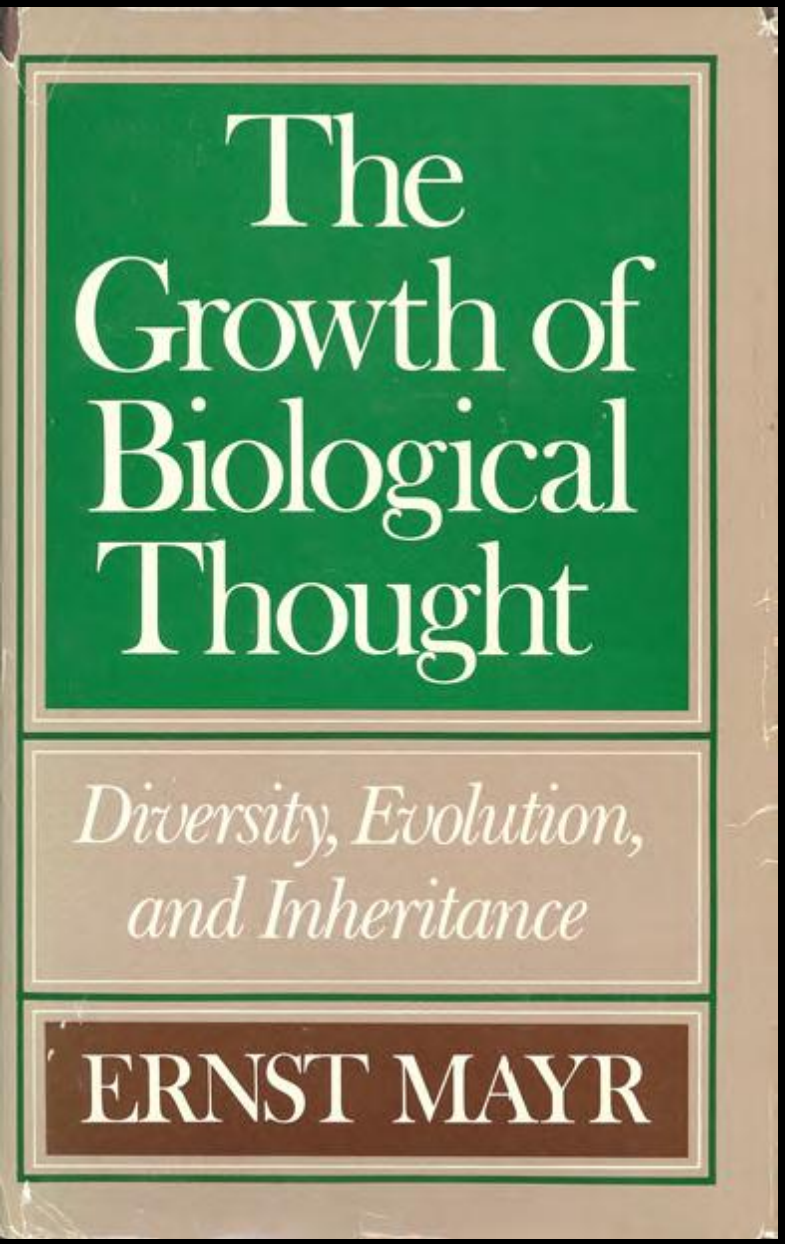
Hempel (1965: 139, *Aspects of Scientific Explanation*

The Goal of Science: To *Causally Understand* What We Observe

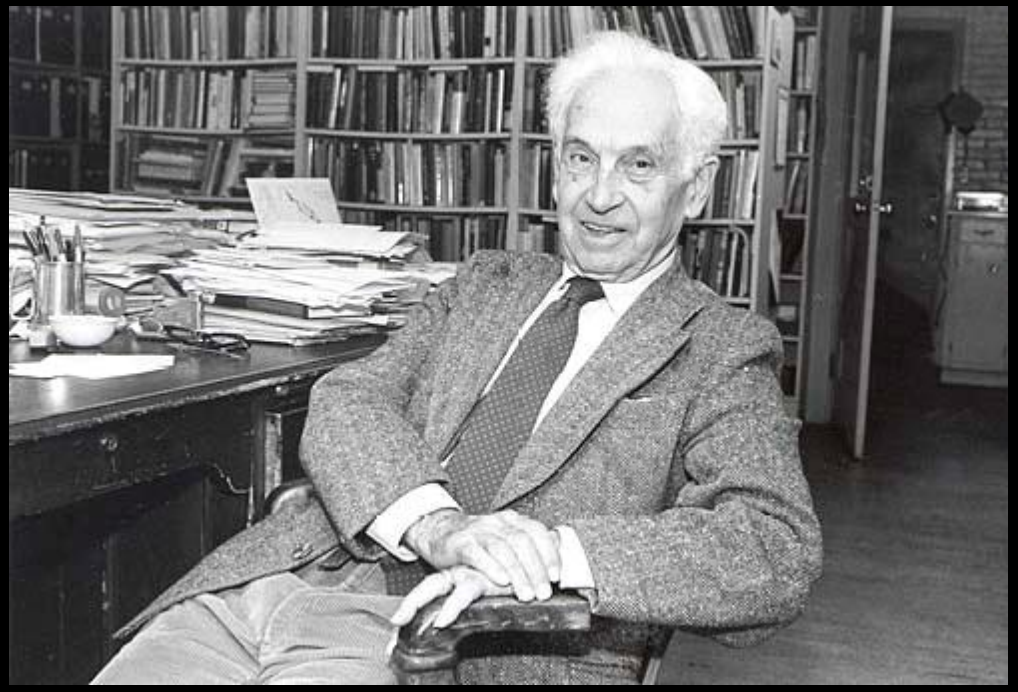
Scientific inquiry has two fundamental components:

Descriptive: observations

Theoretical: inferences of hypotheses and theories



"...biology can be divided into the study of proximate causes, the subject of the physiological sciences (broadly conceived), and into the study of ultimate (evolutionary) causes, the subject matter of natural history...." Mayr (1982: 67)



Biological Understanding *sensu* Mayr

proximate

ontogenetic / functional

ultimate

evolutionary

Biological Understanding *sensu* Mayr

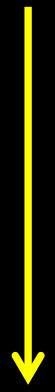
descriptive biology

(observation statements)

"*It is sometimes overlooked how essential a component in the methodology of evolutionary biology the underlying descriptive work is.*"

Mayr (1982: 70)

proximate



ontogenetic/ functional

ultimate

evolutionary

Goal of Science – acquire ever-increasing understanding:

- *descriptive*
- *causal - proximate / ultimate*
- *predictive*

What is the Goal of Biological Systematics?

Some common answers

- “To explain shared similarities among a group of organisms.”
- “To discover natural, hierarchical order, then reflect that order in classifications.”
- “To show the phylogeny/evolutionary history of a group of organisms.”

ARE ANY OF THESE GOALS CONSISTENT WITH THE OVERALL GOAL OF SCIENCE?

What is the Goal of Biological Systematics?

A Formal Definition of Biological Systematics

The actions of biological systematisation. The goal of which is to obtain causal understanding of the properties or characters of organisms exhibited at different stages of their life history or shared among some set of individuals.

What is the Goal of Biological Systematics?

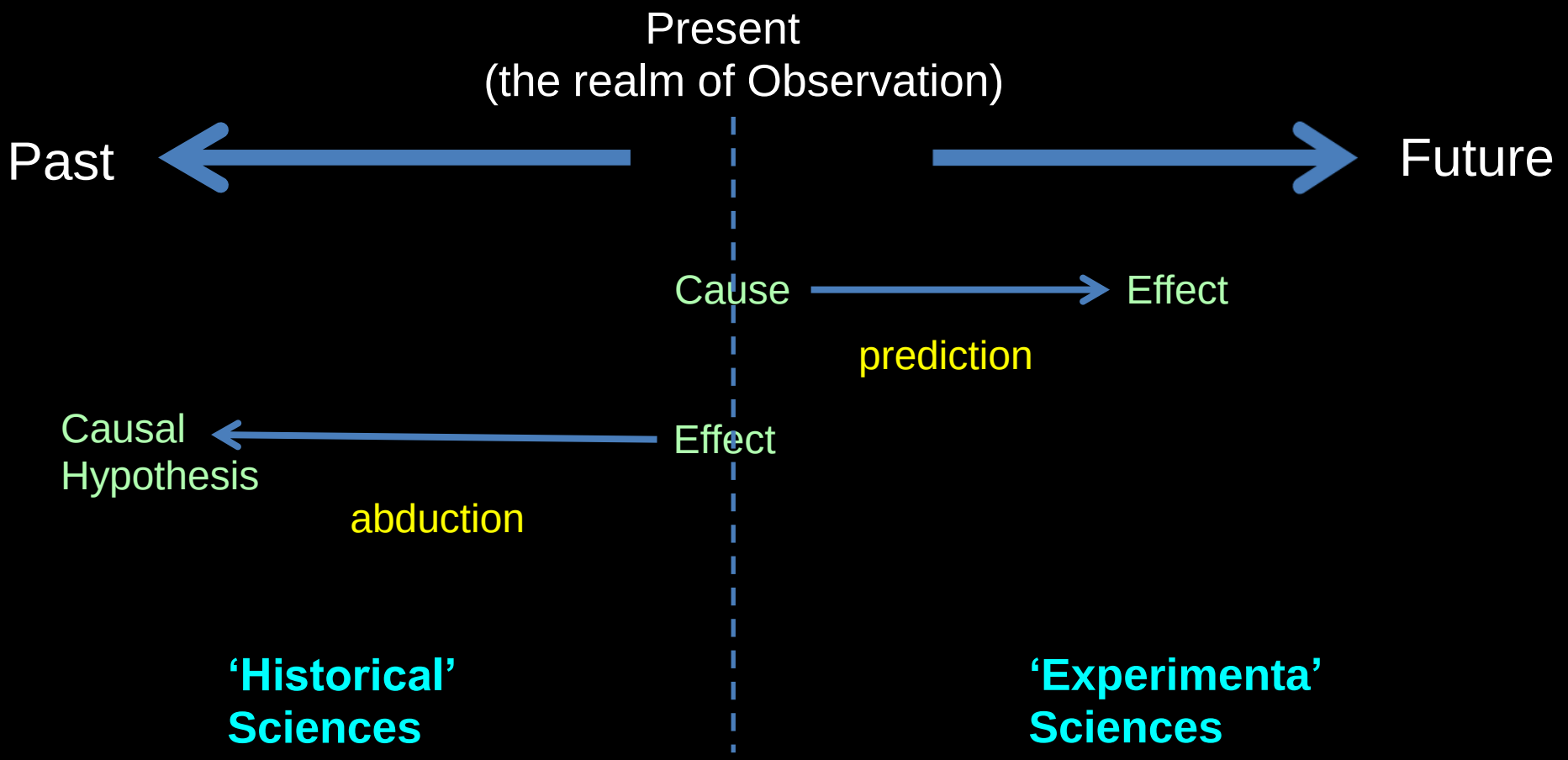
Some Consequences:

• Biological systematics involves the non-deductive inference of explanatory hypotheses and, where possible, their subsequent testing.

• The goal of biological systematics is to move toward ***causal understanding*** of what we observe, not merely to obtain "cladograms," "trees," or to "reconstruct phylogeny."

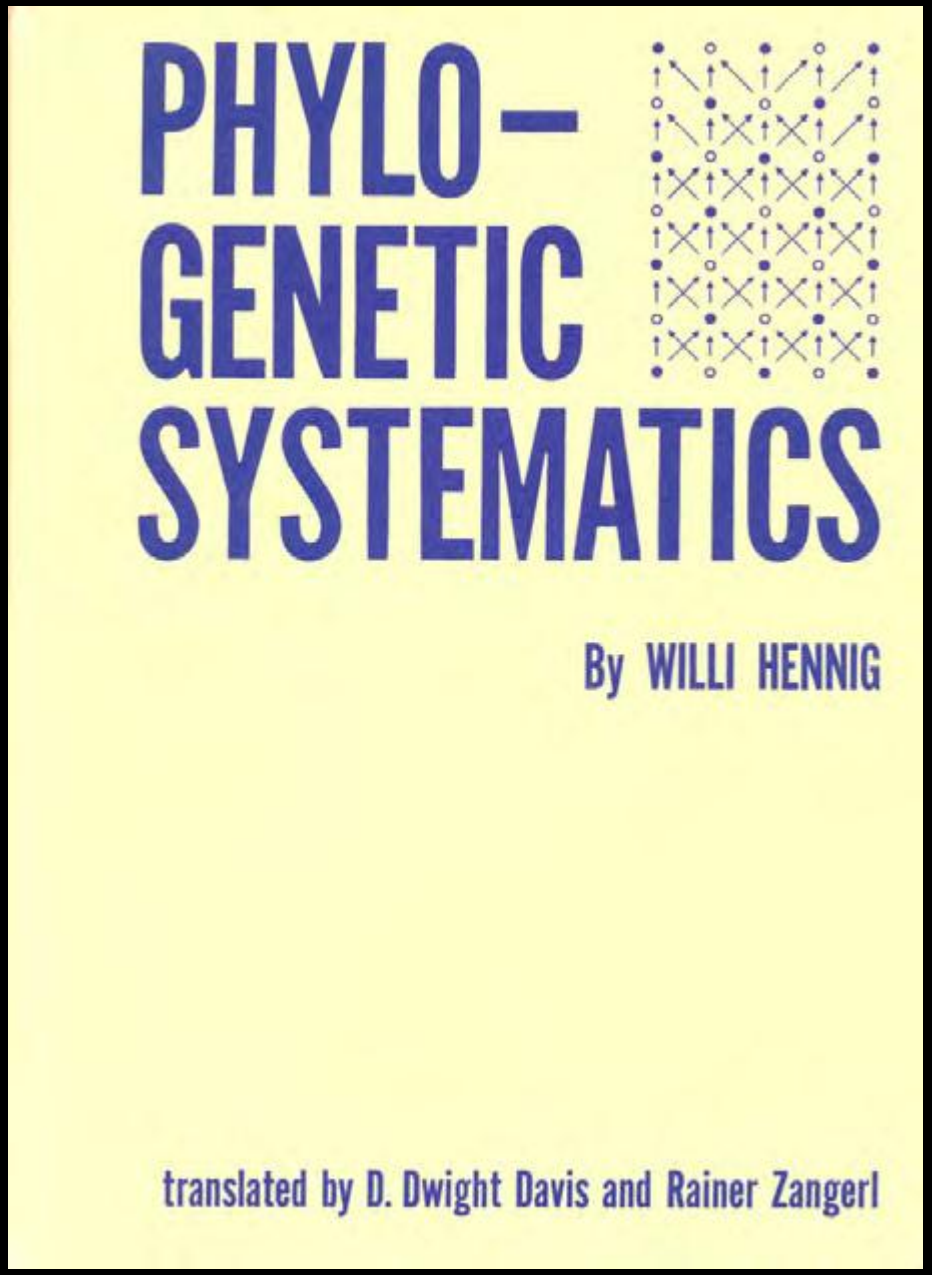
• "Cladograms" are not *things* in themselves, but are very limited ***explanatory hypotheses*** of observed properties of individuals among different taxa.

The Two Realms of Science



Biological systematics is part of the “historical sciences,” where observations in the present are used to infer explanatory hypotheses about past events to account for those observations.

Hennig, W. 1966.
Phylogenetic Systematics



Classes of Relationships

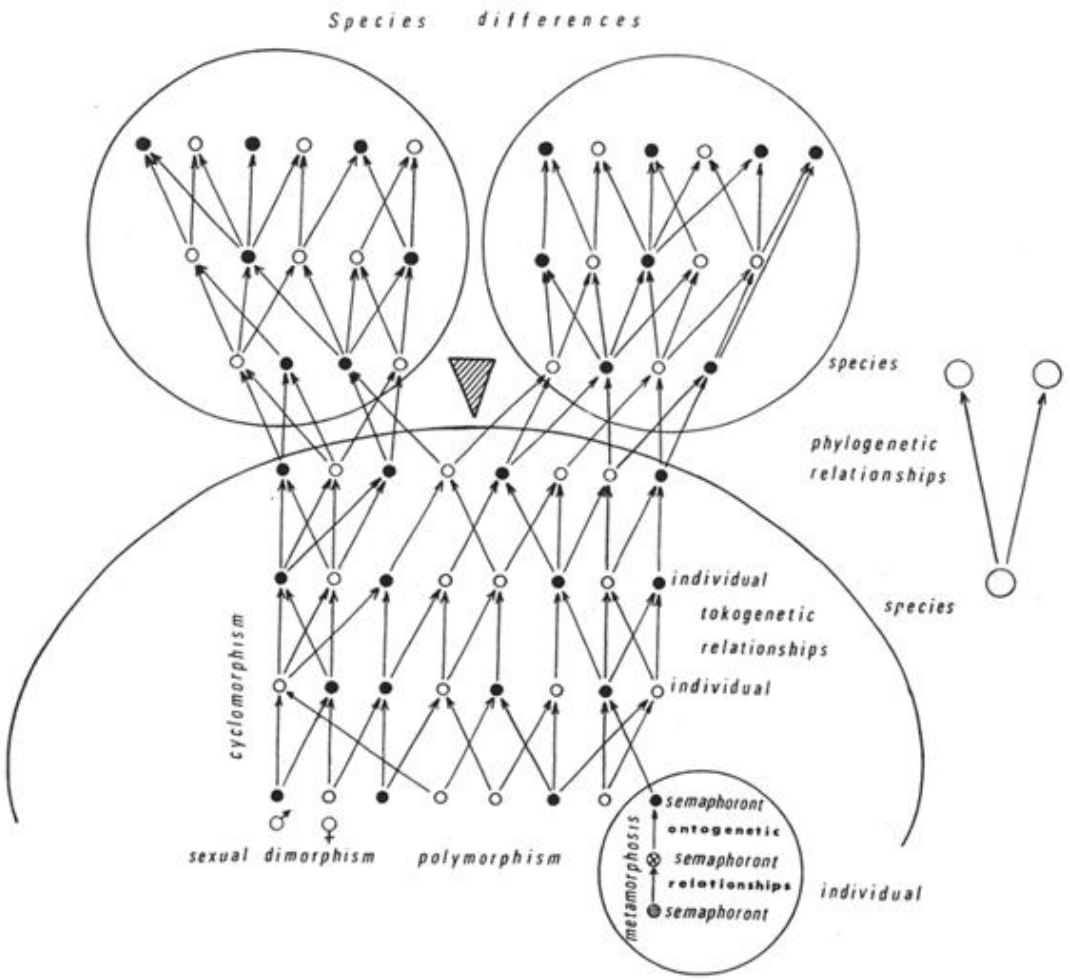


Figure 6. The total structure of hologenetic relationships and the differences in form associated with its individual parts.

1. Ontogenetic
2. Cyclomorphic
3. Sexually dimorphic
4. Tokogenetic
5. Polymorphic
6. Specific
7. Phylogenetic

Each of these classes of relationships refer to the different classes of explanatory hypotheses we call **taxa**.

Classes of Relationships

Kingdom
Phylum
Class
Order
Family
Genus

phylogenetic hypotheses

Ultimate explanations

Species — specific hypotheses
Subspecies — intraspecific hypotheses
Families, demes, populations — tokogenetic hypotheses

Individuals — the objects we perceive

Descriptive explanations
(observation statements)

Semaphoronts — ontogenetic hypotheses
(e.g., ‘larva,’ ‘juvenile,’ ‘adult’)

Proximate explanations

The Foundation for All of Systematics

The Nature of Our Why-Questions

If the goal of biological systematics is to provide causal understanding of the properties of organisms, then we must first recognize the nature of our why questions, to which evolutionary theories and systematics hypotheses provide answers.

Why-Questions

The proper form: Contrastive questions

“Why *P* in contrast to *X*?”

Example: “Why do these specimens have lateral body wall extensions (= appendages) *in contrast to* other specimens with convex body walls?”

P

X

The Fundamentals of Inference

Inference:
The act of reasoning from a statement (premise) or statements (premises), to a conclusion or set of conclusions.

Two Types of Inference Have Traditionally Been Recognized

1. Deduction:

Inferences in which a conclusion drawn from a set of (true) premises cannot contradict those premises, and therefore must also be true.

- All humans are mortal
- Cathy is human

- Cathy is mortal

Two Types of Inference Have Traditionally Been Recognized

2. Induction:

Inferences in which similarities are identified between observed objects or events of a given class, and hypothetically extended to unobserved objects or future events of that class.

- Cathy is human
- Cathy is mortal

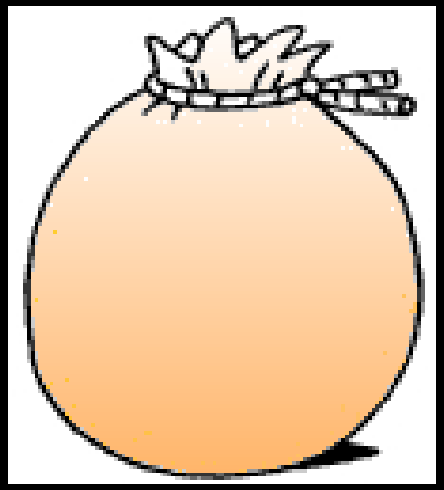
- All humans are mortal

The Structure of Inferences

1. Rule: a law, empirical generalization, or theory, often stating a relation between cause and effect;

2. Case: a statement about a thing(s), or event(s), in the form of causal or initial conditions;

3. Result: a statement of a consequence or effect that is related to the ‘Case.’



Deduction

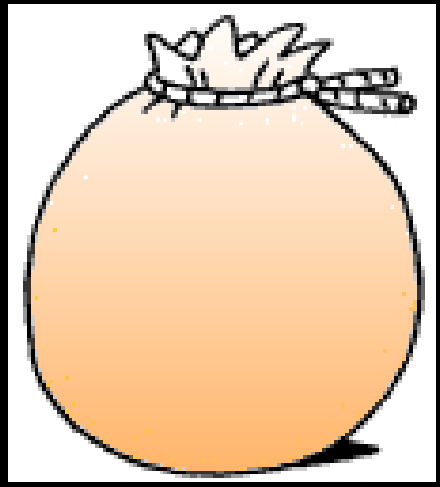
A Simple Example

Rule: All marbles in this bag **[M]** are red **[P]**. **TRUE**

Case: This marble **[S]** is from this bag **[M & P]** **TRUE**

Result: This marble **[S]** is red **[P]**. **TRUE**

S = subject
P = predicate
M = ‘middle term’



Induction

A Simple Example

Case: These marbles **[S]** are from this bag **[M & P]** **TRUE**

Result: These marbles **[S]** are red **[P]**. **TRUE**

Rule: All marbles in this bag **[M]** are red **[P]**. **TRUE/FALSE**

S = subject
P = predicate
M = 'middle term'

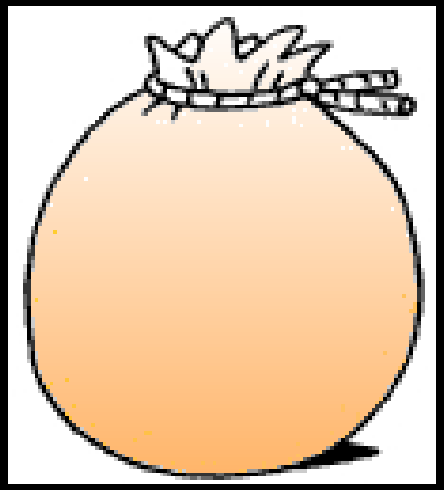
A Third Type of Inference is Often Recognized

Abduction:

Reasoning from observed effects in the present (consequents) to a conclusion(s) of possible cause (or causes) in the past (antecedent).

Abduction is also the form of inference used to develop our observation statements.

As a result, abductive inference is the most common type of reasoning we use on a daily basis.



Abduction

A Simple Example

Rule: All marbles in this bag **[M]** are red **[P]**. **TRUE**

Result: This marble **[S]** is red **[P]**. **TRUE**

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S = subject
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Abductive Inference as the Mechanism for Theory Formation

Background knowledge:

variation/inheritance/differential survival and reproduction

Tentative theory:

Based on what is known of the actions of artificial selection, in conjunction with the above background knowledge, maybe an analogous system of cause and effect relations exists in nature:
Natural selection - organisms with traits that enhance survival and reproduction will leave offspring with those traits.

Observations:

There are differentially shared traits among these observed organisms.

Hypothesis:

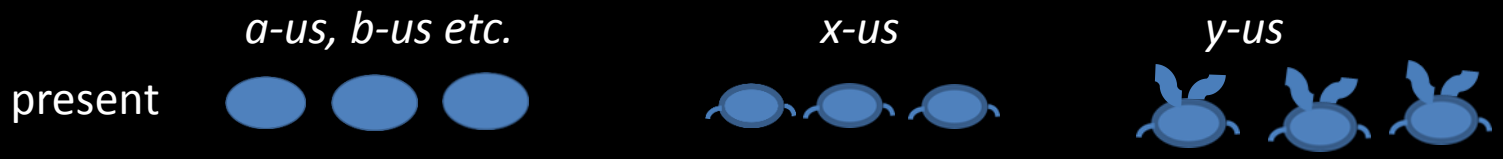
Variation arose in an ancestral population, subsequent to which the traits in question allowed for enhanced survival and reproduction.

Causal Relationships (Taxa) in Biological Systematics

If the goal of biological systematics is to provide causal explanations for the phenomena of differentially shared characters among organisms, then...

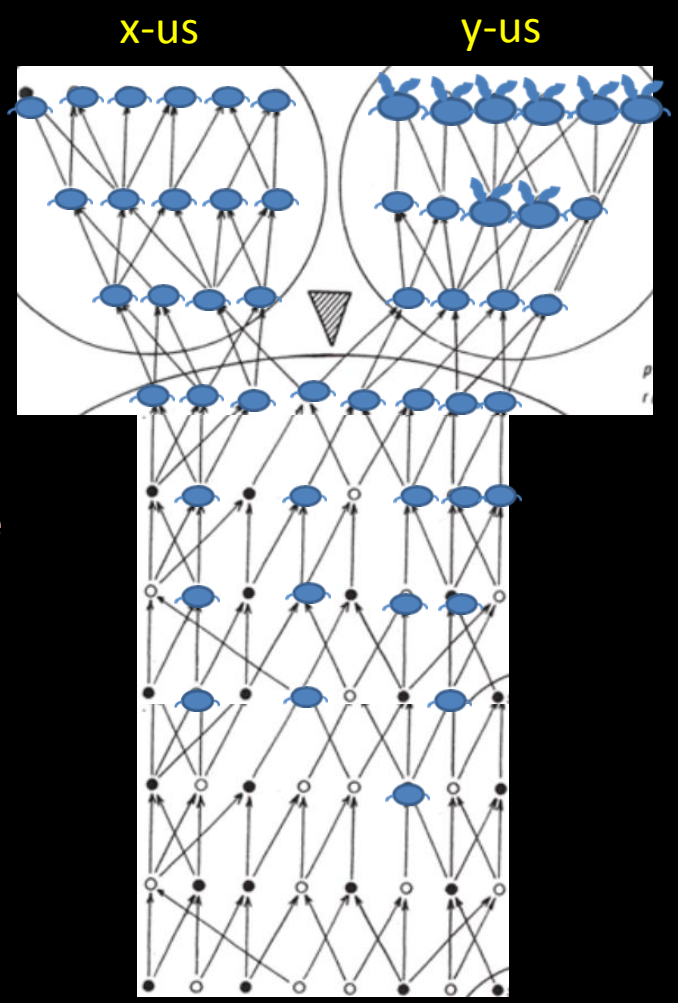
the inferential structure of almost all of systematics is ABDUCTIVE.

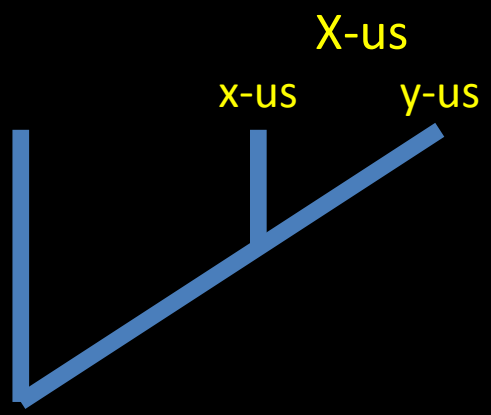
Species hypotheses:



new observations

Causal Conditions (phylogenetic hypothesis X-us):
Ventrolateral margin appendages originated by some unspecified mechanism(s) within a reproductively isolated population with smooth ventrolateral margins, and the appendage condition became fixed in the population by some unspecified mechanism(s) (= ancestral species hypothesis), followed by an unspecified event(s) that resulted in two or more reproductively isolated populations.





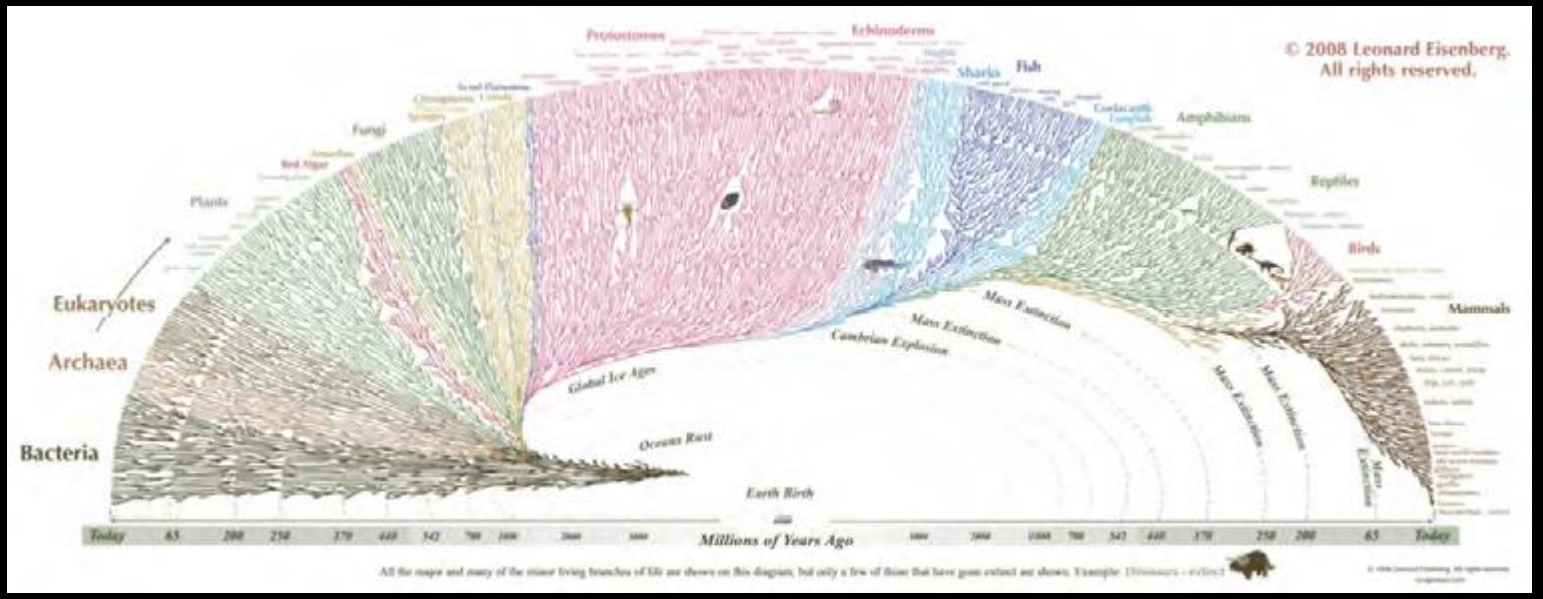
The Limits of Phylogenetic Hypotheses

Phylogenetic hypotheses present very limited causal events.

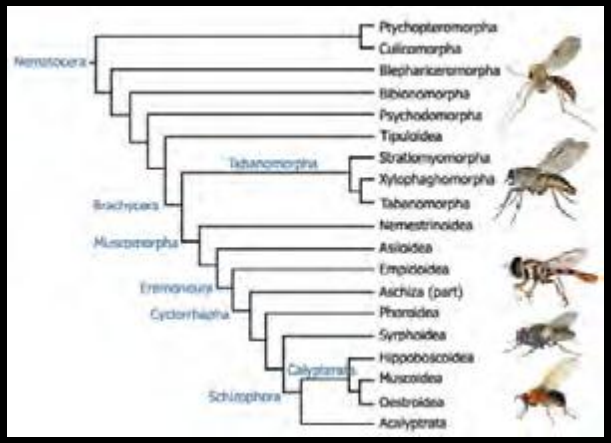
Phylogenetic hypotheses, as graphically represented by ‘cladograms,’ are *explanation sketches* consisting of two classes of causal conditions:

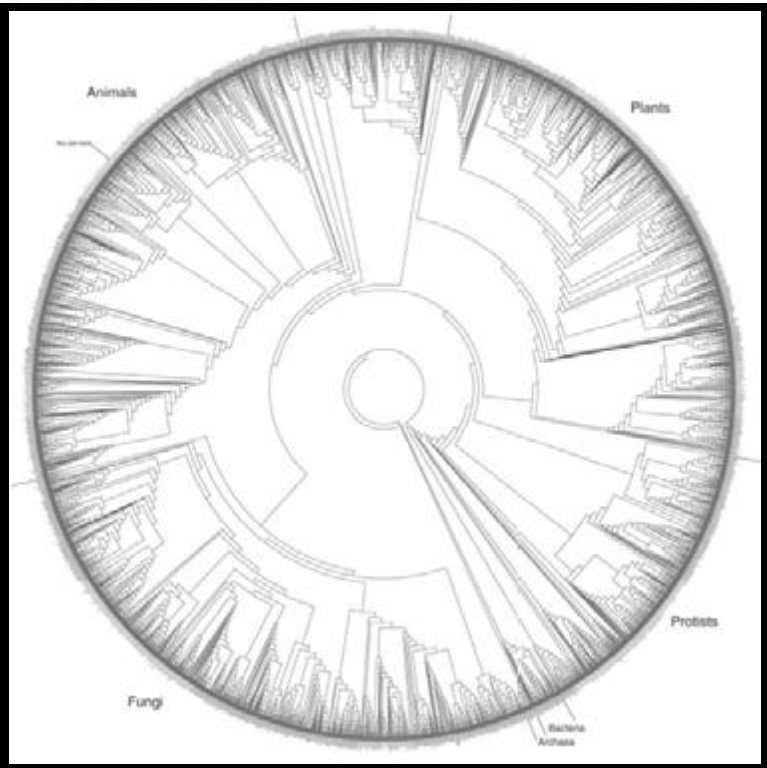
1. character origin and fixation by unspecified causal events among members of an ancestral population/species,
and...
2. subsequent population splitting events by unspecified causal events.

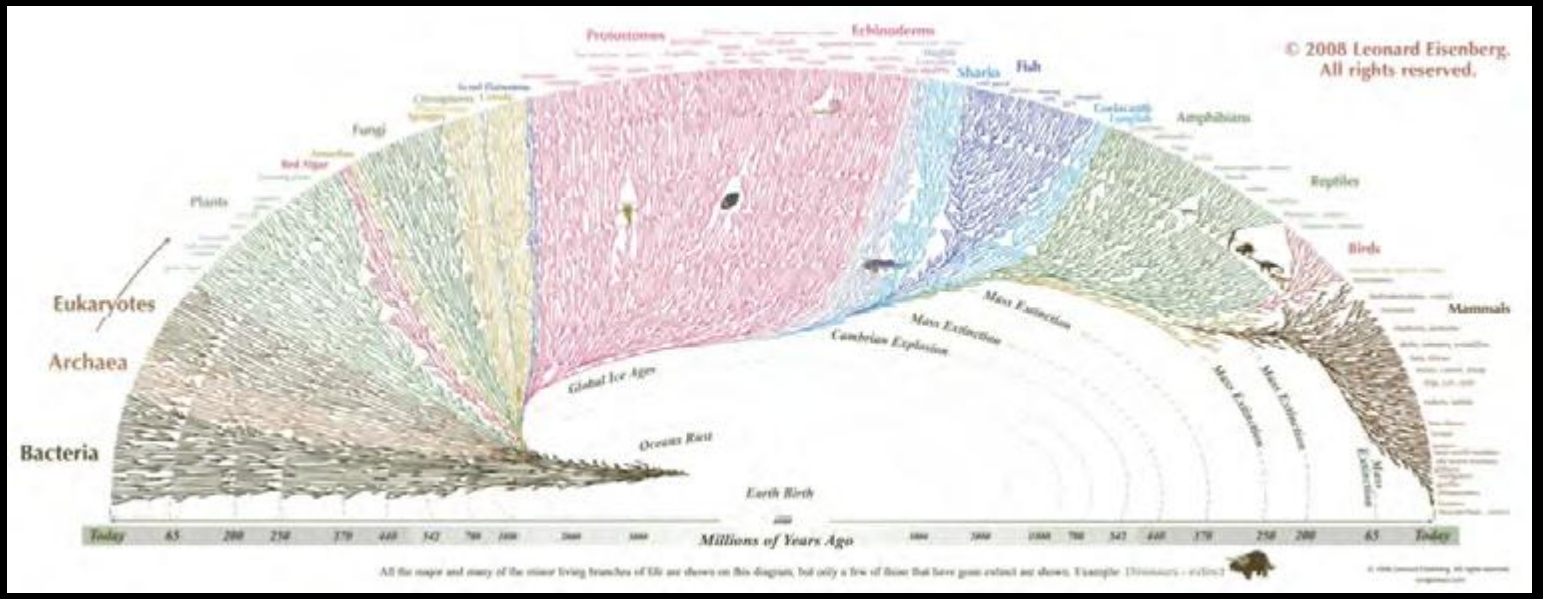
The explanatory depth of cladograms is extremely limited. Cladograms do not provide specific information regarding causal conditions which can serve as complete explanations.



‘Phylogenetic trees’



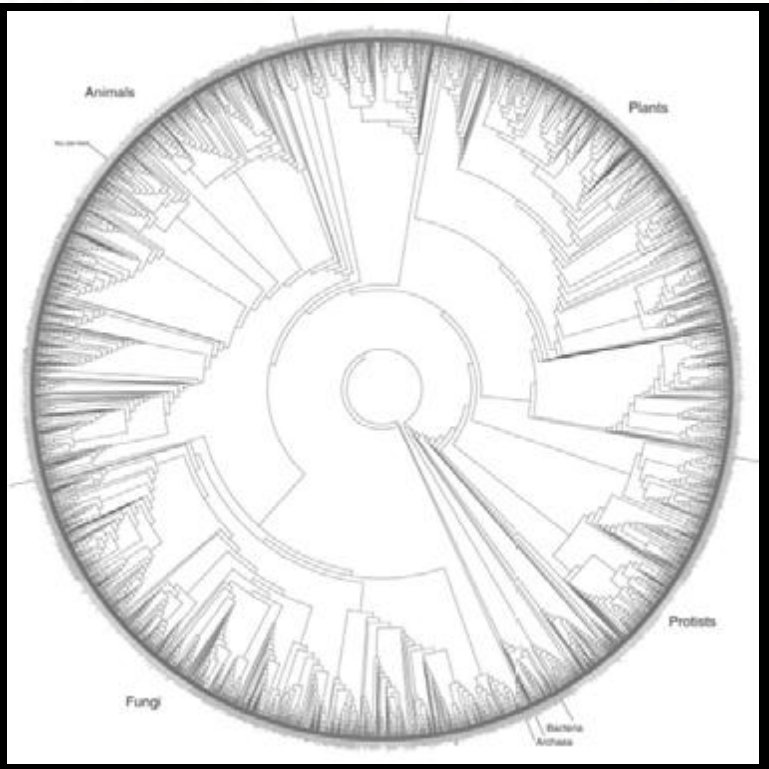




‘Phylogenetic trees’

~ Fallacy of reification ~

Reification: Regarding something abstract as a material thing.



“If science is not to degenerate into a medley of *ad hoc* hypotheses, it must become philosophical and must enter into a thorough criticism of its own foundations.”

Alfred North Whitehead (1925: 25), *Science and the Modern World*.