Morphology and Morphometrics

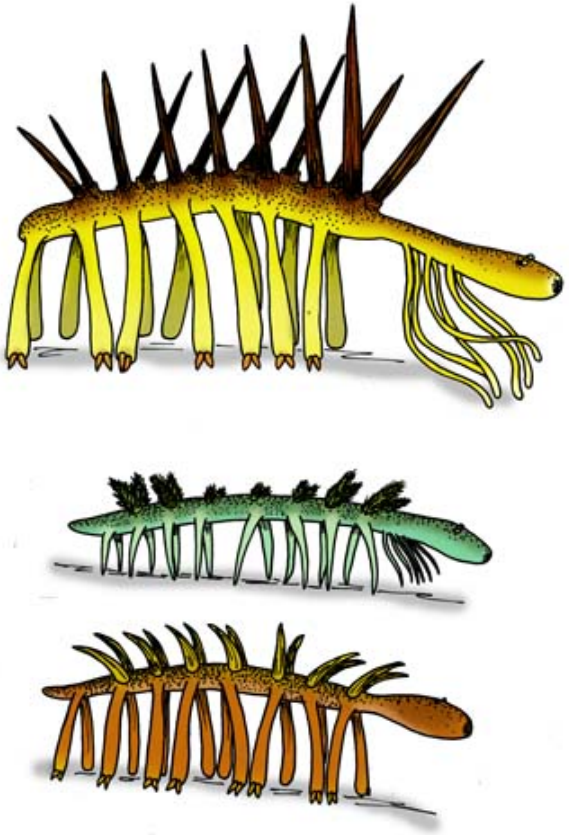
Paleobiology

Origination I (Living)

Monday 25, 2016

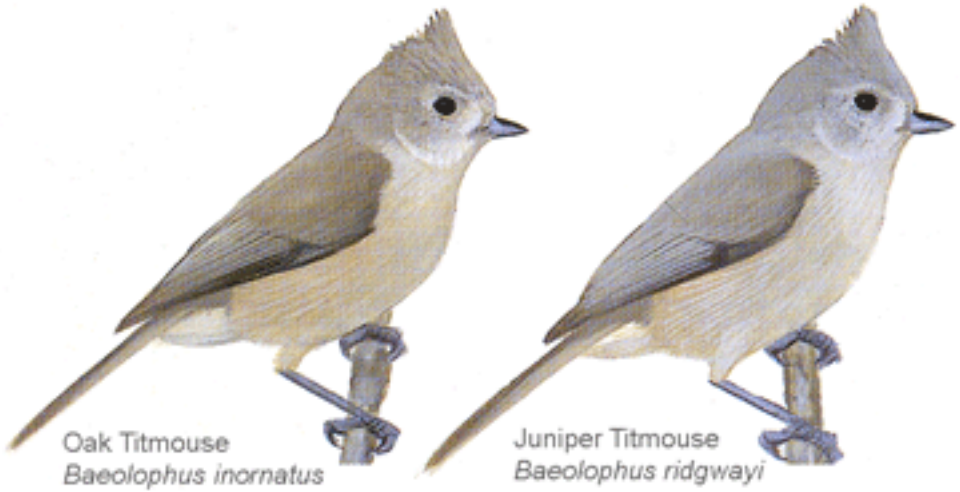
Morphospecies are the only option

MORPHOSPECIES ARE THE ONLY OPTION



MORPHOSPECIES ARE THE ONLY OPTION

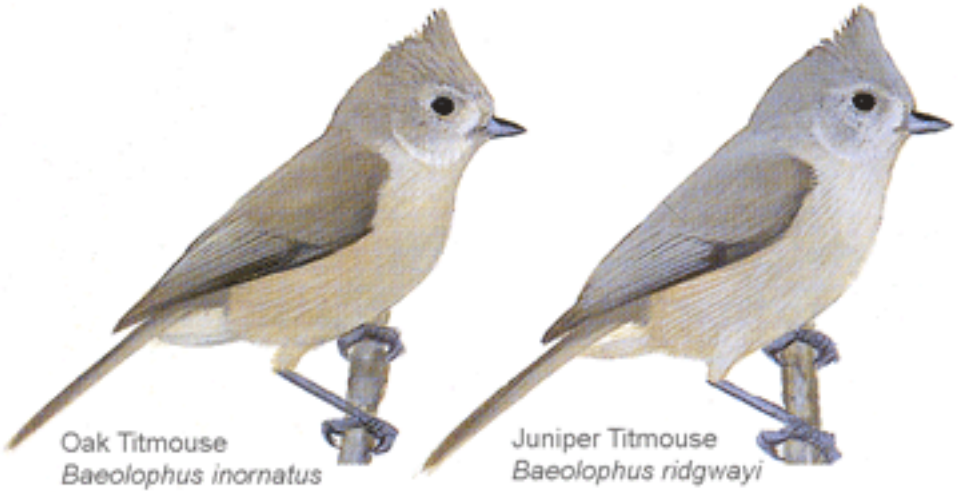
CRYPTIC AND SIBLING SPECIES



Before DNA: For 151 years these common North American birds were considered a single species, although differences in song and range were noted.

Some bird species are indistinguishable by appearance

CRYPTIC AND SIBLING SPECIES



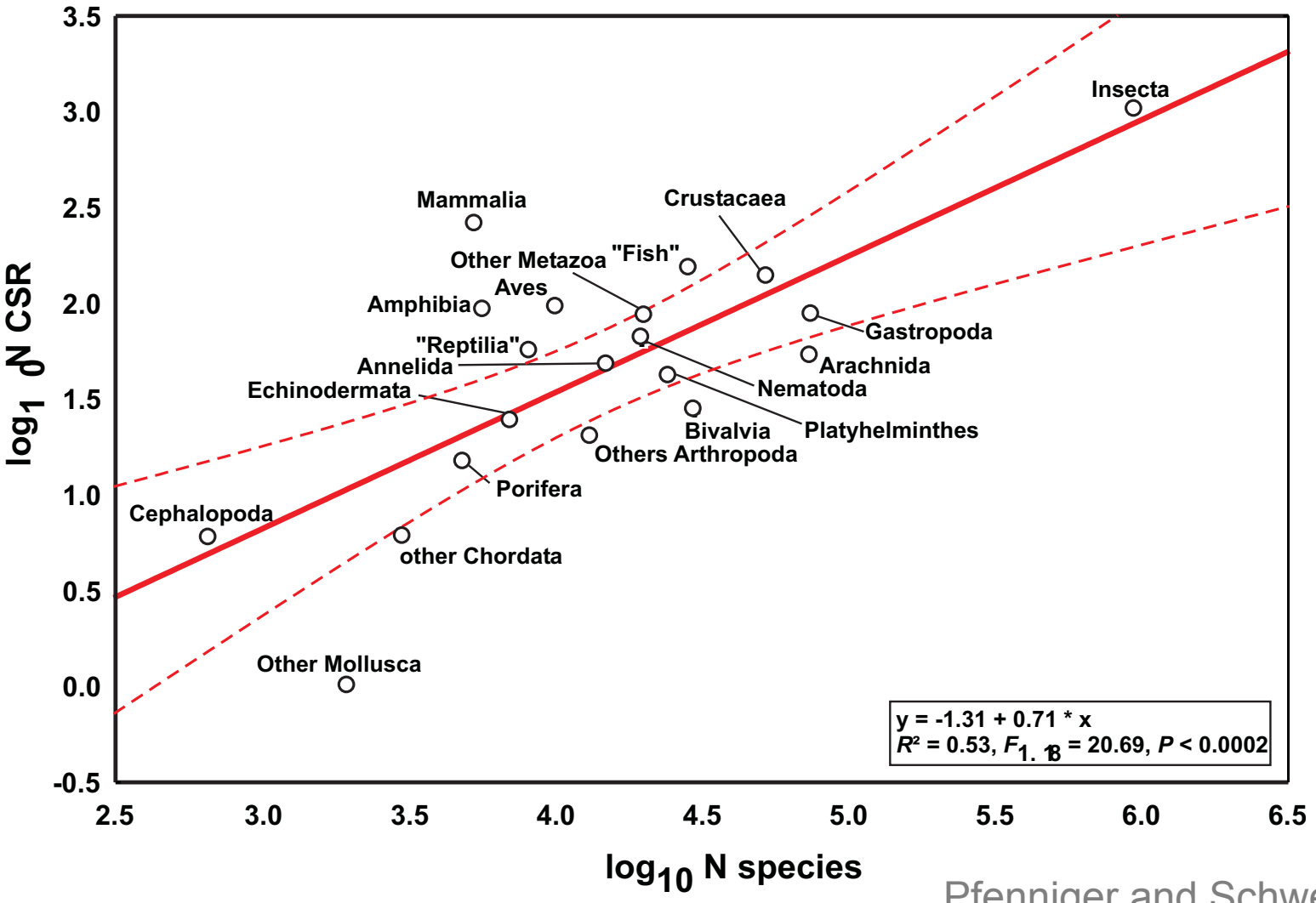
Before DNA: For 151 years these common North American birds were considered a single species, although differences in song and range were noted.

Some bird species are indistinguishable by appearance

Crassatella gibbosula

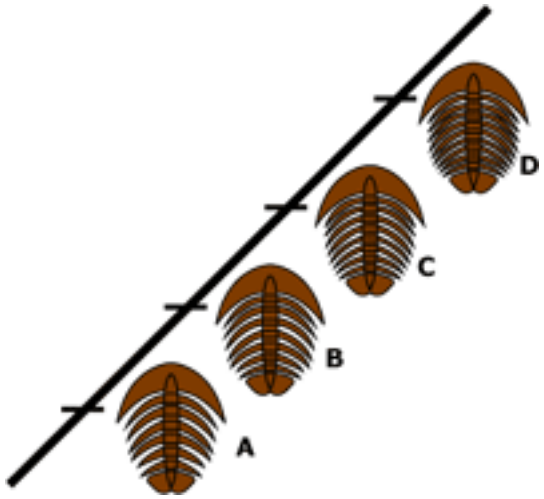
Marvacrassatella marylandica

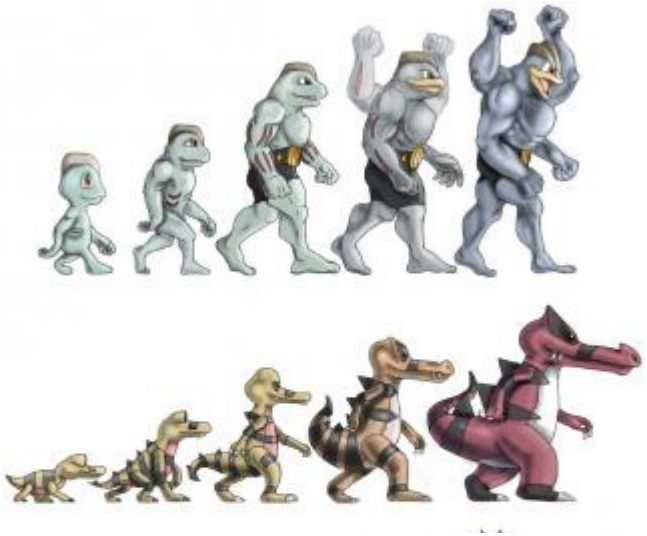
CRYPTIC AND SIBLING SPECIES

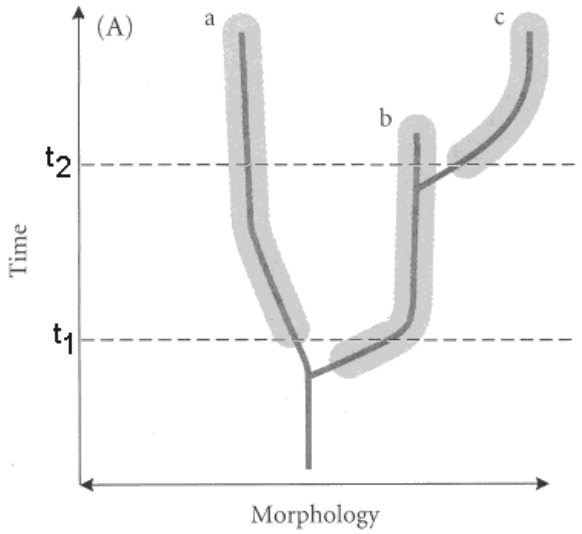


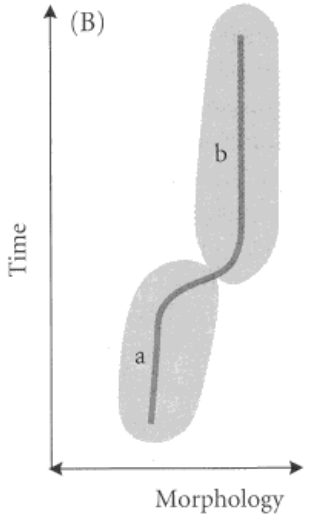
Pfenniger and Schwenk 2007

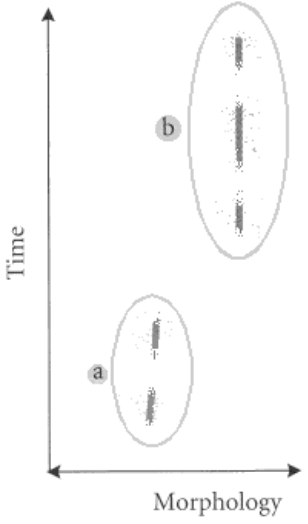
CHRONOSPECIES (AND PSEUDOEXTINCTION)



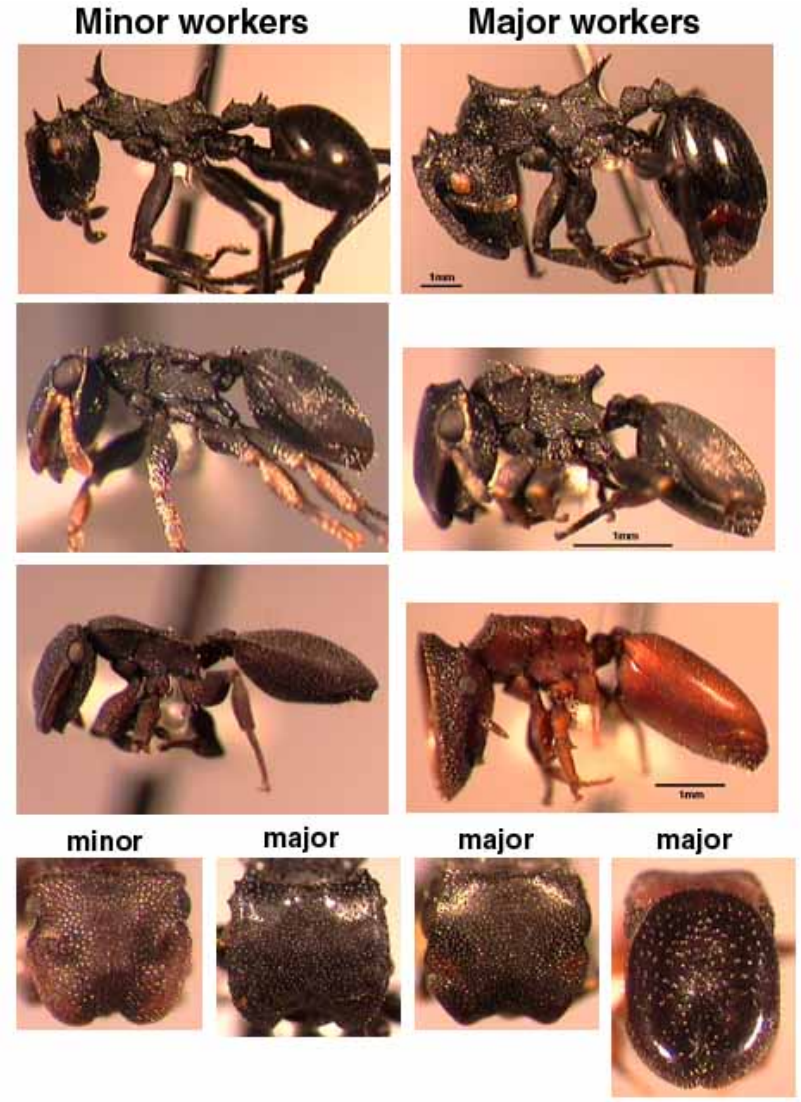


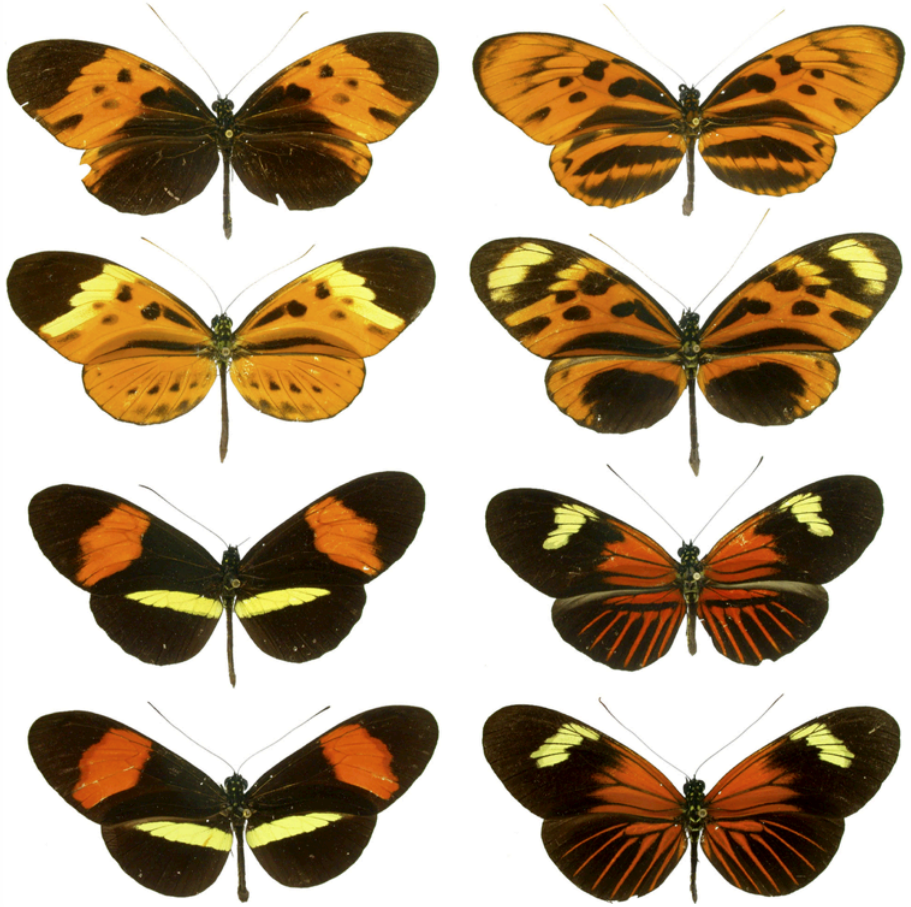






POLYMORPHIC SPECIES



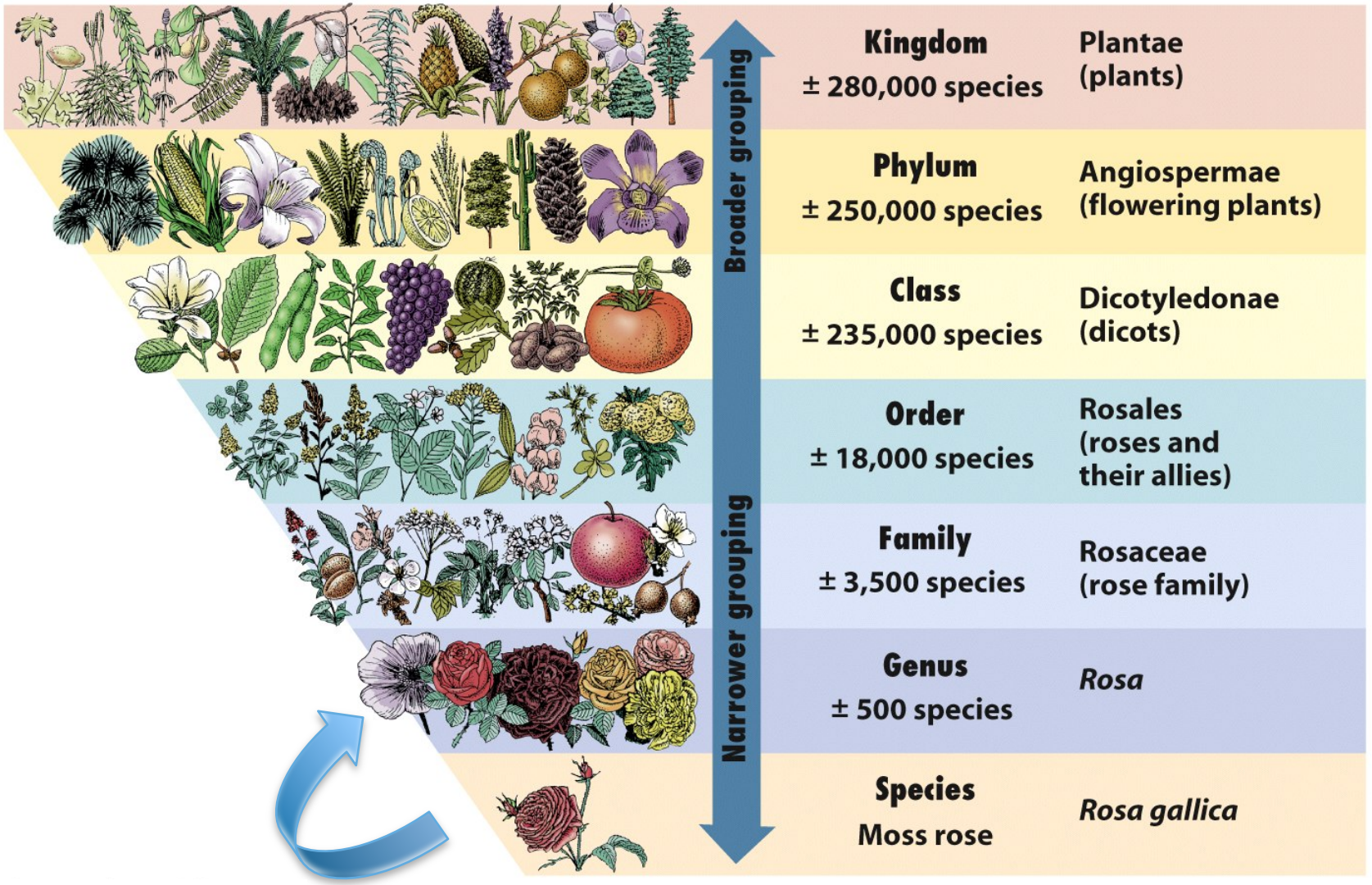


An underlying philosophical choice

Can you have a polymorphic species under a morphospecies paradigm?

A RETREAT TO HIGHER LINNEAN LEVELS

A RETREAT TO HIGHER LINNEAN LEVELS



The Linnean Hierarchy

Kingdom Phylum Class Order Family
Genus species

Kind People Cry Out For
Good samaritans

Keynsian Pandas Came Over For
Good sex

Kangaroos Punch Cowardly Frog

Gangsters savagely

A HIGHLY CONTROVERSIAL DECISION

Paleobiology, 40(4), 2014, pp. 511–528
DOI: 10.1666/13076

The Generification of the Fossil Record

Jonathan R. Hendricks, Erin E. Saupe, Corinne E. Myers, Elizabeth J. Hermsen, and Warren D. Allmon

Abstract.—Many modern paleobiological analyses are conducted at the generic level, a practice predicated on the validity of genera as meaningful proxies for species. Uncritical application of genera in such analyses, however, has led—perhaps inadvertently—to the unjustified reification of genera in an evolutionary context. While the utility of genera as proxies for species in evolutionary studies should be evaluated as an empirical issue, in practice it is increasingly assumed (rather than demonstrated) that genera are suitable proxies for species. This is problematic on both ontological and epistemological grounds. Genera are arbitrarily circumscribed, non-equivalent, often paraphyletic, and sometimes polyphyletic collections of species. They are useful tools for communication but have no theoretical or biological reality of their own and, whether monophyletic or not, cannot themselves operate in the evolutionary process. Attributes considered important for understanding macroevolution—e.g., geographic ranges, niche breadths, and taxon durations—are frequently variable among species within genera and will be inflated at the generic level, especially in species-rich genera. Consequently, the meaning(s) of results attained at the generic level may not "trickle down" in any obvious way that elucidates our understanding of evolution at the species level. Ideally, then, evolutionary studies that are actually about species should be pursued using species-level data rather than proxy data tabulated using genera. Where genera are used, greater critical attention should be focused on the degree to which attributes tabulated at the generic level reflect biological properties and processes at the species level.

A HIGHLY CONTROVERSIAL DECISION

"INCREASINGLY, IT IS COMMON TO READ REPORTS OF GENERIC-LEVEL ORIGINATION AND/OR EXTINCTION RATES (E.G., PETERS 2005, 2006; KIESSLING ET AL. 2010; FOOTE 2012) … WITH LITTLE OR NO EXPLICIT DISCUSSION OF THE PROXY STATUS OF GENERA OR THE RELATIONSHIP OF GENERIC-LEVEL PATTERNS TO UNDERLYING SPECIES-LEVEL PATTERNS AND PROCESSES (SEE ALSO FOOTE 2006; KRUG AND PATZKOWSKY 2007; ZAFFOS AND HOLLAND 2012).

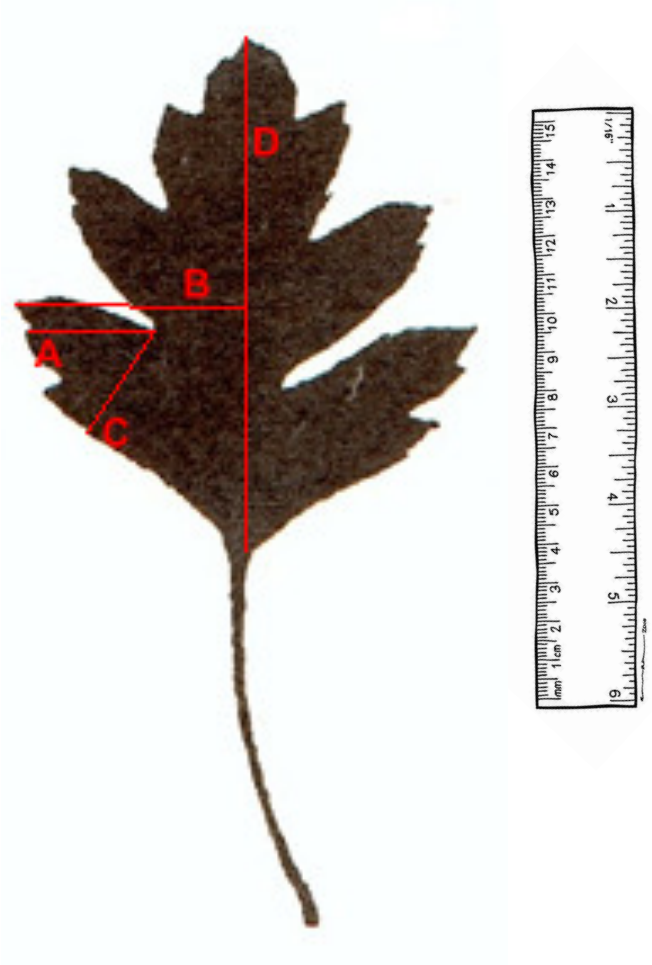
INTENTIONALLY OR UNINTENTIONALLY, THESE STUDIES LEAVE THE IMPRESSION THAT THE GENERA ANALYZED HAVE EVOLUTIONARILY SIGNIFICANT ATTRIBUTES THAT ARE POTENTIALLY INDEPENDENT O THOSE OF THEIR CONSTITUENT SPECIES."

First Day, Two Major Questions

1. Are fossil species, i.e., morphospecies, biologically meaningful entities that can teach us about ecology or evolution?

2. Are higher levels of the Linnean hierarchy, e.g., genera, a biologically meaningful proxy for learning about ecology or evolution?

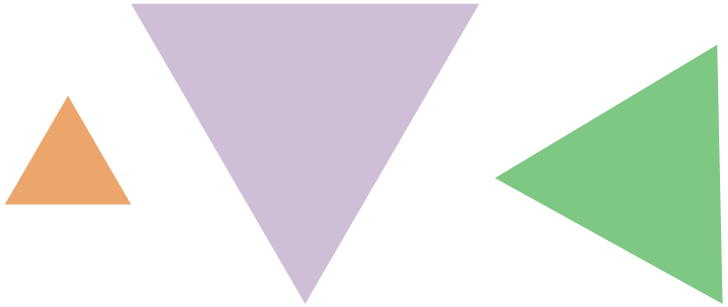
How to characterize morphology?



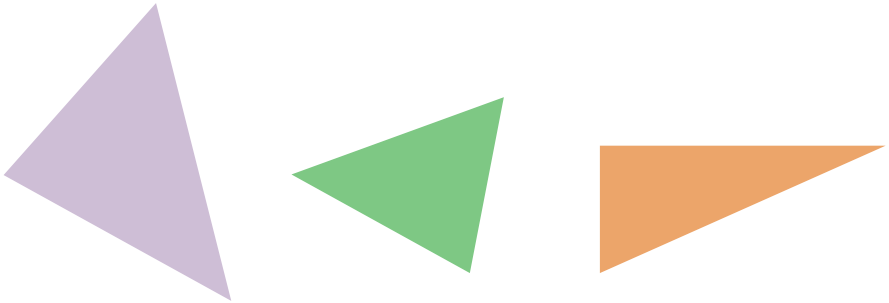
Size is a one dimensional measurement – e.g., length.

Shape is the **proportional** relationship of two or more aspects of size – e.g., length/ width.

THE TWO 'ASPECTS OF FORM'

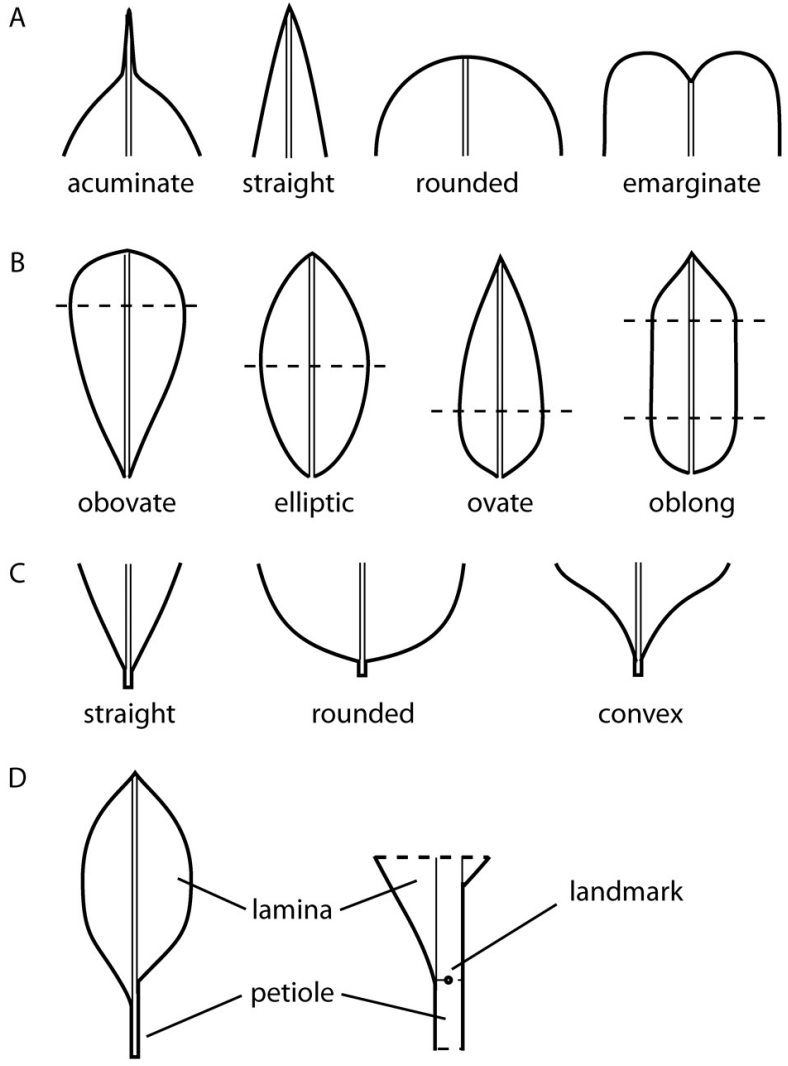


SAME SHAPE
DIFFERENT SIZE



DIFFERENT SHAPE
DIFFERENT SIZE

DESCRIPTIVE TERMINOLOGY



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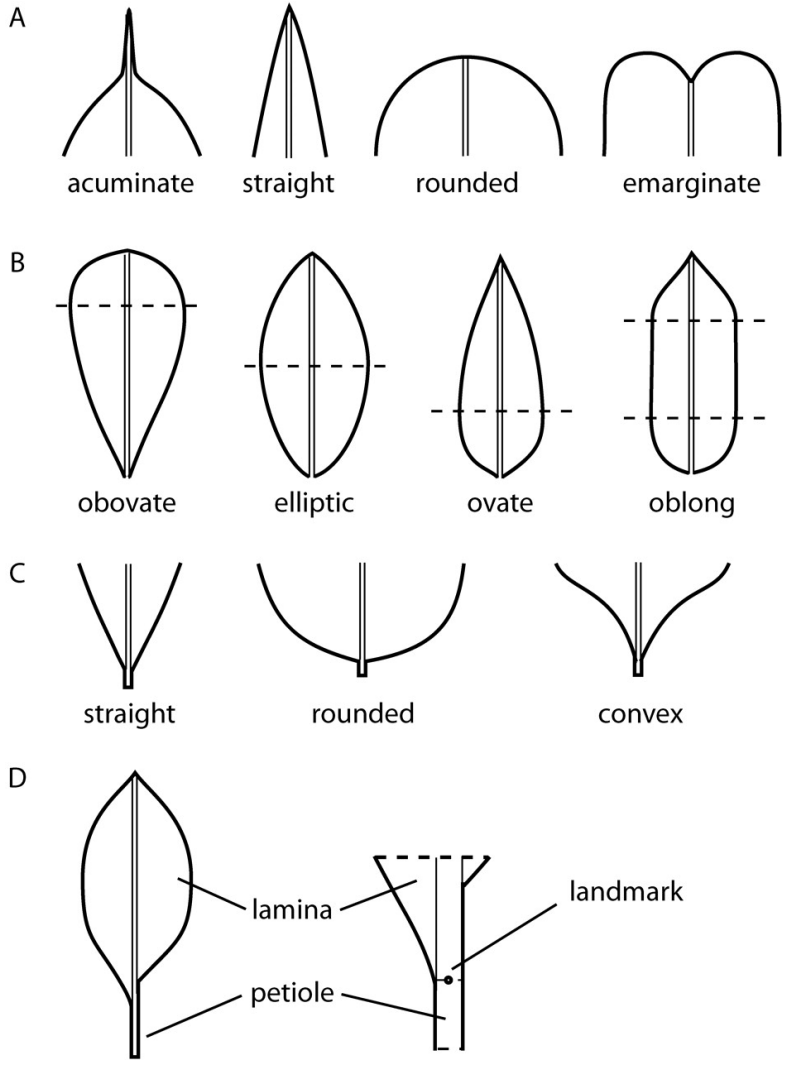
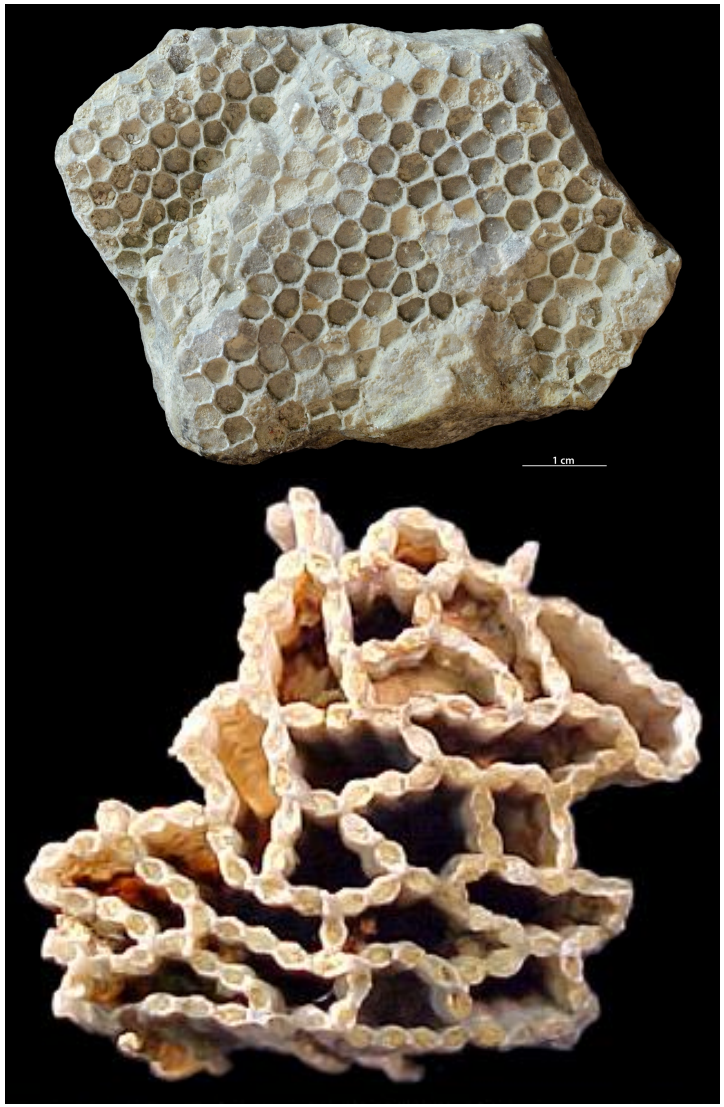
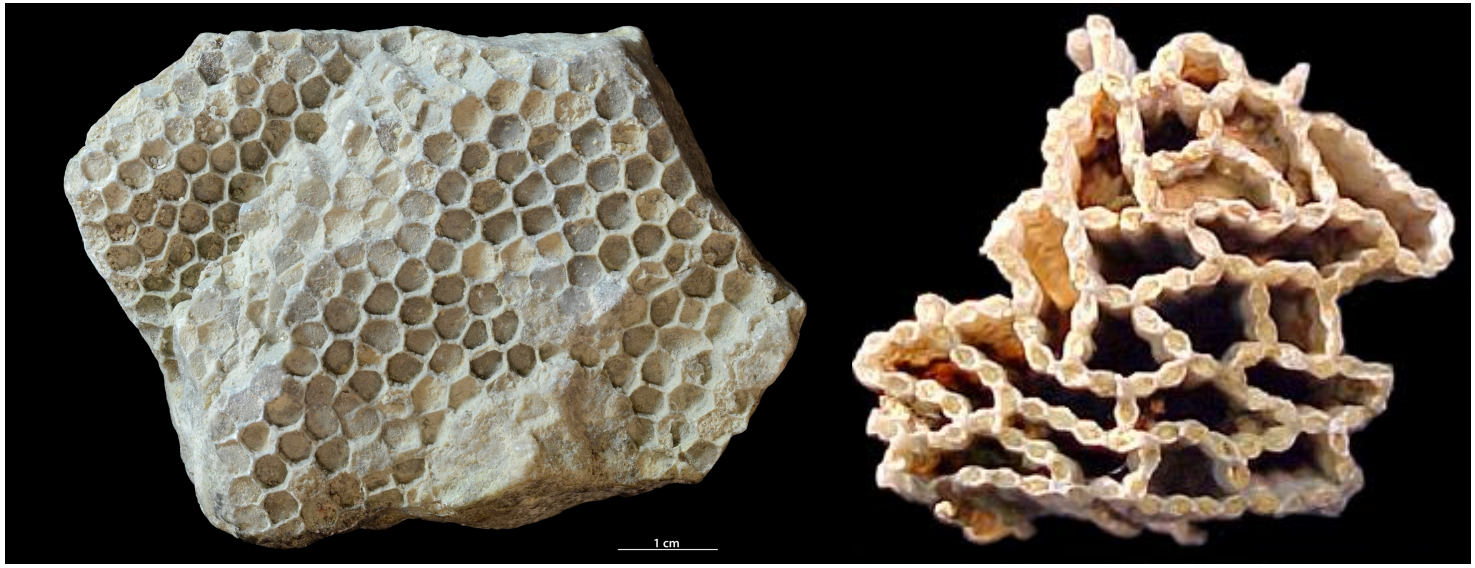
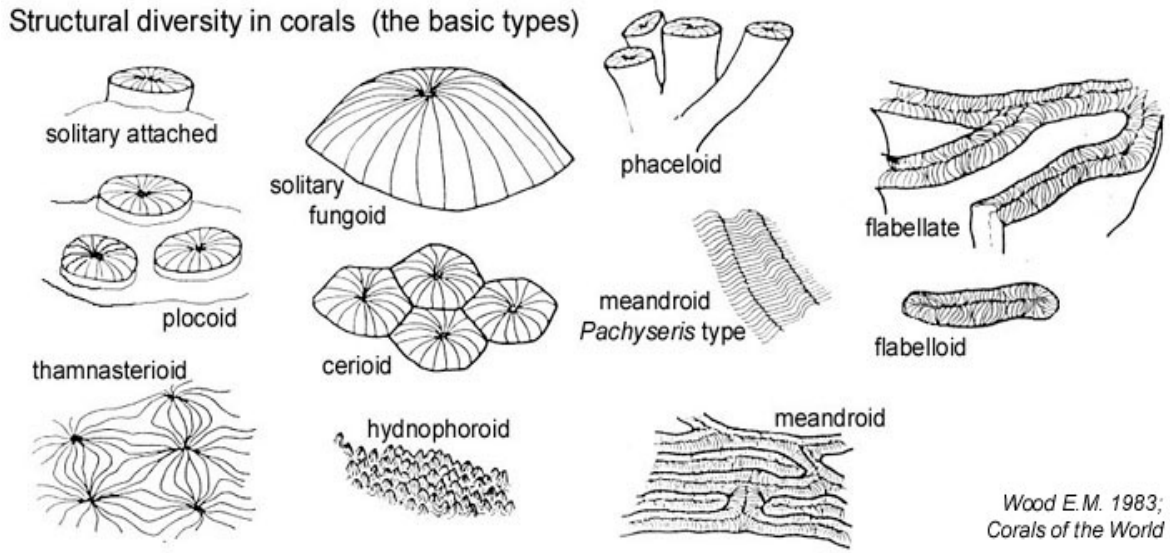


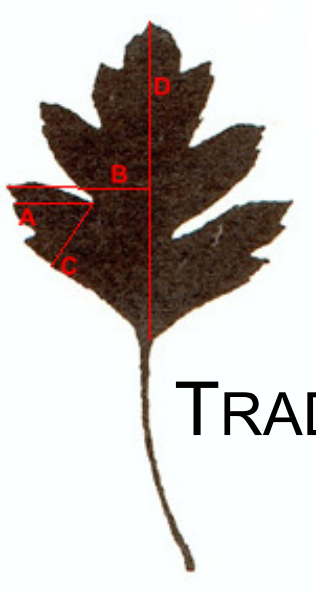


MANY TERMS DON'T WORK ACROSS GROUPS



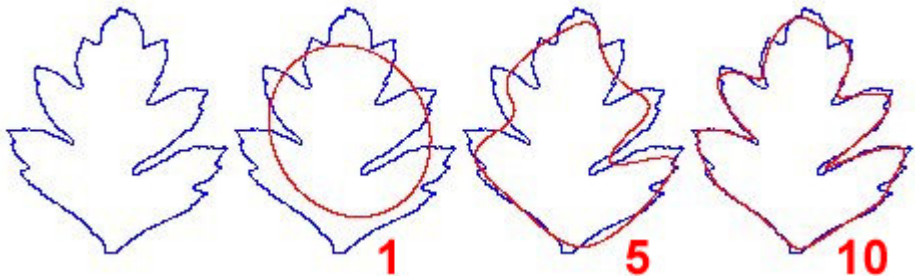


THREE BASIC TYPES OF MORPHOMETRICS



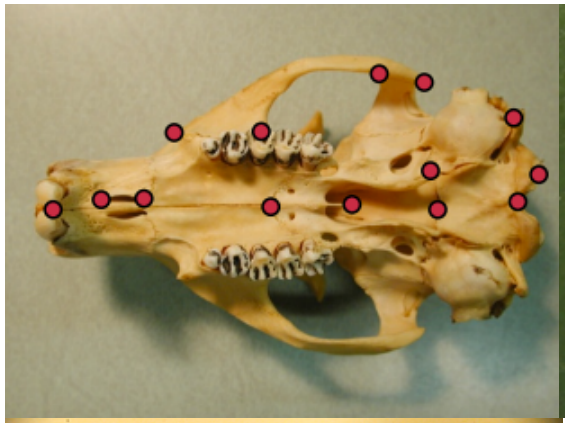
TRADITIONAL

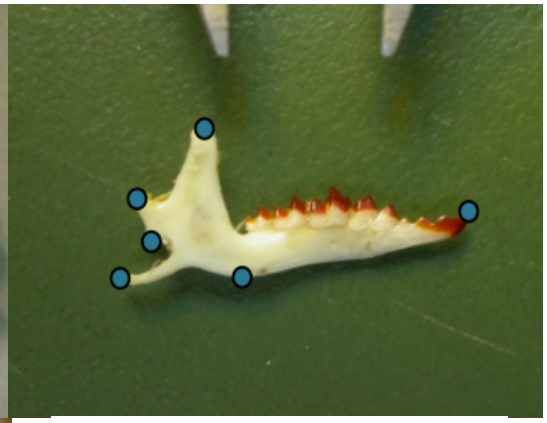
LANDMARK

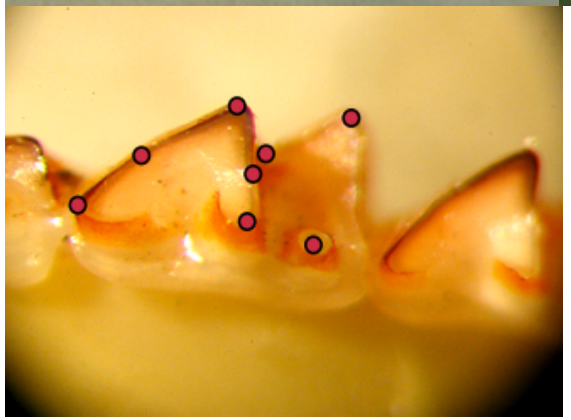


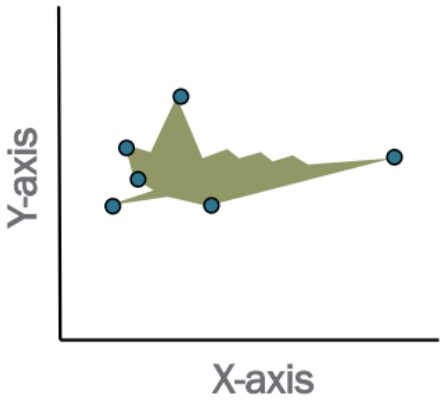
OUTLINE

Landmark Analysis









Landmarks are cartesian (x,y,z) coordinate points used to represent a shape.

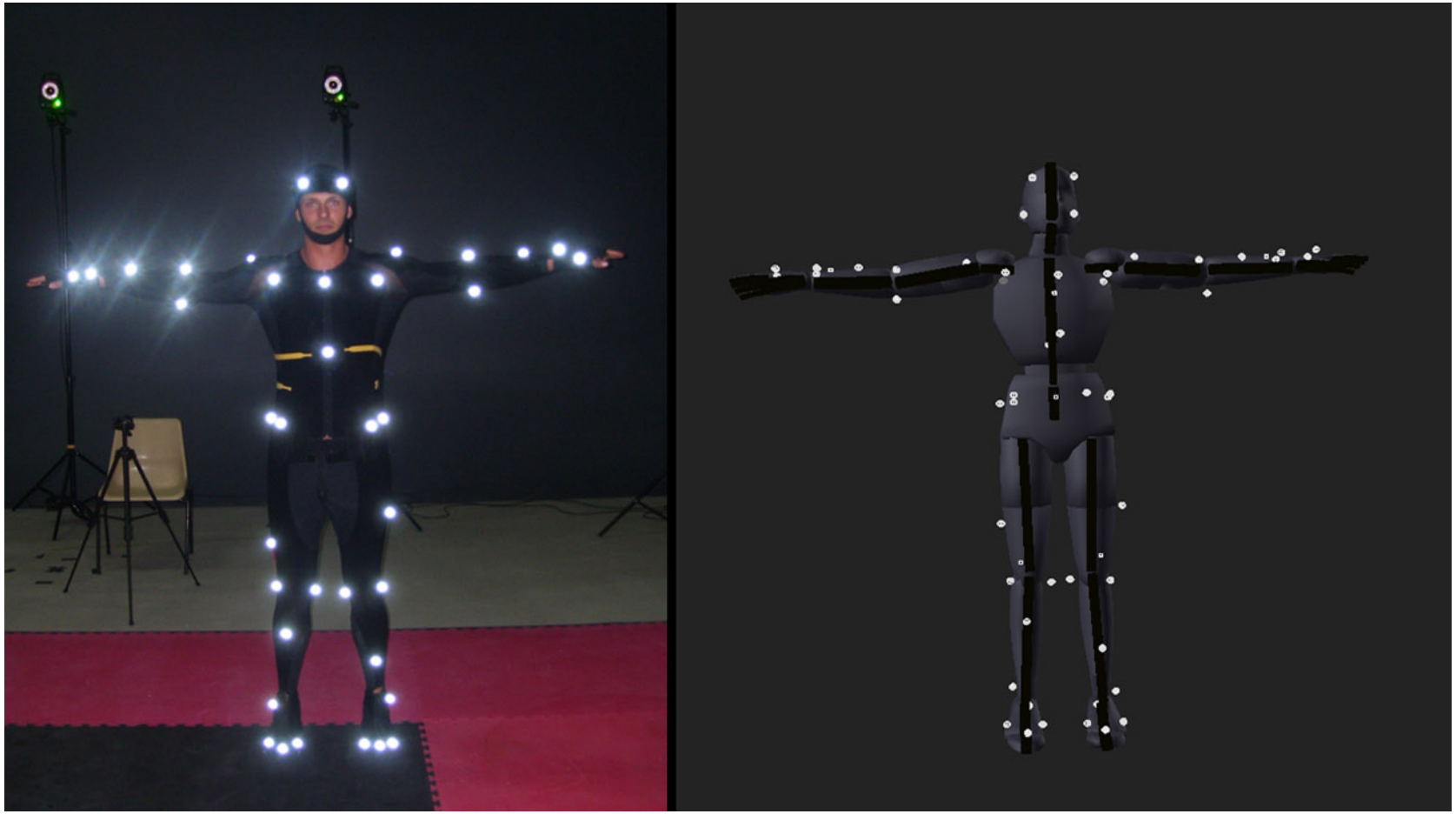
A landmark must be placed on a **homologous** point.

A **semi-landmark** is a point that is placed **arbitrarily** between two or more landmarks.

The big advantage is that you focus on shape over size.

The big disadvantage is that you focus on shape over size.

Landmark Analysis



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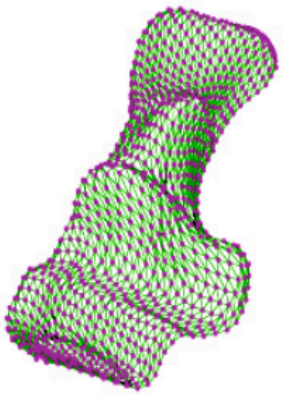
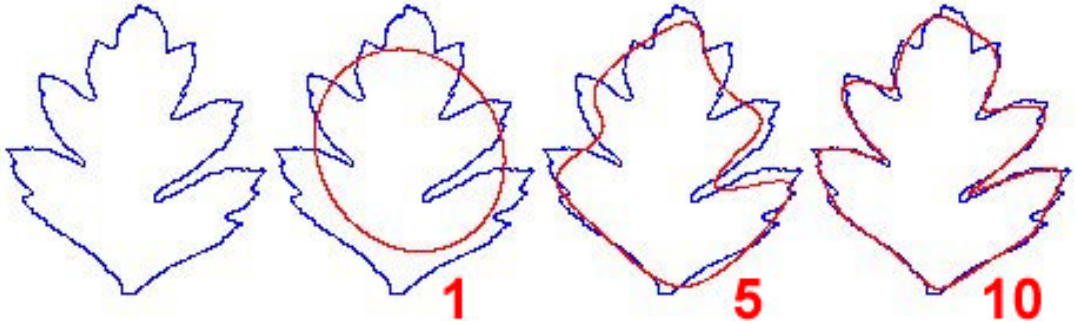


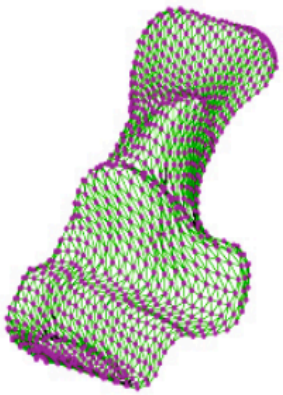


Brute force semi-landmark analysis is sometimes called outline analysis.

This is NOT GENUINE outline analysis, but is a form of landmark analysis.

True outline analysis traces literal outlines, often ellipses, around the specimen.

Outline vs. Landmark is contentous



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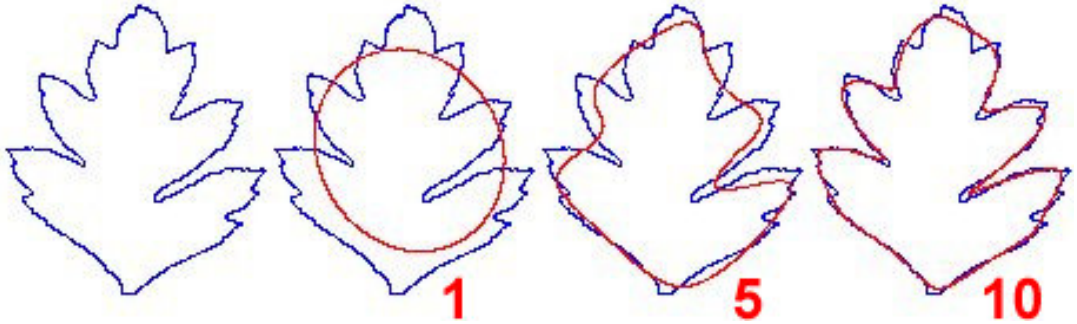

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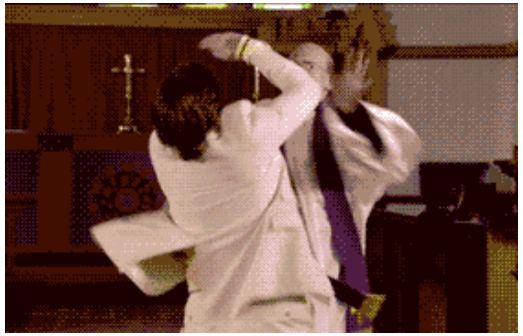
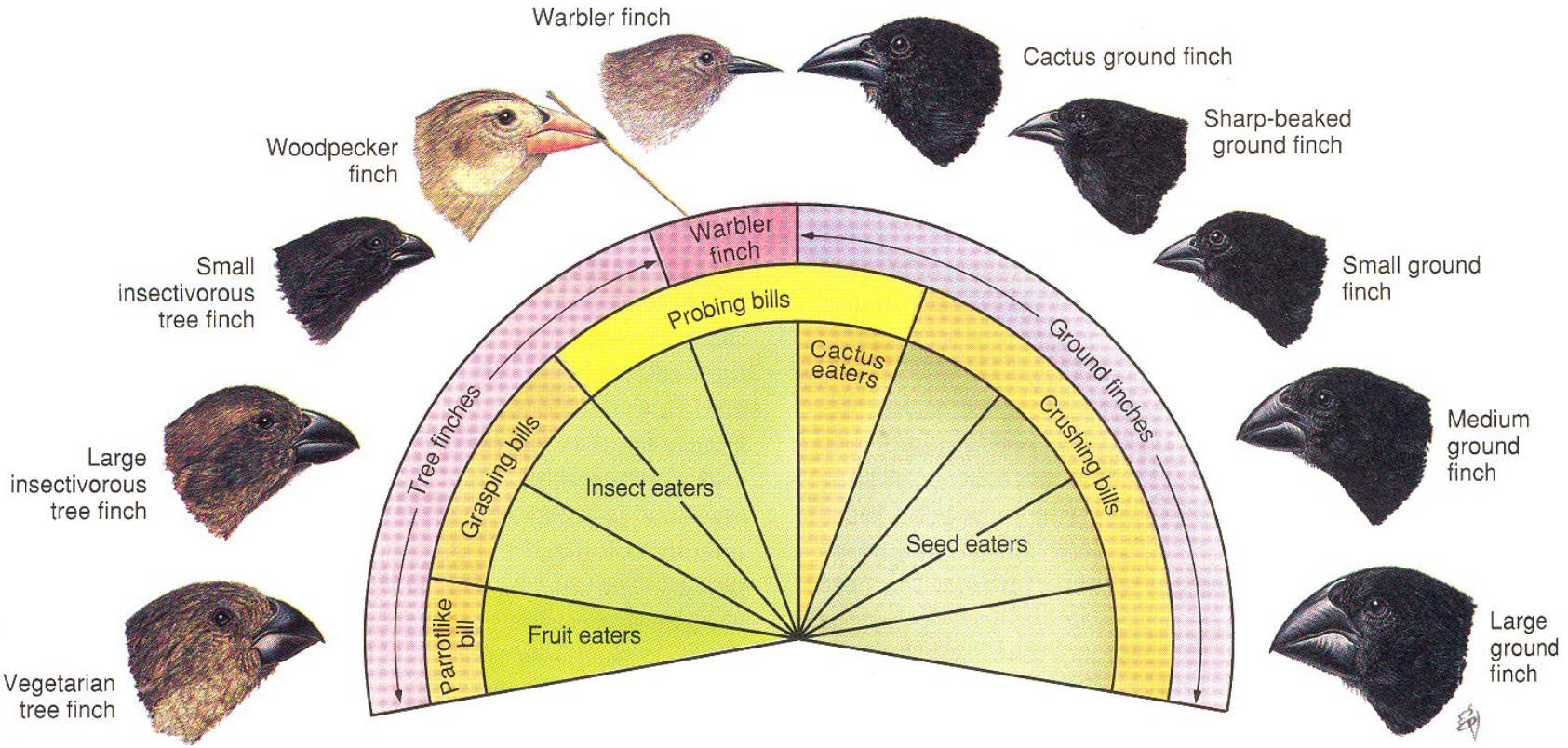
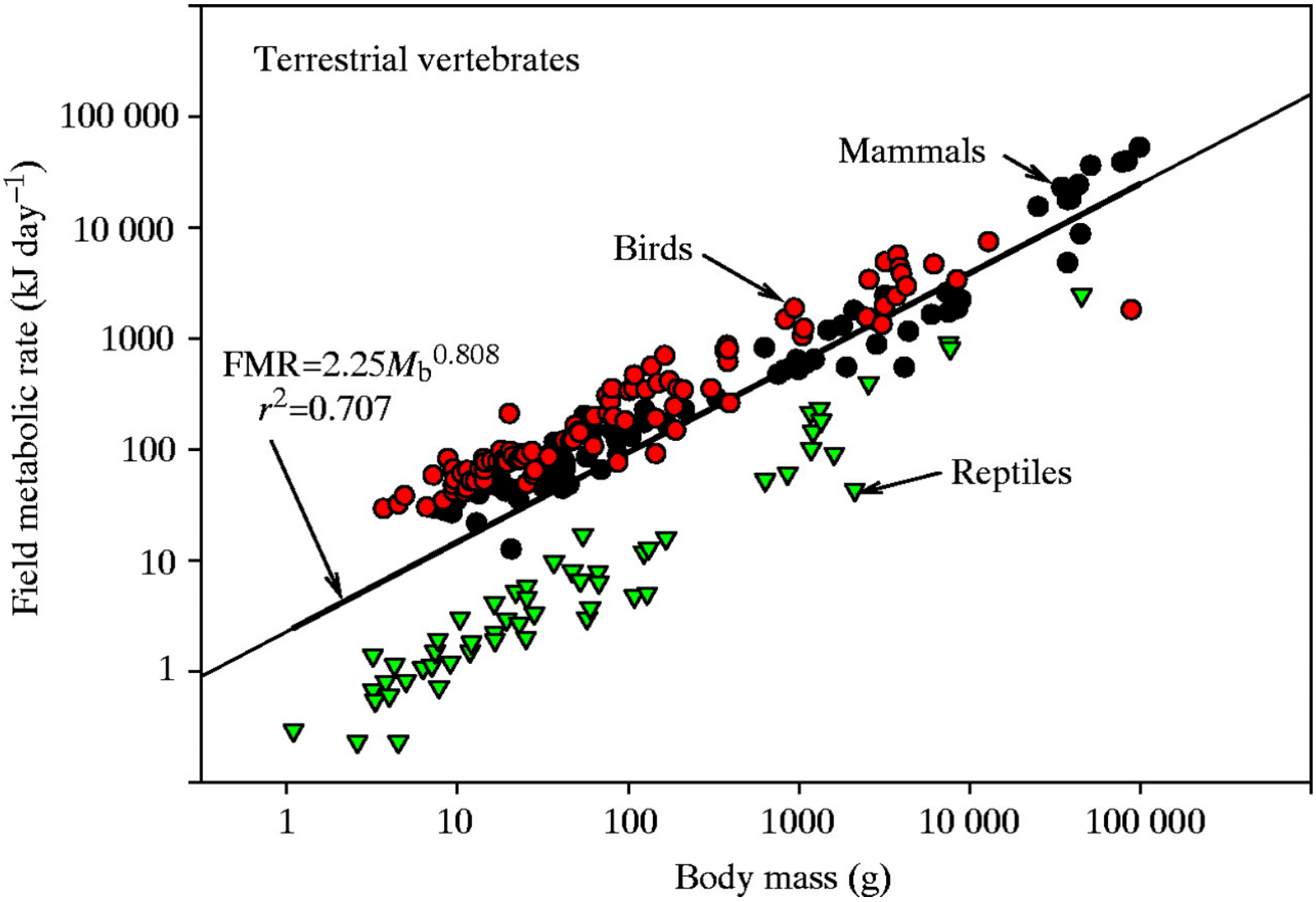


THE OPTIMISTIC VIEW OF MORPHOLOGY

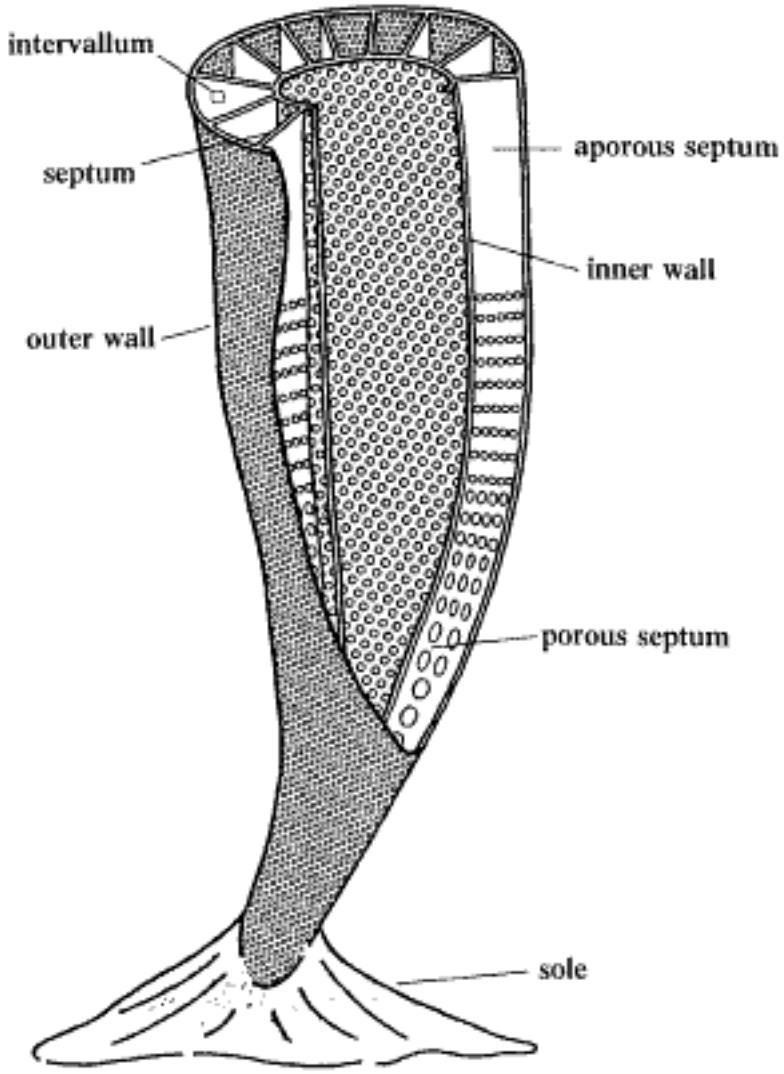


The optimistic view of morphology

THE OPTIMISTIC VIEW OF MORPHOLOGY



FUNCTIONAL MORPHOLOGY



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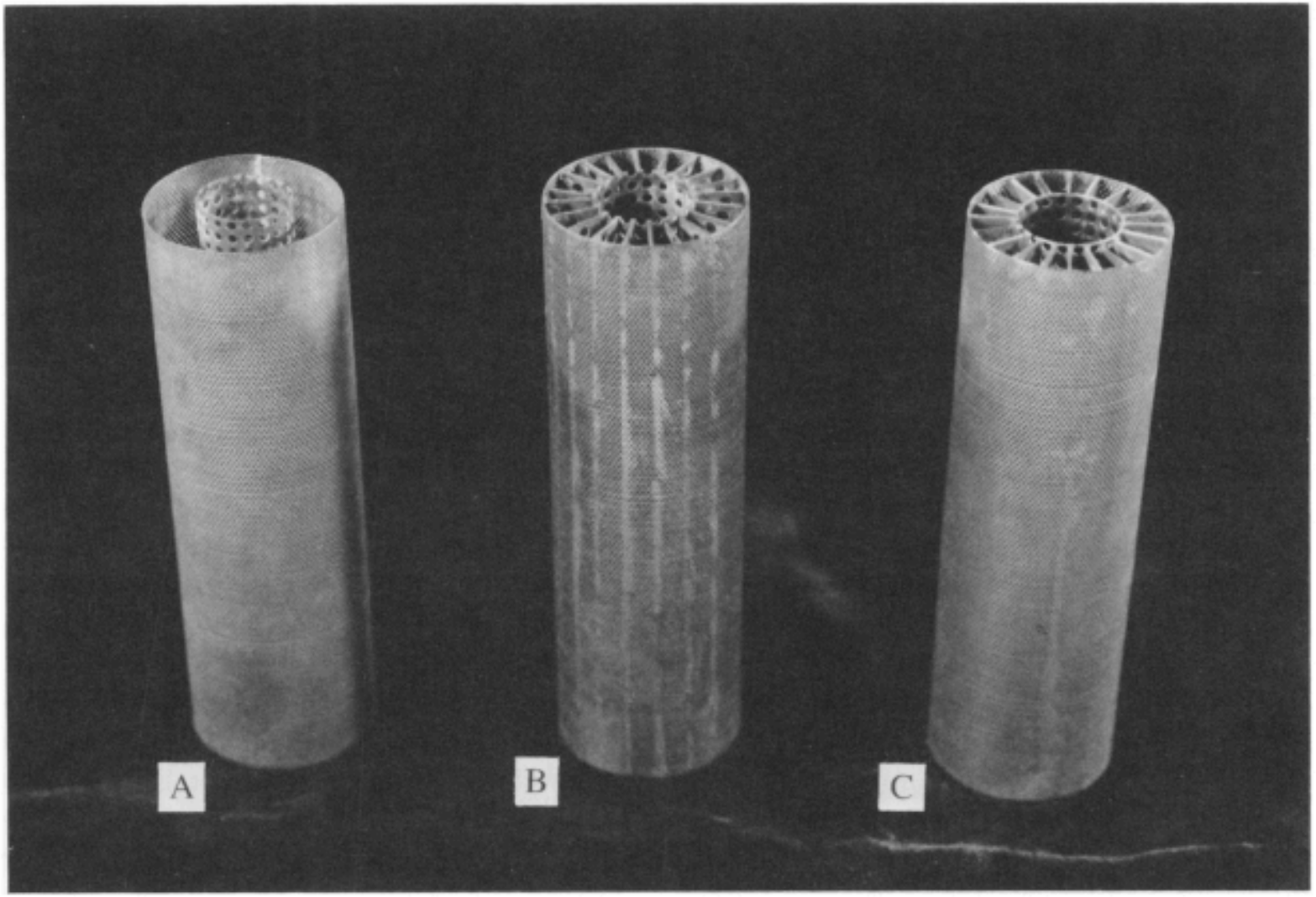
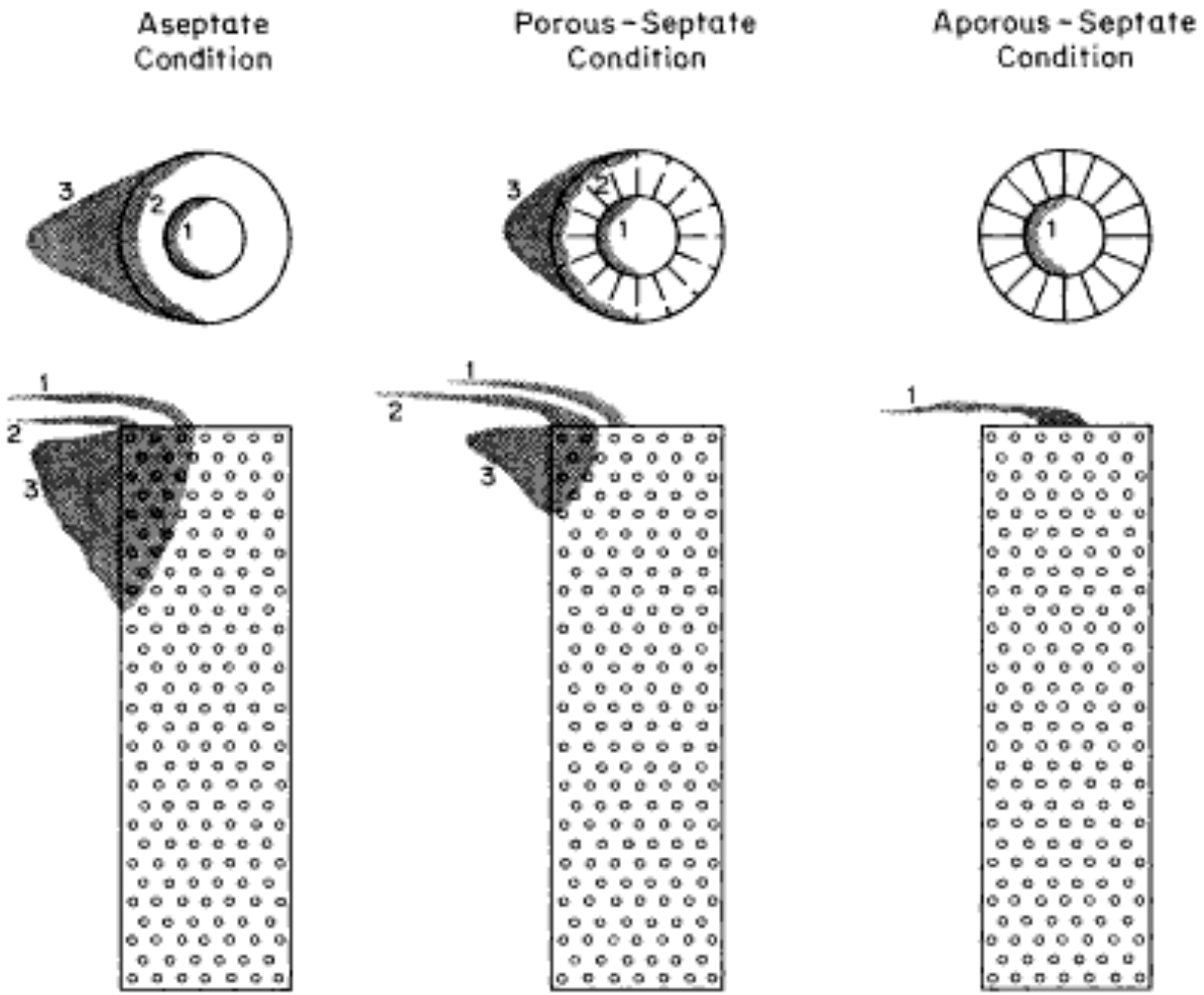


SAVARESE 1992

FUNCTIONAL MORPHOLOGY



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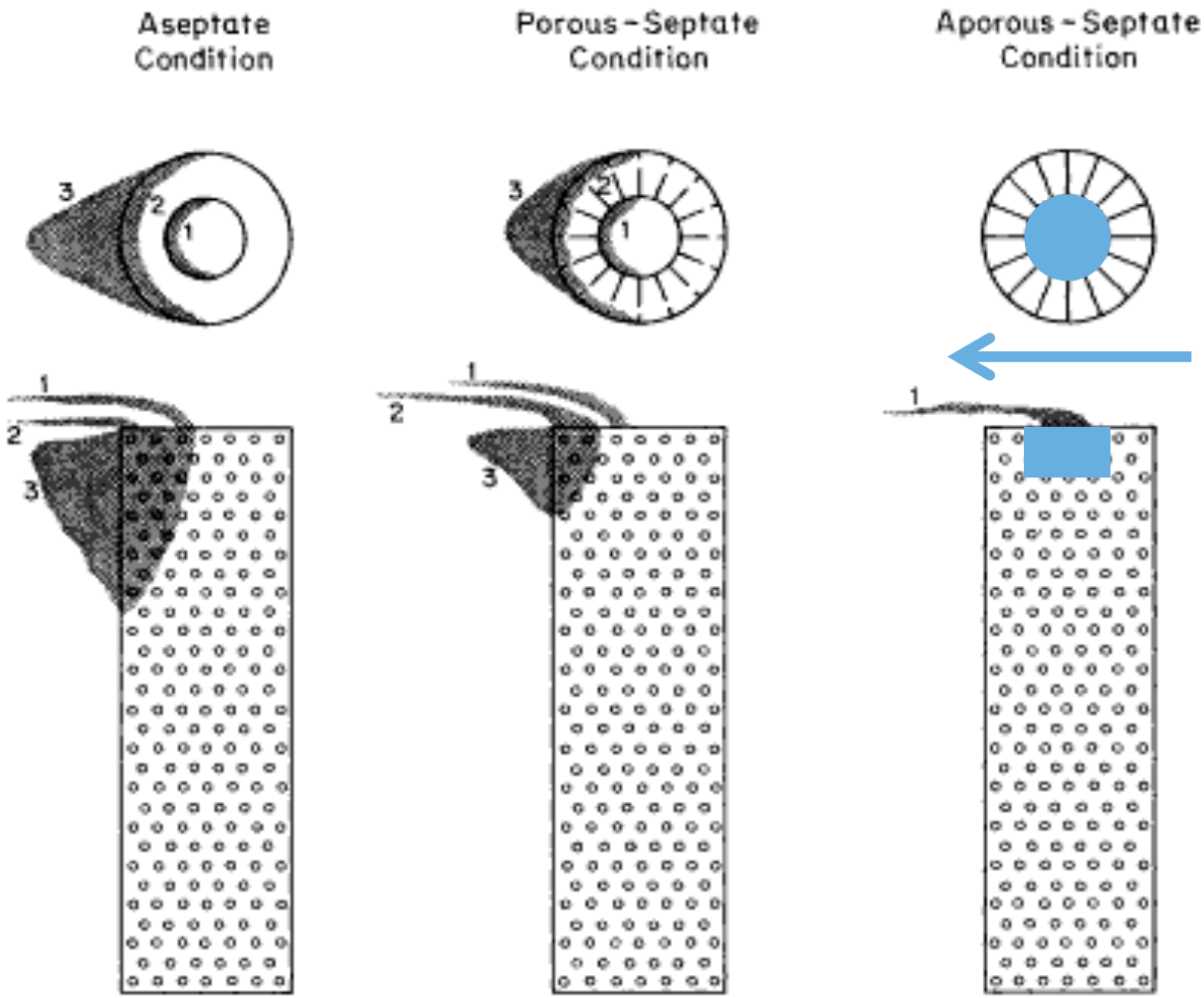

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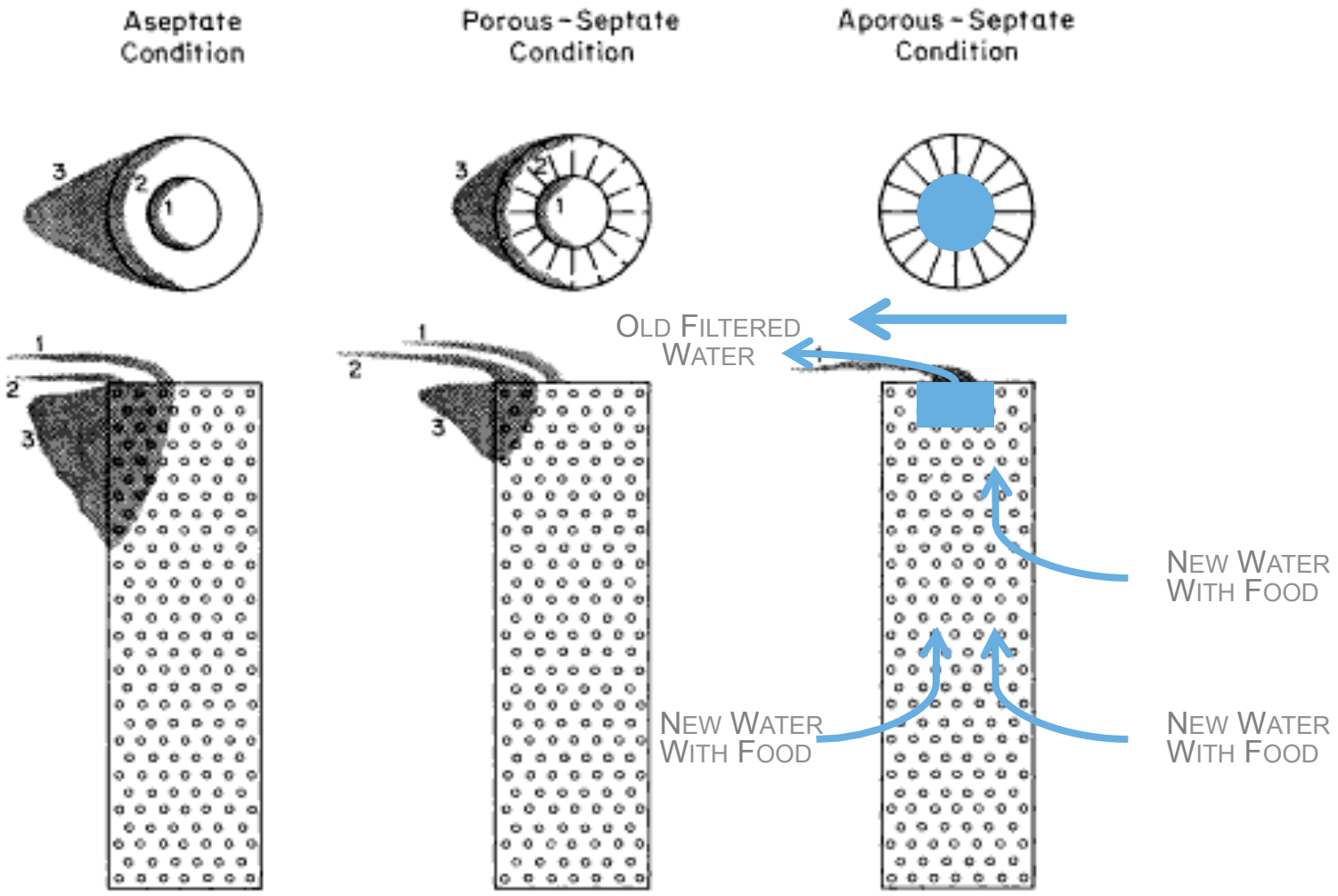

SAVARESE 1992

EXPERIMENTATION OVER MEASUREMENT

"This ranks as pure guesswork in the cocktail party mode; Wright presents no neurological evidence of a brain module for sweetness, and no paleontological data about ancestral feeding. This 'just-so story' therefore cannot stand as a 'classic example of an adaptation' in any sense deserving the name of science." – Stephen J. Gould