Molecular systematics: a panacea?

What molecular tools can and can’t tell us about plant diversity

Richard Olmstead
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Molecular systematics: a panacea?

Panacea: *a solution or remedy for all problems*
Molecular systematics: a panacea?

Panacea: *a solution or remedy for all problems*

To start, we need to know what problems need solutions!

DNA in cesium chloride solution; S. Wagstaff photo
Problems in Plant Diversity:

- How do we know what species are related to each other?
- How do we know what species this plant belongs to?
- How do we know what a species even is?
- How do we know what to name and how do we assign a name?
- How do we know where these plants came from?
- How do we know how old this group of plants is?
- How do we integrate fossil and living plants?
- How do we ...?
Problems in Plant Diversity:

- How do we know what species are related to each other?
  Ever since Darwin, we’ve expected classifications to reflect evolutionary relationships: “all true classification is genealogical”

- How do we know what species this plant belongs to?
  Visual morphological traits are nice, but what if it’s not in flower? What if there is no key? What if you are not trained in plant ID?

- How do we know what a species even is?
  Species concepts are many and varied, but fall into two main categories: 1) mechanism based, or 2) lineage based

- How do we know what to name and how do we assign a name?
  ‘Grouping’ and ‘naming’ are distinct processes. They should be linked!

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- How do we...?
Problems in Plant Diversity

- How do we know what species are related to each other?

Beardsley & Olmstead, 2002
Am. J. Bot. 89: 1093

Phryma

Mimulus

Phrymaceae

Western North America

Australia Mimulus and 4 other genera

Photo: G. Smith
Problems in Plant Diversity

- How do we know what species are related to each other?

Helianthus
Lee-Yaw et al., 2019
Problems in Plant Diversity

- How do we know what species are related to each other?

Dipterocarpaceae

Richetia

Parashorea

Shorea

Rubroshorea

Whole plastid genome

RADseq; 20,000 nuclear loci
100,000 SNPs
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DNA barcoding
Problems in Plant Diversity

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Species concepts are many and varied, but fall into three main categories

1) morphology based: Who cares if they represent anything ‘real’ in nature, we can tell ‘em apart!

2) mechanism based: Can they interbreed? Do they share some ecological attribute? Is there a mate recognition system?

3) lineage based: Do they represent a distinct evolutionary lineage? Species delimitation analysis
Evolution of a species over time
Problems in Plant Diversity

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New classification for *Mimulus*
Barker et al., 2012
Problems in Plant Diversity

- How do we know what to name and how do we assign a name?

ICN: *Solanaceae* is the group of species at the family rank containing the type species *Solanum nigrum*.

*Solanum nigrum*
Problems in Plant Diversity

- How do we know what to name and how do we assign a name?

**ICN:** Solanaceae is the group of species at the family rank containing the type species Solanum nigrum.

**PhyloCode:** Solanaceae is the smallest clade containing Solanum nigrum and Schizanthus pinnatus (specifiers).

**Clade definition**
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- How do we know where these plants came from?

Buddleja
(Scrophulariaceae)
How do we know where these plants came from?

Problems in Plant Diversity

- Africa
- New World
- Australasia
- China

Tecomeae (Bignoniaceae)
Problems in Plant Diversity

- How do we know where these plants came from?

...including ecological transitions

Citharexylum (Verbenaceae)
Problems in Plant Diversity

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_Citharexylum_ (Verbenaceae)
Dated tree of Lamiales

Tank & Olmstead in prep
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So, what’s next?

Isn’t DNA just the current fad?
like:
Morphology
Cytology
2º chemistry
Electron microscopy
Protein biochemistry
etc.