

BIG4 field workshop

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Species concepts and species delimitation

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Unified Species Concept



De Queiroz 2007 (Syst Biol)

- Species concept and delimitation are clearly separated.
- Different species concept criteria seen as lines of evidence for delimitation.
- Implications for current delimitation methods.

Molecular species delimitation

- Apparent statistical rigor and objectivity.
- Boom of genetic-based species delimitation packages.

bGMYC	Reid & Carstens 2012 (BMC Evol Biol)
BP&P	Yang & Rannala 2010 (PNAS)
bPTP	Zhang et al 2013 (Bioinformatics)
Brownie	O'Meara 2010 (Syst Biol)
Geneious Plugin	Masters et al 2010
Geneland	Guillot et al 2005 (Mol Ecol Notes)
GMYC	Pons et al 2006 (Syst Biol)
iBP&P	Solis-Lemus et al 2015 (Evolution)
IMa2	Hey & Nielsen 2007 (PNAS)
spedeSTEM	Carstens & Dewey 2010 (Syst Biol)
Structure	Pritchard et al 2000 (Genetics)

Molecular species delimitation

- Apparent statistical rigor and objectivity.
- Boom of genetic-based species delimitation packages.
- Two main approaches:
 - a) Species Discovery (without *a priori* info)
 - b) Species Validation (assignment of putative sp.)

Species Discovery



Carstens et al 2013 (Mol Ecol)

Species Discovery

- BOLD uses BLAST algorithm to identify a sequence that resembles query sequence above a threshold. *not really Species Discovery.
- GMYC relies on single locus inference (ultrametric tree). Usually a threshold for delimitation, but may be flexible.
- bPTP aimed at single locus, but might potentially work with multi-locus inference. Uses no. of subst to search for transitions in branching patterns.

Species Validation



Species Validation



- The multispecies coalescent model (reviewed in Degnan & Rosenberg 2009).
- BPP assumptions: no gene flow during divergence, unlinked loci, etc.
- Relies in *a priori* putative species assignments and guide species tree.

(c)

(a)

- Hybridization & Introgression
- Gene duplication (Paralogs)
- Gene transfer (NUMTs, pseudogenes)
- Hereroplasmy (multiple mitochondrial haplotypes)



Degnan & Rosenberg 2009 (TREE)

• Hybridization & Introgression



- Hybridization & Introgression
- Gene duplication (Paralogs)



Danforth et al 2004 (Syst Biol)



Degnan & Rosenberg 2009 (TREE)

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Degnan & Rosenberg 2009 (TREE)

Towards an integrative approach

- iBPP, molecular and trait data
- Yet other data may be integrated (discrete traits, geography, etc).
- Improvement in accuracy in gene flow/selectivelydriven divergences.





Take home message

- No single criterion to delimit species.
- Weight alternative lines of evidence (The Gray Zone).
- Integrative approach, different data sources and methods.