# Scientific Disagreement, Taxonomy, and Biodiversity

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# Outline

1. Ambiguity and disagreement in biodiversity and taxonomy
2. What do we do about it?
3. Empirical analyses: taxonomy corpus
   - 3.1 Corpus construction
   - 3.2 Finding disagreement
   - 3.3 Disagreement and genera
   - 3.4 Future ideas

**The take-home:** There's a strong sentiment in biology and philosophy that disagreement is a serious problem for conservation: let's test it!

# Biodiversity and Taxonomy

# History of a Concept

- 1960s–70s: protection of endangered species (1966/1969/1973 in the USA)
- 1985: first conference "The National Forum on BioDiversity"
- 1988: edited volume, *Biodiversity* (edited by E. O. Wilson)

# A Balance

The concept of biodiversity has to be:

- Larger than just single (charismatic) species (to capture ecological relations)
- Smaller than "life itself" (to give us something that it is possible to conserve)

# The Hunt for Indicators

- species richness (with phylogenetic-distance corrections?)
- diversity of traits or characters
- structural diversity of ecological communities
- diversity of ecological niches
- genetic diversity

# From Biodiversity to Taxonomy

# Biodiversity and Taxonomy

If we want to ground our idea of biodiversity in (counts of) species, we need a **privileged taxonomy** for dividing up organisms into those groups.

But any biodiversity studies relying on species inventory will inherit the **rampant uncertainty and disagreement** found in taxonomy!



Part of the vast ornithology collection at the American Museum of Natural History.

# Taxonomy anarchy hampers conservation

The classification of complex organisms is in chaos.
**Stephen T. Garnett** and **Les Christidis** propose a solution.

## *What Is a Species, Anyway?*

Some of the best known species on Earth may not be what they seem.

# What to Do with Disagreement?

# Response 1: Fundamentalism

In the biological and biomedical sciences, what we will call the Definitional Consensus Principle has dominated the design of data discovery and integration tools:

**Definitional Consensus Principle (DCP):** The design of a formal classificatory system for expressing a body of data should be grounded in a consensus about the definitions of the entities that are being classified. (Sterner et al. 2020, p. 2)

# Response 1: Fundamentalism

> We may, then, start from the observations there made [in the *Poetics*], and the stipulation that language to be good must be clear, as is proved by the fact that speech which fails to convey a plain meaning will fail to do just what speech has to do. (*Rhetoric* 1404b1, Aristotle 1984)

# Response 2: Skepticism

> Put bluntly, the position that this paper will argue for is that biodiversity is to be (implicitly) defined as what is being conserved by the practice of conservation biology. (Sarkar 2002, p. 132)

## Save the planet: eliminate biodiversity

**Carlos Santana**

ORIGINAL PAPER

## Taxonomy and conservation science: interdependent and value-laden

**Stijn Conix**[1]

# Response 3: Values in Science

Conservation biology differs from most other biological sciences in one important way: **it is often a crisis discipline.** Its relation to biology, particularly ecology, is analogous to that of surgery to physiology and war to political science. In crisis disciplines, one must act before knowing all the facts; crisis disciplines are thus a mixture of science and art, and their pursuit requires intuition as well as information. (Soulé 1985)
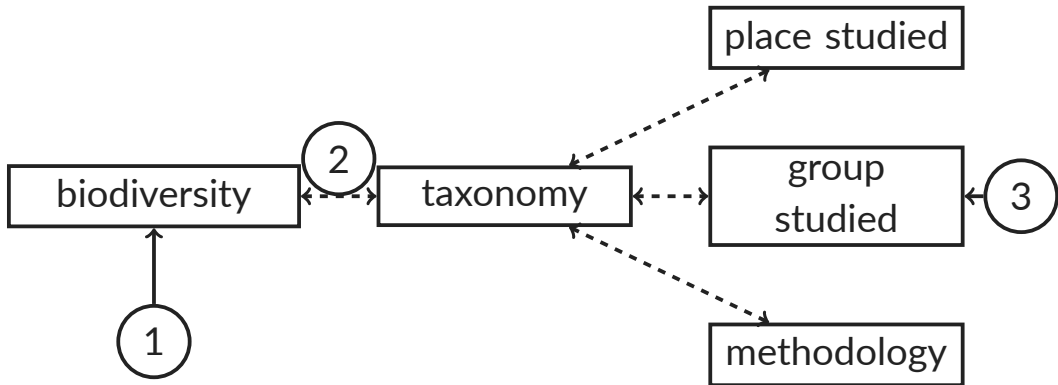
At least part of this is *an empirical problem.* Where is disagreement over biodiversity to be found, and what are its sources?

# The Structure of Disagreement
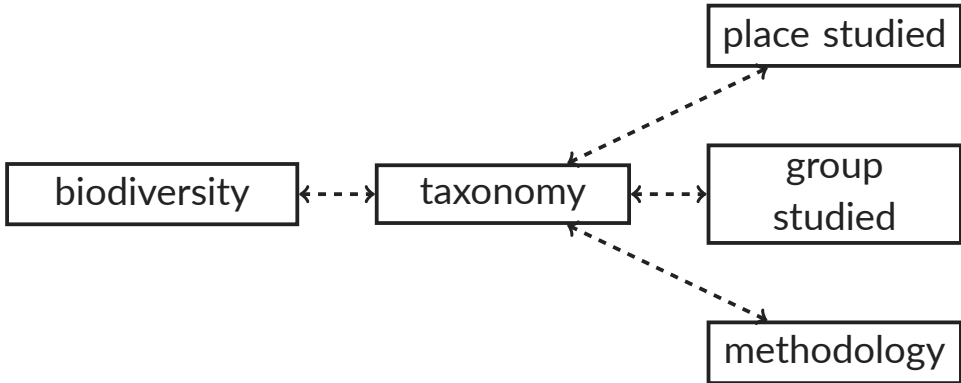
# The Structure of Disagreement

# Empirical Tools

| Journal | Publisher | Size |
| --- | --- | --- |
| *Zootaxa* | Magnolia Press | 31,348 |
| *ZooKeys* | Pensoft | 4,940 |
| *PhytoKeys* | Pensoft | 820 |
| *Journal of Hymenoptera Research* | Pensoft | 382 |
| *MycoKeys* | Pensoft | 315 |
| *Zoosystematics and Evolution* | Pensoft | 153 |
| *Insecta Mundi* | Center for Systematic Entomology | 1,367 |
| *European Journal of Taxonomy* | Museum National d'Histoire Naturelle | 1,105 |
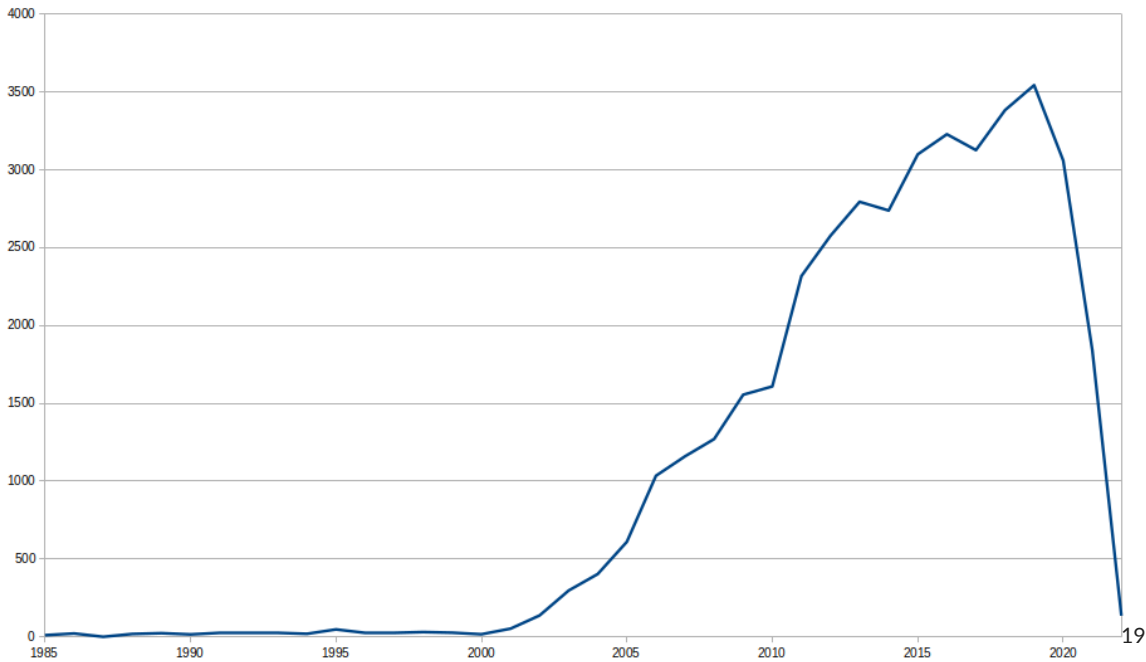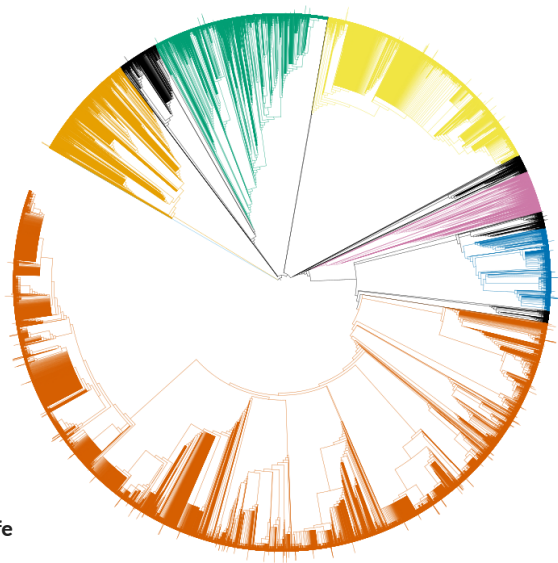
**Complete Open Tree of Life**

**Corpus**

22
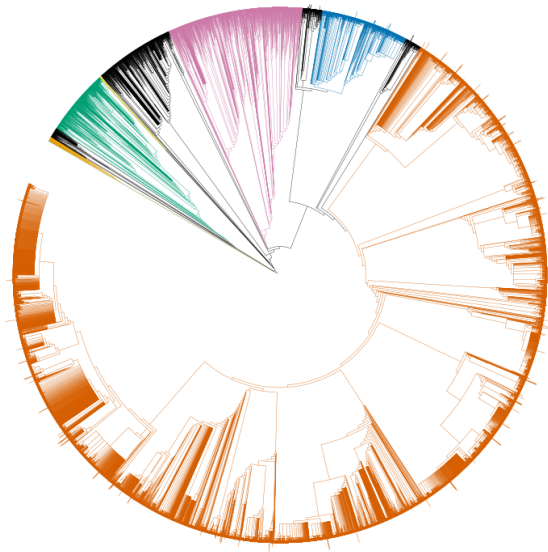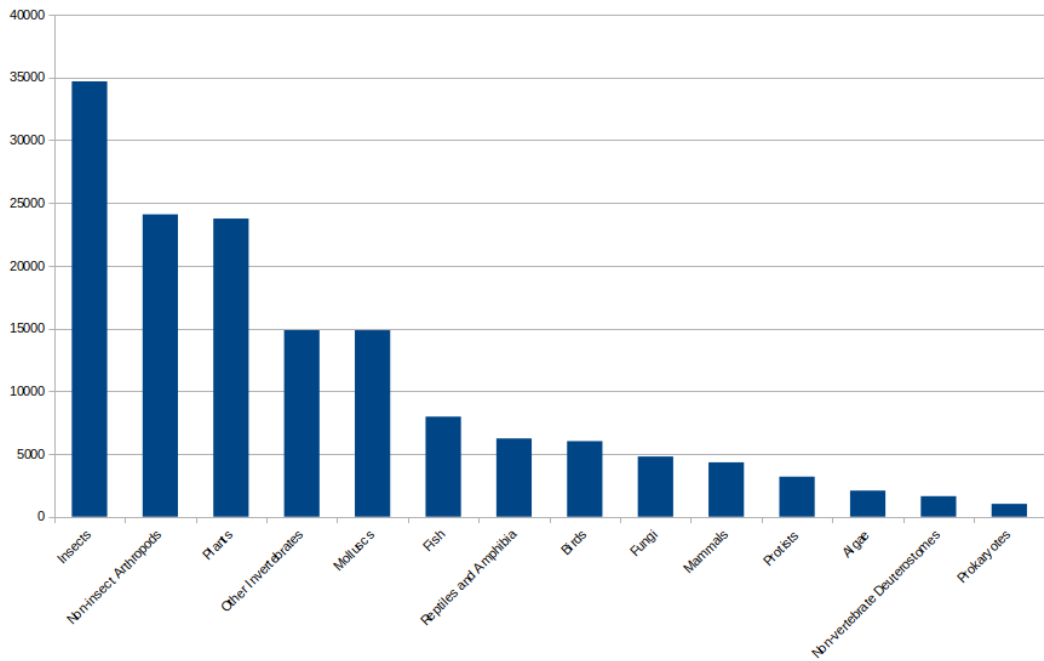
Close reading of a number of papers where we know
that taxonomic disagreement is taking place

# How About Disagreement?

Eaxmple: the "disagreement" list:

- critique
- doubt
- opinion
- disagree
- redundant
- reject
- rebuttal

- debate
- invalid
- misunderstanding
- misconception
- allegation
- allegedly

- mistake
- obsolete
- error
- misclassify
- erroneous
- contentious

In the end, we prepared four lists: terms referring to **epistemic values**, **disagreement**, **pejorative evaluation**, and more general **taxonomic change**

## A "Disagreement Index"

Simple idea: look at the frequency of the terms from these lists, in every document in the corpus

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This can then be correlated with other variables: group of organism studied, etc.

# Disagreement vs. Organism Studied

Divide organisms into colloquial "groups" (e.g., algae, mammals, birds, fish...).

- Much more disagreement ($> 2\times$): birds ($n = 333$); mollusks ($n = 1064$)
- Slightly more disagreement ($> 1.25\times$): mammals ($n = 396$)
- Slightly less disagreement ($< 0.75\times$): fish ($n = 2132$, non-insect arthropods ($n = 7285$)
- Much less disagreement ($< 0.5\times$): prokaryotes (**!** $n = 13$)

# Disagreement vs. Organism Studied

Another hypothesis: What about the age of the group? Test correlation between the **disagreement index** and the **year** in which the paper's main genus was described.

# Disagreement vs. Organism Studied

A significant **negative correlation,** which does match with expectations: the older the genus, the more likely it is to attract disagreement.

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A paper on a genus described in 1750 should have a disagreement index of around 0.003 more than one about a new genus (and 0.003 is approximately equal to the mean disagreement value!).

# Future Directions

- Geocoding for correlations with locations mentioned in papers
- Classification of taxonomic methodologies used in papers
- Build a "high-disagreement" sub-corpus; try to analyze it separately to distinguish different senses of disagreement?
- Topic modeling of paragraphs or even sentences?

# Thanks to Stijn Conix!

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# How about disagreement?

**Ask the topic model:** what topics are likely to select words from our lists of disagreement and related terms?

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- **Disagreement:** Topic 43
- **Epistemic values:** Topic 91
- **Pejorative terms:** Topics 43 and 120

# Topic 43 (disagreement, pejorative)

- 0.015*"specie"
- 0.011*"name"
- 0.010*"description"
- 0.010*"new"
- 0.008*"publish"
- 0.007*"author"
- 0.007*"nomenclature"

- 0.007*"code"
- 0.007*"publication"
- 0.006*"type"
- 0.006*"article"
- 0.006*"zoological"
- 0.006*"original"
- 0.006*"synonym"

- 0.006*"work"
- 0.006*"list"
- 0.006*"valid"
- 0.005*"international"
- 0.005*"available"
- 0.005*"note"

The terms you use to **present a new species** and to **discuss whether a species is a synonym**

# Topic 120 (pejorative)

- 0.018*"character"
- 0.013*"genera"
- 0.011*"taxon"
- 0.011*"group"
- 0.010*"specie"
- 0.010*"genus"
- 0.009*"phylogenetic"
- 0.008*"include"

- 0.007*"analysis"
- 0.007*"family"
- 0.007*"relationship"
- 0.005*"phylogeny"
- 0.005*"clade"
- 0.005*"morphological"

- 0.005*"classification"
- 0.005*"support"
- 0.005*"press"
- 0.005*"new"
- 0.005*"consider"
- 0.004*"present"

The terms you use to **argue about ranking of a clade**

Phylo-Phenetic Species Concept

Phylogenetic Species Concept

Genic Species Concept

Cohesion Species Concept

Genealogical Concordance Species Concept

Genotypic Cluster Species Concept

Genetic Species Concept

Ecological Species Concept

Recognition Species Concept

Genealogical Species Concept

Biological Species Concept

Differential Fitness Species Concept

Compilospecies Concept

Cladistic Species Concept

Hennigian Species Concept

Internodal Species Concept

Mitonuclear Compatibility Species Concept

Pragmatic Species Concept

Inclusive Species Concept

Biosimilarity Species Concept