Tracing Disagreement in Taxonomy

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Outline

1. Ambiguity and disagreement in biodiversity and taxonomy
2. What do we do about it?
3. Construction of the corpus
4. Feature analysis
5. Preliminary results
6. Future ideas

Take-home message: Disagreement in taxonomy seems to be unevenly distributed; to understand it we'll have to analyze the literature empirically

Biodiversity and Taxonomy

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

Biodiversity and Taxonomy

And 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 to Do?

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)

Response 2: Skepticism

Biol Philos
DOI 10.1007/s10539-014-9426-2

Save the planet: eliminate biodiversity

Carlos Santana

Response 3: Values in Science

HPLS (2019) 41:15
https://doi.org/10.1007/s40656-019-0252-3

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)

Response 3: Values in Science

Common response: Ethical value judgments are acceptable in conservation, but should be **kept out of** taxonomy.

But what if taxonomy is **just as value-laden** as conservation biology?

Response 3: Values in Science

Now in progress: case studies and empirical exploration

Contents lists available at ScienceDirect

Perspectives in Plant Ecology, Evolution and Systematics

journal homepage: www.elsevier.com/locate/ppees

Deceiving insects, deceiving taxonomists? Making theoretical sense of taxonomic disagreement in the European orchid genus *Ophrys*

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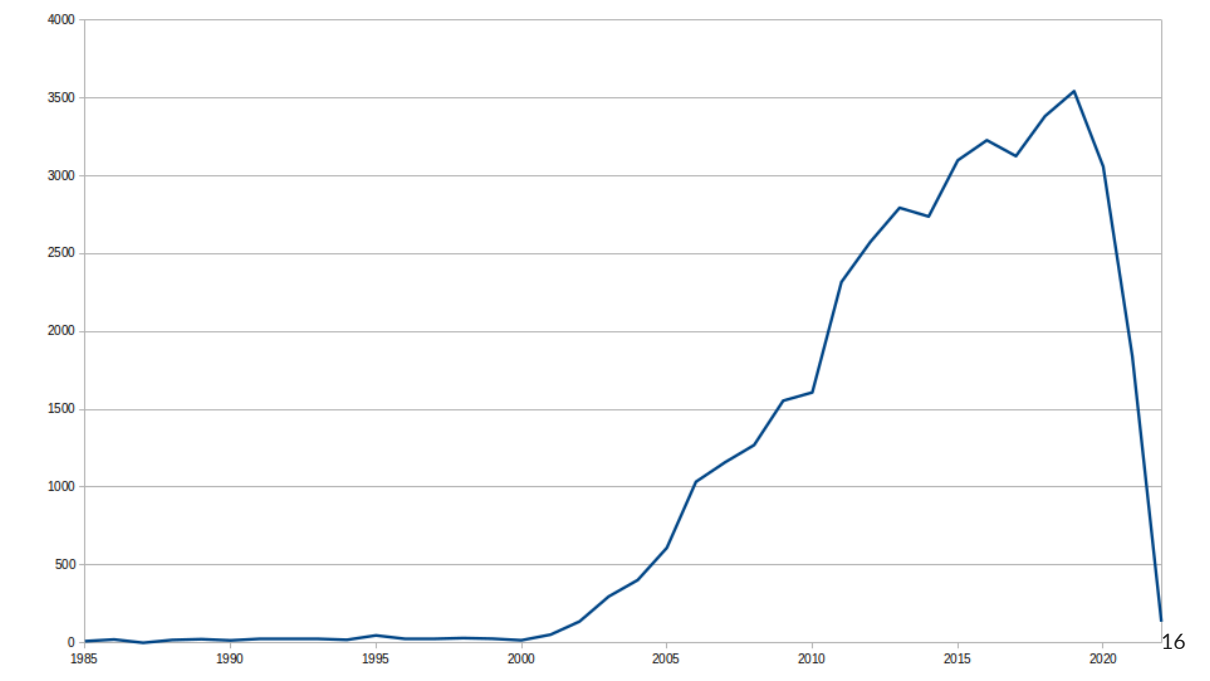
Response 4: History of Biodiversity

Ph.D. project also in progress: how did the concept of biodiversity actually take hold in the scentific community?

Corpus construction

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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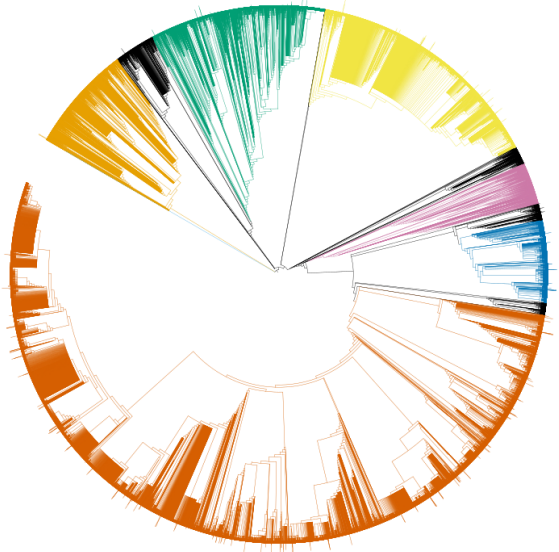
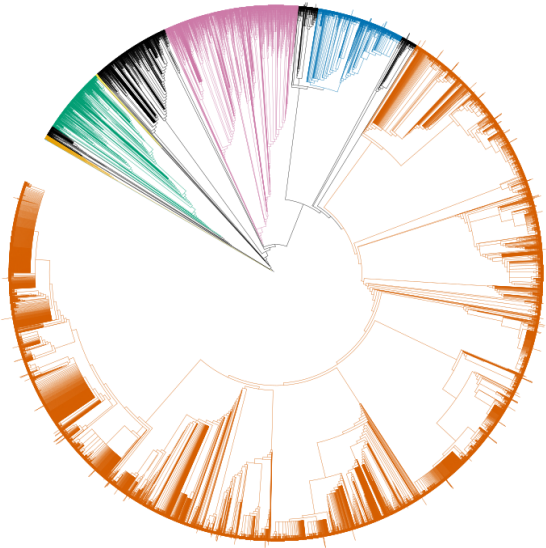


Whole Open Tree of Life

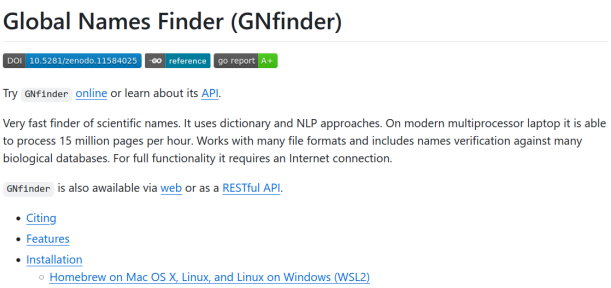


Corpus

Feature Analysis

Taxa

Global Names Finder (gnfinder): detect the names of species and other groups in text, both by comparison with global lists as well as detection of “probable” names



Global Names Finder (GNfinder)

DOI 10.5281/zenodo.11584025 | go reference | go report A+

Try `GNfinder` online or learn about its API.

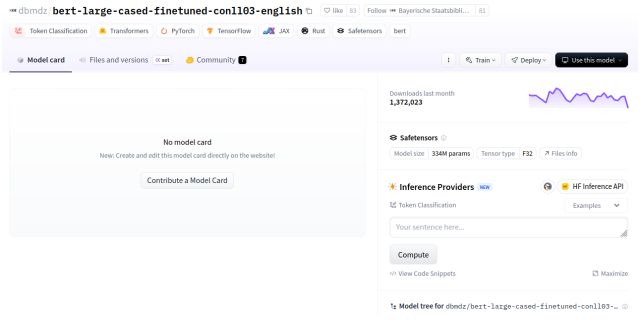
Very fast finder of scientific names. It uses dictionary and NLP approaches. On modern multiprocessor laptop it is able to process 15 million pages per hour. Works with many file formats and includes names verification against many biological databases. For full functionality it requires an Internet connection.

`GNfinder` is also awailable via web or as a RESTful API.

- Citing
- Features
- Installation
  - Homebrew on Mac OS X, Linux, and Linux on Windows (WSL2)

Locations

Pre-trained model for recognizing locations, organizations, and people in an English-language text (trained by the Bayerische Staatsbibliothek)



Topic Modeling

Convert documents into vectors in a 400-dimensional space (using the doc2vec algorithm), then examine clusters in this space. Normally, each cluster corresponds, more or less, to a subject of discussion.

Topic Modeling

But: **less useful than usual** in this corpus! Often, the clusters indicate how scientists talk about different groups of organisms ("fin, ray, gill, dorsal…"), though some might have a more interesting meaning ("barcoding, biodiversity, DNA…").

Disagreement

Close-reading of articles where we're sure that taxonomists are disagreeing with each other, to extract lists of keywords.

Désaccord

Example: the *disagreement* list

- critique
- doubt
- opinion
- disagree
- redundant
- reject
- rebuttal
- debate
- invalid
- misunderstanding
- misconception
- allegation
- allegedly
- mistake
- obsolete
- error
- misclassify
- erroneous
- contentious

Disagreement

3 lists: *epistemic values*, *disagreement*, and *pejorative evaluation*

Measure the relative frequency of these words in each article to give them a kind of “disagreement index.”

Methodology

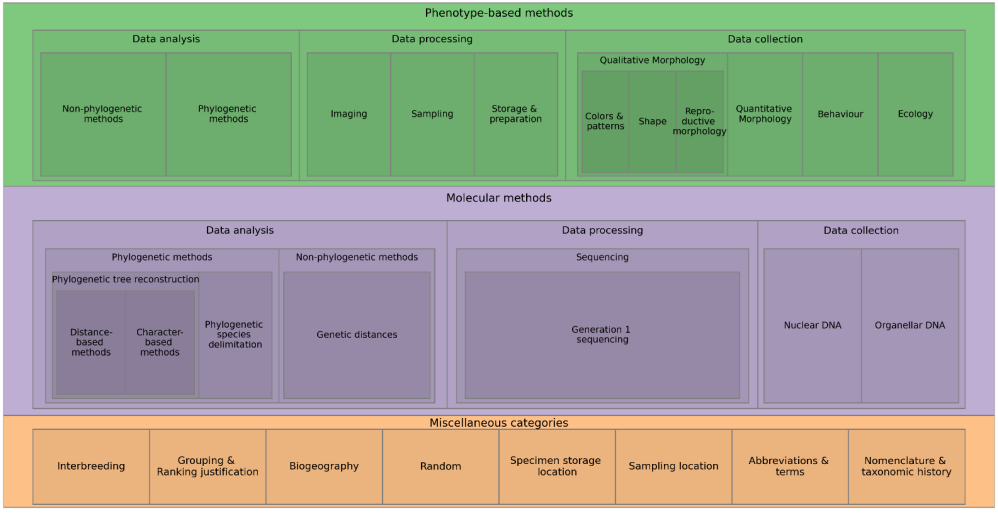
Difficult to detect in taxonomy:

- No “standard” citations for each method
- Different traditions of research (per taxon) = different terminology
- No tradition of describing your methods clearly (exploratory science)
- Lots of amateurs and researchers distributed across the world

Methodology

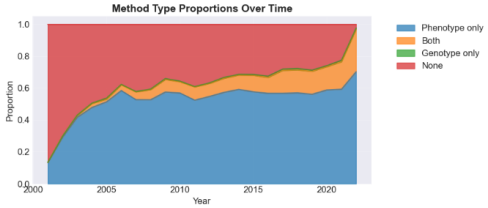
1. Lay out a general, hierarchical structure of methods
2. Isolate the “methods” sections
3. Exploratory analysis with topic modeling of these sections
4. Manual labeling of the paragraphs of these sections
5. Finalize the classification
6. Train classifiers/LLMs to classify the rest of the methods-paragraphs

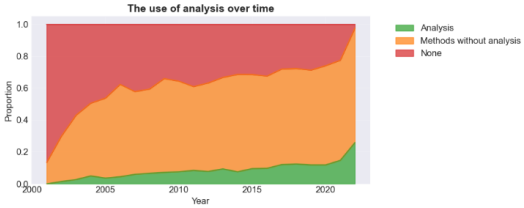
Methodology

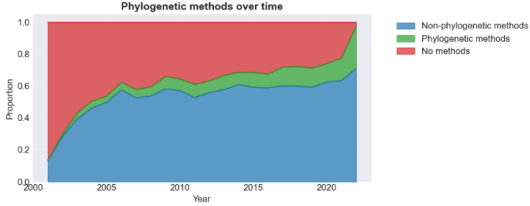


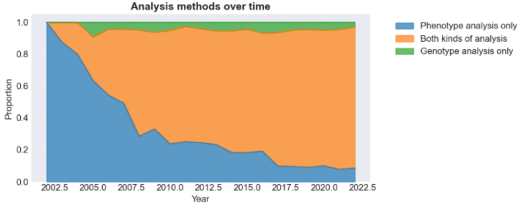
Preliminary results

Methodology

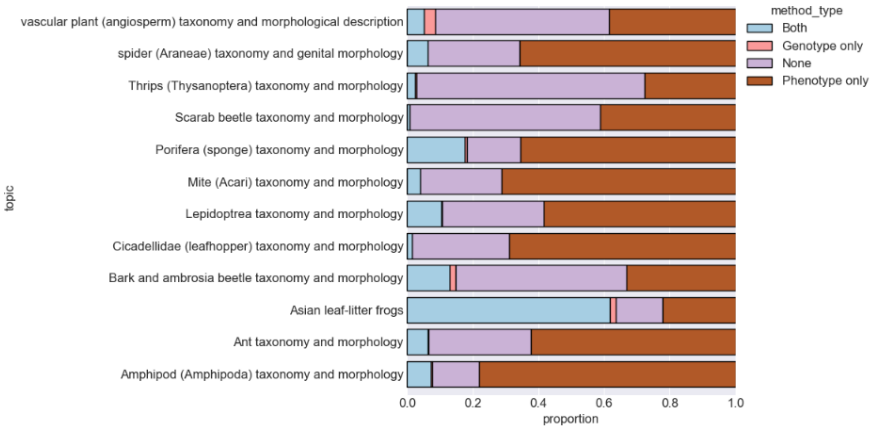




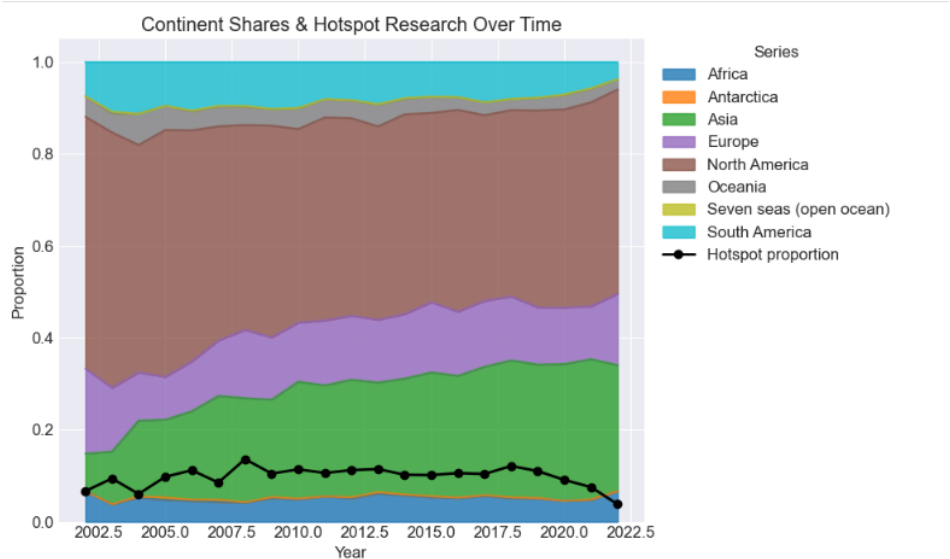




Methodology



Taxonomic attention



Disagreement and taxa

Divide organisms into “colloquial” groups (e.g., mammals, fish, birds, …).

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

Disagreement and taxa

Second hypothesis: What about the **age** of the group? Test the correlation between the “disagreement index” and the year in which the main genus in the article was described.

We expect a **negative correlation**: the older the group, the more we argue about it.

Disagreement and taxa

Confirmed: **significant negative correlation**

An article on a genus described in 1750 should have a disagreement-index around 0.003 higher than one on a newly described genus (and 0.003 is around the mean disagreement index overall!).

Future ideas

Future ideas

- Correlations with places discussed (and especially eco-regions, biomes, etc.)
- In-depth analysis (close-reading) of changes in methodology with time and across taxa
- Construction of a “high-disagreement” corpus, then analysis of it to detect (maybe?) different senses/kinds of disagreement

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Questions?

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