GRAPTOLITE SYNONYMIES: CORRELATION TO NAMING AUTHOR OR NAMING YEAR?

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Abstract

Taxonomy is the method by which organisms are assigned to a genus and species group. It is a science that is constantly evolving in response to our growing knowledge of evolution and of a group of organisms. This is especially true of graptolite taxonomy. Early work with graptolites focused solely on naming graptolites for use in biostratigraphy, such that graptolites were loosely grouped based on their general appearance rather than on biologic concepts of species or phylogeny. As studies into the evolution of graptolite morphology have increased there has been an increasing realization that synonyms, or species that have been given several taxonomic names, exist. Through careful examination of graptolite literature these synonyms are slowly being identified (Mitchell et al., unpublished data). However, the presence of synonyms may not only be due to changes in graptolite research through time. These synonyms may also be related to the authors responsible for the naming of particular species.

This study has determined that the correlation between the number of graptolite synonymies and the year a species is named, the naming author, and both the naming year and author are statistically different from a random distribution. The number of graptolites with a synonym versus the number of senior synonyms are also statistically different from each other when grouped by naming author and year, based on the results of a chi-squared analysis. Further analysis will look at the number of objective and subjective synonyms to determine if these correlations continue to persist. In addition, the numbers of both graptolites with a synonym and senior synonyms will be normalized for the monograph effect and analyzed to determine if there is still a correlation to naming author and year.

Background

The definition of species is initially straightforward: a group of organisms that are capable of interbreeding. However, recognizing an individual species is incredibly difficult in modern organisms, and more so for fossils. As a result, taxonomy changes as the defining characteristics of a species are further clarified or changed. This produces synonymies, where taxa that were already named are assigned a new name, either at the generic or species level.

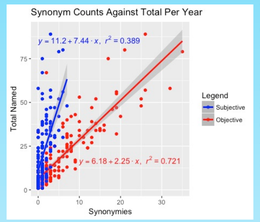
Early assumptions of the rate of synonymy for global diversity and species lists was 20-25%, however this has been revised to an average of 31% for modern insect species, 31% for fossil mammals, an average of 66% for seed plants, and 48% for dinosaurs (Benton 2008, 2010). As these numbers only account for the rate of synonymy to date, the numbers will continue to fluctuate both as more species are added and as further taxonomic names are revised. In addition to renaming an already named species, invalid names can arise from a name with no type material (nomen nudum), a name established and never used (nomen oblitum), a name based on incomplete material (nomen dubium), or a correctly named species that belongs to a different group (misassignment) (Benton 2008, 2010). However, due to changes in standards of recording and cataloging species, older primary sources do not contain the information needed to determine the source behind a change in name. As such, the majority of taxonomic name changes are grouped under the umbrella of "synonymy" for the purpose of the proceeding analyses.

Data & Terms

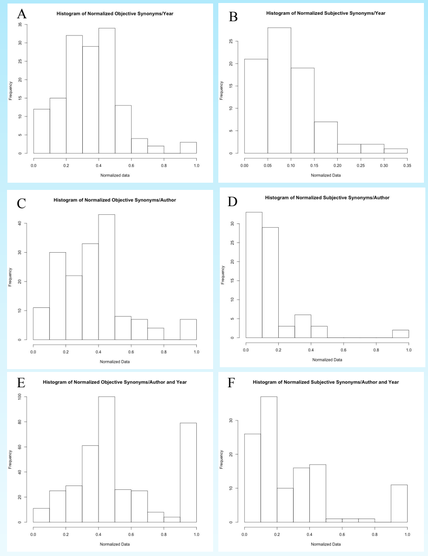
- The data comes from the Graptolite Taxonomic Dictionary (Mitchell et al., unpublished) which has been complied from primary literature sources

- Date: the year in which the taxon was originally named
- Objective synonyms: taxa for which the generic name was changed, the data represent the junior name
- Subjective synonyms: taxa for which the species name was changed, the data represent the junior name
- Senior Author/Codes: the first author name associated with the named taxa when multiple authors are responsible

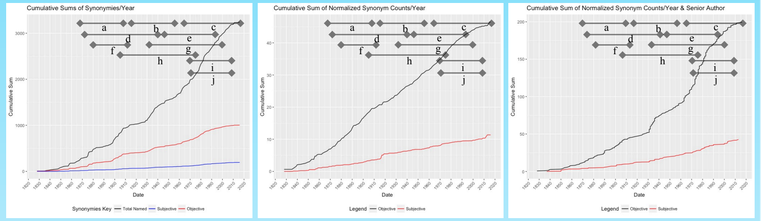
Results



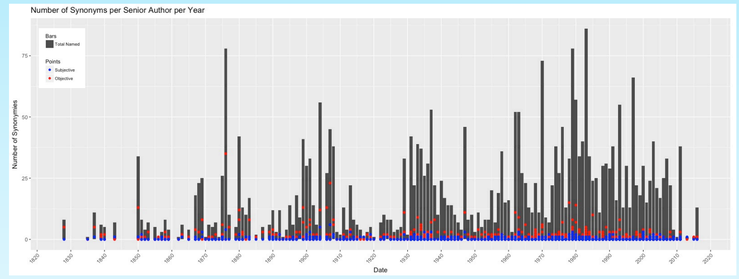
The bi-plot shows a high degree of correlation between the total named taxa and both the number of objective and subjective synonymies. In addition, the average rate of of objective synonymies is 40% and subjective synonymies have a rate of 10%. The lower subjective rate may be due to fewer subjective synonyms included in the dataset.



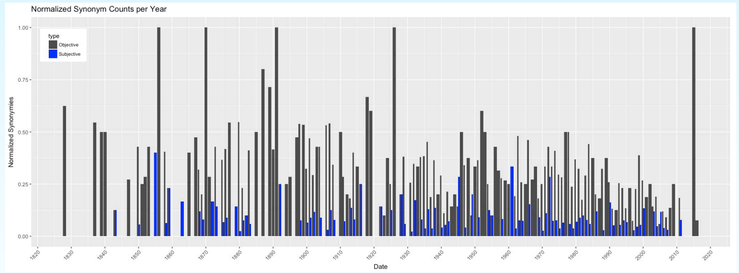
Of the above histograms, B, D, and F show the expected distribution of the frequencies of synonymies. It is expected that the highest frequencies will be for the lowest rates in each category. Graphs A and E show a near normal distribution per year and per author and year, respectively. In addition, the second highest frequency on E represents 100% rate of objective synonymies.



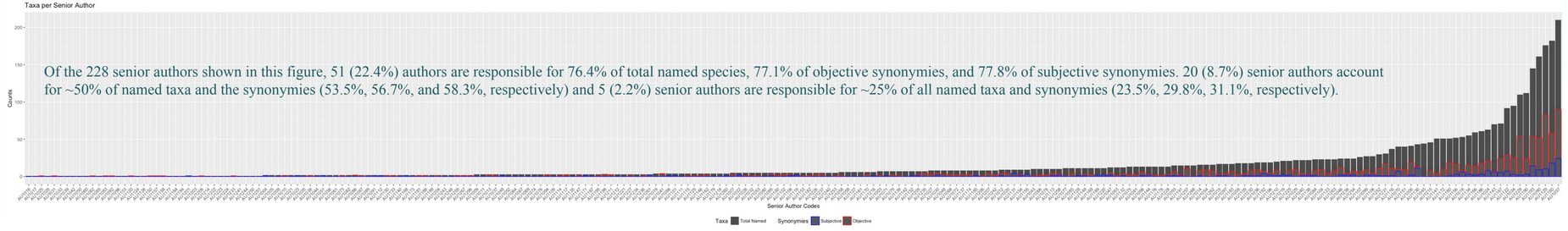
The above graphs show a general linear trend in the cumulative sum of the data. For the normalized graphs, the synonymy data was divided by the total number of taxa per grouping in order to control for large impulses of names, such as a monograph. When the data is normalized both by year and senior author, the objective synonymy line appears similar to the total taxa in the first graph. The bars represent the 10 most prolific authors and when they were active: a) Lapworth, b) Harris, c) Chen, d) Elles, e) Mu, f)Törnquist, g) Boucek, h) Ruedemann, i) Rickards, and j) Koren.



The above graph shows the pattern of synonymies when the data is grouped by senior author per year. Each dot per bar represents a different senior author. While there are points of high contribution to naming early in the span of graptolite research the majority of names occur around 1930 and after.

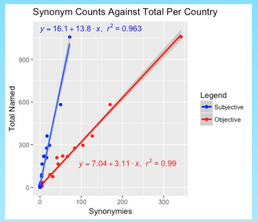


When normalized by the total taxa per year, it is clear that the majority of objective synonymies represent less than half the total taxa named in a year and subjective synonymies account for less than 25% of taxa named per year. However, the 4 bars reaching 1 indicate that 100% of the taxa named in those years are objective or subjective synonymies.



Of the 228 senior authors shown in this figure, 51 (22.4%) authors are responsible for 76.4% of total named species, 77.1% of objective synonymies, and 77.8% of subjective synonymies. 20 (8.7%) senior authors account for ~50% of named taxa and the synonymies (53.5%, 56.7%, and 58.3%, respectively) and 5 (2.2%) senior authors are responsible for ~25% of all named taxa and synonymies (23.5%, 29.8%, 31.1%, respectively).

Future Work



Future work will include examining additional data as well as different types of analyses:

- Determine correlation between rate of synonymies and the country of naming author and examine if correlation remains when data is normalized.
- Determine correlation between rate of synonymies and type locality of named taxa.
- If there is a correlation, why? Is it related to either the modern geology or the paleogeography of the type locality?
- Currently the Taxonomic Dictionary only contains global synonymies. The dictionary will be expanded to include local synonymies, which constitute the majority of subjective synonymies. This will be analyzed to determine if the observed correlations differ when local synonymies are included.
- Future analyses will examine cohorts of data and the associated decay curves of junior synonyms versus senior synonyms.
- Determine the statistical relationship associated with these correlations if the synonymy rate is independent.
- Determine if the rate of synonymy is correlated with the number of active authors.
- Examine other fossil invertebrate groups to determine if correlations observed for graptolites are similar.

References

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- Benton, MJ, 2010, Naming Dinosaur Species: The Performance of Prolific Authors, Journal of Vertebrate Paleontology, 30(5), 1478-1485.
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