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How much biodiversity is concealed in the word 'biodiversity'?

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Amidst a global biodiversity crisis[1], the word 'biodiversity' has become indispensable for conservation and management[2]. Yet, biodiversity is often used as a buzzword in scientific literature. Resonant titles of papers claiming to have studied 'global biodiversity' may be used to promote research focused on a few taxonomic groups, habitats, or facets of biodiversity — taxonomic, (phylo)genetic, or functional. This usage may lead to extrapolating results outside the target systems of these studies with direct consequences for our understanding of life on Earth and its practical conservation. Here, we used a random sample of papers with the word 'biodiversity' in their title to take a long view of the use of this term. Despite improvements in analytical tools, monitoring technologies, and data availability[3,4], we found that the taxonomic scope of research articles has not increased in recent years. We also show that studies with a wider taxonomic scope attract more citations and online attention. Our results have broad ramifications for understanding how extrapolating from studies with narrow taxonomic scope affects our view of global biodiversity and conservation.

We gathered all the articles listed in the *Web of Science* with the word 'biodiversity' in their title (N = 10,170). We randomly sampled ~10% of these papers and extracted detailed information on geographical focus, methodologies, and biodiversity facets considered. Furthermore, we counted the number of unique Phyla/ Divisions (or higher taxonomic ranks for microorganisms) considered in each study (hereinafter 'phyla'). We then computed for each study the sampled number of phyla out of the total possible phyla ('proportion of biodiversity'; Figure S1 in Supplemental information).

We found that as many as 22% of the papers using the word 'biodiversity' in the title did not measure biodiversity at any level. This suggests that biodiversity is often used as a theoretical concept rather than a measurable phenomenon[2].

Across the remaining 661 papers, the proportion of biodiversity investigated by each study showed a highly skewed distribution, with most studies sampling a small proportion of biodiversity and a long tail of comparatively few studies sampling higher proportions (mean ± SE: 3.86% ± 0.15%; mode: 1.78%; range: 1.78–44.64%; Figure S2). The taxonomic scope of papers has not increased in recent years either (Figure 1A).

Next, we investigated the role of 11 factors in explaining the biodiversity sampled by each paper (Figure 1B). Sampled biodiversity was lower in studies set in the Antarctic, Afrotropical, Indomalayan, and Nearctic regions (Figure S2A) and those focusing on the terrestrial realm (Figure S2B). Low sampled biodiversity was associated with studies based on big data (Figure S2C) or focusing on phylogenetic diversity. The most sampled taxa were vertebrates (Chordata) followed by arthropods, whereas microorganisms and fungi were the least studied (Figure S2D).

A possible explanation for these patterns is that certain taxa and regions are more likely to receive research funds and attention[5]. Some taxa are easier to study due to their characteristics (for example, macroscopic size, large geographic range, ease of sampling) and greater availability of data. The finding that research using big data have narrower taxonomic scopes was unexpected. The availability of big data could potentially allow the study of an increasing number of organisms, but in fact, increasing biases in existing databases might not enable short-term data synthesis[6]. Much needed data for biodiversity studies await collection from the field, existing collections, or even 'grey' literature, all requiring massive human effort. Ultimately, it seems that we are flooded by data and analyses on few taxa (in 2020, vertebrates accounted for 68% of data available from the Global Biodiversity Information Facility[7]), increasing biases in inadvertent ways.

Finally, we derived two measures of article impact — number of citations and Altmetric score — and tested how sampled biodiversity and the use of descriptors (mention of taxa, habitat, or locations) in the title affect impact, while accounting for the number of countries of the coauthors and the Impact Factor as confounding factors. In general, not mentioning descriptors led to more citations (Figure 1C) and societal attention (Figure 1D). All else being equal, proportion of biodiversity in interaction with the use of descriptors had a positive effect on impact. Whereas the impact of articles with more than one descriptor in the title was generally low, articles with one or no descriptor in the title attained greater impact when they sampled more biodiversity (Figure 1C,D).

Overall, our results suggest caution when extrapolating from a few taxa, regions, or habitats to the full spectrum of living forms. This practice can misinform and misdirect conservation policies and actions by governments, organizations, and conservation practitioners, misallocating resources[5] and perpetuating known biodiversity shortfalls[6]. In the long run, this may turn out to be detrimental for most species and even the ecosystem services on which we depend.

What can we do to improve this situation? First, in the current trend of increasing publication numbers, fast communication through social media, and decreasing attention span of readers[8], our results are a powerful reminder that scientists should critically read papers and their scope rather than limiting the focus to titles and abstracts. Also, as both editors and reviewers, we should play an active role in reducing the dangers related to 'overselling', for example, by calling out manuscripts with unjustified broad titles. Although overselling may produce short-term positive effects in terms of citations

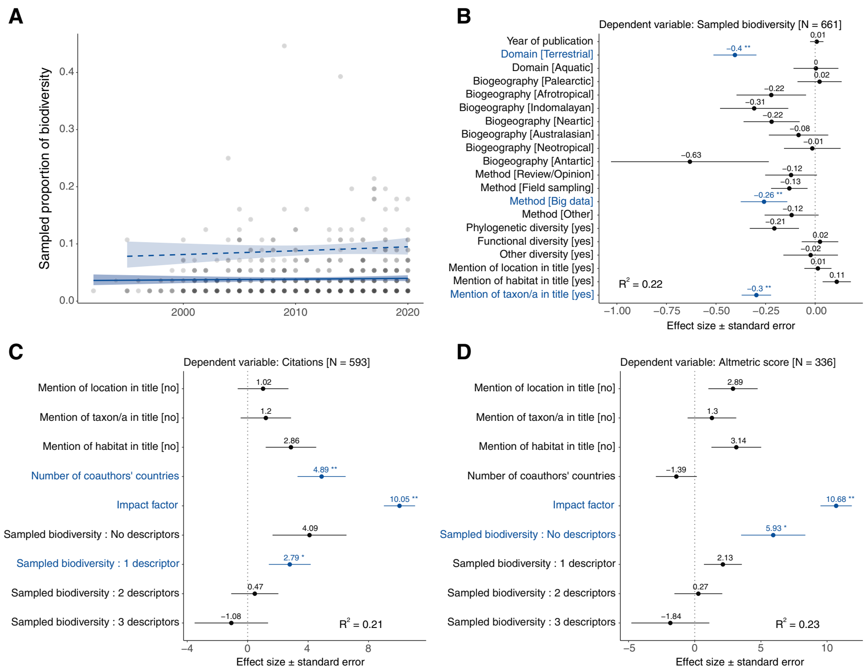

Figure 1. Sampled biodiversity across studies and its relation with their impact.
(A) Annual variations in the proportion of biodiversity considered in each study. Regression lines: filled, full data (quasibinomial generalized linear model; estimated β ± SE: 0.004 ± 0.007, p = 0.587); dashed, only data in the 75–100th percentile (quasibinomial GLM; estimated β ± SE: 0.008 ± 0.009, p = 0.339). (B) Estimated parameters for a negative binomial generalized linear model testing the relationship between sampled biodiversity and different article-level predictors. The model is based on studies with sampled biodiversity > 0. Reference categories: Domain [Multiple]; Biogeography [Global]; Method [Multiple]. (C) Estimated parameters for a linear model testing the relationship between citations and different article-level predictors, including the interaction between sampled biodiversity and the number of descriptors (i.e. mention of taxa, habitat, or locations). (D) Visualization of the influence of the interaction between the number of descriptors and sampled biodiversity on Altmetric scores, including the same interaction as in C. In B–D, error bars indicate standard errors. Significant values (*: < 0.05; **: < 0.01) are highlighted in blue.

and societal attention, it will not serve the long-term goals of prestige and authoritativeness that any journal should strive for.

Given that in most biodiverse biogeographic regions the sampled proportion of biodiversity is systematically low, researchers and journals from these areas should be supported in producing primary biodiversity data and involved in international collaboration[9]. This would decrease existing taxonomic and geographical biases across all biodiversity facets.

Finally, as emphasized several times[10], increasing the number of trained taxonomists and funds dedicated to this type of activity will be instrumental to increasing the taxonomic coverage of studies. Indeed, if some parts of biodiversity research can now largely be automated[4], others build on basic natural history and taxonomic knowledge in the most under-explored regions of the world, which often harbor the vast majority of biodiversity.

SUPPLEMENTAL INFORMATION

Supplemental information includes experimental procedures, data and code availability, acknowledgements and two figures and can be found with this article online at https: //doi.org/10.1016/j.cub.2022.12.003.

DECLARATION OF INTERESTS

The authors declare no competing interests.

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