Improving Diversity in the Ocean Sciences

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No progress on diversity in 40 years

Ethnic and racial diversity are extremely low among United States citizens and permanent residents who earned doctorates in earth, atmospheric and ocean sciences. Worse, there has been little to no improvement over the past four decades.

Rachel E. Bernard and Emily H. G. Cooperdock

Nature Geoscience
2018

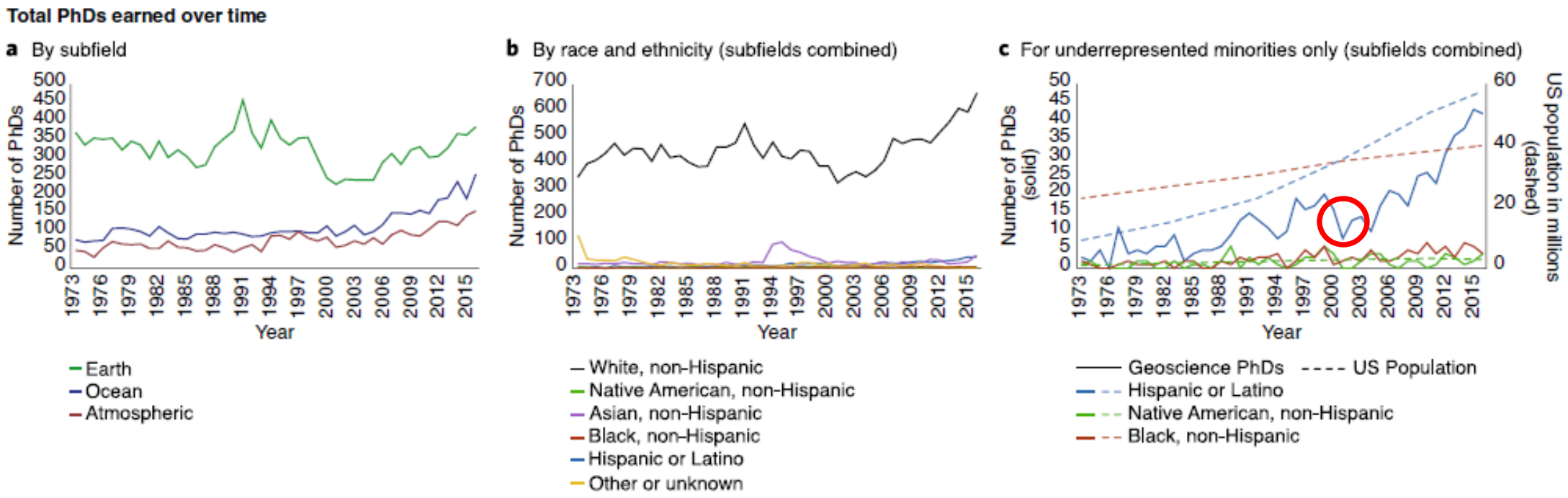

Fig. 1 | PhDs earned by US citizens and permanent residents between 1973 and 2016. a, The total number of PhDs for all races, ethnicities and genders combined have fluctuated around 350 for the earth sciences, but have taken an upward turn from a stable base level in the last decade or so for ocean and atmospheric sciences. **b**, The largest race/ethnicity category by far is the White non-Hispanic PhD group. **c**, Focusing on what the NSF considers to be underrepresented minorities (that is, excluding White non-Hispanics and Asian non-Hispanics), and comparing with the increasing share of these groups in the US population (measured by decadal census and 2016 estimate), it becomes clear that gains in Hispanic or Latino PhDs largely reflect an increase in the relevant population in the US, and that there are no gains in PhDs earned among the other underrepresented groups. Data in **a**–**c** run from 1973 to 2016.

Implicit Bias In Ocean Science

- Engagement/Inclusion
- Resource Allocation
- Academic Identity and Currencies

Engagement and Inclusion

- Unclear understanding by those outside the ocean sciences.

- Ineffective messaging and engagement, particularly at the early undergraduate stage.

- Lack of community and belonging.

Hofstra et al. 2020

The Diversity–Innovation Paradox in Science

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Prior work finds a diversity paradox: Diversity breeds innovation, yet underrepresented groups that diversify organizations have less successful careers within them. Does the diversity paradox hold for scientists as well? We study this by utilizing a near-complete population of ∼1.2 million US doctoral recipients from 1977 to 2015 and following their careers into publishing and faculty positions. We use text analysis and machine learning to answer a series of questions: How do we detect scientific innovations? Are underrepresented groups more likely to generate scientific innovations? And are the innovations of underrepresented groups adopted and rewarded? Our analyses show that underrepresented groups produce higher rates of scientific novelty. However, their novel contributions are devalued and discounted: For example, novel contributions by gender and racial minorities are taken up by other scholars at lower rates than novel contributions by gender and racial majorities, and equally impactful contributions of gender and racial minorities are less likely to result in successful scientific careers than for majority groups. These results suggest there may be unwarranted reproduction of stratification in academic careers that discounts diversity's role in innovation and partly explains the underrepresentation of some groups in academia.

diversity | innovation | science | inequality | sociology of science

Innovation drives scientific progress. Innovation propels science into uncharted territories and expands humanity's understanding of the natural and social world. Innovation is also believed to be predictive of successful scientific careers: Innovators are science's trailblazers and discoverers, so producing innovative science may lead to successful academic careers (1). At the same time, a common hypothesis is that demographic diversity brings such innovation (2–5). Scholars from underrepresented groups have origins, concerns, and experiences that differ from groups traditionally represented, and their inclusion in academe diversifies scholarly perspectives. In fact, historically underrepresented groups often draw relations between ideas and concepts that have been traditionally missed or ignored (4–7). Given this, if demographic groups are unequally represented in academia, then one would expect underrepresented groups to generate more scientific innovation than overrepresented groups and have more successful careers (*SI Appendix*). Unfortunately, the combination of these two relationships—diversity–innovation and innovation–careers—fails to result and poses a paradox. If gender and racially underrepresented scholars are likely to innovate and innovation supposedly leads to successful academic careers, then how do we explain persistent inequalities in scientific careers between minority and majority groups (8–13)? One explanation is that the scientific innovations produced by some groups are discounted, possibly leading to differences in scientific impact and successful careers.

In this paper, we set out to identify the diversity–innovation paradox in science and explain why it arises. We provide a system-level account of science using a near-complete population of US doctorate recipients (∼1.2 million) where we identify scientific innovations (14–19) and analyze the rates at which different demographic groups relate scientific concepts in novel ways, the extent to which those novel conceptual relations get taken up by other scholars, how "distal" those linkages are (14), and the subsequent returns they have to scientific careers. Our analyses use observations spanning three decades, all scientific disciplines, and all US doctorate-awarding institutions. Through them we are able 1) to compare minority scholars' rates of scientific novelty vis-à-vis majority scholars and then ascertain whether and why their novel conceptualizations 2) are taken up by others and, in turn, 3) facilitate a successful research career.

Innovation as Novelty and Impactful Novelty in Text

Our dataset stems from ProQuest dissertations (20), which includes records of nearly all US PhD theses and their metadata from 1977 to 2015: student names, advisors, institutions, thesis titles, abstracts, disciplines, etc. These structural and semantic footprints enable us to consider students' rates of innovation at the very onset of their scholarly careers and their academic trajectory afterward, i.e., their earliest conceptual innovations and how they correspond to successful academic careers (21). We link these data with several data sources to arrive at a near-complete ecology of US PhD students and their career trajectories. Specifically, we link ProQuest dissertations to the US Census data (2000 and 2010) and Social Security Administration data (1900 to 2016) to infer demographic information on students' gender and race (i.e., name signals for white, Asian, or underrepresented minority [Hispanic, African American, or Native American]; see *Materials and Methods* and *SI Appendix*); we link ProQuest dissertations to Web of Science, a large-scale publication database with ∼38 million academic publications (1900 to 2017), to find out which students have continued research careers, and we weigh our inferential analyses by population records of the number of PhD recipients for each distinct university–year combination to render results generalizable to the population (*SI Appendix*).

Significance

By analyzing data from nearly all US PhD recipients and their dissertations across three decades, this paper finds demographically underrepresented students innovate at higher rates than majority students, but their novel contributions are discounted and less likely to earn them academic positions. The discounting of minorities' innovations may partly explain their underrepresentation in influential positions of academia.

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See online for related content such as Commentaries.

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Resource Allocation

- Resource allocation is another area where implicit bias in ocean science arises.
- Who we collaborate with (e.g. old boys network).
- Inequity in who receives funding.
- Internal barriers.

“Parachute Science”

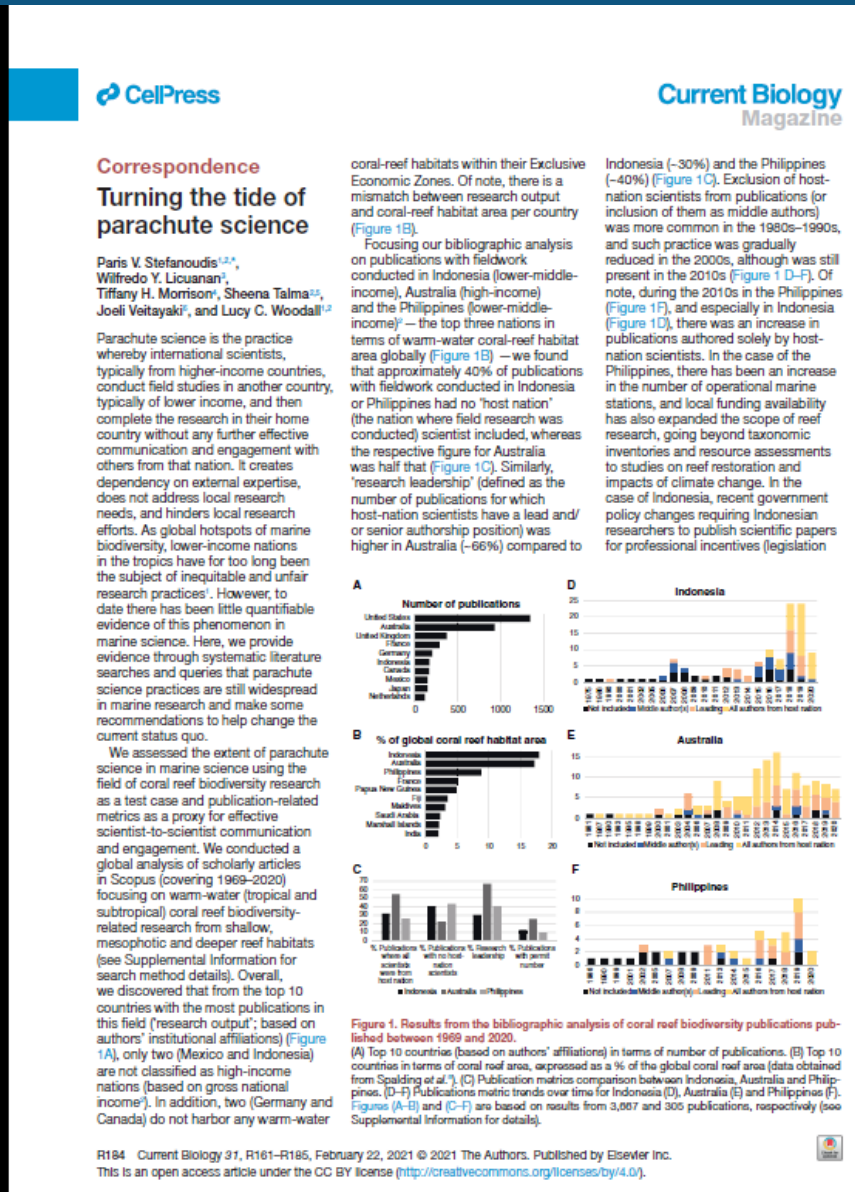
Coral research provides an example of parachute science.

Majority of coral research conducted by Western Institutions.

Local researchers and knowledge often excluded.

Creates a resource and accessibility inequity.

Can feed into future hires in the discipline.



CellPress

Current Biology
Magazine

Correspondence

Turning the tide of parachute science

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Parachute science is the practice whereby international scientists, typically from higher-income countries, conduct field studies in another country, typically of lower income, and then complete the research in their home country without any further effective communication and engagement with others from that nation. It creates dependency on external expertise, does not address local research needs, and hinders local research efforts. As global hotspots of marine biodiversity, lower-income nations in the tropics have for too long been the subject of inequitable and unfair research practices[1]. However, to date there has been little quantifiable evidence of this phenomenon in marine science. Here, we provide evidence through systematic literature searches and queries that parachute science practices are still widespread in marine research and make some recommendations to help change the current status quo.

We assessed the extent of parachute science in marine science using the field of coral reef biodiversity research as a test case and publication-related metrics as a proxy for effective scientist-to-scientist communication and engagement. We conducted a global analysis of scholarly articles in Scopus (covering 1969–2020) focusing on warm-water (tropical and subtropical) coral reef biodiversity-related research from shallow, mesophotic and deeper reef habitats (see Supplemental Information for search method details). Overall, we discovered that from the top 10 countries with the most publications in this field (‘research output’; based on authors’ institutional affiliations) (Figure 1A), only two (Mexico and Indonesia) are not classified as high-income nations (based on gross national income[2]). In addition, two (Germany and Canada) do not harbor any warm-water coral-reef habitats within their Exclusive Economic Zones. Of note, there is a mismatch between research output and coral-reef habitat area per country (Figure 1B).

Focusing our bibliographic analysis on publications with fieldwork conducted in Indonesia (lower-middle-income), Australia (high-income) and the Philippines (lower-middle-income)[2] — the top three nations in terms of warm-water coral-reef habitat area globally (Figure 1B) — we found that approximately 40% of publications with fieldwork conducted in Indonesia or Philippines had no ‘host nation’ (the nation where field research was conducted) scientist included, whereas the respective figure for Australia was half that (Figure 1C). Similarly, ‘research leadership’ (defined as the number of publications for which host-nation scientists have a lead and/or senior authorship position) was higher in Australia (~66%) compared to Indonesia (~30%) and the Philippines (~40%) (Figure 1C). Exclusion of host-nation scientists from publications (or inclusion of them as middle authors) was more common in the 1980s–1990s, and such practice was gradually reduced in the 2000s, although was still present in the 2010s (Figure 1 D–F). Of note, during the 2010s in the Philippines (Figure 1F), and especially in Indonesia (Figure 1D), there was an increase in publications authored solely by host-nation scientists. In the case of the Philippines, there has been an increase in the number of operational marine stations, and local funding availability has also expanded the scope of reef research, going beyond taxonomic inventories and resource assessments to studies on reef restoration and impacts of climate change. In the case of Indonesia, recent government policy changes requiring Indonesian researchers to publish scientific papers for professional incentives (legislation

Figure 1. Results from the bibliographic analysis of coral reef biodiversity publications published between 1969 and 2020.
(A) Top 10 countries (based on authors’ affiliations) in terms of number of publications. (B) Top 10 countries in terms of coral reef area, expressed as a % of the global coral reef area (data obtained from Spalding *et al.*[3]). (C) Publication metrics comparison between Indonesia, Australia and Philippines. (D–F) Publications metric trends over time for Indonesia (D), Australia (E) and Philippines (F). Figures (A–B) and (C–F) are based on results from 3,667 and 305 publications, respectively (see Supplemental Information for details).

Stefanoudis et al. 2021

“Small School” Dynamics

- There can sometimes be an aversion to research engagement at MSIs.
- Historic expectation to focus on teaching.
- Insufficient infrastructure.
- Inexperience/unfamiliarity with grant programs.

Reframing Your Science Identity

- "I'm not an educator, I'm a researcher".

- We need to reframe our personal definition of a scientist.

Josh Kohut, Rutgers University

Why change the research model?

- Improves the diversity of those who engage in STEM.
- Helps bring new ideas and perspectives to our fields.
- Can result in new ways of conducting research.