Conservation Biology

Diversity

Use of double-blind peer review to increase author diversity

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Two recent *New York Times* articles highlight the "Mystery of Missing Women in Science" (Angier 2013) and ask the question, "Why Are There Still So Few Women in Science?" (Pollack 2013). The underrepresentation of women is an issue that scientists, educators, and policy makers continue to tackle. While there have been large gains toward equality over the past decades, there is also hard evidence of continued disparities (Moss-Racusin et al. 2012; Larivière et al. 2013). Gender inequalities occur in hiring, funding, collaborations, academic patents, job satisfaction, and citation rates (Holden 2001; Ding et al. 2006; Bornmann et al. 2007; Moss-Racusin et al. 2012; Larivière et al. 2013). There are more male senior scientists and thus fewer female role models at upper levels, and there is a striking wage gap between men and women in leadership positions (Shen 2013). This situation does not only reflect a gender gap in the upper tiers of science leadership; in many countries, minority and international scientists are also missing (e.g., NSF 2013). Such disparities can feed a subtle but inherent bias about the value and contributions of women, minorities, and international scientists. There are obviously many factors that might be associated with these trends. The question is, what can we do about it?

One solution is to ensure that research contributions are fairly evaluated, particularly in the peer review process. Publications are widely used as metrics of a scientist's productivity and success, but the peer review process is not free from subjectivity and bias (Wold & Wennerås 1997; Møller & Jennions 2001; Lortie et al. 2007; but see Park et al. 2013). For example, most journals use single-blind review, whereby a reviewer's identity is hidden but the authors are revealed. This can allow unintentional or subconscious biases to affect how a reviewer judges a paper based on its authors. An alternative system is double-blind review, in which the identities of both reviewers and authors are concealed. The value of double-blind review is that it allows research products to be judged on content, not their authors' names, gender, institution, or publication history. For example, the switch to blind auditions at the New York Philharmonic Orchestra (where musicians played behind a screen) increased the representation of women from 10% to 45% (Goldin & Rouse 2001). Should a similar approach be applied to scientific peer review?

Double-Blind Debate

Double-blind peer review is not a new proposal. In the late 2000s, widespread debate and controversy ensued after Budden and colleagues (2008*a*) found that a switch to double-blind review in the journal *Behavioural Ecology* led to a small but notable 7.9% increase in the proportion of articles with female first authors (χ^2 test before vs. after double-blind review: $p = 0.03$, effect size $w = 0.19$, $n = 867$ articles). The increase across the same period in 5 other single-blind ecology and evolution journals was 3.7% (SD 2.1) (Fig. 1a). Budden et al. (2008*a*) also found a significant increase in the number of articles with female first authors in one of these 5 journals (*Biological Conservation*), which at the time offered an option to include an anonymous title page (i.e., pseudo double-blind review) (Budden et al. 2008*a*, 2008*b*). Several rebuttals questioned the statistical approach of Budden et al. (2008*a*) and suggested the findings overestimated the bias of single-blind reviews and instead reflected the proportional increase of women in the scientific workforce (Hammerschmidt et al. 2008; Webb et al. 2008; Whittaker 2008). A subsequent study of 1752 articles submitted to *Biological Conservation* between 2004 and 2007 (which now allows only single-blind review) found no evidence of biased acceptance or rejection rates by gender, nationality, or age (Primack

Paper submitted October 22, 2013; revised manuscript accepted March 28, 2014.

Conservation Biology, Volume 29, No. 1, 297–299

DOI: 10.1111/cobi.12333

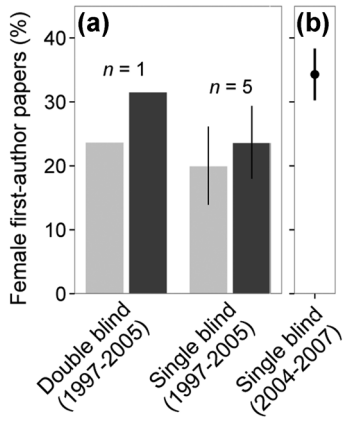

Figure 1. (a) The percentage of articles with a female first author published in ecology and evolutionary biology journals under single and double-blind review policies (light grey, before implementation of double-blind review [1997–2000]; dark grey, after implementation of double-blind review [2002–2005]; data from Budden et al. [2008a]). (b) The average percentage of articles with female first authors accepted for publication in Biological Conservation between 2004 and 2007 under a single-blind review process (data from Primack et al. [2009]).

et al. 2009). This study also found that the average proportion of accepted articles with a female first author (34.3% [SD 4.0]) was slightly higher than the average proportion accepted by *Behavioural Ecology* under double-blind review (31.6%) (Primack et al. 2009) (Fig. 1b). Moreover, both the Budden et al. (2008*a*) and Primack et al. (2009) studies had the statistical power to detect even small effect sizes. In light of the contradictory results of these studies, where does this leave double-blind peer review today?

Recent research suggests that double-blind review should be re-examined—it turns out that a person's name can give away subtle clues that can affect even unconscious and unintended bias. In a randomized and double-blind study of 127 tenure-track academic science faculty, Moss-Racusin et al. (2012) documented a subtle bias against female first names from both male and female scientists. Each faculty member was asked to rank an identical lab manager application from a recent undergraduate student with a randomly assigned first name: John or Jennifer. Regardless of the faculty member's age, gender, area of specialty, or seniority, John scored higher than Jennifer in all areas (i.e., more competent, more hirable, and more worthy of mentoring). The exception to the trend was that Jennifer scored higher on likeability. Overall, John was offered a salary nearly $5000 more than Jennifer based on the exact same qualifications (Moss-Racusin et al. 2012). Similar biases have also been found in response to nationality and culture. A study in the medical journal *Gastroenterology* showed that reviewers from the United States tended to review papers by authors from the United States more favorably than papers by authors from other countries (Link 1998). A study of Scandinavian peer review found that reviewers favored manuscripts written in English over an identical manuscript written in Danish, Norwegian, or Swedish (Nylenna et al. 1994). Despite our best efforts to remain objective, we may be more prone to subconscious and unintended bias than we think we are.

Need for More Data

While double-blind review is popular within the scientific community (Kmietowicz 2008; Nature Geoscience 2013), a lack of evidence for positive impacts has limited its wider use (e.g., Nature 2008). It is then exciting that *Conservation Biology* is actively considering moving from single-blind to double-blind peer review. This provides a valuable opportunity to quantitatively track and evaluate the impact of double-blind review in the flagship journal of conservation science. More journals with double-blind review are needed to evaluate the effect size and statistical power of double-blind review on author diversity. For example, Hammerschmidt et al. (2008) and Webb et al. (2008) suggest comparing the ratios of accepted to submitted manuscripts by female authors relative to male authors before and after the introduction of double-blind review. Similar analyses could consider the effects of double-blind review on author nationality, institution, or age.

A common concern with double-blind review is that expert reviewers can easily identify authors even when their identities are hidden (Nature 2008). However, reviewers may not be as good at guessing authors' identities as they think. In a study of 7 medical journals, reviewers were able to correctly identify authors only 40% of the time (Cho et al. 1998; Justice et al. 1998). Similarly, in a study of reference citations, a machine-learning program correctly identified the authors 40–45% of the time from self-cited citations (a commonly assumed giveaway to an author's identity [Hill & Provost 2003]). Double-blind review has also been criticized for creating an extra workload for journals. However, even simple tweaks to an existing single-blind system could address potential bias, such as identifying manuscripts only with initials of each author and hiding institutional affiliations. It is worth noting that some journals have recently allowed authors to choose between double-blind or single-blind review (Nature Climate Change 2013; Nature Geoscience 2013). However, a mixed-review system can create challenges for impact evaluation (Budden et al. 2008*b*). For *Conservation Biology*, the most effective evaluation would be a mandatory policy of double-blind review.

Peer-reviewed publications are widely used as indicators of research productivity and success. Thus, the scientific community should critically and quantitatively evaluate whether there is any aspect of the peer review system that can be improved to increase diversity in science. A shift to double-blind review at *Conservation Biology* would produce valuable data that could be used to meet this goal. There are obviously many factors that contribute to the ongoing problem of inequality in positions of science leadership around the world. Proposed solutions include targeted education and mentorship programs, a focus on publication quality over quantity, support after career breaks, and programs to foster international collaborations (Webb et al. 2008; Ceci and Williams 2011; Larivière et al. 2013). There is no single, quick, or easy solution to the diversity problem. However, one action to consider and evaluate is the role of different peer-review systems in the publication process. Increasing the diversity of authorship in the scientific literature and science leadership is worth it.

Acknowledgments

I thank M. Burgman and E. Main for discussions that motivated and improved this contribution. I am grateful to J. Bruno, I. Côté, S. K. M. Ernest, J. Friedman, A. Valdivia, E. White, J. Baum, and one anonymous reviewer for helpful feedback and comments. Funding was provided by the David H. Smith Conservation Research Fellowship Program.

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