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# Some perspective on *Molecular Ecology* perspectives: Are women being left out?

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There are a variety of ways one contributes to science--we give talks, publish papers, review manuscripts, serve on editorial boards, and mentor others, to name just a few. Invitations to present talks and review manuscripts, as well as invitations to write review articles and perspectives pieces are important signifiers that our contributions are leading to career progress. The experience that these opportunities provide is likewise very important, since each one provides a chance for scientific growth--who hasn't learned something from performing these tasks?

Unfortunately, the literature shows discrepancies between men and women in such opportunities (Berg, 2019; Cho et al., 2014; Schroeder et al., 2013). A relatively recent analysis, for example, found a very unbalanced ratio in the gender of manuscript reviewers for the journal Functional Ecology--between 82-73% of invited reviewers over a ten-year period (from 2004 to 2014, respectively) were men (Fox, Burns, & Meyer, 2016). The gender of the editors and the reviewers suggested by authors significantly influenced the proportion of women invited to review; since the gender ratio of editors was majority men (from 100-62.5%), and men were more likely to be suggested as reviewers (85-75%), this led to fewer women reviewers overall

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(Fox, Burns, & Meyer, 2016; Fox et al., 2017). This striking difference in reviewing opportunities meant fewer women were offered chances for intellectual growth and for the ability to add their opinions and input to the reviewing process--in other words, they were not given an equal chance to shape the field.

Such differences could also lead to a potentially overlooked phenomenon: a lower proportion of women being invited to write a perspective or opinion piece on emergent work. A correspondence piece in the journal Nature suggests this is likely: only 17% of Nature News & Views articles in the biological and chemical sciences were written by women (Conley & Stadmark, 2012). It would be concerning if ecology journals show similar biases, as it would be another way in which women have not received equal opportunities to shape the field.

We decided to take a look at the potential for this effect within Molecular Ecology. The journal began a perspectives series in 2007 as a way to highlight particularly novel or exciting manuscripts. Currently, the process for finding an author for a perspective piece begins with the Associate Editor, who contacts the News and Views editor and suggests potential perspectives and sometimes authors. Likewise, the reviewer is prompted during the review process to provide feedback on whether or not they believe the manuscript should be highlighted by a perspective. The News and Views editor then decides on whether or not to have a perspective piece written and ultimately selects potential authors and commissions the perspective. Thus, if we were to find differences in the gender of authors of perspective pieces, it could be due to a variety of steps in the process.

To determine if there were potential gender biases in the authorship of the perspective pieces, we downloaded authorship information from ScholarOne for perspectives commissioned since 2009 (2009 to 2017). When a perspective had multiple authors, we used the gender of the submitting author which was typically the author that was invited to write the perspective. We inferred gender designation based on first name; if the name was ambiguous or generally unknown to us, we performed web searches for visual identification. Thus, gender was assigned as binary and based on assumed and perceived gender presentation. We removed entries for which we could not reliably assign gender. Overall, we inferred the gender of scientists for 316 perspective pieces.

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Our analysis found Molecular Ecology perspectives pieces were highly skewed towards male authors. Over the 9 years analyzed, an average of 23.4% of perspectives were authored by women, significantly lower than the percentage of perspectives written by men ($X^2$ = 175.96, df =1, p-value < 0.001). The percentage of perspectives authored by women ranged between 17.2% and 28.6% between 2009 and 2017 (Fig. 1A and Table S1).

What are the underlying reasons for this gender disparity? We examined a few ideas based on the current process of identifying perspectives authors. First, if the reviewer pool of the perspective pieces is highly skewed toward men, that could impact the gender pool of the perspectives authors, as reviewers of a paper are often, but not always, the authors of perspectives pieces about the work. It is also possible that a similar number of women and men are asked to review, but women decline such review requests more often. Finally, we hypothesized that men may suggest manuscripts for perspective pieces during the review process more often than women, ultimately influencing the gender pool of perspectives authors.

We found that women were invited to review only 26.2% of the manuscripts that received perspective pieces, which was significantly lower than the percentage of men invited to review ($X^2$ = 749.48, df =1, p-value < 0.001). This percentage ranged between 23.1% and 31.6% between 2009 and 2017 (Fig. 1B and Table S1). While change over time was not significant, there was an upward trend (Year effect, F = 3.33, df = 1, p-value = 0.07). Once invited, women turned in reviews as often as men (women, 50.5%; men 50.1%, $X^2$ = 0.01, df = 1, p-value = 0.52; Fig 1C and Table S1), indicating that the discrepancy between genders was not due to a lower rate of review submission from women. We also found men suggested manuscripts for perspective pieces more often than women (men, 41.8%; women, 33.3%) and that this difference was significant ($X^2$ = 201.36, df = 1, p-value < 0.001; Table S1). Interestingly, only a little over half (54.7%) of the perspectives authors were reviewers of the original paper (range 34.5-66.7%; Table S1).

We next wanted to determine if these reviewing trends for perspectives were an exception or if they were representative of reviewer trends across all papers more generally. We likewise wanted to characterize the gender ratio of submitting authors--as a potential proxy of the gender ratio in the field more broadly--and determine if editorial decisions were influenced by gender of either the authors or editors. To do so, we compiled data on a subsample of papers reviewed in the journal between 2009-2017. For each year, we retrieved reviewer and author data on the

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first 40 to 48 original papers submitted, with the goal of examining at least 10 submissions/year edited by a woman (Table S2). Our dataset included 395 papers, with 1066 reviews returned and 2283 reviewer invitations. Of these, we could reliably determine gender for 2267 of those invited to perform a review (1059 reviews); we also determined the gender of first and last author of each submission.

Using these data, we found that across all years examined, women received only 30.4% of review requests, which was significantly lower than the percentage of men invited to review ($X^2$ = 689.42, df = 1, p-value < 0.001). This percentage ranged between 18.5% and 35.9% between 2009 and 2017 (Table S2), with no indication this percentage changed over time (Year effect, F = 0.21, df = 1, p-value = 0.64). We found no evidence that women declined review opportunities more often than men, with the review acceptance rate of women at 42.9%, and that of men at 43.6% ($X^2$ = 0.04, df = 1, p-value = 0.42).

Next we explored the basis of gender differences in the reviewer pool. If the community of molecular ecologists is male-biased, especially at the senior level, then the composition of the reviewer pool may reflect this. Analyses of the gender of authors over this period indicates that men were more likely to be both first (M: 59%; $X^2$ = 26.24, df = 1, p-value < 0.001) and last author (M: 76%; $X^2$ = 210.71, df = 1, p-value < 0.001). An examination of authorship per year found a striking difference in the percentage of women in the first and last author position. Across all years, we found that women comprised a median of ~45% of first authors, yet made up only ~23% of the last author position (Fig 1D). Although the data show variability across years, the difference in the percent women in the first and last author position appears to be more pronounced before 2014 (Fig 1D). From 2009 to 2013, for example, the difference in the percentage of women that were first and last author was ~25%. After 2013, this difference shrank to an average of <9%. If author position is indicative of seniority, then the relatively low fraction of senior women in the field of molecular ecology, at least until recently, offers a possible explanation for gender differences in the reviewer pool.

While we identified striking differences in the gender pool of authors and reviewers, and a low percentage of women in senior author positions on submitted manuscripts, we found no significant differences in editorial decisions according to the gender of either the first or last author. Editorial decisions for Molecular Ecology are as follows: Accept; Accept with minor changes; Reconsider after revision; Reject encourage resubmission; Reject. We combined the

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number of papers that received Accept and Accept minor into one category (Accept), and likewise combined the Reconsider after revision and Reject, encourage resubmission decisions into one category (Revision), and compared the proportion of each of the three decision types (Accept, Revision, Reject) according to gender of both first and last author by performing a logistic regression. We found no evidence that the editorial decision was influenced by gender of either the first or last author (First author gender: $X^2 = 0.93$, df = 1, p-value = 0.33; Last author gender: $X^2 = 1.64$, df = 1, p-value = 0.20, see Table S3 for the percentage of each decision according to gender and author position). Furthermore, we likewise found no indication that the gender of the editor influenced editorial decisions (Editor gender: $X^2 = 0.39$, df = 1, p-value = 0.53) nor was there a significant interaction between either first or last author gender and editor gender, which would indicate that men and women editors imparted decisions differently based on gender of the author (Editor gender X first author gender: $X^2 = 3.12$, df = 1, p-value = 0.08; Editor gender X last author gender: $X^2 = 3.17$, df = 1, p-value = 0.08).

We next wanted to determine if the gender of the editor also contributed to fewer women in the reviewing pool. Because the editorial board of Molecular Ecology is majority male (66% male; 34% female), we reasoned that perhaps editors that are men invite more men than women to review (as in Fox, Burns, & Meyer, 2016), which would effectively skew the gender balance of the reviewers. To examine this idea, we looked only at the first 10 papers handled each year by editors of each gender (*i.e.* 180, 10 papers/year/gender); we elected to subsample in this manner so that we had an equal number of decisions made by women and men editors for comparison. We found that women editors invited slightly more women reviewers (33.2%) compared to men editors (29.6%), but the difference was not significant (Editor gender effect, F = 1.42, df = 1, p-value = 0.23); both men and women editors invited a disproportionate amount of men to review (67-70%; Table S4). Interestingly, we found that women were more likely to accept an invitation to review if the editor was a man (50.3%) than if the editor was a woman (38.2%), however this difference was not significant (Editor gender effect, F = 3.28, df = 1, p-value = 0.07). The same trend was observed for male researchers, but the difference was smaller: male reviewer acceptance rate when editor was a man is 42.6%, and 39.9% when editor was a woman (Editor gender effect, F = 0.08, df = 1, p-value = 0.78). These two patterns balanced out, such that about 1/3 of reviewers were women irrespective of the editor being a man (33.3% women reviewers) versus a woman (32.2% women reviewers).

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Overall, we found that significantly fewer women authored perspective pieces compared to men, and that this was likely due to fewer women in the reviewing pool. We also found that women suggested fewer of the manuscripts for perspectives pieces compared to men. We want to stress, however, that we cannot say this latter finding is due to behavioral differences between men and women, or if it is driven by women receiving fewer review opportunities in general, and hence fewer chances to review papers that may be considered perspectives material.

The data that we show are both encouraging and discouraging. On the one hand, it is encouraging that we did not find gender effects on editorial decisions. On the other hand, it is troubling that there are fewer women in our author and reviewer pools, especially given that forty-nine percent of PhDs awarded in the Biological Sciences in the US went to women in 2005, and this has steadily increased to 53% in 2014 (Kang, 2018). Our data appear to show a large increase (~20%) in the proportion of senior women in the field of molecular ecology in just eight years, although we note that the field started from a low base and the data are heterogeneous. With that said, the increase of women in our reviewer pool appears to be more gradual. This could be caused by several factors. Editors might, for example, disproportionately invite senior scientists to serve as reviewers, indirectly leading to a male-biased reviewer pool. Alternatively, authors and/or editors might be more likely to suggest/invite men to serve as reviewers.

We decided to report these trends since subtle barriers that discourage women from science are far-reaching (Wellenreuther & Otto, 2016), and data-driven analyses like we present here can guide how we approach potential discrepancies. Importantly, we feel that a lack of equal access in opportunities in science are antithetical to the promotion of the best science possible—in an ideal scenario, everyone has equal access to the process. Now that we have identified discrepancies, it is incumbent upon us to provide tangible solutions. As recently shown with regard to the proportion of women invited to present at conferences (Débarre, Rode, & Ugelvig, 2018) changes require deliberate actions. Below, we outline ideas to achieve parity in our reviewer pool--some of which are specific to editorial practices within the journal, and other ideas which involve the community of authors that submit to Molecular Ecology.

***Journal based solutions***

We ask that associate editors of Molecular Ecology take special care to balance their review invitations, as well as nominations for perspective piece authorships, with respect to gender and

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other aspects of diversity (persons of color and other minorities). To help Associate Editors diversify their reviewer pool, the journal will integrate a link to a DiversifyEEB, a database of >1400 women and/or underrepresented minorities in ecology and evolution that are at various post-PhD career stages into the initial review request email from the journal. DiversifyEEB maintains contact information of these scientists as well as provides their major and minor topics of study, which will help editors find appropriate experts. DiversifyEEB is expected to be available in perpetuity.

Further, the Chief Editor has been working to increase the number of female associate editors in recent years and will continue to do so. Currently, 21% of full professors across the sciences are female. Recent hiring trends suggest this demographic difference is rapidly changing, as 59% of newly hired tenure track assistant professors in ecology and evolution in 2017/2018 were women (Fox, 2018). At Molecular Ecology, we want to support this changing demographic by working toward greater gender balance on our editorial board. The next step is to monitor the success (or lack thereof) of these suggestions on the review process. Molecular Ecology will perform another similar analysis after three and five years to determine if equality in the review process is being reached.

***Community based solutions***

Work from Fox *et al.* (2017) shows that authors suggest men more often than women as reviewers. Although associate editors do not always use these suggestions, this is one place in which the scientific community at large can ensure that women are receiving an equal chance to guide the field, by the simple act of finding and suggesting appropriate reviewers that are women. As one would expect, there is no difference in reviewing outcome between the genders (Fox, Burns, & Meyer, 2016; Fox *et al.* 2017). Authors can use lists like DiversifyEEB to identify a balanced set of reviewers; we suggest that authors consider this for **every publication** they submit regardless of journal. Additionally, when authors are asked to write a perspectives piece, we suggest they carefully think about who is first author. For example, if a lab head is offered a perspective, are equal opportunities being given to both male and female trainees in authorship?

## Conclusions

Although we report differences in the gender of the reviewing pool and perspective piece authors, we want to emphasize that there are other important aspects of diversity that should be

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reflected in the reviewing process. We did not examine the racial or ethnic background of perspective piece authors or reviewers, nor did we perform analysis according to country of origin. Both are important considerations that are key to the promotion of equitable practices within the field (Espin et al., 2017) and should be systematically analyzed in the future with a larger pool of data than we report here. That women in the senior author position appears to have steadily increased by ~20% over the time period analyzed suggests that the demographics of molecular ecology are changing, and the journal aims to support this change. After recognizing the low percentage of women that have contributed to previous perspectives pieces in Molecular Ecology, the journal made a conscious effort to increase this representation, and in 2018, 47% of the perspectives were first-authored by women. It is our hope that future reviewing pools likewise reflect a relatively equal proportion women and men reviewers.

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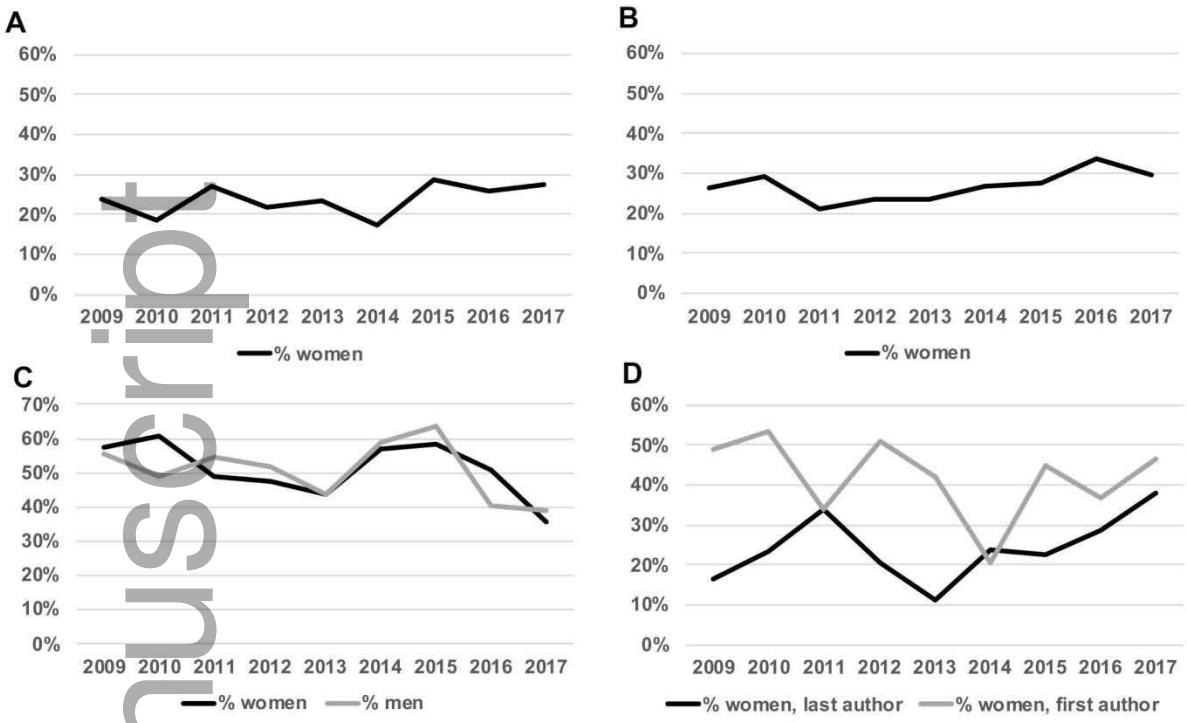
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**Figure legend**

Figure 1. A) The percentage of the 316 perspectives in ME where the lead author is a woman, per year (*i.e.*, a woman was invited and submitted the paper, whether or not she was the sole author, or had senior or junior co-authors). B) The percentage of invitations to review the manuscripts that received a perspective that went out to women. C) The percentage of reviews that were returned once invited, for the 316 papers that received perspectives in ME (men in grey and women in black). Full details in Table S1. D) The percentage of women that are either first (grey) or last (black) authors on a sample of 395 manuscripts submitted to ME between 2009 and 2017.

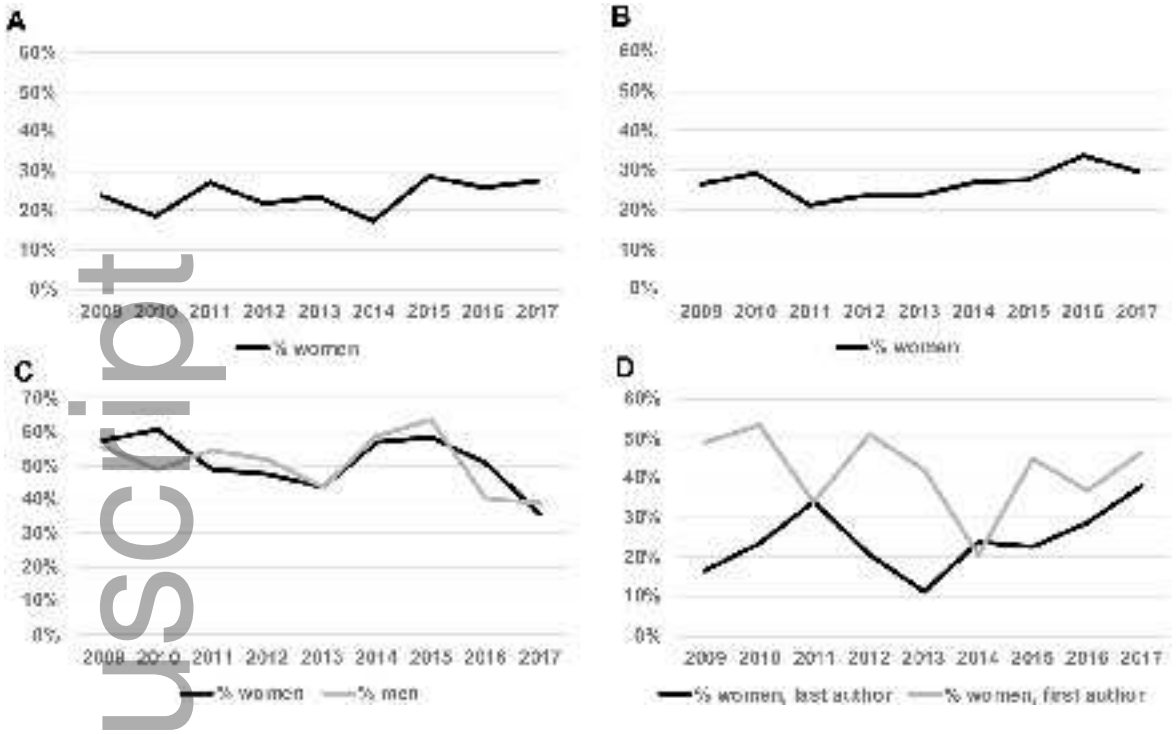
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