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OPINION

Why we shouldn't blame women for gender disparity in academia: perspectives of women in zoology

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ABSTRACT. The following letter, from a network of women zoologists, is a reply to the article of AlShebli et al. (2020), which suggests that female protégés reap more benefits when mentored by men and concludes that female mentors hinder the success of their female protégés and the quality of their impact. This contribution has two parts. First, we highlight the most relevant methodological flaws which, in our opinion, may have impacted the conclusions of AlShebli et al. (2020). Second, we discuss issues pertaining to women in science, bring a perspective of Women in Zoology and discuss how current diversity policies are positively changing our field.

KEY WORDS. Academic settings, diversity, gender gap, gendered metrics, STEM, women in science.

We are part of a patriarchal society, although scientists and academics often fail to recognize it. This patriarchal structure and its misconceptions are reflected in our scientific environment. The recently published study of AlShebli et al. (2020) (now retracted by the authors) is one example of how scientific conclusions can have negative impacts to the academic environment when social data are analyzed apart from their underlying social context.

AlShebli et al. (2020) investigated the role of mentorship in scientific collaborations on the successful outcome of protégés considering the gender of their mentors. Their conclusion was that female mentors hinder the success of their female protégés and the quality of their impact (measured by the number of citations and impact of protégés' articles), suggesting that female protégés reap more benefits when mentored by males instead of their equally-impactful female counterparts. AlShebli et al. (2020) recognize that the specific social mechanisms underlying their findings were not addressed in their study. Despite that, they proposed that their results indicate that diversity policies need to be reviewed, favoring an association between female protégés and male mentors. This suggestion goes against all current policies that aim for more diversity in science, technology, engineering, and mathematics (STEM), contributing to reinforce the patriarchal structure of the academic environment, which has historically constrained the career of many female researchers. Within the context of STEM, we point out some relevant issues that went unnoticed by the reviewers and editor of Nature Communications (or were dismissed during the reviewing process) and discuss why we believe that the findings of AlShebli et al. (2020) should not be used for reviewing diversity policies in STEM. Other criticisms and comments on the same work are available in Deanna et al. (2020) and Diele-Viegas et al. (2020a, 2020b). Lastly, we bring a perspective of Women in Zoology and how current diversity policies are bringing more gender equality to the field.

Below, we point out a few notable methodological flaws in the work of AlShebli et al. (2020). The first one pertains to how they established the mentor-protégé association: they only took into account the mentor-protégé pairs in the same discipline, and by doing so, they missed interdisciplinary hubs, which are more prevalent in gender and ethnically diverse groups (Adams 2013, Uzzi et al. 2013, Campbell et al. 2013, Franzoni et al. 2014, Freeman and Huang 2015); furthermore, even though they endeavored to embrace a broader sense of mentorship when examining the publication networks by including other senior co-authors as mentors besides the thesis' advisor, their criterion was not as broad as it could have been: by excluding the potential mentors that do not share the same affiliation as the protégé, AlShebli et al. (2020) most likely ended up missing many diverse and multidisciplinary research groups in their analysis.

The second methodological flaw we identified is that AlShebli et al. (2020) do not take into account that mentorship also happens outside of the context of co-authorship, and that co-authorship does not necessarily imply an established mentorship. Despite the existence of guidelines with criteria on what configures authorship (e.g. Brand et al. 2015, International Committee of Medical Journal Editors 2019), defining authorship is a complex process that frequently relies on informal agreements (Brand et al. 2015, Albarracín et al. 2020). According to these authors, although activities such as procuring funding or institutional infrastructure do not justify authorship, senior researchers are often included as authors because of those activities. Furthermore, it is possible that behind the success of a protégé there are also mentors who never effectively co-authored with the student (but are mentioned at the Acknowledgements section instead).

According to Estrada et al. (2018), there are three main components in mentorship: instrumental support (including the provision of resources and opportunities for the protégé to attain their research goals), psychosocial support (increasing the protégé's self-confidence and professional effectiveness), and quality of the relationship established between mentor and protégé. AlShebli et al. (2020) analyzed only part of the instrumental support as a proxy of mentorship quality. The authors focused only on the publication impact and the collaboration network of the protégés when following their solo career, ignoring the remaining factors, despite their importance to the protégés' performance, motivation, career outcomes, and health.

Based on the methodological flaws discussed above, the conclusions provided by AlShebli et al. (2020) fail to properly recognize the social component into which epistemic science research fields are constructed and, therefore, end up suggesting that policy makers should not promote female-female mentorships.

All scientists are part of a sexist society and ruled by social conduct (Arruza et al. 2018). Being as such, women scientists attempt to thrive despite all setbacks provided by structural sexism (both explicit and implicit). Such a systemic paradigm results in numerous obstacles during their careers, which lead to a leaky pipeline in academia (Pell 1996, Knobloch-Westerwick et al. 2013, Reuben et al. 2014), hindering their long-term retention, especially in STEM (Hughes 2018). The Matilda effect (Rossiter 1993), defined by a systematic underrecognition of female scientists throughout history, is well-perceived as a major force impairing the progress of women in science (Knobloch-Westerwick et al. 2013). Women are usually disproportionately burdened with household chores including bearing babies and taking care of both children and elderly relations (Goulden et al. 2011), particularly during the current COVID-19 pandemic (Hipólito et al. 2020, Staniscuaski et al. 2020). They are much more frequently affected by harassment (National Academies of Sciences, Engineering, and Medicine 2018), both because of their gender or sexual orientation (Hughes 2018). Women are also systematically less cited (Larivière et al. 2013, Bendels et al. 2018) or less credited for their work (Handley et al. 2015), and the division of labor in scientific work (and subsequent

publications) usually undermine the contribution of women and other minorities (Larivière et al. 2020). All the beforementioned result in a lower inclusion of women in collaboration networks, especially those led by men (Araújo et al. 2017). All these biases should be addressed when discussing the results presented by AlShebli et al. (2020).

What defines success in the academic field?

A list of the 100,000 most prominent scientists was recently published (Ioannidis et al. 2020), based exclusively on citations. It prompted us to question: what defines "success" in academia? Despite publications being a major factor driving the influence a scientist has on the scientific community, there are other ways to measure it and which may be more appropriate for different fields of knowledge (see Bradshaw et al. 2020, Oliveira et al. 2020). The training of future scientists is also an important metric and such training is given by scientists that occupy positions of power as members of university faculties (Catalyst 2005, Clauset et al. 2015).

Still, women are under-represented as professors and researchers, and are more concentrated in universities that are not research-intensive (Chubb and Derrick 2020). Moreover, while teaching quality is reportedly female-dominated, the research realm is more male-dominated (Morley 2003). This results in a larger proportion of women being responsible for student-focused services (in "institutional housekeeping" roles, Bird et al. 2004), which are undervalued, while men are the ones being praised because they have greater publication numbers and their publications have more impact (Chubb and Derrick 2020). That being the case, the most commonly used academic performance metrics benefits men over women. Additionally, when the behavior of a professional contrasts with the established gender roles, it influences how the competence of the professional is judged (Chubb and Derrick 2020). For example, when a woman has strong research success, she is usually undervalued by her peers regarding a particular factor (e.g., time lag of publications, agency, competitiveness, and even private life matters, such as marital status) whereas a man will be overvalued for the same thing (Juraqulova et al. 2015, Eaton et al. 2020, Severin et al. 2020).

Women in STEM: examples coming from the Brazilian Zoological networks and professional advancement

As extensively discussed in the literature, the disadvantage faced by women in STEM fields is usually related to gender stereotypes (Schiebinger 2001, Reuben et al. 2014, Bendels et al. 2018, Eaton et al. 2020). The so-called Matilda Effect affects women since they are young girls and negatively influences their desire to pursue a career in science (Hill et al. 2010, Leite and Diele-Viegas 2020). In Brazil, despite the fact that women author roughly 70% of all the articles published (Crotti et al. 2020), there is a global trend in which the articles that have women as first or last co-author (usually recognized as the 'main authors') are less cited than articles that have men as main authors (Larivière et al. 2013). Furthermore, despite the larger proportion of women enrolled in both secondary (83% women vs. 80% men) and tertiary (59% women vs. 43% men) education in Brazil compared to men, women are more present in fields associated with culture and "care" and less represented in STEM (Crotti et al. 2020).

Only recently, have more women been taking part in positions of power in Zoological Societies in Brazil. For example, the Brazilian Society of Zoology (SBZ) never had female presidents until 2012, when its first female president was elected after 34 years. The 2018-2020 SBZ directorship (with a female president) supported for the first time a symposium "For more women in Zoology" held in the XXXIII Brazilian Congress of Zoology promoting networks among Women in STEM and zoological subjects. Furthermore, in 2019, an all-female directorship was elected for the Brazilian Society of Ichthyology (SBI) being the third all-female directorship among the 19 elected in the history of that society. This all-female board, together with a deliberative council composed mostly by men, has started to discuss gender inequality in ichthyology and best practices to decrease it. Another example is the board of the Brazilian Society of Herpetology (SBH), also mostly composed of women (three women in five positions), while the deliberative council is mainly composed of men (six men in nine positions), reflecting the sharp gender disparity still seen in the field. After the discussion table "Women in Herpetology yesterday, today... and now? Discussing gender for effective inclusion" at the Brazilian Congress of Herpetology in 2019, a list of actions was proposed to reduce gender inequalities in herpetology (see Werneck et al. 2019).

However, gender inequality is still prominent in other Brazilian scientific societies, such as the Brazilian Society of Palaeontology (SBP), which in the last 62 years, of the 29 elected boards, only two had female presidents, and four had the participation of women in the vice-presidency (Kotzian and Ribeiro 2009). It is important to highlight that 45% of the 713 members of this society are women. However, despite having significant participation within the society, the representation of women in Brazilian Palaeontology appears to be significantly less expressive than that of men along its entire existence (Kotzian and Ribeiro 2009).

Similar to what is seen in the SBP, the Brazilian Ornithological Society (SBO) has a relatively balanced proportion, with 44% female members. However, these proportions have not been reflected in the number of publications in the society's main journal. Of the articles published in the last five years in the Brazilian Journal of Ornithology, only 22% had females as first authors (S.A. Sousa, unpublished data). The relatively equal proportion of society members compared to the lack of articles published by women indicates that female ornithologists might face opportunity bottlenecks in academic careers. Usually, being the leading author in a scientific publication requires long term commitment to academia and leadership in laboratory and field experiments.

Although individual efforts have their merits, we believe that research and educational centers need to provide the necessary means to recognize and undermine biases in the availability of opportunities for women scientists. Networks of women in science are gaining strength in Brazil, discussing issues related to gender inequality and giving voice to women in several fields. The initiative "Mulheres na Ciência BR" (Women in Science Brazil), founded by a group of zoologists, started as a social network community of women scientists in 2016 and has since grown to establish an actively-curated digital magazine (http://www.mulheresnaciencia.com.br), where women of all fields and backgrounds showcase their voices and discuss science and gender perspectives in academia. The "Kunhã Asé" network of women in science was founded in 2019 by four women biologists aiming to provide academic and emotional support to female Brazilian scientists at different career stages and encourage young women and girls in science (Leite and Diele-Viegas 2020). The "Parent in Science" group (https://www.parentinscience.com) is an initiative of researchers who are parents, demanding equal access of men and women to funding for academic research in Brazil. The project aims to understand the impact of motherhood and recognize that female scientists often have a double journey, combining academic careers with childcare (Lunetas 2018). Currently, the group proposes symposia to discuss solutions to problems of motherhood and fatherhood in the academy, in addition to increasing awareness of proper authorities to the demands that parenthood adds to academic careers.

Specific disciplines in zoology are also creating their own networks. The "Ictiomulheres" (Ichthywomen) was created in 2017 and researches the gender issues in Brazilian Ichthyology, including promoting women in ichthyological studies and their participation in the field. The network also recently organized the event "Elasmulheres", with prominent women in elasmobranchs research fields. The group "Herpetologia segundo as Herpetólogas" (Herpetology according to women herpetologists) was created in 2018 aiming to disseminate the science made by women in the field of herpetology, including contributions to the conservation of reptiles and amphibians through environmental education, and promoting greater participation of women in Brazilian herpetology. The group "Mulheres na Entomologia" (Women in Entomology) appeared in 2019 with the aim of publishing and disseminating biographies of past and present women entomologists while encouraging young scientists to follow the examples of female researchers in the development of their own careers. Regarding questions of inequality in Brazilian Paleontology, a group of female paleontologists, "Mulheres na Paleontologia" (Women in Paleontology), aims to identify the main gender biases through the project "The gender profile in Brazilian Palaeontology", which has already been approved in the Plataforma Brasil, a national database of research records involving humans. All the above-mentioned initiatives demonstrate some of the projects that begun in recent years to bring awareness to gender inequality and discuss solutions in order to achieve a more diverse and inclusive zoology. These initiatives are possible because of the increase in the number of women participating in some Brazilian Zoological societies and because these women are becoming more conscious of the role of gender bias in their careers. It reinforces the importance of women actively working as part of the scientific community.

Concluding remarks

The academic system is oriented by a particular cultural frame (Geertz 1983), including gendered associations implicit in the academic reward system, which must be addressed and overcome. So, if (and it is a big if) female mentors cannot provide the same outcomes as male mentors to their female protégés, it is not due to some inherent female problem, but to the existing gender-biased system that still confers privilege on male researchers, with or without children. Thus, partnering with male mentors will not solve gender inequality in science and should not be the option given to women to raise their academic status. We expect that discussions and replies like this are no longer necessary someday. But it will only be possible when we have a truly diverse and inclusive science.

The takeaway message we highlight here is an invitation to the scientific community for a broader discussion about the criteria defining success in academia, considering that women play fundamental role in constructing a more inclusive environment for early-career researchers. It is not enough to make science attractive for diverse junior researchers. It is fundamental to create a scientific environment that maximizes the carrots and minimizes the sticks over these people's careers (Galinsky et al. 2015). The only way to do that is by stimulating the construction of diverse research environments and networks (Bendels et al. 2018), the opposite of what was proposed by AlShebli et al. (2020). Finally, we refuse to accept a superficial analysis that does not consider the oppression faced by women. The solutions proposed by AlShebli et al. (2020) do not solve women's problems in STEM, but only reinforce stereotypes and emphasize the sexual division of work and intellectual merit.

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SUPPLEMENTARY MATERIAL

Supplementary material 1

List S1. List of signatories supporting this article.

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