

# Chronicle of an inequality: The case of ecology in Argentina

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**ABSTRACT.** Historically, the trajectories of women in science have been less recognized than those of men. In Ecology, the lower participation of women in academia and scientific articles reflects global gender inequities. We evaluated the representation and visibility of women and men in the field of Ecology in Argentina over the past 30 years. Using generalized linear models, we analyzed gender disparities over time in key areas: the directive board of the Asociación Argentina de Ecología (AsAE), the Argentine Ecology Meeting (RAE), the editorial team of *Ecología Austral* (EA) and the authors publishing in the journal. We found a gender gap spanning 30 years. In both the directive board of AsAE and the editorial team of EA, there was a high representation of men in key leadership positions, while women dominated subordinate roles. Women participated less frequently as invited speakers at conferences and symposia in the RAE and presented more posters than men. Finally, women published more than men as first authors at *Ecología Austral*. Our results align with global trends, which we explain by considering various phenomena and effects that render women invisible and that —despite some initial favorable changes— seem to be still present in our national system. The analysis used gender as a lens to advocate for a fairer and more equitable scientific system. Inclusion of women and other marginalized groups —through an intersectional lens in the construction of scientific knowledge— is not only an ethical and political imperative, but also a catalyst for diverse perspectives and experiences for the development of concepts, approaches and tools leading to new and interesting advances in Ecology.

[Keywords: authorships, gender inequity, hierarchical positions, homophily, positions of power, publications, scientific conference, science, visibility]

Short title: Chronicle of an inequality: Argentine Ecology

## INTRODUCTION

The participation of women in science has increased significantly over the past 50 years (Huang et al. 2020), although they have not received equivalent recognition from their male peers (Langenheim 1996; Ceci and Williams 2011; Huang et al. 2020). In most countries where gender inequality has been studied, the gap between men and women has been demonstrated across various STEM disciplines (Science, Technology, Engineering, and Mathematics) (Barres 2006; Hill et al. 2010), including the Biological Sciences (Holt and Webb 2007; Salerno et al. 2019; Huang et al. 2020; Fontanarrosa et al. 2024; Lomáscolo et al. 2024). Within the Ecology scientific community, several inequalities have been documented, such as gender imbalance at advanced stages of scientific careers (Holt and Webb 2007),

underrepresentation of women among invited keynote speakers at national and international conference (Schroeder et al. 2013; Farr et al. 2017), as well as inequalities in the number of scientific publications, proportion of authorships, leading authorship roles, and thus the potential impact in the career path (Martin 2012; Maas et al. 2021; Hughes et al. 2023; Fontanarrosa et al. 2024). This underestimation or omission of scientific women contributions is part of a feedback process that reinforces their invisibility, known as the "Matthew/Matilda effect" (Merton 1968).

Several mechanisms persist and continue to limit the representation, recognition, and professional development of women and gender-diverse individuals in the scientific field (Wellenreuther and Otto 2016; Huang et al. 2020; Zandonà 2022). Among the most prominent are: the "glass ceiling" (i.e., increasing gender inequality at higher professional stages, resulting in the underrepresentation of women in leadership positions; Cotter et al. 2001), the "sticky floor" (barriers that keep women in lower professional positions), the "leaky pipeline" (higher dropout rates among women at various stages of the scientific career, particularly after earning a PhD; Alper 1993; Huang et al. 2020), the "slippery floor" (greater effort required from women to reach the same goals as their male peers; Lomáscolo et al., this issue), and "overcompensation" (when women must outperform their male colleagues to achieve similar recognition, even though their accomplishments are perceived and evaluated as equivalent; Astegiano et al. 2019; Andersson et al. 2021; Fontanarrosa et al. 2024).

The participation of researchers in leadership or decision-making positions within academia assumes good performance in their field (Morton and Sonnad 2007). Reaching such an academic and scientific milestone is based on academic background that includes publishing in high-impact journals, attending scientific conferences, being part of professional societies and their directive board, collaborating on editorial teams at academic journals (Mauleón et al. 2013), among other activities. These actions are essential for gaining recognition and visibility, staying active and advancing in an academic career, building professional networks, and accessing funding opportunities (Martin 2014; Oester et al. 2017; de Leon and McQuillin 2020). However, in recent years, several studies have shown that women remain underrepresented in many of these scientific and academic spaces (e.g., Schroeder et al. 2013; Liévano-Latorre et al. 2020; Chuliver et al. 2021; Hughes et al. 2023), which perpetuates unequal power dynamics that privilege dominant groups. This is a clear example of the "glass ceiling" phenomenon, one of the main expressions of a gender-unequal system (Cotter et al. 2001; Lomáscolo et al. 2024).

Leading roles in scientific publications (first authorship, corresponding authorship, and last authorship) play a fundamental role in the evaluation of academic careers (Duffy 2017). The contribution as an author, measured by time investment and intellectual input, reflects their position in the authorship list, with the first and corresponding author positions assigned to those who contributed the most, and a decrease of contribution with each subsequent position (Wren et al. 2007). Additionally, the last author position is often held by the person leading the research group or project; which currently holds particular importance in the evaluation of individual scientific productivity (Duffy 2017). Although the overall number of women publishing in leading roles has increased, a gender gap persists. This is evident in the low representation of women as sole authors (Zeng et al. 2016; Walker 2020), their lower contribution in scientific publications and in leading authorship roles (Fontanarrosa et al. 2024), as well as a high degree of homophily (i.e., the tendency to collaborate with others who are similar in certain aspects, such as gender) observed among male researchers in authorship networks (Fagan et al. 2018; Grosso et al. 2021). Fontanarrosa et al. (2024) found that women contributions to articles published in the prestigious scientific journal *Ecology* – measured by authorship position, particularly as first authors, which is commonly associated with higher intellectual responsibility and leadership – were greater than expected based on the proportion of female authors; which may reflect the phenomenon of overcompensation.

One form of peer recognition takes place at scientific conference, which are spaces where researchers present the results of their work. Keynotes are one of the most important activities in terms of peer recognition, as they require a special invitation based on the speaker academic

background, reputation, and visibility. This type of presentation gives greater visibility and prestige, as well as the opportunity to establish potential networks with colleagues and funding agencies (Oester et al. 2017; de Leon and McQuillin 2020), further reinforcing that visibility (Merton 1968; Schroeder et al. 2013). Another category of presentation, symposia, consists of sessions aimed at addressing a specific topic by inviting key experts to present different aspects or perspectives related to their work (Hernández et al. 2008). Oral contributions and posters are the most commonly used formats for sharing research findings and are submitted voluntarily, without an invitation (Hites 2014). These different formats vary in terms of exposure, while oral contributions allow for more direct and dynamic engagement with the audience, the poster presentation provide a more relaxed and flexible interaction (Rezaeian et al. 2017). Across various scientific disciplines, a general trend observed in meetings and conferences is that men are more represented than women in keynotes and symposium (e.g., Chuliver et al. 2021; Solaro et al. 2024), while participation rates in oral and poster contributions are similar between genders (Chuliver et al. 2021).

Another key role in the recognition of a scientist work is the participation in the directive board in scientific societies and in the editorial team of scientific journals, as these are crucial decision-making spaces within academia (Mauleón et al. 2013). Editorial teams play a central role in the supervision of the quality and type of publications, also they establish guidelines, norms, and rules that shape how science is conducted and where it is headed (Zsindely et al. 1982). The participation in these spaces is given by peer recognition within a scientific discipline based on the academic background measured through scientific publications (Morton and Sonnad 2007). However, peer recognition is also influenced by the aforementioned phenomenon of homophily; for instance, editors of some of the most prestigious journals in Ecology are more likely to recommend and favor articles authored by individuals of the same gender (Bradshaw and Courchamp 2018). Despite the increased participation of women in recent years, a strong and widespread gender bias still persists in the editorial boards of the main scientific journals and in the scientific societies of various disciplines (e.g., Cho et al. 2014; Fox et al. 2019; Liévano-Latorre et al. 2020; Grosso et al. 2021).

The Argentine Ecology Association (in Spanish, Asociación Argentina de Ecología, AsAE) founded in 1972, was one of the first ecological societies in Latin America (<https://www.asaeargentina.com.ar>). This association is managed by a directive board integrated of nine regular members with renewable two-year terms, elected by direct vote of active members. Since its foundation, AsAE has held Biennial Conference, and since 1991 publishes the scientific journal *Ecología Austral* (online ISSN: 0327-5477). The editorial team of the journal is integrated by personal invitation based on criteria such as the researcher discipline, institutional affiliation, gender, and career stage, among others (E. G. Jobbágy, pers. comm.).

Understanding that academic development is related to the different opportunities available to each researcher—and that these opportunities may be influenced by gender bias—our general objective is to evaluate the representation and visibility of women and men across various aspects of academic and scientific performance in the field of Ecology in Argentina. Specifically, we aim to identify patterns of hierarchy and/or protagonism in the different participation and contribution of men and women, and to assess if there is a trend of change over the past 30 years. To achieve this aim, we analyzed gender representation in: 1) the directive board of the Argentine Ecological Association (AsAE); 2) the editorial team and scientific publications of the journal *Ecología Austral*; and 3) the scientific conference organized by AsAE, i.e. the Argentine Ecological Conference (RAE). Specifically, we test three general hypotheses: the first, H1, posits that the representation of women in different professional areas in Argentine Ecology is not equitable compared to men. Predictions under H1 include: 1. The proportion of women integrating the directive board of AsAE and the editorial team of *Ecología Austral* in higher-ranking or hierarchical roles will be lower than expected in a scenario of gender equity; 2. In the participation at the RAE that require an invitation (e.g., keynote talks and symposia) the proportion of women relative to men will be lower than in the presentations that do not require an invitation (oral and poster contributions); 3. The proportion of women presenting oral contributions will be lower than the proportion in poster presentations. The second hypothesis, H2,

proposes that the participation of women ecologists from Argentina in leading roles at publications of *Ecología Austral* is not equitable compared to their male counterparts. Based on this hypothesis, we predict: 1. The proportion of women as first, last, and sole authors in articles published in *Ecología Austral* will be lower than expected based on the total number of publishing authors; 2. The proportion of women co-authors will be lower when the first and/or last author is a man, and higher when the first and/or last author is a woman. Finally, the third hypothesis, H3, proposes that the representation of women in the discipline of Ecology has increased over time. We predict that the representation of women across the various academic-scientific spaces analyzed in the previous hypotheses will tend toward progressive equity relative to men throughout the study period (Table 1).

## MATERIALS AND METHODS

### *Workload organization*

For the organization of this work, we applied sociocracy, a governance model that intentionally distributes leadership and power based on equity, mutual benefit, effectiveness, and transparency (Rau and Koch-Gonzalez 2018). The core team of this work assumed different sociocratic roles (i.e., facilitation, secretariat, and coordination). We held weekly meetings where decisions regarding the construction of each section of the work were made through consent and consensus. This methodology included: facilitated meetings with a pre-planned agenda, listening rounds and intentional participation (where each person had their space and time to express themselves and be heard), collective proposals (structured brainstorming), and structured work and feedback frameworks (Cockle et al. 2025). To promote transparency and equity in authorship decisions and their order, we carried out a structured practice following the proposal by Cockle et al. (2025), which involves exploring individual contributions and recognizing both one own and others work.

### *Methodology for gender assignment and data curation*

For gender assignment, we used each person given name as a gender indicator and, based on that, classified individuals as either “male” or “female.” While we acknowledge that binary categorization cannot fully capture self-perceived gender and excludes other gender identities present within the scientific community, we were unable to broaden our approach due to analytical and operational constraints. In some of the RAE abstract books, authors names appeared only as initials; therefore, to assign gender, we searched for the full name using Google Scholar, ResearchGate profiles, and other academic social networks (following the methodology used by Chuliver et al. 2021 and Grosso et al. 2021), or by consulting available databases (such as Gender Checker 2020). Finally, we excluded the few cases in which we were unable to assign a gender to one or more authors (i.e., we only included cases with complete information). Given that these exclusions represented a very small proportion of the dataset, they did not affect the overall sample size or the validity of the conclusions. The data curation was performed manually by the authors in several consecutive rounds of database review.

### *Data collection and statistical analysis*

We used the R environment (R Core Team 2024) for all analyses and plots. To import data from Excel files, we used the *readxl* package (Wickham and Bryan 2023). For the analyses related to H1 and H2, which involved frequency and proportion analyses, we used the *tidyverse* package (Wickham et al. 2024), particularly the *dplyr* (Wickham et al. 2023) and *tidyr* (Wickham et al. 2024) packages. For the analyses related to H3, which consisted of generalized linear models (GLMs), we used the *MASS* package (Venables and Ripley 2002). For data visualization, we used the *ggplot2* package (Wickham 2016). We analyzed the data considering a significance level of  $\alpha=0.05$  for all statistical tests. Below, we provide further details regarding the methodology associated with each hypothesis and its corresponding predictions.

Gender proportion in the directive board of AsAE and in the editorial team of *Ecología Austral*. To test H1-P1, we collected the available information from the AsAE website and *Ecología*

Austral journal regarding the gender proportion of the association board of directors (i.e., president and other board members) and the editorial team of *Ecología Austral* (both general editor and associate editors) during the time period 1993-2024 (32 years). The equity in the proportional participation of women versus men in these two scenarios was analyzed using Chi-square tests. For the gender proportion analysis of associate editors, a Chi-square test with Monte Carlo simulation was used because we observed expected values lower than five in at least one cell of the contingency table.

Gender proportion among participants in the RAE. To test H1-P2 and H1-P3, we collected the abstracts books from all RAE from 1999 to 2024, both national and binational, 12 conference over 25 years in total. We organized the information into four categories of presentations: 1) keynotes, 2) symposia, 3) oral contributions, and 4) posters. For keynotes and symposia, we recorded all presentations from the abstract's books; for oral contributions and posters, due to the large amount of available information, we randomly recorded 30% of the pages from each abstract book using the sample function from the base R package (R Core Team 2024). We assumed that the first author listed was the one presenting the work. In all cases, we recorded the gender of the author lists and compared the proportional participation of women versus men using a Chi-square test. For H1-P2, we compared the gender proportion between invited contributions (keynotes and symposia) and non-invited contributions (oral contributions and posters). For H1-P3, we compared the gender proportion between those presenting oral contributions and those presenting posters.

Gender proportion in authorship of articles published in *Ecología Austral*. To test H2-P1 and H2-P2, we recorded the gender of the authors of articles published in the categories "Article," "Review," and "Special Section" from 1999 to 2024 (25 years). For P1, we used Fisher's exact tests with Monte Carlo simulation, while for P2, we analyzed the equity in the publication of men and women in the journal publications using Chi-square tests.

Temporal variation in gender proportion. To test H3-P1, we analyzed the temporal variation in gender proportion among the board of directors in the AsAE, the editorial team and the authors of articles published in *Ecología Austral*, and the participants in the different modes of participation in the RAE, between 1999 and 2024. We applied generalized linear models (GLM) using a binomial distribution family and a logit link function (Table 2). We identified two different cases depending on the analytical approach. In the first case, we used a binary variable when analyzing the occupation of a position (e.g., presidency or other roles within the board of directors in the AsAE, editor-in-chief in *Ecología Austral*), assigning the value 1 to the presence of women and 0 to their absence (i.e., presence of men). In the second case, we calculated the proportion of women when analyzing the probability of occupying multiple positions simultaneously. The coefficients estimated by these models represent the natural logarithm of the odds of an event occurring in one group (e.g., women occupying specific roles) versus the odds of it occurring in another group (e.g., men). Finally, the probability associated with each group was calculated using the formula  $P = \text{odds} / (1 + \text{odds})$ .

## RESULTS

### *Gender proportion in the directive board at asae and in the editorial team at *Ecología Austral**

During the period 1993–2024, the data base of the board of directors of AsAE included 473 records across up to 16 positions (with an average of 14.78 positions per year). During the analyzed period, the average proportion of women on the board of directors (0.38) was lower than that of men ( $\chi^2=26.05$ ,  $df=1$ ,  $P<0.001$ ) (Figure 1). Moreover, when analyzing the gender proportion by position (across all years), the proportion of women was also lower than that of men ( $\chi^2=79.61$ ,  $df=15$ ,  $P<0.001$ ). Men held the majority of the positions of president, vice-president, secretary, recording secretary, four board member positions, and three auditing roles; while women predominantly held the treasurer position and one of the auditing roles (Supplementary Material 1-Table S1).

Regarding the editorial team of *Ecología Austral*, during the study period there were 32 records corresponding to the editor-in-chief and 497 records corresponding to associate editors (an average of 1 editor-in-chief and 15.53 associate editors per year). The proportion of women in the

editor-in-chief position (0.28) was lower than that of men ( $\chi^2=10.56$ ,  $df=1$ ,  $P=0.001$ ) (Figure 1), as well as the proportion of women among associate editors (0.31) ( $\chi^2=6.37$ ,  $df=1$ ,  $P<0.001$ ) (Figure 1).

#### *Gender proportion among participants in RAE with and without invitation*

Regarding the comparison between participants in RAE with invitation (keynotes and symposia) and without invitation (oral and poster contributions), the database consisted of 3170 contributions between 1999 and 2024. The proportion of women in the 'without invitation' category (0.62) was higher than the proportion of men ( $\chi^2=134.41$ ,  $df=1$ ,  $P<0.001$ ), whereas the proportion of women in the 'with invitation' category (0.39) was lower than that of men ( $\chi^2=40.63$ ,  $df=1$ ,  $P<0.001$ ). Additionally, the proportion of women in the 'without invitation' category was higher than the proportion of women in the 'with invitation' category ( $\chi^2=133.19$ ,  $df=1$ ,  $P<0.001$ ).

#### *Gender proportion among participants in RAE without invitation: oral and poster contributions*

Regarding the presentations in RAE without invitation, the database included 802 oral contributions and 1498 poster presentations from 1999 to 2024. The proportion of women in oral contributions (0.53) was similar to that of men ( $\chi^2=0.36$ ,  $df=1$ ,  $P=0.55$ ) (Figure 2), while the proportion of women in poster presentations (0.67) was significantly higher than that of men ( $\chi^2=11.56$ ,  $df=1$ ,  $P<0.001$ ) (Figure 2). However, the proportion of women in both types of presentations was similar ( $\chi^2=1.63$ ,  $df=1$ ,  $P=0.20$ ).

#### *Gender proportion in authorship of articles published in Ecología Austral*

The dataset of multi-authored articles included 647 papers published between 1999 and 2024 (26 years). The proportion of women as first authors (0.56) was significantly higher than that of men ( $\chi^2=8.24$ ,  $df=1$ ,  $P=0.004$ ) (Figure 3), whereas the proportion of women as last authors (0.39) was significantly lower than that of men ( $\chi^2=29.86$ ,  $df=1$ ,  $P<0.001$ ) (Figure 3).

For solo-authored articles, the dataset comprised 45 publications. The proportion of women (0.44) was similar of men as solo authors ( $\chi^2=0.56$ ,  $df=1$ ,  $P=0.46$ ) (Figure 3). No solo-authored, neither by men nor by women, were published in 2009, 2015, 2017, 2019, or 2021.

#### *Gender proportion among co-authors in articles published in Ecología Austral*

Articles with women as first or last authors exhibited a higher proportion of female co-authors (0.54 and 0.61, respectively) compared to those led by men first (0.41) or last authors (0.47) ( $\chi^2=34.59$ ,  $df=1$ ,  $P<0.001$ ;  $\chi^2=35.04$ ,  $df=1$ ,  $P<0.001$ , respectively) (Figure 4).

#### *Temporal variation in gender proportion*

Temporal changes in the directive board of AsAE and in the editorial team of Ecología Austral. The proportion of women in the board of directors of AsAE increased by an average of 3.91% per year (GLM  $b=0.04$ ,  $z=3.40$ ,  $P<0.001$ ) (Figure 5) (Model 1, Supplementary Material 1-Table S3). The probability of women holding the presidency increased on average by 12.95% per year (GLM  $b=0.12$ ,  $z=-2.40$ ,  $P=0.02$ ; Model 2, Supplementary Material 1-Table S3), while the probability for the vice presidency did not change over the same period of time (GLM  $b=0.02$ ,  $z=0.46$ ,  $P=0.64$ ; Model 3, Supplementary Material 1-Table S3). On the other hand, the gender of the president did not influence the gender of the vice-president (GLM interaction of time and president  $b=-0.001$ ,  $z=-0.06$ ,  $P=0.96$ ; president  $b=11.82$ ,  $z=0.06$ ,  $P=0.95$ ; Model 4, Supplementary Material 1-Table S3), nor the gender proportion of the board of directors (GLM interaction of time and president  $b=0.03$ ,  $z=1.08$ ,  $P=0.28$ ; president  $b=-54.44$ ,  $z=-1.07$ ,  $P=0.28$ ; Model 5, Supplementary Material 1-Table S3).

Regarding the editorial team of Ecología Austral, we did not find a change in the probability of women holding the position of editor-in-chief over time (GLM  $b=0.04$ ,  $z=0.95$ ,  $P=0.34$ ; Model 6, Supplementary Material 1-Table S3). On the other hand, the proportion of women in associate editor positions increased on average by 8.01% per year (GLM  $b=0.08$ ,  $z=5.58$ ,  $P<0.001$ ; Model 7, Supplementary Material 1-Table S3) (Figure 5). The gender of the editor-in-chief did not influence the gender proportion of the associate editors throughout the study period (GLM interaction of time and

editor-in-chief interaction  $b=0.05$ ,  $z=0.71$ ,  $P=0.48$ ; editor-in-chief  $b=-108.62$ ,  $z=-0.71$ ,  $P=0.48$ ; Model 8, Supplementary Material 1-Table S3).

Temporal changes in the RAE. We found a significant change in the gender proportion between presentations that require invitation (keynotes and symposia) and those that do not (oral and poster contributions) throughout the study period ( $\chi^2=133.19$ ,  $df=1$ ,  $P<0.001$ ) (Figure 6). Initially, the probability of being invited was lower for women, varying from 20.23% of total presentations in 1999 to 59.63% in 2023 (GLM interaction of time and invitation  $b=0.04$ ,  $z=3.03$ ,  $P=0.002$ ; invitation  $b=-72.21$ ,  $z=-3.07$ ,  $P=0.002$ ; model 9, Supplementary Material 1-Table S3).

The proportion of female keynote speakers at the RAE was lower than that of male speakers throughout the study period ( $P=0.01$ ). In fact, in 2010 all keynote speakers were men. The probability of women giving a keynote talk increased by an average of 11.21% per year (GLM  $b=0.11$ ,  $z=3.30$ ,  $P<0.001$ ; model 10, Supplementary Material 1-Table S3). For the symposia, although the proportion of invited women increased by 4.48% per year on average (GLM  $b=0.04$ ,  $z=6.26$ ,  $P<0.001$ ; model 11, Supplementary Material 1-Table S3), that proportion remained lower than that of men ( $\chi^2=94.14$ ,  $df=11$ ,  $P<0.001$ ). Regarding oral and poster contributions, we observed significant differences in gender proportion only for the years 1999, 2001, 2004, 2008, 2010, and 2023 ( $\chi^2=45.07$ ,  $df=1$ ,  $P<0.001$ ) (Figure 7) (Supplementary Material 1-Table S2). The probability of women giving an oral contribution increased by an average of 4.72% per year (GLM  $b=0.05$ ,  $z=4.98$ ,  $P<0.001$ ; model 12, Supplementary Material 1-Table S3), and the probability of women presenting a poster increased by an average of 3.46% per year (GLM  $b=0.03$ ,  $z=4.82$ ,  $P<0.001$ ; model 13, Supplementary Material 1-Table S3).

Temporal changes in articles published in Ecología Austral. We did not observe significant differences in gender proportion among first authors in articles published in *Ecología Austral* over the study period ( $P=0.79$ ). The probability of women publishing as first authors increased by an average of 2.50% per year (GLM  $b=0.02$ ,  $z=2.23$ ,  $P=0.03$ ; model 14, Supplementary Material 1-Table S3). We also did not find significant differences in gender proportion among last authors ( $P=0.54$ ). The probability of women being last authors did not change over the analyzed period (GLM  $b=0.01$ ,  $z=1.07$ ,  $P=0.29$ ; model 15, Supplementary Material 1-Table S3).

Regarding solo authorship in articles published in *Ecología Austral*, we observed no significant differences in gender proportion over the study period ( $P=0.49$ ), nor in the probability of women being sole authors (GLM  $b=0.02$ ,  $z=0.58$ ,  $P=0.56$ ; model 16, Supplementary Material 1-Table S3).

With respect to co-authorship, their gender tended to align with the gender of the first author more frequently than expected by chance ( $\chi^2=34.59$ ,  $df=1$ ,  $P<0.001$ ) (Figure 8). Articles with a female first author had a higher proportion of female co-authors than articles with a male first author ( $t=3.21$ ,  $df=49.57$ ,  $P=0.002$ ), and vice versa (Figure 8). The proportion of female co-authors increased by an average of 1.94% per year (GLM  $b=0.02$ ,  $z=2.95$ ,  $P=0.003$ ; model 17, Supplementary Material 1-Table S3), but this increase was not influenced by the gender of the first author (GLM interaction of time and first author  $b=-0.005$ ,  $z=-0.36$ ,  $P=0.72$ ; first author  $b=9.99$ ,  $z=0.38$ ,  $P=0.71$ ; model 18, Supplementary Material 1-Table S3).

Regarding the effect of the gender of the last author on co-authorship, the general trend observed was similar to that of the first author: there was a higher proportion of co-authors of the same gender as the last author ( $\chi^2=8.99$ ,  $df=NA$ ,  $P<0.004$ ) (Figure 9). However, the positive effect of a female last author on the probability of having female co-authors was stronger at the beginning of the study period and decreased over time. In contrast, the negative effect of a male last author on the probability of having female co-authors was more pronounced at the beginning of the period and also decreased over time (GLM interaction of time and last author  $b=-0.03$ ,  $z=-2.41$ ,  $P=0.02$ ; last author  $b=68.07$ ,  $z=2.43$ ,  $P=0.02$ ; model 19, Supplementary Material 1-Table S3).

## DISCUSSION

Globally, gender studies reveal the underrepresentation of women in leadership and prominent roles within the discipline of Ecology (Hughes et al. 2023; Salerno et al. 2019; Joyce et al. 2024). Our findings

in Argentina support this global trend by showing that inequality in the proportion of women across many dimensions of academic and scientific development in ecology has been present for at least 32 years and continues to this day. Although we can observe some changes in recent years pointing toward greater representation of women in leadership and prominent positions within Argentine scientific community (also in line with global trends), these changes do not yet reflect conditions of equity.

Our analysis of women participation in hierarchical and decision-making roles across various academic domains of Argentine Ecology reveals chronic inequality and confirms our predictions. Over the last 32 years, both in the board of directors of AsAE and in the editorial team of *Ecología Austral*, men have been more represented in key leadership positions (e.g., president, vice-president, and editor-in-chief), while less hierarchical roles have been predominantly occupied by women (e.g., treasurer) or showed no significant gender differences (e.g., associate editors). This low representation of women in leadership positions — where the organization, functioning, key debates, and stances of this scientific discipline in Argentina are decided — is a clear expression of the barriers that women still face in accessing decision-making roles (“glass ceiling”, Cotter et al. 2001). This reality despite a temporal shift toward a more equitable situation, likely the result of affirmative action policies and greater visibility of structural inequalities. Leadership positions within the board of directors and editorial team are attained through different processes: either by democratic vote (active members of AsAE vote among the proposed lists) or by invitation (from the editor-in-chief). For a woman to be elected for a leadership role, she must first run for the election and then she must be voted in; while to obtain an invitation, her academic career must be recognized and valued by the scientific community to the extent that she is considered by her peers for such an invitation. Therefore, it is necessary to explore the mechanisms operating behind the low representation of women in the management and governance spaces of scientific work in Ecology in Argentina.

Availability for scientific activities and for occupying decision-making positions is closely linked to reproductive labor (Lione 2023), child-rearing, and caregiving tasks. The time and energy devoted to these tasks is not distributed equally among all individuals, as it varies according to gender, socioeconomic class, life stage, and other factors (Carrasquer et al. 1998; León 2009). In a recent study, Lomáscolo et al. (2024) found that caregiving responsibilities (i.e., unpaid domestic labor) among Argentine ecologists fall more heavily on women than on men, meaning that women have less uninterrupted time for paid work — which is crucial for conducting science. This could be a limiting factor for women participation in hierarchical management positions. In this context, since caregiving tasks also require greater financial investment (for paid caregiving services, child-rearing costs, etc.), women with dependents and limited economic resources or women who are sole heads of household (80% of single-parent households in Argentina; Poverty Bulletin 2021) face even greater constraints. These women are often forced to prioritize their paid jobs over taking on additional responsibilities that could help them advance in their academic careers, or they participate in leadership roles at the cost of increased mental, physical, and emotional exhaustion (e.g., burnout; Maslach and Jackson 1981). This additional burden, which is difficult to sustain over long periods, has even been cited by Alper et al. (1993) as one of the causes for drop out scientific careers (leaky pipeline). The low representation of women may also be the result of seemingly innocuous policies, practices, and interactions both within and outside the scientific community — such as microaggressions, the “grateful guest” syndrome, invisibility, and inclusion taxation — that lead women to negatively question their own abilities, merits, and sense of belonging (i.e., impostor-related factors; Hirshfield and Joseph 2012; Gutierrez and Cole 2023), ultimately placing themselves in lower hierarchical positions (Feenstra et al. 2020). These perceptions are often reinforced by the accumulation of negative experiences in academic settings, such as higher rejection rates for publications and funding applications compared to their male colleagues (Blanco 2023; Gutierrez and Cole 2023). In fact, a recent study on how researchers in the field of Ecology in Argentina evaluate their own work performance revealed that women underestimated their performance relative to their peers, despite having similar productivity metrics (measured as the number of first-author

publications in indexed journals; Lomáscolo et al. 2024). Taken together, these dynamics create a system in which individuals from privileged and dominant groups—in terms of gender (cisgender men), but also considering intersections of race and class (white and upper-class individuals)—are more likely to become recognized leaders in key positions. Meanwhile, women (and other individuals from marginalized groups) are excluded or confined to lower-ranking roles in decision-making spaces (Cech 2022).

In several scientific disciplines, a low proportion of women has been documented in high-profile and visible roles at academic meetings and conferences, such as being invited by scientific committees to participate in keynotes and symposia (Schroeder et al. 2013; Kalejta and Palmenberg 2017; Chuliver et al. 2021; Solaro et al. 2024). Our findings are consistent with these observations, which results in reduced visibility for women in research fields and findings, their perspectives, and the recognition of their contributions. This can also influence how they are recognized by their peers (the “Matilda effect,” i.e., the attribution of scientist women achievements to their male colleagues). Previous studies in the Argentine scientific community have shown that most scientists tend to think of a male researcher when asked to name leading figures in their field, highlighting the low number of women seen as role models—a consequence of longstanding biases and stereotypes (Chuliver et al. 2021; Lomáscolo et al. 2024). This may be influencing academic committees’ decisions when it comes to selecting women researchers as speakers for keynotes and symposia at scientific meetings and conferences .

Our results indicate that, over the years, the number of women speakers at the RAE has increased, as well as in scientific meetings and conferences of other disciplines (e.g., the Argentine Mammalogy Conference, the Argentine Meeting on Evolutionary Biology, the Argentine Ornithology Meeting, and the Light in the Museum and the Care of Heritage Symposium). This may be the result of equity policies that establish quotas requiring 50% of the speakers to be women, as was the case in the 2021 edition of the RAE. While these policies can be an important starting point toward achieving equity—and this is where their value lies—it is important to note that they do not necessarily lead to social justice. Therefore, beyond maintaining such measures, it is essential to review and improve them. In fact, in many cases, gender quotas are not enough to prevent the perpetuation of power structures because, although they ensure women participation, there is a risk that this participation remains mostly limited to privileged white, cisgender, heterosexual women—thereby excluding women who experience oppression at the intersection of multiple identities (e.g., ethnicity, social class, sexual orientation, neurodiversity, disability), as well as other historically marginalized groups (Radi 2019).

On the other hand, our results show that women participate in a higher proportion than men in presentations without invitation by the scientific committee at the RAE, and that there is a higher proportion of women presenting their work in poster format—a trend that has increased over the years. Among those presentations without invitation, oral contributions received greater visibility and exposure than poster presentations; posters, by contrast, involve a more relaxed format and are often preferred by early-career researchers and/or students presenting their results for the first time (Rezaeian et al. 2017). In our analyses, women more frequently choose the poster format over oral contributions, resulting in a double invisibility (lower participation as invited speakers and in oral contributions). A negative self-perception rooted in social environments and interactions shaped by gender biases and stereotypes (Feenstra et al. 2020; Gutierrez and Cole 2023) may be leading women to undervalue their own work and to avoid public speaking at scientific meetings.

Although the proportion of women as first authors in papers in *Ecología Austral* has increased, when we analyzed other leading roles, we found that the proportion of women in the last authorship position was lower than that of men and showed no trend of change over the period analyzed. Studies on scientific publications in other disciplines have reported this trend for first authorship (Fox et al. 2018; Salerno et al. 2019; Frances et al. 2020), while the participation of women as last authors declines over time, likely indicating a shorter duration in scientific careers (Grosso et al. 2021). Our results may suggest that women are publishing as first authors in the early stages of

their scientific careers, while they are underrepresented in roles such as project or research group leaders, perhaps reflecting the effect of the “leaky pipeline” (Alper 1993).

Regarding collaborative publications in *Ecología Austral*, our results show homophily for both women and men—that is, we found a higher proportion of co-authors of the same gender as the first or last author, in line with findings reported in other studies (Fox et al. 2018; Salerno et al. 2019; Frances et al. 2020; Grosso et al. 2021). In general, when the first author of an article is a woman, the proportion of female co-authors is higher compared to articles led by men. Nevertheless, overall there is a steady increase in the participation of women as co-authors, regardless of the gender of the first author. Moreover, articles with multiple co-authors are increasingly common, and some studies have shown that they are cited more frequently than solo-authored or small-team research articles (Wuchty et al. 2007). It is important to highlight the different impact that the author gender can have in solo-authored papers; in *Ecology*, single-authored articles by men rank sixth in terms of number or impact of publications, whereas those written by women rank twelfth (Fontanarrosa et al. 2024).

Despite the extensive and thorough nature of our work, it is also important to acknowledge some of its limitations. Mainly, our methodology did not allow us to move beyond a binary gender framework; which excludes other gender identities, as well as intersectionalities (and other historically marginalized groups) that involve not only gender but also social class, ethnicity, sexual orientation, neurodiversity, and disability, among others. The scientific community is not homogeneous, and this must be taken into account to avoid, once again, omissions and overgeneralizations (Lione 2020). In this study, we used gender as an entry point to reflect on how we might achieve a more equitable and just scientific system. However, in order to address the unequal opportunities in knowledge production and access to the scientific system, it is essential to understand the systematic exclusion of people and ideas from science as the result of multiple, interconnected axes of oppression that interact with one another (i.e., interlocking systems of oppression, Combahee River Collective Statement 1977; hooks 2015; Soares et al. 2023; Cockle et al. 2025).

#### *Final considerations*

Beyond the specific results of this work, it is necessary to consider the true inclusion and participation of women and intersectionally marginalized people in the construction of scientific knowledge—not only as an ethical and political goal—but also to bring diverse perspectives and experiences that can help us develop concepts and approaches that foster new and exciting advances in this scientific discipline.

To aspire to a more equitable scientific system, intentional measures must be taken both in public policy and at the community and individual levels. Among these measures, the representation of women with intersectional identities and individuals from historically marginalized groups could be increased within the boards of directors of scientific associations, editorial team of scientific journals (Ruelas Inzunza et al. 2023), and as keynote speakers at scientific meetings. Additionally, specific opportunities could be arranged for those who present and also have caregiving responsibilities (e.g., grants provided by the RAE for participants with caregiving duties). Alternative plenary formats could also be encouraged—ones that promote the participation of more people, such as collectively presenting group work (as proposed for RAE 2025)—with the goal of inspiring and motivating more equitable and collective recognition models, different from the classic single-speaker format that rewards individual leadership. To give visibility to the research of women and people from other marginalized groups in science, we suggest intentionally promoting the citation of their work and including them in our references (Cockle et al. 2025). To reflect on the ethics of our collaborations and citations, we suggest the use of structured reflexivity statements (i.e., a set of questions for authors to reflect on how equity is promoted in the research process; see example in Ruelas Inzunza et al. 2023) and transparent practices for authorship decisions (Liboiron et al. 2017; Cockle et al. 2025). Finally, from our space of influence, we suggest shifting away from the pursuit of individual excellence and the reward of personal leadership, toward fostering working groups where

collective leadership and the distribution of power are promoted. This includes enabling, listening to, and valuing all voices through intentional practices when exploring ideas and making decisions. Unconventional governance models, such as sociocracy (Rau and Koch-Gonzalez 2018; Cockle et al. 2025), can help make the scientific system a more welcoming place with equal opportunities to conduct science.

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**Table 1.** Summary of the hypotheses and predictions that organize the development of the methods and results, and their subsequent discussion.

Hipótesis	Predicciones
H1: la representación en distintos ámbitos de desempeño profesional en la ecología de la Argentina no es equitativa	<p>H1-P1: La proporción de mujeres que forman parte de la comisión directiva de la AsAE y del equipo editorial de Ecología Austral en roles de mayor jerarquía, será menor a la esperada en un escenario de equidad</p> <p>H1-P2: En las modalidades de participación en las RAE que requieren invitación, la proporción de mujeres respecto de varones será menor que en modalidades que no la requieren</p> <p>H1-P3: La proporción de mujeres en presentaciones orales será menor que su proporción en presentaciones en formato póster</p>
H2: la participación en los roles protagónicos en las publicaciones en la revista Ecología Austral no es equitativa	<p>H2-P1: La proporción de mujeres como primeras, últimas y únicas autoras en los artículos publicados en Ecología Austral, será menor a lo esperado sobre la base del total de autores/as que publican en la revista</p> <p>H2-P2: La proporción de mujeres como co-autoras será menor cuando el primer o el último autor es varón y mayor cuando la primera o la última autora es mujer</p>
H3: la representación de las mujeres en la ecología ha aumentado con el transcurso del tiempo	H3-P1: La representación de mujeres en los distintos espacios académico-científicos de la ecología argentina analizados bajo las hipótesis anteriores, mostrará una tendencia de progresiva equidad en relación a los varones en el período de estudio

**Table 2.** Generalized linear models used in the data analysis to answer the hypothesis 3.

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Evaluación de la proporción de género en la comisión directiva de la AsAE en el período 1993-2024

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Modelo 1: proporción de género de los/as miembros de la comisión directiva de AsAE en función del tiempo

Modelo 2: género del/a presidente/a en función del tiempo

Modelo 3: género del/a vicepresidente/a en función del tiempo

Modelo 4: género del/a vicepresidente/a en función del tiempo y del género del/a presidente/a, incluyendo la interacción entre estos factores

Modelo 5: proporción de género de los integrantes de la comisión directiva en función del tiempo y del género del/a presidente/a, incluyendo la interacción entre estos factores

Evaluación de la proporción de género en el equipo editorial de la revista científica Ecología Austral en el período 1993-2024

Modelo 6: proporción de género de los/as editores/as asociados/as en función del tiempo

Modelo 7: género del/a editor/a general, mujer o varón, en función del tiempo

Modelo 8: proporción de género de los/as editores/as asociados en función del tiempo y el género del/a editor/a general, incluyendo la interacción entre estos factores

Evaluación de la proporción de género entre las personas que participaron en las RAE en el período 1999-2023

Modelo 9: género de la persona invitada, mujer o varón, a participar de la RAE en función del tiempo

Modelo 10: género del/a conferencista, mujer o varón, en función del tiempo

Modelo 11: proporción de género de los/as integrantes de un simposio en función del tiempo

Modelo 12: género del/a primer/a autor/a, mujer o varón, de una presentación oral en función del tiempo

Modelo 13: género del/a primer/a autor/a, mujer o varón, de una presentación en formato póster en función del tiempo

Evaluación de la proporción de género entre los/as autores/as de los artículos publicados en EA en el período 1999-2024

Modelo 14: género del/a primer/a autor/a, mujer o varón, en función del tiempo

Modelo 15: género del/a último/a autor/a, mujer o varón, en función del tiempo

Modelo 16: género del/a único/a autor/a, mujer o varón, en función del tiempo

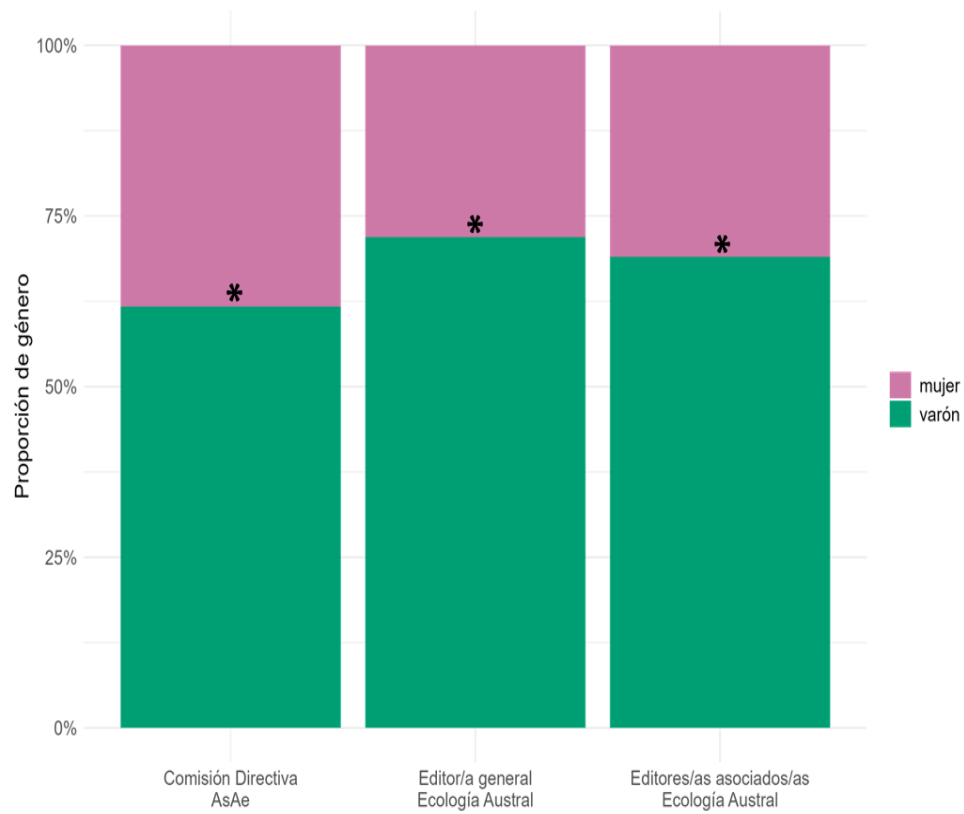
Modelo 17: proporción de género de los/as co-autores/as en función del tiempo

Modelo 18: proporción de género de los/as co-autores/as en función del tiempo y del género del/a primer/a autor/a

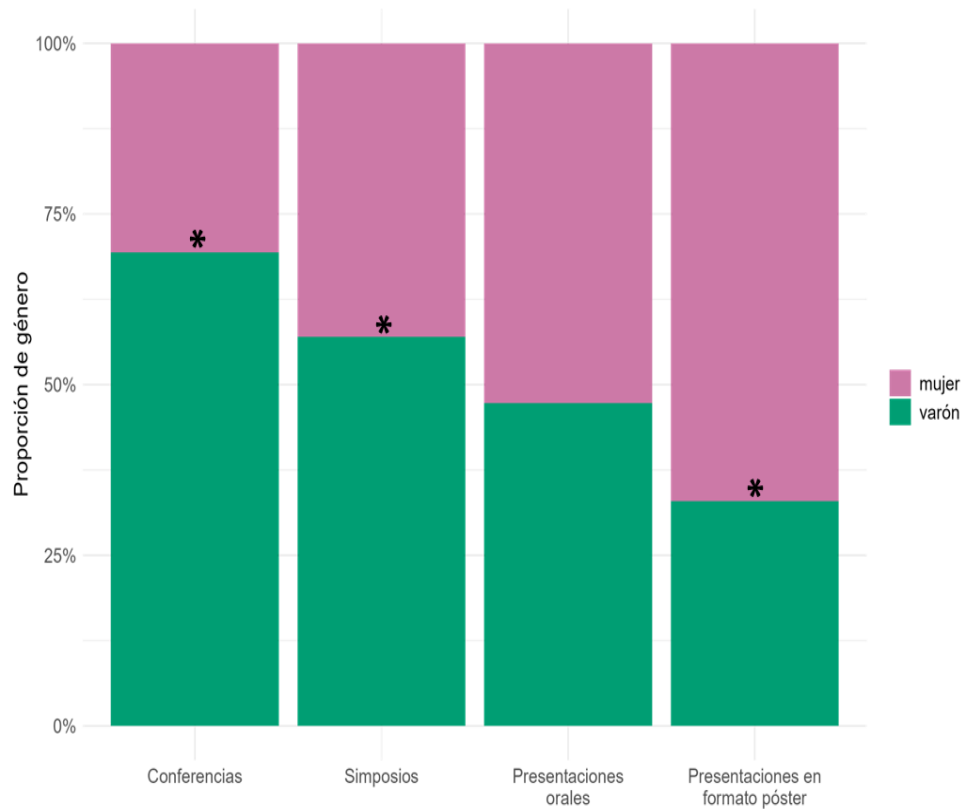
Modelo 19: proporción de género de los/as co-autores/as en función del tiempo y del género del último autor/a

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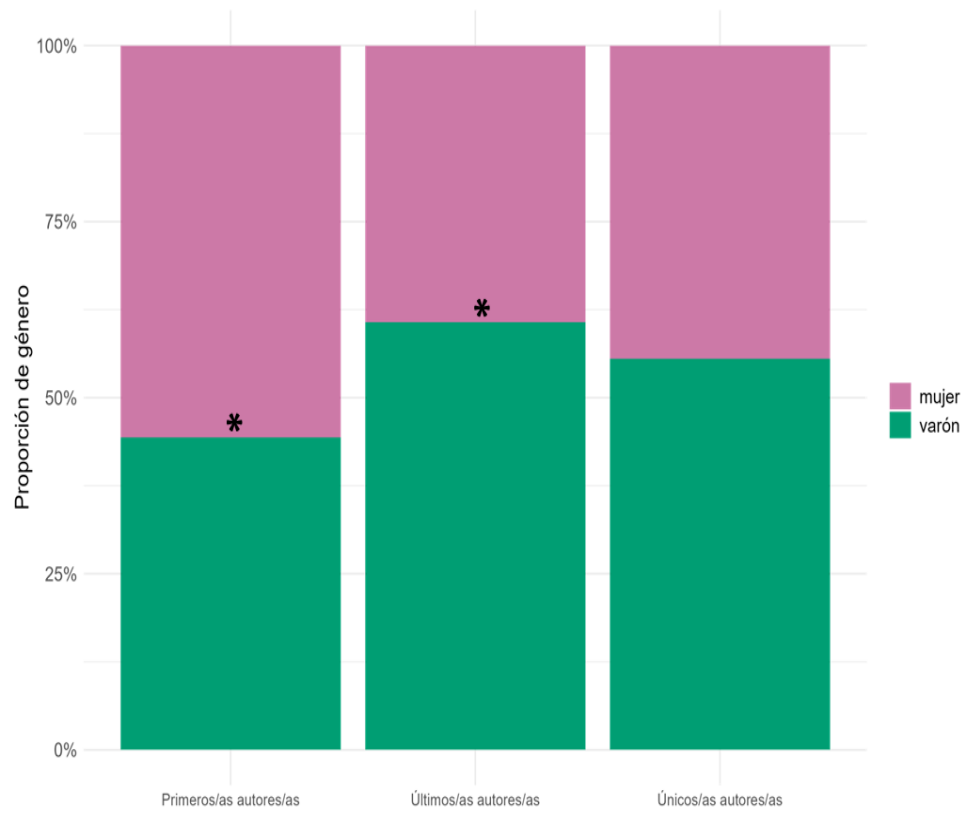
**Figure 1.** Average gender proportions of the board of directors of the AsAE and the editorial team of EA. Asterisks indicate those cases where the difference in gender proportion is significant.



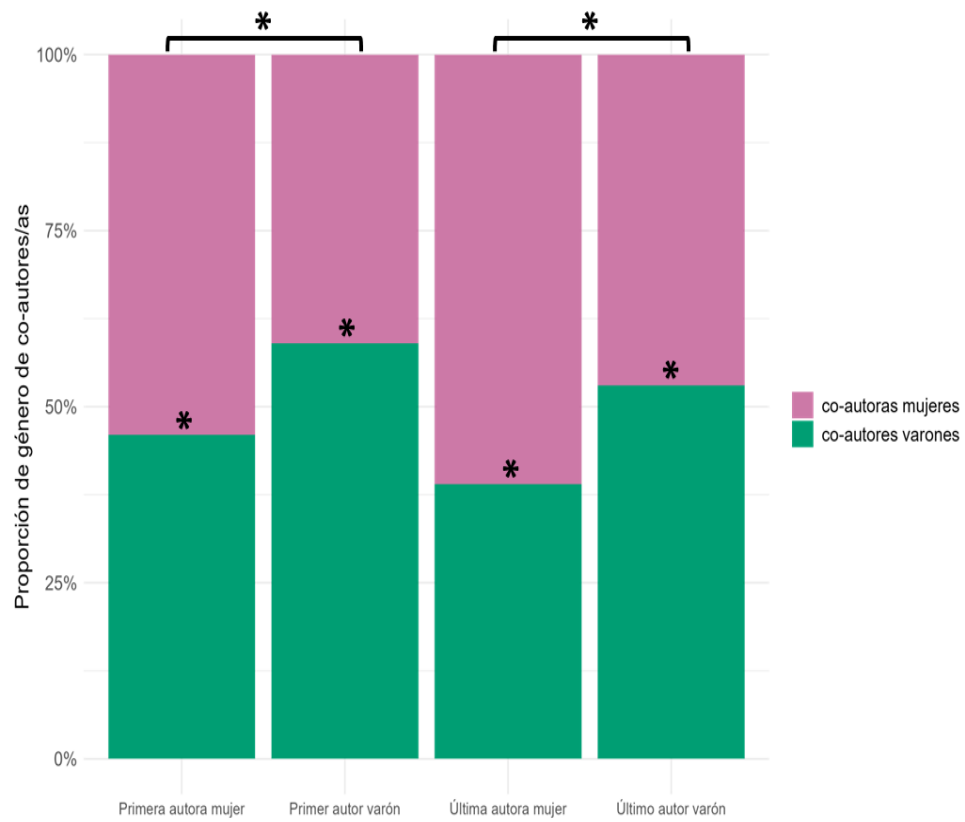
**Figure 2.** Average gender proportions of the different participation modalities at the RAE. Asterisks indicate those cases where the difference in gender proportion is significant.



**Figure 3.** Average gender proportions in different places in the author lists of articles published in *Ecología Austral*. Asterisks indicate those cases where the difference in gender proportion is significant.



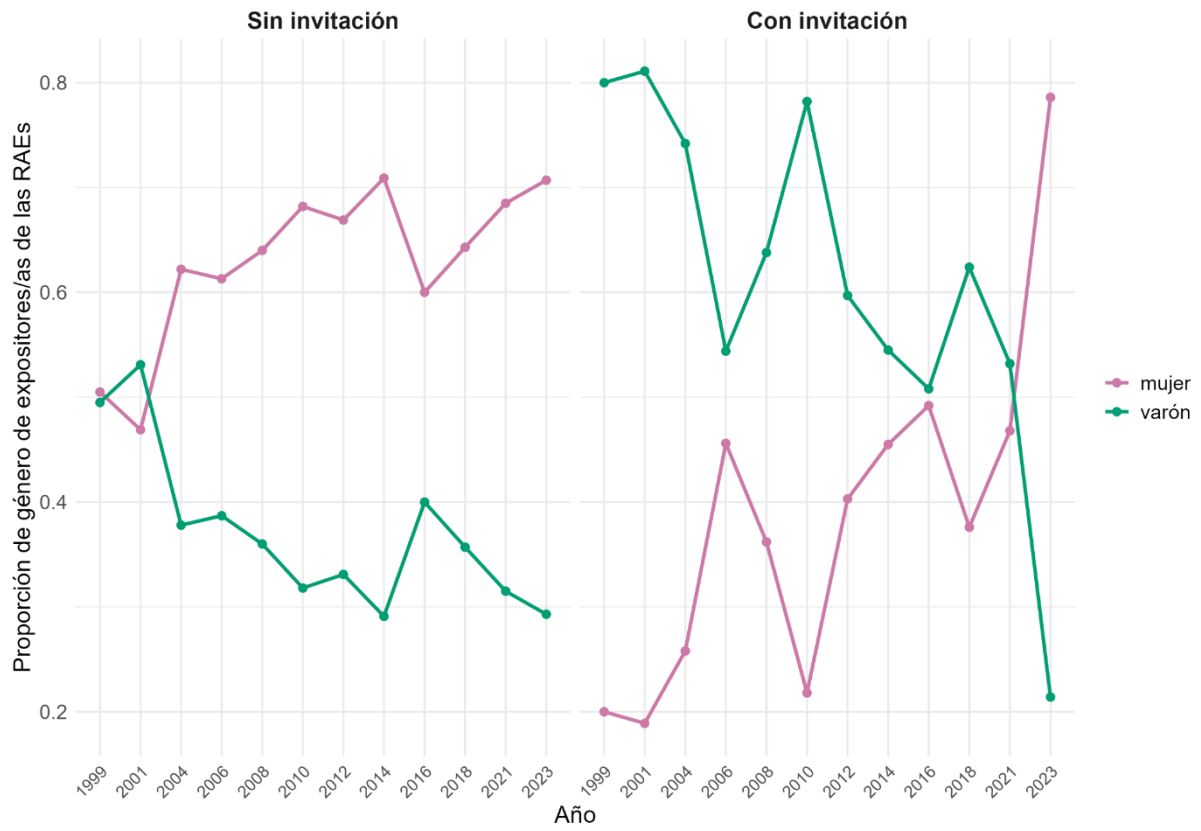
**Figure 4.** Average gender proportions among co-authors of articles published in *Ecología Austral* in relation to the gender of the first and last author. Asterisks indicate those cases where the difference in gender proportion is significant, both within each category and between categories.



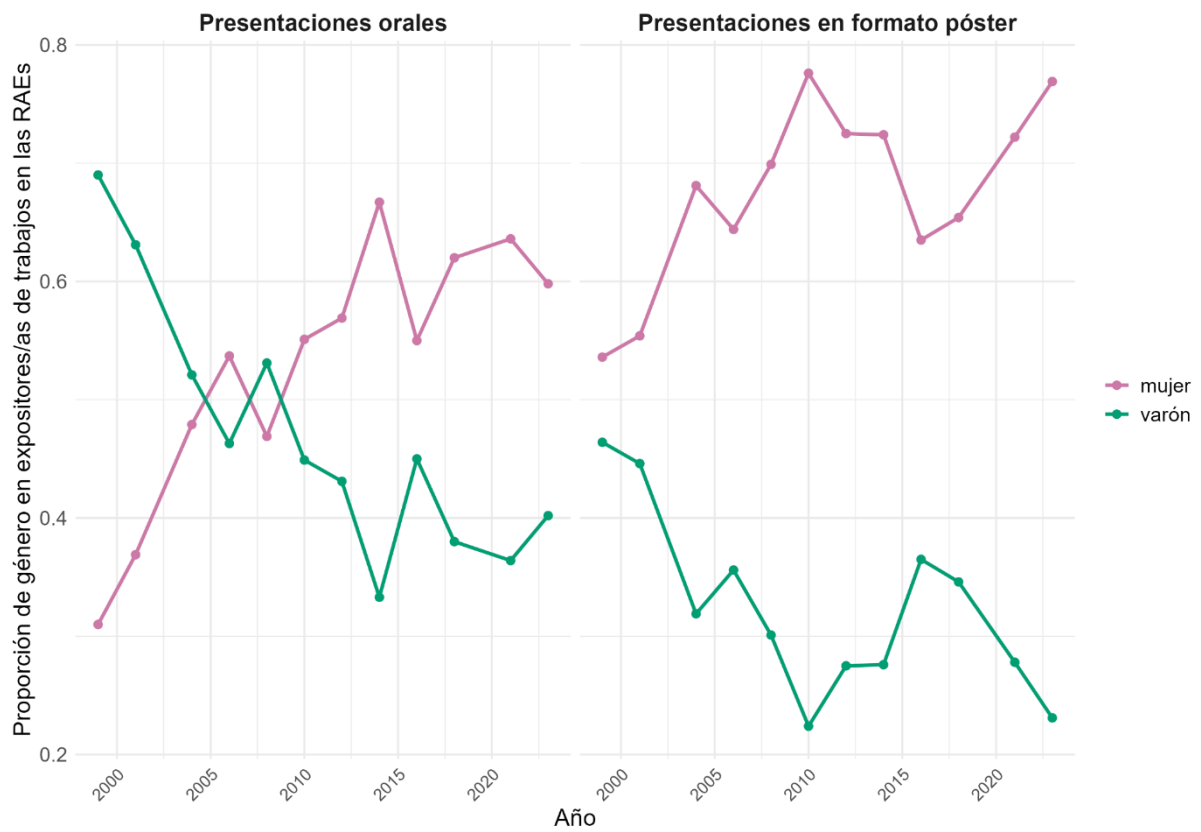
**Figure 5.** Average gender proportions by year in the board of directors of AsAE (solid lines) and among associate editors of Ecología Austral (dashed lines) between 1993 and 2024 (32 years).



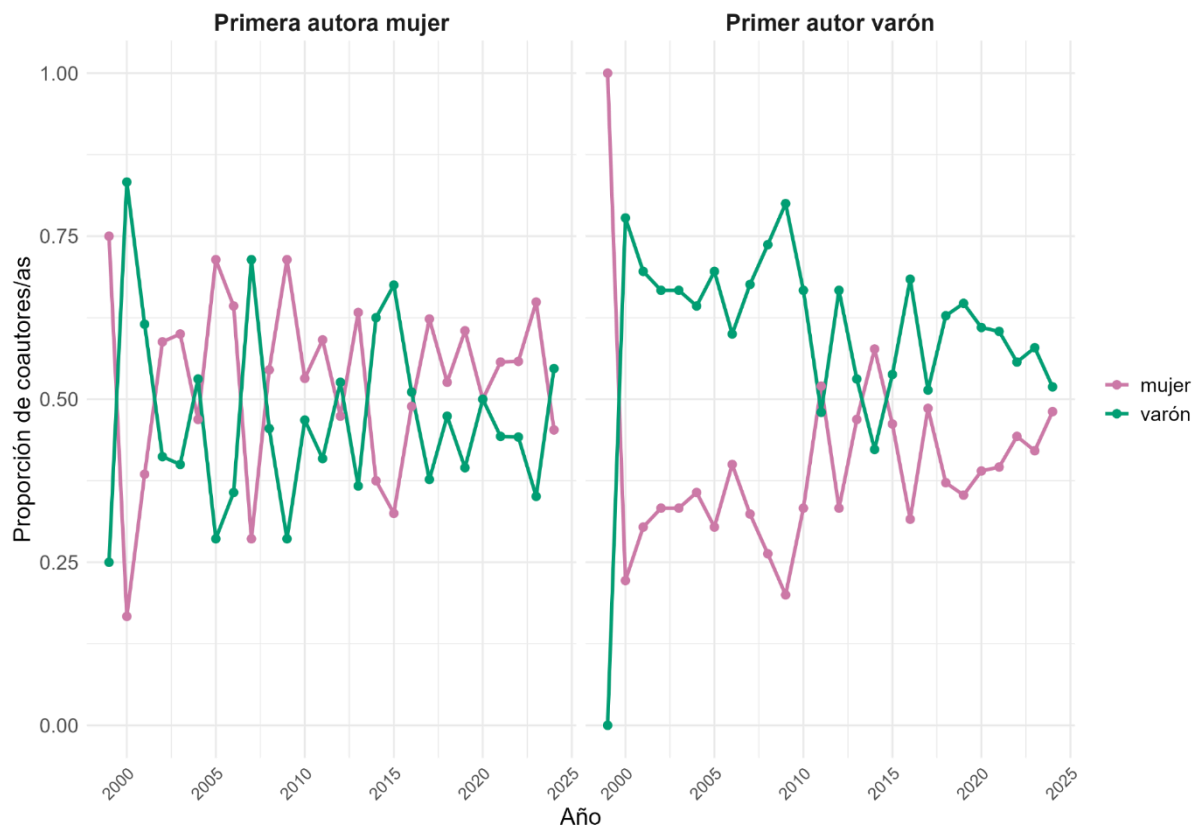
**Figure 6.** Average gender proportions among presenters of invited (conferences and symposia) and non-invited (oral and poster presentations) modalities at the editions of the Argentine Ecology Meeting held between 1999 and 2023.



**Figure 7.** Average gender proportions among presenters of oral and poster presentations at the editions of the Argentine Ecology Meeting held between 1999 and 2023.



**Figure 8.** Average gender proportions among co-authors of papers published in *Ecología Austral* between 1999 and 2024, according to the gender of the first author, with the first author being a woman (left panel) or a man (right panel).



**Figure 9.** Average gender proportions among co-authors of papers published in *Ecología Austral* between 1999 and 2024, according to the gender of the last author, with the last author being a woman (left panel) or a man (right panel).

