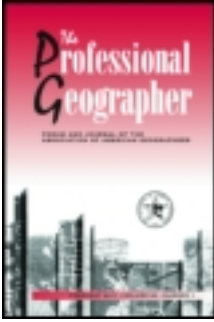


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Authorship, Collaboration, and Gender: Fifteen Years of Publication Productivity in Selected Geography Journals*

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Authorship, Collaboration, and Gender: Fifteen Years of Publication Productivity in Selected Geography Journals*

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In academia, publication productivity, defined as the number of peer-reviewed articles published and the frequency of citations, is a primary factor in the assessment of tenure and promotion. One of the most cited gender differences in academia is the “productivity puzzle,” which suggests that women publish less than men, thereby affecting every aspect of a woman’s academic career. Peer-reviewed articles published in the *Annals of the Association of American Geographers* (*Annals*) and *The Professional Geographer* (*PG*) between 1995 and 2006, and in four subdisciplinary journals between 2005 and 2009, as well as citation reports, were used to explore whether gender differences are present in publication productivity. Gender differences were evident in the proportion of women authors, the frequency of collaboration, and the number of citations across a broad range of prestigious geographic journals. For all journals studied, women were underrepresented, especially in the authorship positions that equate to notions of respect and merit. Although the number of collaborative articles increased during the study period, single-authored papers are the dominant mode of publication for both men and women for most geographic journals. The authorship patterns for frequently cited articles generally mirror those for all articles. Because the frequency of collaborative publication was high for women, the dual trends of a general increase in publication collaboration and increasing participation of women in academic geography bodes well for increased female productivity as it relates to publishing. Nevertheless, it is important to note that, currently, males as lead or single authors represent the predominant voice of geography within the journals examined in this study. **Key Words:** authorship, citation, collaboration, gender, publication.

在学术界，出版生产力，定义为发表的同行评审的文章数量和被引用的频率，是终生教授和职称评定的首要因素。在学术界被引用最多的性别差异的之一，是“生产力拼图”，它表明女性比男性发表文章少，从而影响女性学术生涯的每一个方面。使用 1995 年和 2006 年之间，发表在美国地理学家协会年鉴（*Annals*）和专业地理学家（*PG*）上，和 2005 年和 2009 年之间发表在四个子学科期刊上的同行评审的文章，以及引用报告，本文探讨是否在出版生产力上存在性别差异。在女性作者的比例，合作的频率，跨越广泛的著名地理杂志的引用数量上，性别差异是很明显的。对于所有被研究的期刊，尤其是在等同于名声和业绩的作者位置，女性作者代表不足。虽然协作的文章数量在研究期间有所增加，单一撰写的文章仍是男性和女性作者在大多数地理杂志出版的主导模式。由于女性协作出版的频率高，这个出版合作的普遍提高和女性参与学术地理的增加的双重趋势，很好地预示了女性著作生产力的提高。不过，重要的是要注意到，目前男性作为主要的或单一的作者，代表了本研究中所探讨的期刊的主要地理声音。关键词：作者，引用，合作，性别，出版。

En el ámbito académico, la productividad en publicación, definida como el número de artículos de selección arbitrada que han sido publicados y la frecuencia de citaciones, es un factor primario en la evaluación para tenencia y promoción. Una de las diferencias por género en academia más citadas es el “rompecabezas de productividad”, que sugiere que las mujeres publican menos que los hombres, circunstancia que afecta cada aspecto de la carrera académica de una mujer. Se utilizaron artículos arbitrados publicados en *Annals of the*

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Association of American Geographers (Annals) y *The Professional Geographer (PG)* entre 1995 y 2006, y en cuatro revistas subdisciplinarias entre 2005 y 2009, lo mismo que informes sobre citas, para determinar si existen diferencias por género en productividad de publicaciones. Las diferencias de género fueron evidentes en la proporción de autoras, en la frecuencia de colaboración y en el número de citas a través de un ámbito amplio de revistas geográficas prestigiosas. En todas las revistas estudiadas las mujeres estaban subrepresentadas, especialmente en las posiciones de autoría que se equiparan con nociones de respeto y mérito. Aunque el número de artículos de autoría plural aumentó durante el período de estudio, los escritos de un solo autor son el modo dominante de publicación tanto para varones como mujeres en la mayoría de las revistas geográficas. Los patrones de autoría en lo que concierne a los artículos más frecuentemente citados generalmente reflejan los patrones observados para todos los artículos. Debido a que la frecuencia de publicación colaborativa era alta para mujeres, las dobles tendencias de un aumento general en publicación por colaboración y participación creciente de las mujeres en geografía académica, permiten anticipar una creciente productividad femenina en lo que concierne a publicaciones. No obstante, es importante hacer notar que, actualmente, los varones, como autores líderes o como autores individuales, representan la voz prominente de la geografía en las revistas examinadas en este estudio. **Palabras clave:** autoría, citación, colaboración, género, publicación.

There are many ways to assess one's career within the academic world of geography: effective teaching, student mentoring, committee work, grantsmanship, pure and applied research, and conference and workshop participation. For most academics, publication productivity is the ultimate gauge of success. Publication productivity, the number of published peer-reviewed articles and the frequency of citations per publication, is essential for two important reasons: First, research findings are disseminated through publication (Lortie et al. 2007) and, second, publication productivity is associated with one's eligibility for tenure and promotion, along with other forms of institutional merit (Fox 2004). One of the most noted gender differences in academia is the "productivity puzzle" (Cole and Zuckerman 1984, 1991; Cole and Singer 1991; Xie and Shauman 2003), or the notion that when age and other factors are taken into account, men publish more than women (Cole and Zuckerman 1984, 1991; Xie and Shauman 2003).

Women's participation in geography as a discipline has grown dramatically over the past several decades. Using membership in the Association of American Geographers (AAG) as an indicator, the proportion of women in geography has risen from 20.3 percent in 1980 to 36.2 percent in 2009 (Figure 1). The proportion of women AAG members holding a teaching or research position at a university or college has risen more dramatically, from 9.6 percent to 26.8 percent (Figure 1). In the absence of productivity barriers, women's share in published work would be expected to reflect the gender balance in the discipline, as a whole, or in any of its subfields.

A rich literature explores gender differences in publication productivity (e.g., Al-Ghamdi et al. 1998; Ones and Viswesvaran 2000; Prpic 2002; Sax et al. 2002; Stack 2004; Braisher, Symonds, and Gemmell 2005; Leahey 2006), including the status of women in geographic literature either explicitly or implicitly (García-Ramón, Castener, and Centelles 1988; Lee 1990; Brunn 1995; Robic and Rossler 1996; Groop and Schaetzel 1997; Dumayne-Peaty and Wellens 1998; Madge and Bee 1999; Luzzader-Beach and Macfarlane 2000; Winkler 2000; Brinegar 2001; Stack 2002; Monk 2004; Monk, Droogleever Fortuijn, and Raleigh 2004; Michalec and Welsh 2007; Babbit et al. 2008). But, no previous studies have specifically examined the gender differences in the recent geographic literature of (1) publication frequency, (2) frequency of

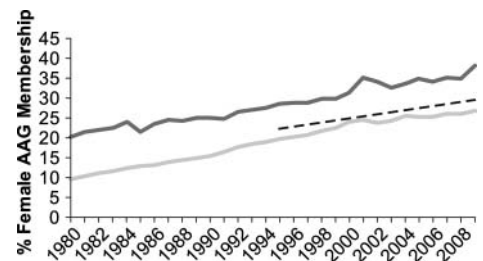


Figure 1 Representation of women in the Association of American Geographers (AAG), 1980–2009: The proportion of total AAG membership that is female (dark line) and the proportion of female members in university or college positions (gray line); percentage of female first authors in the *Annals* (dashed line).

Table 1 Fifteen geography journals and their 2008 impact factor

Journal	Impact factor
<i>Transactions of the Institute of British Geographers</i>	3.967
<i>Progress in Human Geography</i>	3.482
<i>Progress in Physical Geography</i>	3.010
<i>Economic Geography</i>	2.986
<i>Annals of the Association of American Geographers</i>	2.679
<i>Geographical Analysis</i>	2.564
<i>Landscape Ecology</i>	2.453
<i>Political Geography</i>	2.295
<i>Landuse and Urban Planning</i>	1.953
<i>Environment and Planning D</i>	1.807
<i>The Professional Geographer</i>	1.714
<i>International Journal of Geographical Information Science</i>	1.596
<i>Social & Cultural Geography</i>	1.484
<i>Physical Geography</i>	0.613
<i>Geographical Review</i>	0.467

collaboration, and (3) citation rate. The goal of this study is to identify whether gender differences exist in publication productivity and impact, based on publications in a selection of geography journals for the past fifteen years.

Lee and Evans (1984) conducted a study in which they assessed thirty-four geography journals based on perception of quality and journal familiarity. The *Annals* and *PG* ranked within the top three, suggesting that these journals were perceived by a majority of geographers, at that time, as prestigious. Using prestigious journals in a publication productivity study is important for three reasons. First, they are acknowledged to have maximum impact within a given discipline. Second, their ranking or impact factor (see Table 1) tends to remain stable over time. Third, they represent a high quality of research within the given field (Wiseman and Skilton 1999).

In this study, we concentrate on authorship and collaboration for approximately 2,300 peer-reviewed articles published in the *Annals*, *PG*, *Geographical Analysis (GA)*, *Social & Cultural Geography (SCG)*, *Environment and Planning D (EPD)*, and *Physical Geography (Phys. G)* between 1995 and 2009. We also examine citations using the twenty-five most cited articles (Thomson Reuters 2010) published in that time period ($N = 375$) from a total of fifteen geography journals (Table 1).

We examine four facets of publication productivity:

1. Are there gender differences, both in terms of author position and overall publication rates within a given journal?
2. Are there gender differences in collaboration within the journals?
3. Are there gender differences in the authorship of the most highly cited articles in geographic journals?
4. Are differences in authorship (position and publication rate), collaboration, and frequency of citations evident within the four subdisciplines of geography as identified in the *Annals*, namely, Environmental Sciences; Methods, Models, and GIS; Nature and Society; and People, Place, and Region?

Methodology

The sample of peer-reviewed articles analyzed in this study were drawn from three sources: (1) two high-profile geography journals, the *Annals* (1995–2009; $n = 559$), and *PG* (1995–2009; $n = 553$); (2) a five-year snapshot (2005–2009) in four subdisciplinary journals, *GA* ($n = 103$), *SCG* ($n = 251$), *EPD* ($n = 287$), and *Phys. G* ($n = 183$); and (3) the twenty-five most cited articles (Thomson Reuters 2010) during 2005 to 2009, drawn from all peer-reviewed articles published between 1995 and 2009 ($n = 375$), from a total of fifteen geography journals (Table 1).

Gender and authorship position (authors one through nine) were determined for each article, except those in the form of a presidential address (*Annals*), editorial, forum, commentary, book review, response or reply, discussion, or research note. Similarly, we omitted any article for which an author's gender could not be ascertained ($n < 25$) from sources such as their department's Web site or by using search engine image requests (i.e., Google.com). The total number of authors per article and proportion of male and female authors per article were calculated for each article. Collaborative efforts were qualified as male–male (MM), female–female (FF), male–female (MF), or female–male (FM). For articles with more than two authors, the collaboration category of MF or FM is used

to denote that there was a female or male collaborating author, respectively, on the paper, but not necessarily in the second author position. Further, we segregated authorship and collaboration data for the *Annals* based on the journal's subdiscipline categorizations: Environmental Sciences ($n = 73$); Methods, Models, and GIS ($n = 112$); Nature and Society ($n = 96$); and People, Place, and Region ($n = 239$). These data were subsequently compared to data collected from topically oriented journals with similar thematic focus: *Phys. G*, *GA*, *SCG*, and *EPD*.

To select the fifteen geography journals for the citation portion of this study, we created a list of geography journals from several citation lists including: ISI Web of Knowledge Geography Journal Citation Reports (Thomson Reuters 2010), Lee and Evans's (1984) American Geographers' Rankings of American Geography Journals, SCImago Journal & Country Rank (SCImago 2007), Journal-Ranking by RedJasper (RedJasper 2006), and Trinity College Dublin's Journal Citation Reports (Journal Citation Reports 2009). From this list of journals we selected fifteen journals: the six already being used for the authorship and collaboration portion of the analysis, two institutional-based journals comparable to the *Annals* and *PG* (*Transactions of the Institute of British Geographers* and *Geographical Review*), and seven randomly selected journals (Table 1).

A citation report for each journal (ISI Web of Knowledge, searching both the Expanded Science Citation Index and the Social Sciences Citation Index) was obtained for articles published during the years 1995 through 2009 (set by the authors to mirror the time frame of the authorship and collaboration portion of the study). Citations were compiled for the most recent five-year period, a limit imposed by the ISI Web of Knowledge database. Authorship, gender, and author positions were determined for the twenty-five most cited articles ($n = 375$) within each of the fifteen journals, using the methods described previously. For each authorship/collaboration category (M, F, MM, FF, MF, FM) the citation proportion was calculated where the number of citations within each collaboration category was divided by the total citations across all collaboration categories for each journal.

Results

Authorship and Publication Rate

From 1995 to 2009, 36.8 percent of *Annals* articles and 41.4 percent of *PG* articles had at least one female author in any of the possible nine authorship positions. Although the maximum number of authors per article was nine, almost 95 percent of articles in the *Annals* and *PG* had three or fewer authors. Women accounted for 21.7 percent of total authorship between 1995 and 2009. Data published by the AAG (based on those who reported gender; AAG 2011) suggest that women comprised roughly 25 percent of the membership in 1990, increasing to 36 percent by 2009 (Figure 1). When the AAG membership is limited to women holding academic positions, 27 percent in 2009 (Figure 1), the proportion of total female authorship for the *Annals* and *PG* is close to female AAG academic membership (AAG 2011).

The question of gender representativeness in scholarship is not as simple as total authorship, however. It is commonly held and well understood in the academic community that the lead author position and single-authored articles are perceived to hold greater merit and prestige (Xie and Shauman 2003; van Praag and van Praag 2004). For some fields authorship is given in alphabetical order (usually identified by a footnote) or the last (and usually corresponding) author position might hold the most prestige, but this tends not to be the case in geography. In aggregate, across both the *Annals* and *PG*, for the period from 1995 to 2009, authors in the first authorship position (including single-authored articles) were predominantly male (Figure 2). *PG* had a slightly higher proportion of female first authors than the *Annals* (31 percent and 26 percent, respectively; Figure 2). Women accounted for approximately 16 percent of all single-authored articles published in either the *Annals* or *PG* from 1995 to 2009 (Figures 3A, 3B). As the representation of women in academic geography increased (based on AAG membership, University and College, 1980–2009) the percentage of female first authors in the *Annals* also increased for the period of this study from 23 percent in 1995 to 30 percent in 2009 (Figure 1), whereas *PG* was more consistent.

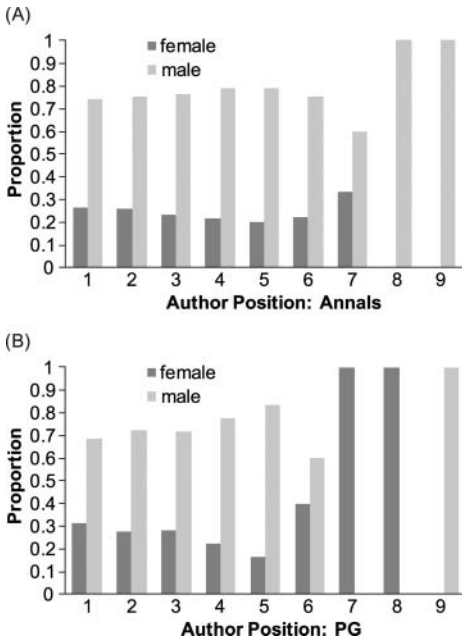


Figure 2 The proportion of male (gray columns) and female (dark columns) authors broken down by authorship position for articles published in (A) the *Annals* and (B) *PG*, between 1995 and 2009.

When the authorships of the twenty-five most cited articles for each of the fifteen journals used in this study were analyzed (articles published 1995–2009 cited in last five years; Table 1), the proportion of female first authors was 25.7 percent (sum of F, FF, and FM; Figure 4).

Collaboration

In general, the number of authors per article in the *Annals* and *PG* increased from 1995 to 2009 (Figure 5). In 1996, the average number of authors per article was 1.3 and 1.4 in the *Annals* and *PG*, respectively. These values rose to 2.2 for the *Annals* in 2009 and 2.3 for *PG* in 2008 (Figure 5). Single-authored articles were still prevalent, however, with 38 percent (35 percent) and 15.5 percent (16.5 percent) of *Annals* (*PG*) articles published by individual male and female authors, respectively (Figures 3A, 3B). Male authors (single [M] or multiple [MM]) made up approximately 63 percent of the total authorship for the *Annals* and 58.5 percent for

PG (Figures 3A, 3B). The categories with female authors (single [F] or multiple [FF]) made up 19.4 percent and 21.7 percent of the total publication for the *Annals* and *PG*, respectively (Figures 3A, 3B). Between 1995 and 2009, males and females collaborated on only 17–18 percent (sum of MF and FM; Figures 3A, 3B) of the manuscripts in the *Annals* and *PG*. Although the maximum number of authors was nine, over 95 percent of the articles published in the *Annals* and *PG* over the study period had three or fewer authors.

Collaborations were similar to publication rate by authorship category for the twenty-five most cited articles per journal (Figures 3A, 3B), with two minor exceptions. Compared to their respective publication rates, highly cited single-authored (S) articles (especially male) in the *Annals* received a greater proportion of citations (Figure 3A) and single-authored articles by women in *PG* received a greater proportion of citations (Figure 3B).

Authorship and Collaboration by Subdiscipline

Between 1995 and 2009, almost 40 percent of all articles in the *Annals* were authored by individual male researchers; however, the percentage varies with subsection (Figure 3), ranging from 17.8 percent in Environmental Science to 52.1 percent in Nature and Society. In most cases, authorship for the four subsections of the *Annals* closely mirrors authorship and collaboration patterns in the four subdisciplinary journals analyzed for the period of 2005 through 2009 (Figure 3). Similar to the Nature and Society subsection, single-authored articles were predominant in *SCG* (71.8 percent compared to 68.5 percent, respectively), whereas collaborative articles were most frequent for both the Environmental Science subsection and *Phys. G* (79.5 percent compared to 80.9 percent, respectively). Collaborative authorship was slightly more frequent in *GA* (compared to the *Annals*' Methods, Models, and GIS section, particularly for multiple male authors [MM]). Interestingly, single-authored articles in *GA* received more citations compared to multiple authored articles.

Of the fifteen journals analyzed, *Landscape Ecology* stands out, with 75.6 percent of its citations associated with collaborative articles,

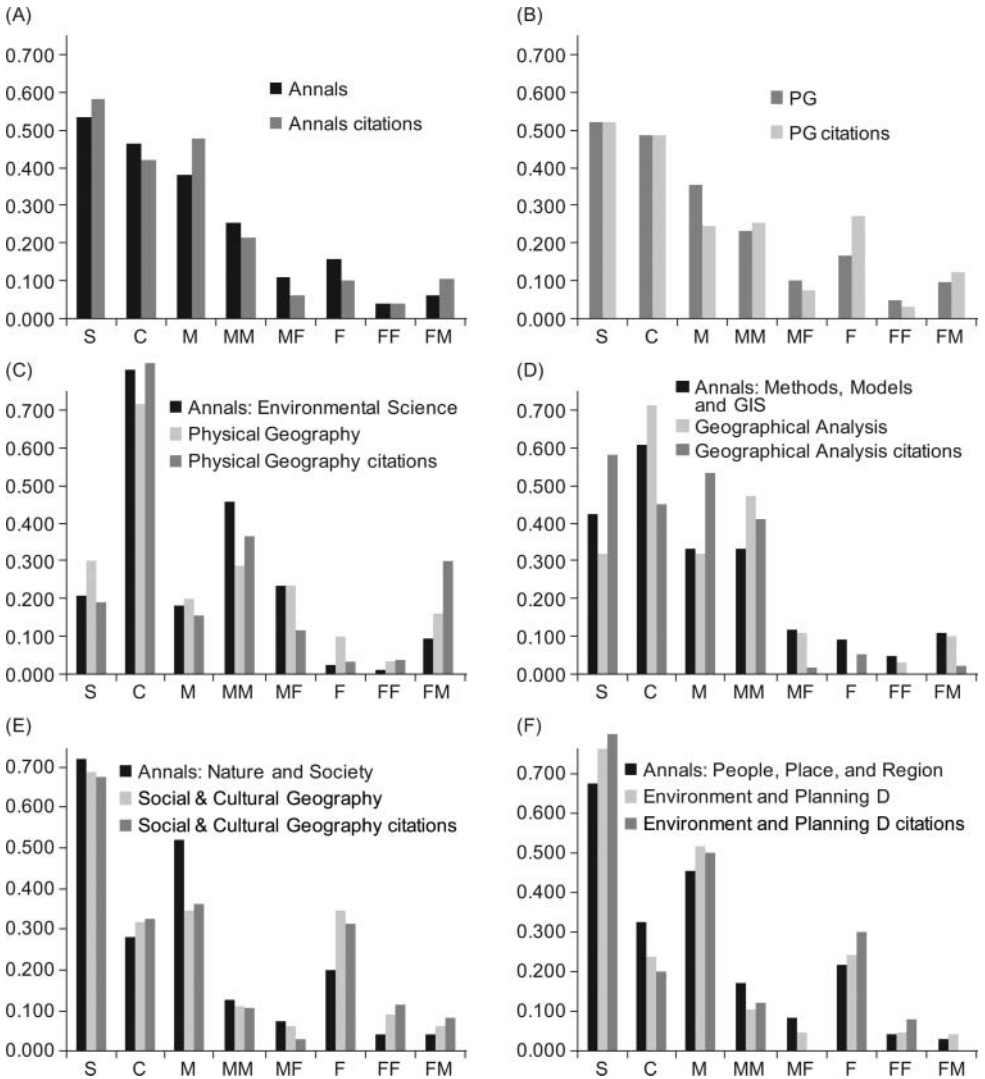


Figure 3 Publication proportion (dark columns) and mean weighted citation proportion (light columns) for each authorship/collaboration category (M, F, MM, FF, MF, FM). Single-authored articles (S) and collaborative efforts (C) are also presented.

which was similar to our findings in *Phys. G*. Furthermore, in these two journals, 22 percent of the citations in *Landscape Ecology* (no figure shown) and 34 percent of the citations in *Phys. G* (Figure 3C) are accounted for by FF and FM collaborative efforts.

Based on a chi-square analysis of gender versus journal subfield category, single-authored

articles by female researchers (F) are more frequent in journals associated with cultural geography, whereas collaborative efforts (C) are more frequent in the environmental and GISciences, ($\chi^2[5] = 18.16, p < 0.05$). Single-authored articles by women (F) made up a larger proportion of the total number of articles in *Phys. G* (first) than in either the *Annals*

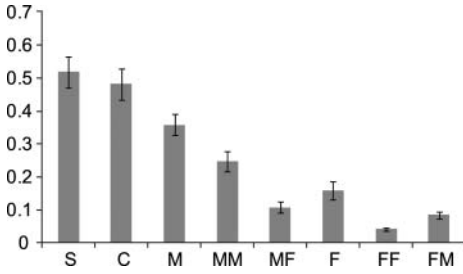


Figure 4 The mean citation proportion for each authorship/collaboration category (M, F, MM, FF, MF, FM) for the top twenty-five most cited articles averaged across the fifteen journals. Single-authored articles (S) and collaborative efforts (C) are also presented. Error bars represent 95 percent confidence intervals.

(second) or *PG* (fourth), and single-authored articles by men (M) were proportionately more frequent in *GA* (first) and *SCG* (second) compared to the *Annals* (third) and *PG* (fifth). In *GA*, *Political Geography*, *EPD*, and *Geographical Review*, 50 percent or more of the citations were associated with single-authored articles by men (M). In the *Transactions of the Institute of British Geographers*, 15 percent of the citations were for articles that had at least one woman as an author (in any author position). In *Progress in Human Geography*, *Economic Geography*, *EPD*, *PG*, and *SCG*, single-authored articles by women (F) were generally associated with more than 25 percent of citations.

Over all fifteen journals, single-authored articles written by men (M) were more frequently

cited than either multiple-authored papers or single-authored papers written by women (FF or F). Collaborative articles by men (MM or MF) were also more frequently cited than papers written by women, either singly (F) or with other women (FF).

Discussion

This study examined authorship, collaboration, and citation in regard to gender in recent geographic literature. Research on academic productivity, particularly publication rate, has shown that women publish less than men across all disciplines (Xie and Shauman 1998). A report by the National Academy of Sciences (2007) stated that male academic scientists and engineers produced 30 percent more publications than women but that the productivity gap is narrowing (down to 25 percent) for women and men at similarly ranked institutions and equivalent faculty positions. Some gender differences in publication productivity could be attributable to institution type. Prior studies have shown that female professors are less likely to work in research institutions and consequently are less likely to secure research funding and assistance and more likely to spend time teaching (Primack and O’Leary 1993; Xie and Shauman 1998; Hill, Corbett, and St. Rose 2010), resulting in less time for publication efforts. Although the data on institution type by gender are not reported by the AAG, a 2008 National Science Foundation (NSF) report indicated that women in full-time tenured or tenure-track positions represented 28 percent of the comprehensive and liberal arts college faculty, whereas at research classified institutions this value drops to 23 percent (Burrelli 2008). Therefore, as the proportion of women in research institutions increases and as more women advance in academic rank, women’s publication and citation rates should also increase (National Academy of Sciences 2007).

Since Cole and Zuckerman (1984) branded the term *productivity puzzle*, much literature has explored the concept of gendered academic publication productivity (Sax et al. 2002) within various disciplines, including social work (Fox and Faver 1985), biochemistry (Long 1992), ecology (Primack and O’Leary 1993),

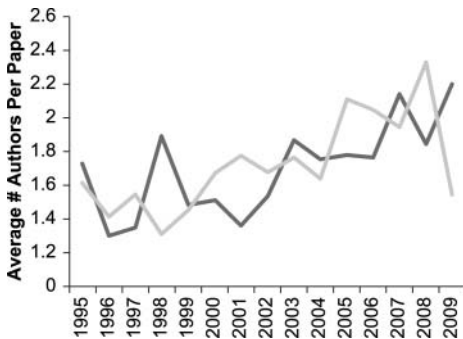


Figure 5 Average number of authors per published article in the *Annals* (dark line) and *PG* (gray line), from 1995 until 2009.

information science (Al-Ghamdi et al. 1998), health education (Ransdell et al. 2000), psychology (Ones and Viswesvaran 2000), and sociology and linguistics (Leahey 2006).

Within the biological and ecological sciences there is an ongoing debate regarding potential gender bias in the manuscript review process (Budden et al. 2008; Webb, O'Hara, and Freckleton 2008; Whittaker 2008; Borsuk et al. 2009; Primack et al. 2009; Ceci and Williams 2011). In particular, Budden et al. (2008) found a significant increase in female first authors with the adoption of double-blind reviews. Furthermore, Wennerås and Wold (1997), in an analysis of peer-review scores for postdoctoral fellowship applications in Sweden, showed that the productivity puzzle not only affected women's careers in the obvious ways but that women had to be 2.2 times more productive in terms of publications to receive merit gains, such as grants, comparable to their male counterparts.

The analyses presented in this article suggest that, within geography, gender differences in authorship, collaboration, and impact (as measured by citations) are present for a broad cross-section of geographic journals. Our analysis showed that males dominated first- and second-author positions for articles published in the *PG* and *Annals*. When the analysis was confined to single-authored articles or the first authorship position, the proportion of women as first authors was slightly higher in the *PG* than in the *Annals*, but women remained underrepresented compared to their male colleagues in these authorship positions that equate to notions of respect and merit in academia (van Praag and van Praag 2004). Similarly, other studies of authorship have found fewer women than men represented in their disciplinary literature, including applied psychology (< 40 percent of articles by women; Ones and Viswesvaran 2000) and criminal justice (women publish approximately half as many articles as men; Stack 2002), and a thirty-five-year (1970–2004) study of the academic medical literature found only 10.3 percent of articles published had a woman as first author from among six prominent journals (Jagsi et al. 2006).

This analysis found that the Nature and Society section within the *Annals* showed the greatest dominance by single-authored males but also the greatest proportion of single-authored

female articles, highlighting a subdisciplinary trend away from collaboration in publication. The Environmental Sciences was the most collaborative of the four subfields, followed closely by the Methods, Models, and GIS field. Interestingly, within Volume 30, Issue 3 of *Pbys. G* (2009), every article had a female lead author.

A trend in academia, generally, is a rise in the level of publication collaboration (Weltzin et al. 2006), as suggested in published reports from a variety of disciplines including economics (van Praag and van Praag 2004) and information sciences (Al-Ghamdi et al. 1998). Over the past several decades, collaboration in publication has risen within both the *Annals* and *PG*, as evidenced by an increase in the number of authors per article. From our analysis, women participate more often in collaborative efforts in certain subdisciplines, such as physical geography, but single-authored articles are the predominant publication format in geography, with the large majority of these articles being written by men. When collaboration did occur, the dominant mode was male–male or female–female, with collaborative articles involving both male and female authors totaling only 17 to 18 percent of published manuscripts in both the *Annals* and *PG*.

Increasing collaboration has the potential to favor women and junior faculty. Al-Ghamdi et al. (1998) found increasing representation of women as authors with increased collaboration in information sciences. Among economists in academia, van Praag and van Praag (2004) suggested that career prospects are better for those who are first authors early in their careers. Leimu and Koricheva (2005a, 2005b) found that increasing the number of authors on a paper within ecology increases the citation rate. Although collaboration in geography appears to be increasing, it remains to be seen whether women will be more frequently listed as first author and whether this will impact longer term career success.

Studies have suggested that although women publish less, women's articles might be cited more than their male colleagues in certain fields (Cole and Zuckerman 1984; Long 1992). Our study did not find this to be in the case for any of the journals examined, with the interesting exception of single-authored articles by women published in *PG*. The authorships of highly cited articles in geography journals mirror

the general authorship trends; that is, single-authored articles, especially those written by men, were cited more than collaborative efforts. In certain journals, however, there was a strikingly low citation rate for female-authored articles, with a stark example of this being the *Transactions of the Institute of British Geographers*.

Lee and Evans (1984) showed that women, as a group, preferred publishing in journals of disciplinary specialization, as they rated journals such as *Arctic and Alpine Research*, *Quaternary Research*, and *Phys. G* more highly than broader disciplinary journals. This is counter to Leahy's (2006) suggestion that women's reduced productivity might be due, in part, to women specializing within their disciplines less than men. Although our data do not directly answer questions of specialization, differences in collaboration according to areas of specialization are suggested, with women and men alike more prone to publishing collaboratively in some geographic specialties compared to others.

Conclusions

This study sought to answer questions relating to women's publication participation in geography and the so-called productivity puzzle. Using fifteen years of authorship and collaboration data compiled from the *Annals*, *PG*, and four representative topical journals, we asked whether there are gender differences in authorship proportion and placement, the frequency of collaboration, and the number of citations across a broad range of prestigious geographic journals. The results from this study show that there are nominal differences in male and female authorship rates and collaboration in the *Annals* and *PG*. Males dominate total authorship and first author on collaborative articles, especially in the *Annals*. Female authorship rates, both singly and as collaborators, mirror female academic membership rates in the AAG, suggesting that some portion of the nominal differences seen are artifacts of the current gender composition of the discipline. There are significant differences in rates of authorship and collaboration by subfield. Single-authored articles by women are more common in journals associated with cultural geography, and women's collaborative efforts are more common in the environmental

and GISciences. Similar to the authorship findings, citation rates were highest for articles either singly or collaboratively authored by males.

Any study is not without limitations. We confined our analysis to a fifteen-year period and to only fifteen journals. For many of the analyses we further confined our examination of the literature to just *PG* and the *Annals*. This might not be sufficient to fully explore the nature of publication productivity in the broad discipline of geography, but it does provide a benchmark for more expansive studies. In particular, we need to establish whether similar differences in authorship and citation exist across all subfields of geography and whether these differences are diminishing as more women are hired into research academic positions and advance in their career. We also need to establish whether geography is following other disciplines in terms of collaboration trends and to what extent women participate in collaborative work as lead or secondary authors.

For the past several decades, considerable research has been directed toward understanding of women and other underrepresented groups in academic careers (Leslie, McClure, and Oaxaca 1998; Sax 2001; Jackson 2002; Rankin and Nielson 2004; Nelson 2005; Bystydziński and Bird 2006; Stewart, Malley, and LaVaque-Manty 2007; Hill, Corbett, and St. Rose 2010). These studies show that within a broad variety of departments, women are less likely than men to collaborate with male faculty or male graduate students and less likely to publish (Fox 2004; Gornick 2009).

As collaboration becomes more the norm in geography and its subfields, academic units will need to confront the question of how authorship position is evaluated in tenure and promotion. Will the culture of our discipline adjust the way in which prestige is allocated (Brunn 1996) as collaboration continues to increase? Geography is not alone in facing this question. Ecology, for example, has proposed publication authorship bylines that detail each person's specific contributions to the paper (Weltzin et al. 2006). Although this might not address any prestige bias accompanying nonlead authorship position, it might alleviate misperceptions of secondary authors as contributing less and therefore encourage more ungendered scholarly exchange. Even today, in a world where

the gaps between men and women are reportedly closing, there are still many barriers for women to overcome if they choose to work in academia (Tripp-Knowles 1995; Hill, Corbett, and St. Rose 2010), including geography. The trends of increasing numbers of authors per article and increasing participation of women in academic geography bode well for increased female publication productivity. ■

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