

The Influence of Author Gender, National Language and Number of Authors on Citation Rate in Ecology

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Abstract: Citation metrics are widely used as a surrogate measure of scientific merit; however, these indices may be sensitive to factors and influences unrelated to merit. We examined citation rates for 5883 articles in relation to number of authors, first author's primary language, and gender. Citation rates were unrelated to primary language and gender but increased with author number. These findings add to a growing body of indirect evidence for potential attitudinal bias in the perceived merit of publications within ecology.

Keywords: Citation rate, ecology, gender, language, publication bias.

INTRODUCTION

Citations are widely considered a measure of scientific success and relative importance of an article and its author (Hamilton 1990). The use of citation metrics in a number of disciplines, including ecology is, however, susceptible to both attitudinal and statistical bias, or influence by factors unrelated to scientific merit (Leimu and Koricheva 2005a). Contrary to an attitudinal bias present within the scientific process in which male-authored articles receive higher quality ratings as compared to those of women (Lloyd 1990), there has been no evidence of either gender being differentially cited in ecology (Leimu and Koricheva 2005a). There is also a generally higher citation rate for authors from the United States as opposed to those from other countries (Leimu and Koricheva 2005a, Link 1998). In addition to country, language of origin may be a source of attitudinal bias. Most published articles are from countries where English is the national language, though it is unknown whether this is due to higher submission rates, a publishing preference or the added inconvenience of translation (Tregenza 2002). Further, it has been shown that citation rates in ecology increase with number of authors (Leimu and Koricheva 2005a, Leimu and Koricheva 2005b). These factors may not be related to the actual merit or quality of articles, and therefore a visibility bias in some form remains a plausible explanation for disparities in citation rates. Bias can lead to misrepresentation of the importance of ideas,

research programs, or individuals when inferring scientific value.

In this paper, we examine variation in citation rates by first author's gender; by the language of the host institution, delineated as English national language or other; and by the number of authors. Similar hypotheses have been previously addressed; however, we are testing these trends on a much larger scale. In an earlier study, data included 228 articles (Leimu and Koricheva 2005a) whereas we present data from 5883 articles, taken from a subset of ecology journals across seven years. We test the null hypotheses that there is no effect of the following on citation rates: (i) first author gender, (ii) first author national language, and (iii) number of authors.

METHODS

Data Collection

Six journals were selected for this study: Animal Behaviour, Behavioral Ecology, Behavioral Ecology and Sociobiology, Biological Conservation, Journal of Biogeography, and Landscape Ecology. These journals were selected on the basis of the following criteria: ISI listed as 'ecology', an impact factor in 2004 between 2 and 2.5 (to control for differences in perception of journals), and availability of online tables of contents extending to 1997 listing author first names.

Data were collected from 1997 to 2004. For each article, we recorded the number of authors, author names, year of publication, first author's country of host institution, and annual number of citations in the year of publication and two

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years following. Articles published in 2001 were not included as one of our journals (*Behavioral Ecology*) implemented a change to its review policy in this year. Data were obtained using journal contents pages and ISI citation reports. For each first author, we assigned gender on the basis of first name (protocol and designations of Budden *et al.* (2008)), designating each author as female, male, unknown (gender could not be unambiguously determined from the first name), or initials (only initials were provided). There have been no differences found between in terms of tendency towards using initials to publish (Borsuk *et al.* 2008, Tregenza 2002).

Not all of the publications included in the tables of contents were listed by the ISI citation database and some were therefore removed. In addition, editorials, errata, reviews, correspondences, and miscellany were also removed. Citation rates for each article were calculated as the sum of the citations received during the year of publication and two years following publication (*sensu* Leimu and Koricheva (2005a)).

Our final dataset had a total of 5883 articles. The first author's country of host institution was categorized according to national language (United Nations Educational, Scientific and Cultural Organization 2000). 'English' was assigned to a country if it was included as one of its national languages and all other countries were categorized as 'Other'. We recognize that this classification may not accurately characterize individuals publishing from within an institution outside of their native country. In addition to including number of authors as a continuous variable, in some analyses, we also divided the number of authors into four categories; one, two, three, and four or more authors (*sensu* Tregenza (2002), Leimu and Koricheva (2005a)).

Statistical Analyses

Chi-square statistics were used to test whether the distribution of respondents varied significantly by gender, author number category, and national language. Authors identified by their initials and those of unknown gender were not included in the chi-square analysis as there was no preset

expected frequency. A general linear model (GLM) was used to test effects of first author gender, national language, and author number category on citation rates. Journal identity was included as a variable. Although similar journals were selected according to the pre-determined criteria, variation in journal citations existed nonetheless. We further explored the relationship between citation rate and number of authors using regression analysis. In all cases alpha was set at 0.05, tests were two-tailed, and data met the requirements for parametric analysis. Tukey post hoc tests were done when a significant main effect was detected. SPSS version 16 and JMP version 5 were used (JMP 2004, SPSS 2007).

RESULTS

Author Demographics

There were significantly more male first authors than females ($\chi^2_1=706.079$, $p<0.0001$). Males were first authors in 53.3% (3136) of all publications, females in 23.4% (1375), authors with initials in 13.3% (781) and authors of unknown gender in 10% (591). There were significantly more articles by authors with English as a national language ($\chi^2_1=496.538$, $p<0.0001$; 64%, 3790 publications). Finally, quantity of articles produced by each category of number of authors varied significantly from the expected equal distribution ($\chi^2_3=341.398$, $p<0.0001$; 1 author 18%, 2 authors 35%, 3 authors 25%, 4+ authors 22%).

Citation Rates

There were no significant differences in citation rates by first-author gender ($F_{3,5839}=2.050$, $p=0.105$) or first-author language ($F_{1,5839}=0.127$, $p=0.721$). But articles differed in citation rate depending on the number of authors ($F_{3,5839}=18.015$, $p<0.001$). Post-hoc test showed that articles written by four or more authors were more highly cited than articles with one, two, or three authors (Fig. 1). Regression of mean citation rate for each number of authors was significant and best fit by a linear model ($r^2=0.331$, $p=0.005$; Fig. 2). Citation rates also varied according to journal identity ($F_{5,5839}=9.081$, $p<0.001$).

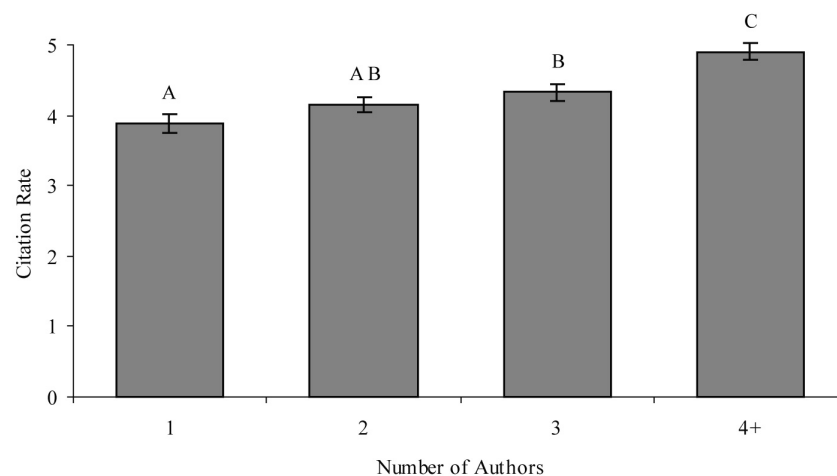


Fig. (1). Mean (\pm SE) citation rates for papers with 1 ($n=1061$), 2 ($n=2043$), 3 ($n=1461$) and ≥ 4 ($n=1318$) authors. Means that do not share the same letter above bars are significantly different ($p<0.05$) according to tukey post hoc analysis.

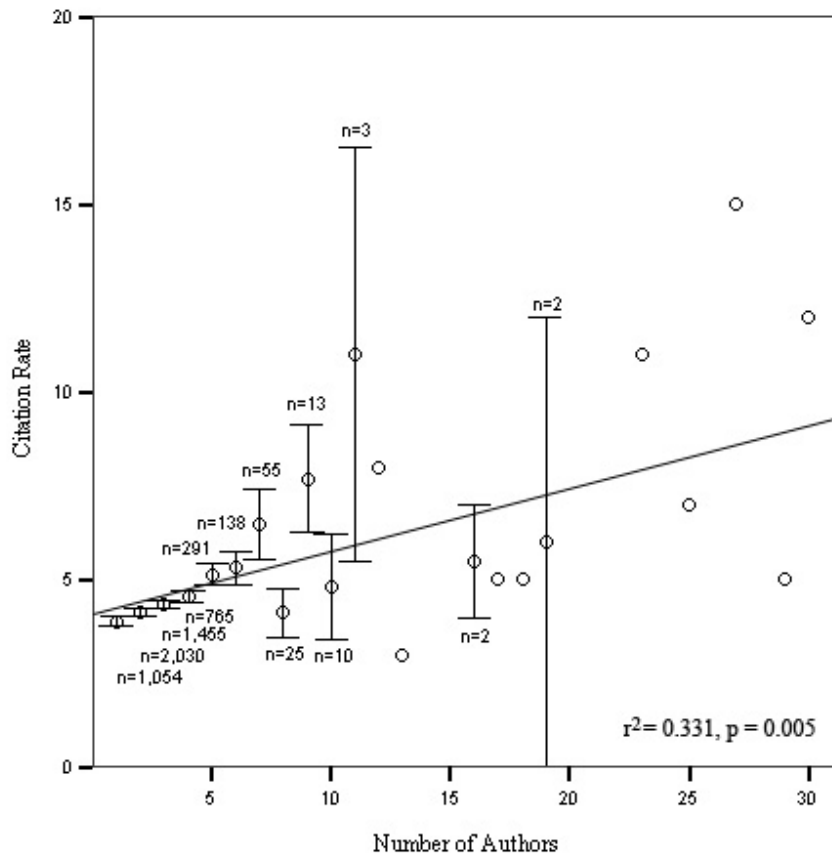


Fig. (2). Linear regression of mean citation rate for each number of authors ($y = 0.196x + 3.910$).

DISCUSSION

Publication bias refers to the potential for some studies to be subject to assessment based on attributes other than the scientific merit of the article in question (Lortie *et al.* 2007, Paludi and Bauer 1983, Tregenza 2002). In this paper, we tested the null hypotheses that citation rates are not affected by first author gender, first author national language and number of authors. We detected no statistical bias by gender and language, but a significant difference by number of authors. This does not necessarily deny the existence of attitudinal bias, as if present, they may counteract each other and thus become much more difficult to detect.

The number of publishing males in this ecological data set was significantly greater than female authors. Consistent with our null hypothesis, there were no significant differences in citation rates between male authors, female authors, authors of unknown gender and those identified by their initials. This may be partially attributable to the higher proportion of women working in the ecological field as compared to other scientific disciplines such as physics or mathematics (National Science Foundation 2006), in conjunction with the attitudes within these fields associated with individuals of each gender. These results suggest that author gender does not play a significant role in researchers' decisions on which literature to cite in ecology.

Approximately 64% of articles were from authors emerging from countries with English as a national language. This discrepancy may be produced by a difference in submission rates; we were unable to assess this possibility in the present study, but future work should evaluate the role of submission rates. The greater number of publications from English-speaking countries is also consistent with previous findings which showed that articles written by authors from native English speaking countries were more likely to be accepted for publication (Tregenza 2002). Standard journal policies create pressure for authors whose primary language is not English to write articles in English (Bakewell 1992, Egger *et al.* 1997, Tregenza 2002). These authors may have more difficulties writing in a language other than their first. However, despite the obstacles associated with publishing in English language journals encountered by non English speakers, the citation rate between probable native and non-native English speakers did not differ.

We found a significant increase in citation rates with number of authors, which suggests that the number of authors is an important attribute of a publication. There are several possible explanations for this. Previous studies have similarly found that articles with four or more authors were both more likely to be accepted and cited (Leimu and Koricheva 2005a, Tregenza 2002). As the number of authors increases, opportunities for self-citations concomitantly

increase (Hamilton 1990); and it is also known in ecology that along with the increase of self-citations, there is a parallel increase in external citations (Leimu and Koricheva 2005b). An increase in citation rate with number of authors can reflect (1) an overall positive effect of collaboration on quality or scientific merit of an article, perhaps due to additional editing or a greater diversity in experience and background of study authors, or (2) that the community perceives greater merit for an article when there are more authors listed, i.e. 'they can't all be wrong'. Furthermore, it is likely that with more authors, there is a greater network of colleagues who may cite the paper because of familiarity with an author (Fisher *et al.* 1994). Therefore, the contribution of multiple authors in the composition of a manuscript may serve to increase the quality and recognition of an article and thus increase its potential to accrue citations.

CONCLUSIONS

Primary language and gender of first author had no effect on the citation rate of ecological articles, suggesting scientists may not consider author attributes when citing research. Citation rates did however increase with higher number of authors, either (1) because articles authored by numerous individuals legitimately command a higher level of credibility, (2) because multi-authored articles may be more prone to self-citations, or (3) because of a higher probability that others publishing ecological work may be familiar with one or more of the additional authors. These latter implications suggest that scientists' opinions may be influenced by external factors; however, collaboration may provide many research benefits, including the potential to improve a manuscript and increase its rate of citation.

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REFERENCES

- Bakewell, D (1992) French research - publish in English, or perish. *Nature*, 356, 648.
- Borsuk, RM (2008) The Peer Review System in Ecology. Master's Thesis. York University, Toronto, ON.
- Budden, AE, Tregenza, T, Aarson, LW, Koricheva, J, Leimu, R & Lortie, CJ (2008) Double-blind review favours increased representation of female authors. *TRENDS in Ecology & Evolution*, 23, 4-6.
- Egger, M, Zellweger-Zöhner, T, Schneider, M, Junker, C, Lengeler, C & Antes, G (1997) Language bias in randomised controlled trials published in English and German. *Lancet*, 350, 326-329.
- Fisher, M, Friedman, SB & Strauss, B (1994) The effects of blinding on acceptance of research papers by peer-review. *Journal of the American Medical Association*, 272, 143-146.
- Hamilton, DP (1990) Publishing by - and for? - the numbers. *Science*, 250, 1331-1332.
- JMP The Statistical Discovery Software 5.1.1. (2004) SAS Institute, Cary, USA.
- Leimu, R & Koricheva, J (2005a) What determines the citation frequency of ecological papers? *TRENDS in Ecology & Evolution*, 20, 28-32.
- Leimu, R & Koricheva, J (2005b) Does scientific collaboration increase the impact of ecological articles? *BioScience*, 55, 438-443.
- Link, AM (1998) US and non-US submissions - an analysis of reviewer bias. *Journal of the American Medical Association*, 280, 246-247.
- Lloyd, ME (1990) Gender factors in reviewer recommendations for manuscript publication. *Journal of Applied Behavior Analysis*, 23, 539-543.
- Lortie, CJ, Aarssen, LW, Budden, AE, Koricheva, JK, Leimu, R & Tregenza, T (2007) Publication bias and merit in ecology. *Oikos*, 116, 1247-1253.
- National Science Foundation (2006) Doctorates awarded to women, by field of study: 1996-2005.
- Paludi, MA & Bauer, WD (1983) Goldberg revisited - what's in an author's name. *Sex Roles*, 9, 387-390.
- Statistical Package for Social Sciences 16.0.1. (2007) SPSS Inc, Chicago, USA.
- Tregenza, T (2002) Gender bias in the refereeing process? *TRENDS in Ecology & Evolution*, 17, 349-350.
- United Nations Educational, Scientific and Cultural Organization (2000) World Cultural Report. Cultural Practices and Heritage - Leading Languages.

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