



Two decades of data reveal that Biological Invasions needs to increase participation beyond North America, Europe, and Australasia

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Abstract Most published papers in ecology come from a handful of countries, and invasion science as an ecological subdiscipline is no exception. Based on the country of corresponding authors, we analyzed patterns in submissions, reviews, and publications in the journal *Biological Invasions* from its first issue in 1999 to 2020. Regionally, North America, Europe, and Australasia submitted and published the most articles during this period and supplied most reviewers and journal editors. As a country, the USA stands out in

terms of papers published and reviewers involved in the process. The dominance of published articles from USA-based scientists declined through time, but such articles still constitute one-third of all articles in recent years. However, as biological invasions are a worldwide phenomenon acting on local to global scales, research from all regions of the world is needed to better understand and manage invasions. By tracking and reporting the trends in the countries of origin of the journal's authors and reviewers, and by encouraging

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submissions from more countries, we hope that geographical differences will decrease and that a more global understanding of biological invasions will emerge.

Keywords Diversity · Bias · Inclusiveness · Global science

Introduction

Recent studies in ecology and related disciplines show that researchers from a handful of countries publish the majority of scientific articles, while publications from many regions of the world are poorly represented in international journals (Martin et al. 2012; Lowry et al. 2013; Mammides et al. 2016; Manlove and Belou 2018; Nuñez et al. 2019; Maas et al. 2021). This skewed geographic distribution of international journal publications has many causes often related to socio-economic factors (Barlow et al. 2018) but is also due to language barriers (Amano and Sutherland 2013; Amano et al. 2016). As a consequence, we lack adequate knowledge of a significant number of regions, thereby limiting our understanding of ecological problems and potential solutions. Our scientific disciplines and management approaches are further impoverished because they often do not include the perspectives and insights of researchers and managers who may view the world through different lenses.

The recent report on invasions in Antarctica (*e.g.*, Hughes et al. 2020) made evident that no area of the planet is free from risk of invasion. Geographical disparity in the peer-reviewed literature can deeply affect our understanding of invasions. Are the tropics indeed less invaded, as has often been asserted (*cf.* Chong et al. 2021), or are tropical invasions simply underrepresented in the literature? What are the main drivers of invasions, and can this question be answered without a more geographically balanced global literature? Which traits facilitate plant invasions and do these vary geographically? Are there fewer invasive species in central Africa relative to central Europe? We may attempt to answer such questions, but without solid global knowledge and data, our answers are at most tentative, and in some cases, possibly wrong.

The geographical disparity in publications of leading journals is a problem not only for

understanding but also for managing invasive species. For a thorough understanding of the phenomena that will help to inform management in both donor and recipient countries, we need a holistic understanding of the process. An incomplete geographic view of biological invasions can have serious consequences for how researchers understand invasions and how practitioners and policymakers address this urgent topic (Nagendra 2018). In particular, resistance or vulnerability to invasion varies by taxa, biotic and abiotic conditions of the recipient ecosystem (including extant invasions), and economic and cultural factors. Therefore, different regions may require different prevention and management approaches based on the respective invasive species, ecosystem type, available resources, and available expertise (Nuñez and Pauchard 2010). Tools for proper management and real economic costs can be missed if knowledge from some regions is neglected, particularly owing to language barriers (Nagendra 2018; Angulo et al. 2021).

Here, we analyzed the geographical distribution of corresponding authors and invited reviewers in *Biological Invasions* by country of institutional affiliation. One goal is to highlight the distribution of countries from which papers are being submitted and published and the pool from which reviewers are being drawn. A second goal, also shared by Kuebbing et al. (2021), which focuses on the *Biological Invasions* editorial board demography, is to identify potential geographic disparities in the review and publication process in order to reduce regional and country-level disparities in *Biological Invasions*. The main goals of this analysis are to add transparency to the publication process of the journal and to attract more submissions from countries that are poorly represented in the journal to expand global coverage and enrich invasion science overall.

Methods

Springer-Nature provided us with the following information from two databases. One database recorded corresponding authors and the other recorded reviewers. Below we explain in detail both databases.

Author database

Querying the author database for *Biological Invasions*, we analyzed geographical patterns of manuscript submission (2003–2020) and articles accepted (1999–2020) in the journal *Biological Invasions* using the countries of the institutional affiliation of the corresponding author. We focused on corresponding authors in order to streamline and focus our analysis. While we recognize that this approach ignores international collaborations on many papers, Springer maintains a database of corresponding authors only, not all authors. Data on submissions were unavailable before 2003 because the journal was published by Kluwer prior to this time and records were not transferred when Springer became the publisher in 2003.

Reviewer database

We investigated the geographic locations of reviewer invitations and acceptances using data from all reviewer invitations and acceptances for *Biological Invasions* from 2003 to 2020. As for author data (above), *Biological Invasions* was published by Kluwer prior to 2003, after which Springer became the publisher. No records of reviewers were available prior to 2003.

Analysis

We built cartograms to illustrate geographic differences of manuscript submissions and acceptances to *Biological Invasions*, as well as the number of reviewers *per* country. The numbers of submissions, acceptances, and reviewers *per* country were used to distort country land areas using the ‘Cartogram’ package (Jeworutzki 2016). To account for population size and facilitate drawing comparisons among countries, we normalized our data and built cartograms of manuscript submissions and acceptances, and reviewers *per* million inhabitants. We calculated rates *per* million inhabitants as follows:

$$\frac{\text{Number of articles}}{\text{Estimated country population}} * 1000000.$$

We used population size and the list of countries of the World Bank (UNESCO Institute for Statistics 2018). To analyze temporal changes, we calculated the annual total numbers of manuscripts and countries of

corresponding author’s affiliation for both submitted and accepted articles. Temporal changes could not be analyzed for the reviewer database owing to a lack of annual information.

Results

Manuscript submissions and acceptances

Overall, *Biological Invasions* has published 3478 articles since 1999. From 2003 to 2020, *Biological Invasions* received a total of 9838 submissions, of which 3339 were accepted, corresponding to an overall acceptance rate of 34%. On a continental scale and over the 22-year period analyzed, *Biological Invasions* received the most manuscripts from North America ($n = 3208$), followed by Europe ($n = 2852$) (Fig. 1a, Table 1). The next highest numbers of submissions originated from Asia ($n = 1479$), Latin America (including the Caribbean) ($n = 1068$) and Australasia ($n = 783$), while the fewest came from Africa ($n = 356$) and Pacific Islands ($n = 21$). Rates of manuscript acceptance for publication were higher for submissions from North America (49%) and Australasia (45%), followed by Europe (34%), while rates were around 25% for all other regions. However, when population size by country is considered, the numbers of submissions and acceptances *per* million inhabitants show a somewhat different pattern (Fig. 1b). In the cartograms country sizes are represented in relation to their number of submissions and acceptances. North America, particularly the USA, recedes in dominance and New Zealand and Australia gain importance owing to the high number of articles published and relatively low population sizes (Fig. 1b).

On a national scale, submissions were dominated by the USA ($n = 2694$) (Fig. 1). The second-largest number of submissions, four times lower, was from China ($n = 615$) followed by Australia (560), Brazil (513), Spain (496), Canada (369), and UK (330) (Table 2). Manuscript acceptance rates were highest for New Zealand, Sweden, Switzerland, and the USA. Interestingly, ten of the twelve countries with acceptance rates of at least 40% are countries with English as a first language or Scandinavian countries known to have a high level of English proficiency among their populations. Switzerland and the Czech Republic were

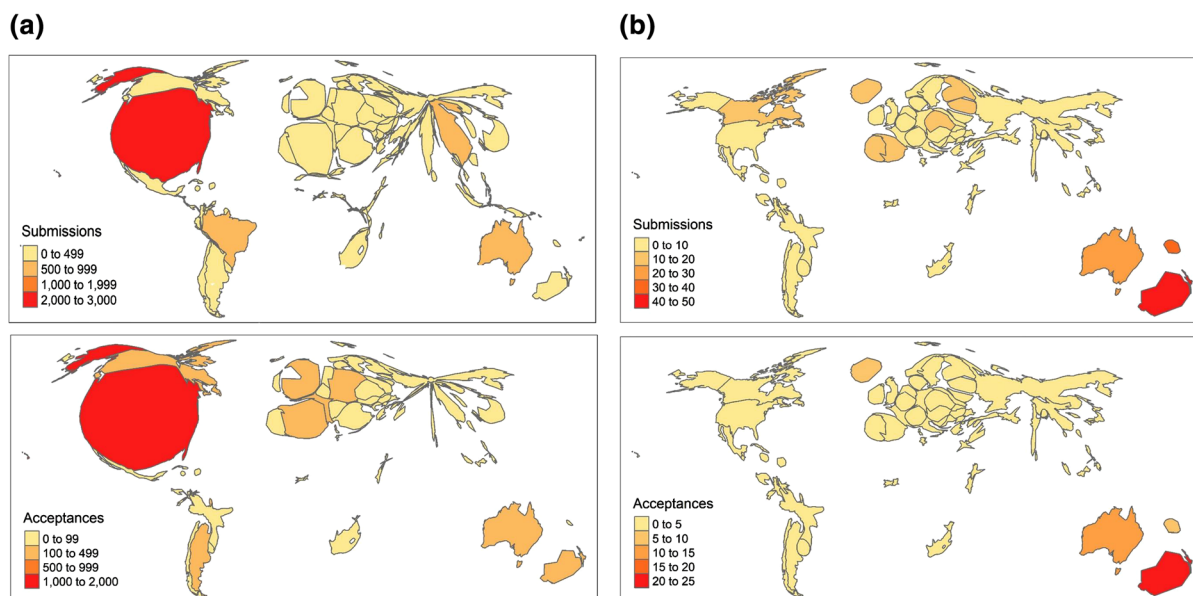


Fig. 1 **a** Cartograms showing distorted land area of countries based on their contributions of submissions (top panel) and acceptances (bottom panel) to the journal *Biological Invasions*. We used the corresponding author's country of institutional affiliation for articles received between 2003 and 2020 and

articles accepted between 1999 and 2020. **b** Cartograms with resized land area based on numbers of papers submitted and accepted *per million inhabitants* in each country to the journal *Biological Invasions* from 1999 to 2020

Table 1 Number of submitted articles, accepted articles, and invited and accepted reviewers from 2003 to 2020 for continental regions

Region	Submitted articles	Accepted articles	Acceptance rates	Invited reviewers	Accepted reviewers	Rate of acceptance
Africa	356	93	0.26	718	389	0.54
Asia	1479	232	0.16	688	355	0.52
Australasia	783	347	0.44	2461	1456	0.59
Europe	2858	946	0.33	6625	3775	0.57
North America	3208	1466	0.46	13,608	7752	0.57
Pacific Islands	21	5	0.24	0	0	0
South America	1068	245	0.23	1176	629	0.53

the other two countries with an acceptance rate of 40% or more.

Based on the institutional affiliation of the corresponding authors, the journal received submissions from 132 countries and published articles from 76 countries. Because there are 195 countries worldwide as defined in our database, this means that based on corresponding authors alone, researchers from 32% of

all countries have never submitted a manuscript to the journal during this period, and researchers from 61% of countries have not published a single article in *Biological Invasions*. Corresponding authors from only five countries (USA, China, Australia, Spain, and Brazil) submitted 50% of the published articles, and corresponding authors from three countries (USA, Australia, and Canada) published 51% of all papers

Table 2 Number of submitted articles, accepted articles, and invited and accepted reviewers during the period of 2003 to 2020 for the top twenty countries with the most submitted articles

Country	Submitted articles	Accepted articles	Acceptance rates	Invited reviewers	Accepted reviewers	Rate of acceptance
United States	2694	1276	0.47	12,205	6884	0.56
China	615	93	0.15	302	159	0.53
Australia	560	235	0.42	1599	908	0.57
Brazil	513	80	0.16	359	175	0.49
Spain	496	158	0.32	743	372	0.5
Canada	369	165	0.45	1314	821	0.62
United Kingdom	330	133	0.4	1347	824	0.61
Italy	317	87	0.27	491	284	0.58
Argentina	310	104	0.34	589	322	0.55
Germany	293	110	0.38	773	414	0.54
France	275	101	0.37	820	498	0.61
India	251	14	0.06	61	34	0.56
New Zealand	223	112	0.5	862	548	0.64
South Africa	219	77	0.35	718	389	0.54
Japan	210	59	0.28	160	79	0.49
Poland	159	22	0.14	113	66	0.58
Portugal	154	50	0.32	264	140	0.53
Mexico	145	25	0.17	89	47	0.53
Chile	133	33	0.25	221	130	0.59
Czechia	120	48	0.4	319	182	0.57

(Fig. 1a, b). When one accounts for population size, New Zealand, American Samoa, Australia, and Switzerland become the leaders (highest number of papers published per capita). However, acceptance rates also vary widely by country and region, ranging from 49% in North America to 5% in Pacific Islands (Tables 1, 2).

Biological Invasions received an increasing number of submissions following 2004 with a particularly steep (265%) increase in submissions between 2006 and 2011 (Fig. 2). Likewise, the number of accepted articles rose, although at a lower rate (144%), from 2006 to 2011. Although the number of submissions plateaued after 2011, the number of countries of first author's affiliation has increased continuously until the present. However, for accepted manuscripts, the number of countries remained rather constant since 2011 at around 34 countries of corresponding author's affiliation on average. The proportion of papers submitted from the USA seems to be fairly constant

over time while acceptances show a decline, especially from 1999 to 2009.

Manuscript reviews

By far, most invitations were sent to reviewers from North America (Fig. 3, Table 1), while European researchers received only half as many, and still fewer were sent to reviewers from other regions. The rate of acceptances of reviewer invitations was surprisingly constant around 50–60% across all regions. In line with submissions, by far most reviewers were invited from the United States (47% of all invited reviewers), while for Australia, United Kingdom, and Canada rates were 6–7%, and for other countries the number of invited reviewers was below 5%. When one accounts for population size, New Zealand, American Samoa, and Australia had the highest number of reviewer invitations (17%, 10% and 6% of all invited reviewers normalized by population sizes, respectively).

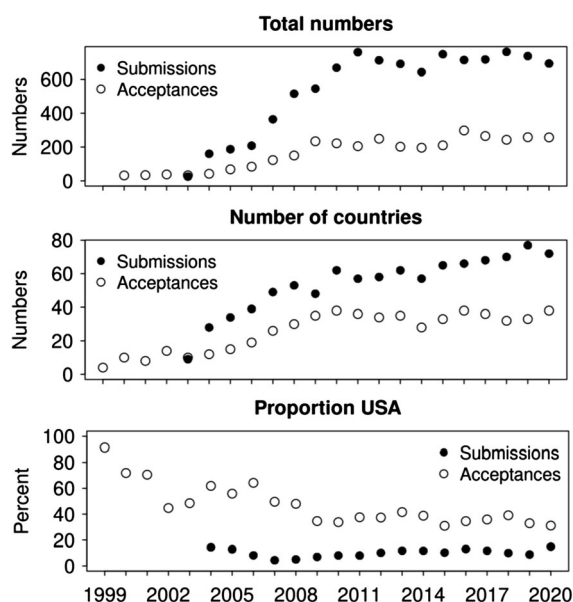


Fig. 2 Time series of total numbers of articles, numbers of countries, and proportion of articles of corresponding authors with affiliation in the USA. All data are shown for submitted articles (2003–2020) and accepted articles (1999–2020)

Discussion

Not surprisingly, most papers published in *Biological Invasions* have corresponding authors from a small subset of countries in North America, Europe, and Australasia. While multiple factors may contribute to this outcome, these results suggest that this journal does not fully represent invasion science. This situation is not unique to *Biological Invasions* but also occurs in other ecological sciences (Martin et al. 2012; Nuñez et al. 2019, 2021).

The large number of publications from corresponding authors located in North America, Europe, and Australasia is driven largely by the number of submissions received by *Biological Invasions*. Through time, the numbers of countries with submissions and acceptances are increasing, but acceptances lag behind submissions (Fig. 2), and the acceptance rate varies substantially among countries. The reasons for the geographic disparity in submissions are manifold, including challenges associated with publishing in English for authors from non-anglophone countries, national population sizes, financial support of ecological research, and interest in and support of scientific publications, among others. While no single journal can solve all these problems, *Biological Invasions* can

take steps to begin to ameliorate some of them, and in fact, some of these efforts are already underway. For example, results of this analysis were shared with the *Biological Invasions* Editorial Board to make them aware of countries and regions that have published few or no papers in the journal, and editors were encouraged to give this pattern particular consideration. This does not mean that submissions of countries underrepresented in the journal should be accepted more readily, as the scientific rigor employed in assessing the scientific quality of studies should be the same for all submissions.

The number of reviewers from North America was significantly higher than those from other regions (Fig. 3). Reviewer invitations and reviews completed manifested even stronger patterns, with the most invitations by far sent to USA researchers (47%). This is potentially problematic, since reviewers might lack relevant regional expertise and having uneven geographical representation in the reviewer pool might also affect acceptance rates of different regions. Submissions from the USA have the highest acceptance rates after New Zealand (Table 2), but a deeper dive into the data is necessary to test whether or not the reviewer pool determines which papers are published. Interestingly, the proportion of articles published by researchers based in the USA declined continuously throughout the study period (Fig. 3). Although the proportion remains high, it indicates an increasing diversity of corresponding authors' affiliations. Nonetheless, a more uniform global distribution of reviewers is still an important next step.

Many factors can be driving these geographic disparities. The number of accepted reviewer invitations seems not to vary much among regions (See Fig. 3 and Table 1), suggesting a global interest by researchers in the topic of biological invasions. The disparity in reviewer invitations may simply follow the patterns seen by Kuebbing et al. (2021), where the numbers of editors (and therefore their interaction networks) are heavily weighted towards anglophone nations or those nations where the majority of the population has strong English language skills.

Addressing the issues

Some solutions are beyond the scientific community and this journal, such as allocating budgets to scientific research in a given country or increasing access to English language training. However, we can take

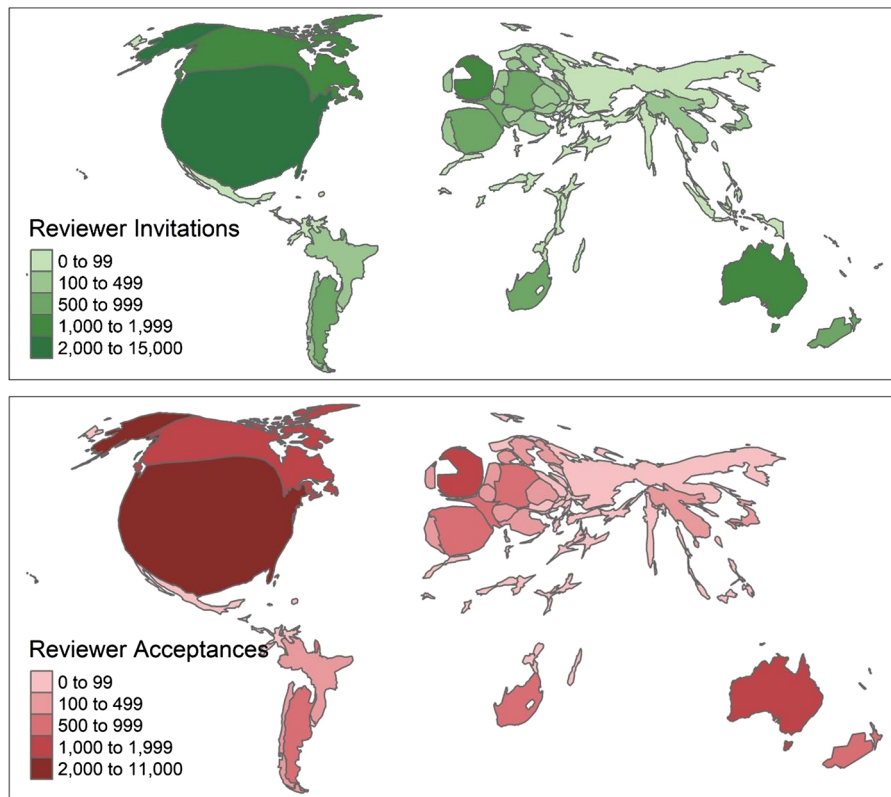


Fig. 3 Cartograms with resized land area based on reviewer invitations (top panel) and accepted reviews (bottom panel) *per country* to the journal *Biological Invasions*. Data included all reviewers for *Biological Invasions* from 2003 to 2020

several steps at *Biological Invasions* to address some of these disparities. Below we describe the journal's efforts on different fronts including *diversifying the editorial board*, *diversifying reviewers*, *increasing outreach to unrepresented regions*, and *continued transparency*.

Editorial Board

At *Biological Invasions* we have assessed geographic representation on our Editorial Board (Kuebbing et al. 2021) and are taking steps to increase its breadth by identifying and inviting expert researchers from outside of North America and Europe to become Associate Editors. Wider representation on the board may yield different assessments of the novelty and quality of articles submitted to the journal, and it will further diversify our reviewer pool. We believe that maintaining our standards is fundamental and fair for all authors and will in no way preclude increasing diversity. In fact, diversifying the editorial board of *Biological Invasions* is likely to help us to understand in greater

detail what is important or interesting to authors from other regions. We see this benefit as particularly important, because views on what is interesting or important are unlikely to be universal. Recognizing the added burden many international researchers face owing to the requirement of publishing in English, the journal has recently clarified its policies to Associate Editors and reviewers that manuscripts should not be rejected solely based on language issues.

Diversifying reviewers

The high percentage of reviewers (nearly half) from the United States is troubling. There is, of course, a large community of researchers outside of the United States that is fully capable of reviewing manuscripts for *Biological Invasions*. While language barriers may exist among some potential reviewers, the dominance of the USA is unwarranted given the number of submissions the journal receives from outside the USA, the large number of other anglophone countries

globally, and the diversity of our editorial board (see Kuebbing et al. 2021). The journal will take steps to increase reviewer diversity through ongoing discussions at editorial board meetings.

Conclusions

Not surprisingly, this analysis shows strong geographical disparities. However, we note that our analysis included only corresponding authors and not all authors listed on every submitted and published paper. Therefore, our results present an accurate but incomplete picture. Nonetheless, Springer will publish statistics on the country of affiliation for authors and reviewers in their annual reports for *Biological Invasions* to track progress and maintain transparency. Other journals focused on invasions, such as *Neobiota*, *Invasive Plant Science and Management*, and *BioInvasion Records*, might consider conducting similar analyses to investigate whether or not similar patterns are observed. We hope our analyses will stimulate discussions in both *Biological Invasions* and other journals.

Our analysis of the journal *Biological Invasions* shows the patterns seen in other areas of ecology: a limited set of countries generate most published articles in our pages. This disparity limits our understanding of global phenomena and is likely limiting our understanding of processes and solutions. There is an urgent need for solutions in the field of invasion biology, and we believe that making our science more global will aid this search.

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Availability of data and materials Data are available from the corresponding author on reasonable request.

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