Are Latin American ecologists recognized at the world level? A global comparison

Jaime R. Rau* and Fabian M. Jaksic

Abstract

Background: Ioannidis et al. (2020) reported a standardized estimate of scientific productivity obtained from a worldwide database of 6,880,389 scientists who published at least 5 papers picked up by the Scopus database, and elaborated a ranking of ca. 120,000 scientists by both whole trajectory (career-long) impact and their current impact at year 2019. The goal of our paper is to contextualize Latin American ecologists’ contribution at the world level based on the four most scientifically productive countries in the region.

Methods and findings: Ioannidis et al. (2020) proposed a composite index that is the sum of six scientometric indicators: (1) The number of allocites, (2) the $h$ index, (3) a per capita corrected version of $h$, (4) the allocites received as single author, (5) those received as single + first author, and (6) those as single + first + last author. We selected data for ecologists from Argentina, Brazil, Chile, and Mexico and comparatively analyzed their productivity according to the proposed index. We also compared these data with those obtained from a global sample of the top ecologists worldwide.

Conclusions: Based on Ioannidis et al.’s proposition to evaluate scientific productivity we extract three lessons: (1) It does not pay to publish many papers; what counts is the number of allocites (i.e., self-citations do not add up). (2) Either be single, first, or last author; it does not pay to be in the middle of an authorship line. (3) Even worse it is to be among many co-authors because the proposed index allocates credits on a per capita basis.

Keywords: Productivity, Scientometrics, Ioannidis index, Allocites, Self-citation, Brazil, Mexico, Argentina, Chile
Latin American ecologists’ contribution at the global level, thus possibly aiding public-policy decision-making, including categorization, prioritization, and financing of research and researchers.

Methods
To obtain their metrics, Ioannidis et al. [3] used a composite index that is the sum of the decimal logarithms of six scientometric indicators that include: (1) The number of allocites (NC, cites excluding self-citation); (2) the h index (H, Hirsch 2005, 2007); (3) a corrected version of it (Hm, [4]); it is H based on a fractionalized counting of papers according to the number of co-authors; (4) the allocites received by quality of authorship as single author (NCS); (5) those received as single + first author (NCSF); and (6) those as single + first + last author (NCSFL).

The formula to calculate the composite indicator for career-long impact or single-year (2019) impact is obtained by summing the ratio of log of 1 + the indicator value over the maximum of those indicator logs for the 6 indicators (see [3] for details). All summands are equally weighted (= 1). Notice that total production of papers is not an addend in this formula, that total citations received contribute to the H and Hm personal indices indirectly, and directly to the three NC’s --but only if they are received as single, first, or last author of a paper. Authors with only co-authorships, not leading or trailing an authorship line, will add zero in these three summands (= log of 1).

Allocites are quotations that other authors make about the work of a specific author [5]. To find out the identity and productivity of the ecologists of the currently four most productive Latin American countries, we filtered the Excel spreadsheets of Tables S-6 and S-7 of Ioannidis et al. [3], first by country, and then by discipline (Biology) and sub-disciplines. We used only the term “Ecology” as the sub-discipline of interest. For comparative purposes, we used information from those two tables to build a global sample of the most productive ecologists in the world, with sample size set up by the largest and most populous Latin American country, Brazil.

Results
The list of ecologists and their scientometric parameters (position in the whole trajectory rank, No. allocites, No. papers) with institutional addresses in any of the four most scientifically productive Latin American countries is in Table 1. Also shown are those ecologists from the developed world that rank highest in a global sample of 16 scientists, equivalent to the largest Latin American country sample. Specifically, Brazil was represented by 16 ecologists (one female), followed by 9 from Chile (no females), 8 from Argentina (two females), and 3 from Mexico (one female). In the global sample, 9 were from the US, 6 from the EU, and one from Singapore (no females were represented).

Ranges of the three scientometric parameters show (Table 2) that Brazil rankings start at position 3000, Argentina at 16,000, Chile at 20,000, and Mexico at 30,000. They all end at about position 110,000. The broadest range in allocites is found in Chile and the narrowest in Mexico. Brazil is the country that published the most papers, followed by Chile. In the global sample, about 1000 papers were published.

Using data from Table 1, coefficients of variation, CV (%), were generated for each parameter and shown in Table 3. Brazil and the global sample yielded the lowest CVs in ranking, while Chile and Argentina showed higher variability in No. allocites and No. papers.

Table 4 presents the same scientometric parameters as in Table 1, but this time for 2019 only. In this case, the global sample is made up of 31 ecologists (those found in the largest Latin country sample, Brazil). Among the Brazilians, only three are females. Argentina yields 13 ecologists (two females), followed by Chile with 10 (no females), and Mexico with 6 (one female). The global sample yielded only one female among the 31 ecologists: 12 of these from the US, 9 from the EU, 5 from Australia, 4 from Canada, and 1 from New Zealand. Although there are relatively fewer US ecologists in this sample as compared to the Career-long sample of 16 ecologists (Table 1), there was no significant difference in frequencies between them (Chi-square = 0.252; P = 0.355).

Ranges of the three scientometric parameters show (Table 5) that Brazil comes first in single-year (2019) ranking, followed by Argentina. Broadest ranges of allocites are found in the global sample, from 1000 to 10,000 while the four Latin American countries are rather homogenous among them. No. papers ranged 100 to 1000 globally while Latin American countries were less variable in this respect.

Coefficients of variation for each single-year parameter are shown in Table 6. Chile yielded the lowest and Mexico the highest CVs in 2019-ranking. CV for No. allocites was narrowest in Brazil and broadest in Mexico, exactly the opposite for CV in No. papers. No pattern was detected for CVs in the global sample.

By comparing Tables 1 and 4 it is evident that the number of researchers increased, with new names added in 2019 that were not detected in the whole-trajectory ranking, and with some career-long researchers disappearing from the 2019 parameter estimates. In Brazil, 15 new ecologists were detected while one long-career disappeared. In Mexico, four were added and one disappeared; in Argentina, five new with none disappearing.
Table 1 Whole trajectory (Career-long) impact ranking of Latin American ecologists, No. allocites, and No. papers in the Scopus database, based on Table S-6, Career-long ranking, by Ioannidis et al. [3]. Here and elsewhere countries in decreasing order by total population size (Table 7). For the global sample, countries are identified by their ISO 3166 Codes

| Ecologists                  | Career-long rank | No. allocites | No. papers |
|-----------------------------|------------------|---------------|------------|
| **Brazil**                  |                  |               |            |
| Fearnside, Philip Martin    | 3804             | 10,675        | 237        |
| Diniz-Filio, Jose A. F.     | 30,832           | 10,388        | 337        |
| Junk, Wolfgang J.           | 30,938           | 4736          | 126        |
| Metzger, Jean Paul          | 39,906           | 7208          | 136        |
| Galetti, Mauro              | 57,379           | 6426          | 176        |
| Vasconcelos, Heraldo L.     | 61,500           | 5586          | 138        |
| Fernandes, Geraldo W.       | 63,217           | 4994          | 359        |
| Magnusson, William E.       | 75,881           | 5026          | 225        |
| Martinelli, Luiz A.         | 77,082           | 12,480        | 225        |
| Pillar, Valerio D.          | 87,368           | 4447          | 150        |
| Bini, Luis Mauricio         | 87,806           | 7925          | 217        |
| Oliveira-Filho, Any T.      | 91,374           | 3738          | 94         |
| Oliveira, Paulo S.          | 95,680           | 2482          | 99         |
| Begossi, Alpina             | 96,919           | 2079          | 87         |
| Escarano, Fabio R.          | 101,871          | 2215          | 101        |
| Tabarelli, Marcelo          | 110,477          | 4861          | 134        |
| **Mexico**                  |                  |               |            |
| Morrone, Juan J.            | 29,903           | 3756          | 178        |
| Ceballos, Gerardo           | 49,596           | 6803          | 124        |
| Williams-Linera, Guadalupe  | 96,735           | 1901          | 65         |
| **Argentina**               |                  |               |            |
| Diaz, Sandra                | 16,779           | 24,616        | 168        |
| Aizen, Marcelo A.           | 24,268           | 8957          | 131        |
| Paruelo, Jose               | 52,361           | 17,020        | 167        |
| Vazquez, Diego P.           | 56,310           | 5228          | 71         |
| Austin, Amy T.              | 72,262           | 4951          | 64         |
| Morales, Juan M.            | 92,256           | 3791          | 82         |
| Oesterheld, Martin          | 93,268           | 8529          | 79         |
| Kitzberger, Thomas          | 96,056           | 6905          | 102        |
| **Chile**                   |                  |               |            |
| Castilla, Juan Carlos       | 22,950           | 38,925        | 92         |
| Thiel, Martin               | 30,033           | 6697          | 232        |
| Bozinovic, Francisco        | 37,334           | 13,340        | 271        |
| Niemeyer, Hermann M.        | 45,942           | 4470          | 243        |
| Jaksic, Fabian M.           | 50,576           | 7306          | 137        |
| Marquet, Pablo A.           | 60,565           | 3642          | 162        |
| Santelices, Bernabé         | 71,212           | 14,151        | 96         |
| Gianoli, Ernesto            | 95,480           | 9161          | 146        |
| Navarrete, Sergio A.        | 100,707          | 1829          | 124        |
and in Chile, four new appeared and three long-careers disappeared. In the global sample, 18 were added and four disappeared.

Given the contrasting population sizes of the four Latin American countries being compared, some form of standardization is mandatory. We chose the number of ecologists (obtained from Tables 1 and 4) per million inhabitants. This calculation done, it is clear that the smallest countries (Argentina and Chile) have more per capita ecologists than the largest ones (Brazil and Mexico) (Table 7).

**Discussion**

Extracting information on the estimate of the population sizes for the year 2020 (http://www.wikipedia.org), and the number of ecologists from Table S-6 for the whole-trajectory impact index, and from Table S-7 for the annual 2019 rank of the paper by Ioannidis et al. [3], it can be corroborated in Table 7 that the sequence of these countries is reversed if the data are expressed as the number of ecologists per million inhabitants. In such analysis, Chilean and Argentinian ecologists occupy the first and second per capita place followed by Brazilian and Mexican ecologists. Interestingly, Chile currently ranks second after Brazil in Latin America when it comes to publication in high-impact mainstream journals (https://www.natureindex.com/annual-tables/2019/country/all).

On the other hand, while Brazilian ecologists may not publish in the highest-ranking journals, they do attract abundant citations (see [6]). Noteworthy is the place occupied by Mexico in the whole-trajectory ranking, with

### Table 1

| Ecologists         | Country | Career-long rank | N° allocites | N° papers |
|--------------------|---------|------------------|--------------|-----------|
| Global sample      |         |                  |              |           |
| Tilman, David      | US      | 63               | 81,754       | 274       |
| Møller, Anders Pape| FR      | 171              | 38,556       | 952       |
| Gaston, Kevin J.   | GB      | 251              | 47,195       | 638       |
| Vitousek, Peter M. | US      | 265              | 54,644       | 290       |
| Reich, Peter B.    | AU      | 377              | 61,267       | 635       |
| Carpenter, Stephen R.| US    | 432              | 69,414       | 399       |
| Chapin, F. Stuart  | US      | 562              | 72,218       | 431       |
| Shine, Richard     | AU      | 573              | 29,081       | 952       |
| Ricklefs, Robert E. | US    | 603              | 22,516       | 365       |
| Hanski, Ilkka      | FI      | 612              | 23,686       | 271       |
| Levin, Simon A.    | US      | 630              | 34,367       | 405       |
| Wardle, David A.   | SG      | 700              | 40,086       | 331       |
| Simberloff, Daniel | US      | 705              | 30,301       | 285       |
| Brown, James H.    | US      | 708              | 38,873       | 262       |
| Körner, Christian  | CH      | 722              | 24,280       | 339       |
| Holt, Robert D.    | US      | 754              | 33,481       | 263       |

### Table 2

| Countries | Career-long Rank | No. allocites | No. papers |
|-----------|------------------|--------------|------------|
| Brazil    | 3804 – 110,477   | 2079 – 12,480| 87–359     |
| Mexico    | 29,903 – 96,735  | 1901 – 6803  | 65–178     |
| Argentina | 16,779 – 96,056  | 3791 – 24,616| 64–168     |
| Chile     | 22,950 – 100,707 | 1829 – 38,925| 92–271     |
| Global sample | 63–754   | 22,516 – 81,754| 262–952    |

### Table 3

| Countries | CV Rank | CV No. allocites | CV No. papers |
|-----------|---------|----------------|--------------|
| Brazil    | 43.7    | 51.9           | 46.8         |
| Mexico    | 58.5    | 59.6           | 46.2         |
| Argentina | 49.3    | 72.0           | 39.1         |
| Chile     | 48.1    | 100.0          | 39.4         |
| Global sample | 43.2    | 43.0           | 52.0         |
| Ecologists                          | 2019 Rank | N° allocites | N° papers |
|-----------------------------------|-----------|--------------|-----------|
| Brazil                            |           |              |           |
| Fearnside, Philip Martin          | 3171      | 1444         | 237       |
| Metzger, Jean Paul                | 17,850    | 1585         | 136       |
| Diniz-Filho, José A. F.           | 19,583    | 1576         | 337       |
| Galetti, Mauro                    | 25,181    | 1962         | 176       |
| Junk, Wolfgang J.                 | 26,289    | 619          | 126       |
| Phalan, Benjamin T.               | 30,627    | 850          | 69        |
| Fernandes, Geraldo W.             | 30,783    | 982          | 359       |
| Pardini, Renata                   | 41,288    | 737          | 71        |
| Soares-Filho, Britaldo S.         | 46,309    | 1361         | 98        |
| Araújo, Luiz E.O.C.               | 49,214    | 1566         | 164       |
| Pillar, Valerio D.                | 52,541    | 1120         | 150       |
| Bini, Luis Mauricio               | 54,287    | 1302         | 217       |
| Tabarelli, Marcelo                | 58,953    | 1016         | 134       |
| Martinelli, Luiz A.               | 61,856    | 1878         | 225       |
| Vasconcelos, Heraldo L.           | 64,916    | 812          | 138       |
| Oliveira-Filho, Any T.            | 69,133    | 618          | 94        |
| Loyola, Rafael                    | 69,630    | 851          | 129       |
| Escarano, Fabio R.                | 72,267    | 462          | 101       |
| Ladle, Richard J.                 | 72,980    | 969          | 150       |
| Rangel, Thiago Fernando           | 77,389    | 788          | 106       |
| Magnusson, William E.             | 81,307    | 1004         | 225       |
| De Marco Jr., Paulo               | 82,760    | 607          | 146       |
| Jenkins, Clinton N.               | 86,536    | 1405         | 58        |
| Begossi, Alpina                   | 87,957    | 351          | 87        |
| Lewinsohn, Thomas M.              | 90,482    | 497          | 73        |
| Morelato, Leonor P. C.            | 93,616    | 506          | 111       |
| Brancalion, Pedro H.S.            | 98,574    | 891          | 138       |
| Strassburg, Bernardo              | 103,510   | 728          | 55        |
| Schøngart, Jochen                 | 106,591   | 570          | 62        |
| Ribeiro, Milton C.                | 106,903   | 820          | 108       |
| Werneck, Fernanda P.              | 122,234   | 237          | 38        |
| Mexico                            |           |              |           |
| Morrone, Juan J.                  | 10,511    | 612          | 178       |
| Ceballos, Gerardo                 | 13,381    | 1741         | 124       |
| Balvanera, Patricia               | 45,671    | 1842         | 84        |
| Villaseñor, Jose L.               | 66,672    | 344          | 143       |
| Valiente-Banuet, Alfonso          | 83,635    | 558          | 102       |
| MacGregor-Fors, Ian               | 104,564   | 433          | 78        |
| Argentina                         |           |              |           |
| Diaz, Sandra                      | 6877      | 5484         | 168       |
| Aizen, Marcelo A.                 | 14,021    | 1565         | 131       |
Table 4 Single-year (2019) impact ranking of Latin American ecologists, their No. allocites, and No. papers in the Scopus database (from Table S-7, 2019 Single-year ranking, by Ioannidis et al. [3]). For the global sample, countries are identified by their ISO 3166 Codes (Continued)

| Ecologists                | 2019 Rank | Nº allocites | Nº papers |
|---------------------------|-----------|--------------|-----------|
| Jobbágy, Esteban G.       | 27,829    | 1740         | 143       |
| Paruelo, José             | 30,087    | 2279         | 167       |
| Austin, Amy T.            | 30,943    | 767          | 64        |
| Vázquez, Diego P.         | 32,213    | 794          | 71        |
| Morales, Juan M.          | 59,359    | 660          | 82        |
| Garibaldi, Lucas A.       | 63,733    | 1128         | 85        |
| Di Bitetti, Mario S.      | 65,338    | 396          | 70        |
| Kitzberger, Thomas        | 69,215    | 1252         | 102       |
| Grau, H. Ricardo          | 83,230    | 548          | 75        |
| Oesterheld, Martín        | 91,394    | 1019         | 79        |
| Farji-Brener, Alejandro G. | 118,514   | 241          | 111       |

Chile

| Ecologists                | 2019 Rank | Nº allocites | Nº papers |
|---------------------------|-----------|--------------|-----------|
| Thiel, Martin             | 13,539    | 2052         | 232       |
| Castilla, Juan Carlos     | 29,417    | 862          | 192       |
| Bozinovic, Francisco      | 35,041    | 788          | 271       |
| Gianoli, Ernesto          | 49,810    | 591          | 146       |
| Marquet, Pablo A.         | 54,350    | 1343         | 162       |
| Fajardo, Alex             | 83,281    | 532          | 61        |
| Gelich, Stefan            | 86,820    | 636          | 111       |
| Niemeyer, Hermann M.      | 130,755   | 266          | 243       |
| Rezende, Enrico L.        | 140,786   | 373          | 72        |
| Lara, Antonio             | 218,062   | 553          | 94        |

Global sample

| Ecologists                | Country | 2019 Rank | Nº allocites | Nº papers |
|---------------------------|---------|-----------|--------------|-----------|
| Tilman, David             | US      | 42        | 11,128       | 274       |
| Reich, Peter B.           | AU      | 147       | 10,768       | 635       |
| Folke, Carl               | SE      | 162       | 10,021       | 251       |
| Gaston, Kevin J.          | GB      | 180       | 6879         | 638       |
| Carpenter, Stephen R.     | US      | 230       | 10,295       | 399       |
| Vitousek, Peter M.        | US      | 268       | 6133         | 290       |
| Anderson, Marti J.        | NZ      | 350       | 3985         | 107       |
| Legendre, Pierre          | CA      | 358       | 5719         | 311       |
| Peñuelas, Josep           | ES      | 365       | 7869         | 691       |
| Wardle, David A.          | SG      | 370       | 6431         | 331       |
| Körner, Christian         | CH      | 426       | 3052         | 339       |
| Farhig, Lenore            | CA      | 447       | 3181         | 197       |
| Costanza, Robert          | AU      | 473       | 5868         | 291       |
| Asner, Gregory P.         | US      | 483       | 6572         | 513       |
| Laurance, William         | AU      | 541       | 4968         | 385       |
| Thuiller, Wilfried        | FR      | 551       | 6297         | 288       |
| Berkes, Fikret            | CA      | 627       | 2619         | 205       |
| Wu, Jianguo               | US      | 659       | 3695         | 262       |
| Loreau, Michel            | FR      | 672       | 4749         | 269       |
only three ecologists listed (Table 1). We speculate that the most recognized Mexican ecologists are currently affiliated to US institutions (e.g., Rodolfo Dirzo, José Sarukhán, Jorge Soberón). Contrary to expectations of a decline in the impact of global sample ecologists, in favor of fast-growing economies such as China, no support for that prediction was found by Smith et al. [6], based on 17 years of data for eight sub-disciplines, including Ecology.

Recently, Rau et al. [7] showed that ecologists from the four Latin American countries considered here currently publish (Web of Science database) a larger number of citable scientific documents but are nevertheless less cited than in the past. They hypothesized that this may be due to an asymmetry in the pattern of cross-citations: Latin Americans cite global ecologists more than expected but they receive fewer cites than expected. That is, there is no reciprocity in citations. To counteract this phenomenon in good faith would require that Latin Americans conduct research with local environmental and social relevance, but also with new methodologies and approaches; and with theoretical concepts and principles of global interest, coupled with an increase in international collaboration (Anderson et al. [8], Rau et al. [9]). Of course, this strategy involves having sufficient institutional economic support and resources for the payment of publishing costs, which are higher in magazines of greater international impact (Rau & Fuentes [10], Fontürbel & Vizentin-Bugoni [11]).

Another remarkable pattern is the low participation of female ecologists, both globally and at the Latin American level. This corresponds to the so called “Matilda effect” in science [12]. Gender bias in the refereeing process of Ecology and Evolution papers has been addressed but not found (e.g., [13]). Indeed, according to [14], citation rates of ecological papers are more affected by the study outcome with respect to the hypotheses tested, by article length, and by their country and university of affiliation, than by gender.

Understandably, Latin American productive ecologists not listed among the ca. 120,000 researchers ranked by Ioannidis et al. [3] may complain about the specifics of the impact ranking procedure. First, because total production of papers is not considered (only its first or...
second derivative is: number of citations), numerous non-citable publications do not add to the compound index, leading to the paradox that perceived highly productive ecologists do not appear in the ranking. Secondly, because of the different weights given to the three qualifications in authorship, reputedly productive ecologists that collaborate with many authors but are in the middle of long authorship lines may not show in the ranking.

Conclusions
Based on Ioannidis et al.’s proposed index of scientific productivity we extract three lessons: (1) It does not pay to publish many papers; what counts is the number of allocites (i.e., self-citations do not add up). (2) Either be single, first, or last author; it does not pay to be in the middle of an authorship line. (3) Even worse it is to be among many co-authors because the Hm index allocates credits on a per capita basis. The current practice of involving numerous authors in papers published in prestigious journals (aimed at increasing total citations, but not necessarily personal H index) should be pondered by prospective collaborators, if compound indices such as the one discussed here become commonly applied.

Abbreviations
NC: Number of allocites; H: h index; Hm: corrected h index; NCS: single author; NCSF: single + first author; NCSFL: single + first + last author; CV: coefficient of variation

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Ethics approval and consent to participate
Not applicable.

Table 7 No. of ecologists in the four most scientifically-productive Latin American countries (From Tables S-6 and S-7 by Ioannidis et al. [3]), standardized by population size

| Countries | N° people | N° Career-long ecologists/million | N° Single-year ecologists/million |
|-----------|-----------|----------------------------------|-----------------------------------|
| Brazil    | 212,216,052 | 0.07                             | 0.15                              |
| Mexico    | 126,014,024 | 0.02                             | 0.05                              |
| Argentina | 40,117,096  | 0.20                             | 0.32                              |
| Chile     | 19,458,310  | 0.46                             | 0.51                              |

Consent for publication
Not applicable.

Competing interests
The authors have no competing interests.

Author details
1Laboratorio de Ecología, Departamento de Ciencias Biológicas y Biodiversidad, Universidad de Los Lagos, Campus Osorno, Osorno, Chile. 2Center of Applied Ecology and Sustainability (CAPES), Pontificia Universidad Católica de Chile, 8331150 Santiago, Chile.

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