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

Jaime R. Rau[1*] and Fabian M. Jaksic[2]

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

Background

Scientific productivity refers to the productivity of scientists in their research performance. In other words, the term concerns how much output scientists produce within a certain time period, which enables comparisons among them. Based on first authors who published in journals indexed by the Web of Science database, the four most scientifically productive Latin American countries in 2017 were: Brazil, Argentina, Mexico, and Chile, in decreasing order, together accounting for 9.3% of the world production [1]. A more current study [2] shows that the descending sequence is now: Brazil, Mexico, Argentina, and Chile. Here, we study the scientific productivity of these four countries on a worldwide comparison, based on the results of the recent review paper by Ioannidis et al. [3], wherein these authors reported a database built with an extensive sample of ca. 120,000 scientists from a worldwide universe of 6,880,389 who published at least five articles indexed in the Scopus database (stored at the Mendeley web site). Toward this, they considered 22 disciplinary areas and 176 sub-disciplines, and elaborated a ranking of scientists by both whole trajectory (career-long) impact and their current impact at year 2019, using a productivity index of their own design.

It is hence tempting to assess the Latin American contribution to world science of any discipline, but by reason of academic interest we choose to concentrate on the contribution and accomplishments in the Ecological sub-discipline. Thus, the goal of this paper is to contextualize

* Correspondence: jrau@ulagos.cl
[1]Laboratorio de Ecología, Departamento de Ciencias Biológicas y Biodiversidad, Universidad de Los Lagos, Campus Osorno, Osorno, Chile
Full list of author information is available at the end of the article

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	N° allocites	N° papers
Brazil			
Fearnside, Philip Martin	3804	10,675	237
Diniz-Filho, José 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, Ary 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, José	52,361	17,020	167
Vázquez, Diego P.	56,310	5228	71
Austin, Amy T.	72,262	4951	64
Morales, Juan M.	92,256	3791	82
Oesterheld, Martín	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	37,534	13,340	271
Niemeyer, Hermann M.	45,942	4470	243
Jaksic, Fabián 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

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 *(Continued)*

Ecologists		Career-long rank	N° allocites	N° papers
Global sample	**Country**			
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

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 of these countries 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 2 Ranges of scientometric indicators, with regard to position in the Whole trajectory (Career-long) impact ranking, No. allocites, and No. papers in the Scopus database, for the most scientifically productive countries in Latin America (from Table-S6, Career-long ranking, by Ioannidis et al. [3])

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 Coefficients of variation, CV (%), with regard to position in the Whole trajectory (Career-long) impact ranking, their associated No. allocites, and No. papers in the Scopus database, for the most scientifically productive countries in Latin America (from Table-S6, Career-long ranking, by Ioannidis et al. [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

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

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
Aragão, 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, Ary 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
Morellato, Leonor P. C.	93,616	506	111
Brancalion, Pedro H.S.	98,574	891	138
Strassburg, Bernando	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	N° allocites	N° 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				
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
Gelcich, Stefan		86,820	636	111
Niemeyer, Hermann M.		130,755	266	243
Rezende, Enrico L.		140,786	373	72
Lara, Antonio		218,962	553	94
Global sample	**Country**			
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
Farhrig, 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

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	N° allocites	N° papers
Scheffer, Marten	NL	710	6842	278
Brown, James H.	US	730	4011	262
Holt, Robert D.	US	744	4347	263
Chapin, F. Stuart	US	750	8941	431
Levin, Simon A.	US	762	4460	405
Simberloff, Daniel	US	764	3138	285
Westoby, Mark	AU	865	4984	250
Hughes, Terry P.	AU	945	4977	129
Jackson, Robert B.	US	965	8125	314
Goulson, Dave	GB	974	3757	282
Kremen, Claire	CA	1054	4496	156
Poff, N. Le Roy	US	1065	3548	142

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], Fontúrbel & 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

Table 5 Ranges of scientometric indicators, regarding position in the 2019 Single-year impact ranking, No. allocites, and No. papers in the Scopus database, for the most scientifically productive countries in Latin America (from Table-S7, 2019 Single-year ranking, by Ioannidis et al. [3])

Countries	2019 Rank	No. allocites	No. papers
Brazil	3171–122,234	237–1962	38–359
Mexico	10,511 -104,564	344–1842	78–178
Argentina	6877– 118,514	241–5484	64–168
Chile	13,539 -218,962	266–2052	61–271
Global sample	42–1065	3052 – 11,128	107–691

Table 6 Coefficients of variation, CV (%), regarding position in the Single-year impact ranking-2019, No. allocites, and No. papers in the Scopus database for the most scientifically productive countries in Latin America (from Table-S7, 2019 Single-year ranking, by Ioannidis et al. [3])

Countries	CV 2019 Rank	CV No. allocites	CV No. papers
Brazil	47.0	46.0	54.8
Mexico	70.2	73.9	32.3
Argentina	61.7	99.0	35.8
Chile	34.3	66.4	47.0
Global sample	50.0	41.0	44.6

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

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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Author details

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

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