Honduras publications in the Science Citation Index Expanded: institutions, fields and authors

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Abstract: Honduras is the second largest country in Central America, but 63 % of its population lives in poverty and it is the Central American country with less scientific journals. Even though Honduras has been included in general studies about Latin American science, there are no specific bibliometric studies about the productivity of the country, so this is the first formal study about the most productive institutions, fields and authors in Honduras. The Science Citation Index Expanded (SCI-EXPANDED), Web of Science Core Collection was used to collect the bibliographic data. There are no Honduras publications from 1903 to 1972 in SCI-EXPANDED. Honduras publications from 1973 to 2015 were further analyzed. A total of 1 146 Honduras publications with 13 document types in the Science Citation Index Expanded from 1973 to 2015 were found. Nearly 95 % of the articles in the database are in English, suggesting that articles in this language have the greatest visibility in the database, similar to other Central American countries. The countries with which Honduras publishes (e.g. Mexico, other Central American countries) follow the geographic and cultural affinity model, i.e. researchers tend to collaborate with colleagues that have similar culture or that are geographically close. This pattern has been found for other Central American countries. The focus of Honduran scientists in health and agriculture problems is typical on the less developed countries; on this respect Honduras is more similar to its closest neighbor, Nicaragua, than to smaller but more developed Central American countries like Panama and Costa Rica. Overall, the situation of scientific research and output in Honduras is improving, with more articles and citation in the SCI-EXPANDED, and this positive trend should bring about benefits for the people of Honduras. Rev. Biol. Trop. 65 (2): 657-668. Epub 2017 June 01.

Key words: Web of Science, Latin America, scientific productivity, most productive authors and institutions, research fields.

Honduras is the second largest country in Central America, but with a per capita Gross Domestic Product of only $2 368 and 63 % of its population living in poverty, it is in urgent need of scientific and technological investment (WorldBank.org). The oldest study that presents data on the scientific output of Honduras seems to be one by Garfield (1995) who wrote that, at the time, Honduras had 108 articles in the Science Citation Index and occupied the 24th place in the Latin American ranking. In that decade, Honduran researchers published mainly in the fields of agriculture and health, 74 % of it as part of international cooperation; cooperation was mostly with the USA, Europe and Mexico (Fernández, Gómez, & Sebastián, 1998). It also produced 0.15 % of Latin American library science research (Licea de Arenas, Vaues, Arévalo, & Cervantes, 2000).

International studies in the next five years found that Honduras had moved three places up in the Latin American productivity ranking and that it had 49 technical and scientific journals (Saavedra-Fernández, Sotolongo-Aguilar,

& Guzmán-Sánchez, 2002; Cañedo Andalia, Hernández San Juan, & Fresno Chávez, 2003; Arenas, Dovalina, & Licea de Arenas, 2004).

In the last decade Honduras has doubled the number of articles in international databases (to 300 articles) and is publishing in more varied fields, including a small number of articles in computing, and hydraulics (Rojas-Sola & Jordá-Albiñana, 2009, 2011; Aguillo, Corera-Álvarez, & Martínez, 2010; Rojas-Sola & San Antonio-Gómez, 2010). Nevertheless, even though Honduras has 1.4 % of the Latin American population, its scientific output is only 0.09 % of Latin American productivity (Montoya, 2012).

Even though Honduras has been included in general studies about Latin American science (Salomón, 2014), there are no specific bibliometric studies about the productivity of the country, so this is the first formal study about the most productive institutions, fields and authors.

MATERIALS AND METHODS

Science Citation Index Expanded (SCI-EXPANDED) of Web of Science Core Collection of Thomson Reuters was used to collect the bibliographic data. A search was conducted for papers with the phrase "Honduras" in the address field and restricted to all document types, and then refined by author country to Honduras. Initially, 1 238 publications were identified and these documents were published between 1900 and 2015 (Date of search: June 23th, 2016). Document information included names of authors, title, year of publication, source journals publishing the articles, contact address, and yearly citation times for every publication. Data were downloaded into Microsoft Excel software, and additional coding was manually performed for country, institute of the collaborators, and impact factors of the publishing journals (Li & Ho, 2008). Besides, the reported impact factor (IF_{2015}) of each journal was obtained from the 2015 JCR. The total number of times a document was cited from the Web of Science Core Collection since its publication to the end of 2015 was recorded as TC_{2015} (Wang, Fu, & Ho, 2011). Likewise, C_{2015}, the total number of citations of a paper in 2015 only (Ho, 2012) was employed to characterize Honduras publications. In addition, the citations per total publications (TP) since publication ($CPP = TC_{2015}/TP$), were also used (Chuang & Ho, 2015). Recently, Ho proposed a relationship between highly cited articles and their citations per publication ($CPP = TC_{year}/TP$) by year (Ho, 2013; Chuang & Ho, 2015) and we also applied the ratio to Honduras data.

Articles originating from England, Scotland, Northern Ireland, and Wales were reclassified as originating from the United Kingdom (UK). Articles from Federal Republic of Germany (Fed Rep Ger) and Germany were reclassified as originating from Germany (Ho, 2012).

RESULTS

Historically, the database covers little of the early production of Honduras. The first Honduras article in the database, entitled "Honduras. Report from La Ceiba-Fruit port" (Peters, 1901) was published in *Public Health Reports* in 1901. The second was published in 1973. During this long period, Honduras published 91 letters including 53 letters in 1900, 24 in 1901, and 14 in 1902. All these letters were published in *Public Health Reports* without any citations since publication to the end of 2015 ($TC_{2015} = 0$). There are no Honduras publications from 1903 to 1972 in SCI-EXPANDED. Honduras publications from 1973 to 2015 were further analyzed.

Document type and language of publication: A total of 1 146 Honduras publications with 13 document types in the Science Citation Index Expanded from 1973 to 2015 were found (Table 1). Figure 1 illustrates the trends of these documents. Altogether 810 articles were extracted from the 1 146 documents for further analysis. A 95 % of all these journal articles were published in English (771 articles), followed by Spanish (33; 4.1 %), French (3; 0.37 %), Portuguese (1; 0.12 %),
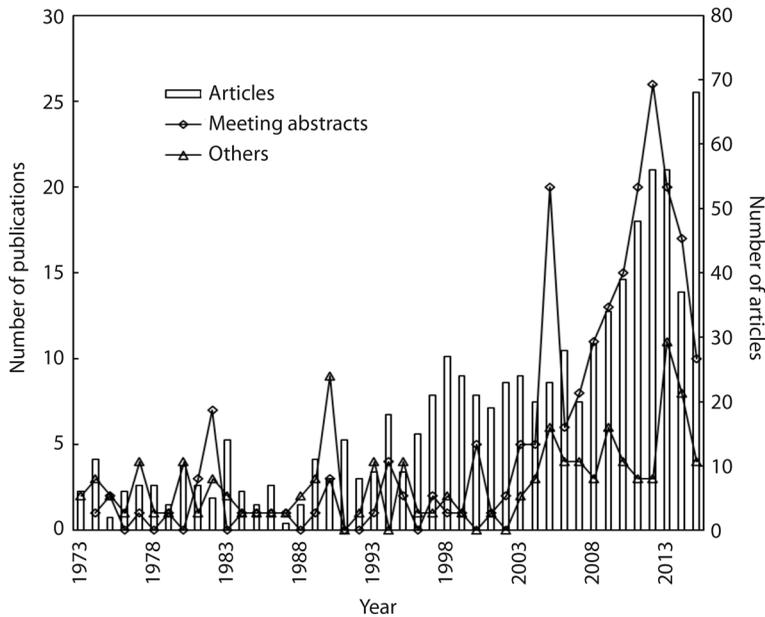
Fig. 1. Number of articles, meeting abstracts and other publication types from Honduras in the SCI-EXPANDED.

TABLE 1
Citations and publication type for Honduras
in the SCI-EXPANDED

Document type	TP	TC_{2015}	CPP
Article	810	13 075	16
Meeting abstract	218	43	0.20
Note	32	218	6.8
Proceedings paper	28	344	12
Letter	22	58	2.6
Editorial material	22	47	2.1
Review	19	1 083	57
News item	12	34	2.8
Discussion	7	0	0
Correction	2	0	0
Book chapter	1	43	43
Bibliography	1	24	24
Reprint	1	0	0

TP: total number of publications; TC_{2015}: total citations since publication to the end of 2015; CPP: citations per publication ($CPP = TC_{2015}/TP$).

German (1; 0.12 %), and one article (published in *Revista de Neurología*) was bilingual (Spanish and English).

In the period 1973-1995 around seven articles were included in the database every year; this increased to around 20 per year from 1996 to 2007; and there was a clear increase afterwards to reach 68 articles in 2015 (Fig. 1).

Articles represent the great majority of Honduras publication in the SCIEXPANDED, followed by meeting abstracts. Each of all other kinds of publications such as letters, editorials, reviews, and book chapters do not represent more than 2 % of publications (Table 1).

Collaboration: Interestingly, internal collaboration among Honduras institutions is small, representing about 10 % of all papers in the database (Table 2). International collaboration is reported in more articles. There are three

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TABLE 2

Top 20 collaborative countries for Honduras articles in the Science Citation Index Expanded (1973-2015)

Country	CP	CPR (%)	FPR (%)	RPR (%)
USA	464	1 (57)	1 (41)	1 (42)
Mexico	125	2 (15)	3 (3.3)	3 (3.7)
Brazil	71	3 (8.8)	7 (1.6)	7 (1.6)
Argentina	69	4 (8.5)	9 (1.1)	11 (1.1)
El Salvador	64	5 (7.9)	25 (0.25)	N/A
Colombia	63	6 (7.8)	15 (0.74)	15 (0.53)
Spain	63	6 (7.8)	2 (4.1)	2 (4.5)
Guatemala	61	8 (7.5)	20 (0.37)	23 (0.26)
Chile	57	9 (7.0)	9 (1.1)	8 (1.3)
Costa Rica	56	10 (6.9)	8 (1.4)	8 (1.3)
UK	53	11 (6.5)	5 (2.1)	5 (1.8)
Peru	48	12 (5.9)	13 (0.86)	13 (0.92)
Honduras	46	13 (5.7)	28 (0.12)	27 (0.13)
Sweden	44	14 (5.4)	4 (3.0)	4 (2.9)
Italy	37	15 (4.6)	11 (1)	10 (1.2)
Panama	34	16 (4.2)	16 (0.62)	18 (0.39)
Venezuela	33	17 (4.1)	20 (0.37)	18 (0.39)
France	31	18 (3.8)	16 (0.62)	15 (0.53)
Canada	29	19 (3.6)	6 (1.7)	5 (1.8)
Netherlands	26	20 (3.2)	16 (0.62)	15 (0.53)

CP: internationally collaborative articles with Honduras; *CPR* (%): rank of internationally collaborative articles and percentage; *FPR* (%): rank of article with first author and percentage; *RPR* (%): rank of article with corresponding author and percentage.

basic groups of countries that have international scientific collaboration with Honduras. The first group is composed of the largest scientific powers North and South of Honduras, namely the USA, Mexico, and Brazil; the second group is made up of smaller countries that

are culturally close to Honduras, and the third group is composed of distant countries that are far more advanced than Honduras (Table 2).

Top producers: In Honduras, the main producer of scientific articles that reach the database is the Universidad Nacional Autónoma de Honduras, UNAH (Table 3). The UNAH, founded in 1847, is the largest public university in the country and is active in all the typical areas of Latin American universities such as humanities and pure and applied sciences. The most productive research department in that university is the Tegucigalpa Hospital School, which publishes medical research. The second producer is the Pan American Agricultural School ("El Zamorano"), founded in 1942 to educate staff for the United Fruit Company, but now it is an independent school. The third producer is the Ministry of Health, also known as Secretaría de Salud, founded in 1900 and currently in charge of the coordination and execution of all health related projects of the Honduras government. Finally, the now merged United Fruit Company (founded in 1899) had a research division that produced an important number of articles included in the database (Table 3).

Web of Science subject categories and journals: Web of Science subject categories analysis can explain the distribution of research fields in Honduras. Our results are based on the 176 classifications of categories for 2015 in SCI-EXPANDED, and 809 articles

TABLE 3

Top institutions for Honduras articles in the Science Citation Index Expanded

Institute	TP	TPR (%)	% IC (IC)	% NC (NC)	% II (II)	% FP (FP)	% RP (RP)
Universidad Nacional Autónoma de Honduras	187	19 (22.7)	371 (174)	4.2 (3)	25.2 (10)	116 (54)	101 (45)
Escuela Agrícola Panamericana (El Zamorano)	57	10 (7.1)	140 (39)	0 (0)	60 (18)	95 (27)	92 (26)
Secretaría de Salud de Honduras	37	14 (4.6)	196 (36)	4 (1)	0 (0)	0 (0)	0 (0)
United Fruit Company	12	9 (1.5)	33 (4)	0 (0)	67 (8)	83 (10)	75 (9)

TP: total number of articles; *TPR* (%): rank of total number of articles and percentage; % *IC* (*IC*): percentage in *TP* in an institute and number of internationally collaborative articles; % *NC* (*NC*): percentage in *TP* in an institute and nationally collaborative articles; %*II* (*II*): percentage in *TP* in an institute and institutional independent articles; % *FP* (*FP*): percentage in *TP* in an institute and first author articles;% *RP* (*RP*): percentage in *TP* in an institute and corresponding author articles.
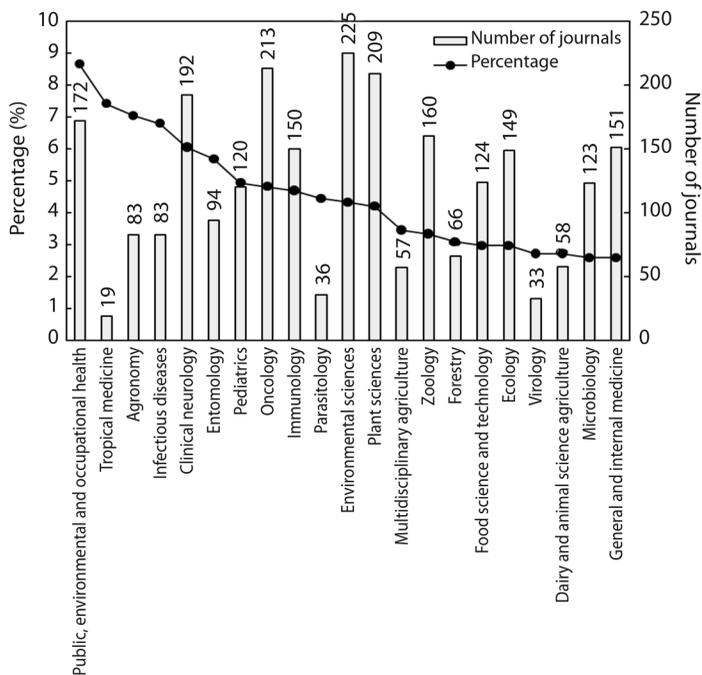
Fig. 2. Number of journals per specialty, in decreasing percent order, for Honduras publications in the SCI-EXPANDED.

published by Honduras scientists with category information in Web of Science, distributed in a wide range of 124 categories. Particularly, public, environmental and occupational health contributed the most of 70 articles (8.7 % of 809 articles), followed by tropical medicine (60 articles; 7.4 %), agronomy (57; 7.0 %), infectious diseases (55; 6.8 %), clinical neurology (49; 6.1 %), entomology (46; 5.7 %), pediatrics (40; 4.9 %), oncology (39; 4.8 %), and immunology (38; 4.7 %). Meanwhile, 71 (88 %) of 124 categories each contributed less than 10 articles, and 29 categories (23 %) each contributed only one article. Figure 2 shows distribution of these categories and a number of journals in the categories.

The 810 Honduras articles were published in 412 journals. Of the 412 journals, 267 (65 %) contained only one Honduras article, 65 (16 %) journals contained two articles, 25 (6.1 %) journals contained three articles, and 24 (5.8 %) journals contained four articles. The top journals with Honduras articles that are covered in the database were the *American Journal of Tropical Medicine and Hygiene* (24 articles), *Tropical Agriculture* (13), *Turrialba* (11), *Epilepsia* (10), *Journal of Child Neurology* (10), *Journal of Clinical Microbiology* (10), and *PLoS One* (10) (see Digital Appendix 1 and Appendix 2 for details). Three articles were published in *New England Journal of Medicine* with IF_{2015} of 59.558. Articles were also published in other high impact journals such as *Lancet* (IF_{2015} = 44.002), *Nature* (IF_{2015} = 38.138), *JAMA-Journal of the American Medical Association* (IF_{2015} = 37.684), and *Nature Genetics* (IF_{2015} = 31.616).

Citations: The top productive authors in the database are Honduras researchers working in the health and agriculture areas such as Medina, Ponce and Ferrera, as well as foreign scientists working in the country such as Cave, Stover and Andrews (Table 4).

The articles most cited in the database are in the fields of health, including rotavirus vaccines, cervical cancer, epilepsy, Epstein-Barr virus, dengue, breastfeeding, *Plasmodium,*

Top nine authors for Honduras articles in the Science Citation Index Expanded. Only authors with at least 10 articles

Author	Affiliation	rank (*TP*)	rank (*FP*)	rank (*RP*)	rank (*SP*)
M.T. Medina	Instituto de Neurociencias, Tegucigalpa	1 (32)	3 (6)	5 (5)	N/A
A. Ferrera	Universidad Nacional Autónoma de Honduras	2 (22)	3 (6)	2 (8)	N/A
C. Ponce	Secretaría de Salud de Honduras	3 (21)	2 (7)	8 (4)	2 (4)
R.D. Cave	Escuela Agrícola Panamericana El Zamorano	4 (19)	10 (3)	9 (3)	6 (1)
J.C. Rosas	Escuela Agrícola Panamericana El Zamorano	5 (17)	6 (5)	5 (5)	N/A
R.H. Stover	United Brands Company	6 (14)	1 (10)	1 (9)	1 (8)
K.L. Andrews	Escuela Agrícola Panamericana El Zamorano	7 (12)	8 (4)	9 (3)	6 (1)
G.A. Fontecha	Universidad Nacional Autónoma de Honduras	8 (10)	10 (3)	3 (6)	N/A
A.G. Gernat	Escuela Agrícola Panamericana El Zamorano	8 (10)	32 (1)	3 (6)	6 (1)

TP: total number of articles and percentage; *FP*: number of article with first author; *RP*: number of article with corresponding author; *SP*: number of article with single author N/A: not available.

Helicobacter, mosquito disease vectors, Chagas disease, and diarrhea. Also highly cited are agricultural articles, mainly banana, maize, and bean production; followed by other topics such as climate change, atomic structure, entomology, and ichthyology (Table 5 and Digital Appendix 3).

The variation with article life of citations per publication for all the 810 Honduras articles (Figure 3) shows that citations increased more rapidly in the first two years after publication and reached a peak in the 4th year. The *CPP* relationship indicates a sharp increase after 2007 (Figure 4). The *CPP* for 810 Honduras
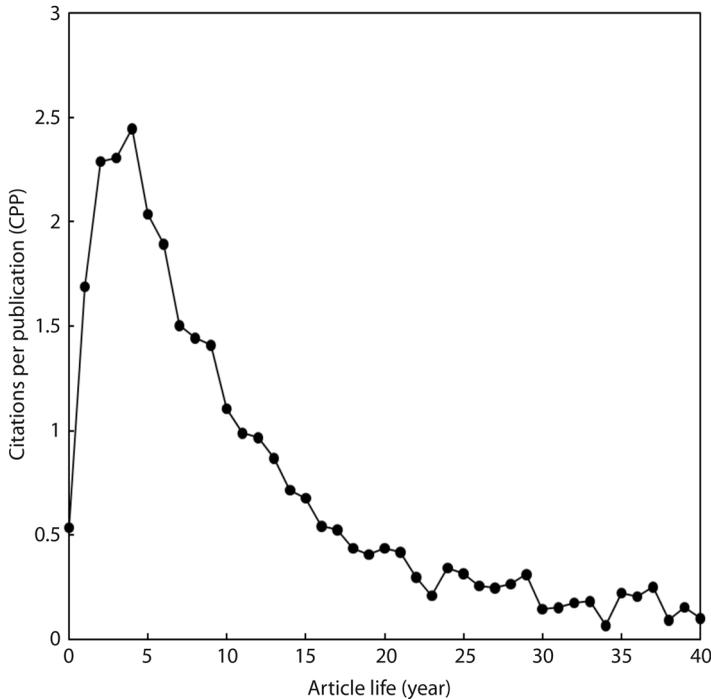

Fig. 3. Citation lifespan for Honduras articles.

TABLE 5
Top 11 Honduras independent articles with more than 20 citations ($TC_{2015} > 20$)

Rank (TC_{2015})	Rank (C_{2015})	Article title	Institution	Reference
31 (67)	106 (3)	Banana breeding - polyploidy, disease resistance and productivity	United Brands Co	Stover and Buddenhagen (1986)
41 (59)	48 (6)	Control of larval *Aedes aegypti* (Diptera, Culicidae) by cyclopoid copepods in Peridomestic breeding containers	Minist Salud Publ Honduras	Marten et al. (1994)
58 (49)	147 (2)	RAPD markers linked to three major anthracnose resistance genes in common bean	DOLE Honduras	Young and Kelly (1997)
85 (34)	385 (0)	Single and multiple queen colonies of imported fire ants (Hymenoptera, Formicidae) in Texas	Standard Fruit Co	Mirenda and Vinson (1982)
87 (32)	385 (0)	Heat-treatment and meristem culture for production of virus-free bananas	Tela Railroad Co	Berg and Bustaman (1974)
92 (31)	385 (0)	Fast Poisson solvers for problems with sparsity	Univ. Nacl. Autónoma Honduras	Banegas (1978)
98 (30)	231 (1)	Reproductive-biology and feeding-habits of Cuyamel, *Joturus pichardi* and Tepemechin, *Agonostomus monticola* (Pisces, Mugilidae) from Rio-Platano, Mosquitia, Honduras	Field Museum Nat Hist	Cruz (1987)
104 (29)	147 (2)	Current situation of Chagas disease in Central America	Secretariat Hlth	Ponce (2007)
118 (26)	106 (3)	Parasitism and diarrhea in children from 2 rural communities and marginal barrio in Honduras	Natl Autonomous Univ Honduras	Kaminsky (1991)
121 (25)	147 (2)	Relationship of soil characteristics to vegetation successions on a sequence of degraded and rehabilitated soils in Honduras	Zamorano; GTZ	Paniagua et al. (1999)
121 (25)	385 (0)	Effect of black sigatoka on plantains in Central America	Trop Agr Res Serv	Stover (1983)

TC_{2015}: total number of times article cited from the Web of Science Core Collection since its publication to the end of 2015: C_{2015}: total number of citations of a paper in 2015 only.

articles was 16. An extremely high *CPP* was found in 1993 with 68, which is attributed to the article "Measurement of the spin-dependent structure-function $g_1(x)$ of the deuteron" (Adeva et al., 1993) by 158 authors from 17 countries with TC_{2015} of 359. Top cited articles published before 1994 usually had around 10 citations, while those published afterwards received around 20 citations each (Fig. 4).

Those that were led by Honduras authors received around 10 citations, while those led by authors from scientifically powerful countries received around 20 (Fig. 5). A more detailed inspection shows three basic article types by citation: nationally collaborative articles, which are rare but still have around seven citations per paper; institutionally independent and Honduras independent articles (with a mean of eight citations per paper); and a more cited group in which neither the first nor the correspondence authors are Honduras nationals, with a mean of 19 citations per paper (Fig. 5).

When the top cited articles are analyzed in detail, i.e. those on rotavirus, cancer and atom spin, it is clear that they all follow the same general pattern: rapidly increasing the number of citations in the first 4-5 years after publication and then falling to a plateau (Fig. 6).
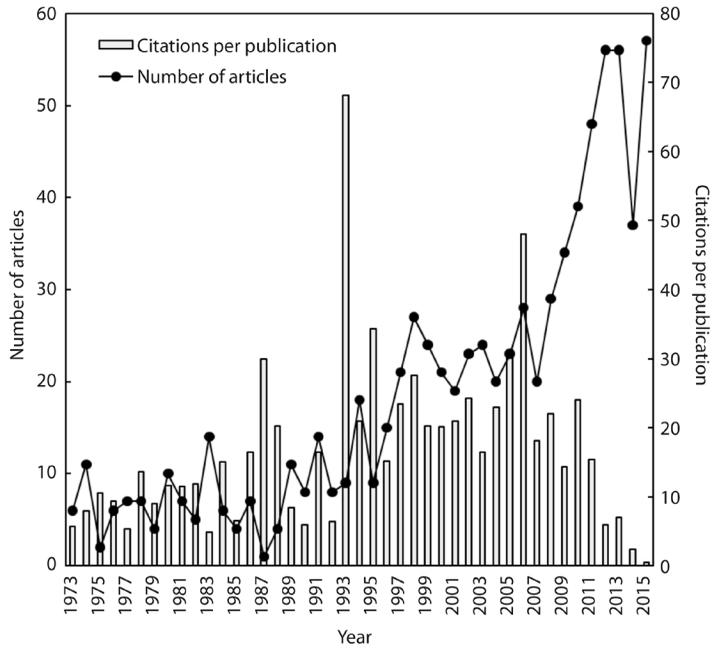
Fig. 4. Number of articles and citations per year for Honduras publications covered by the SCI-EXPANDED.
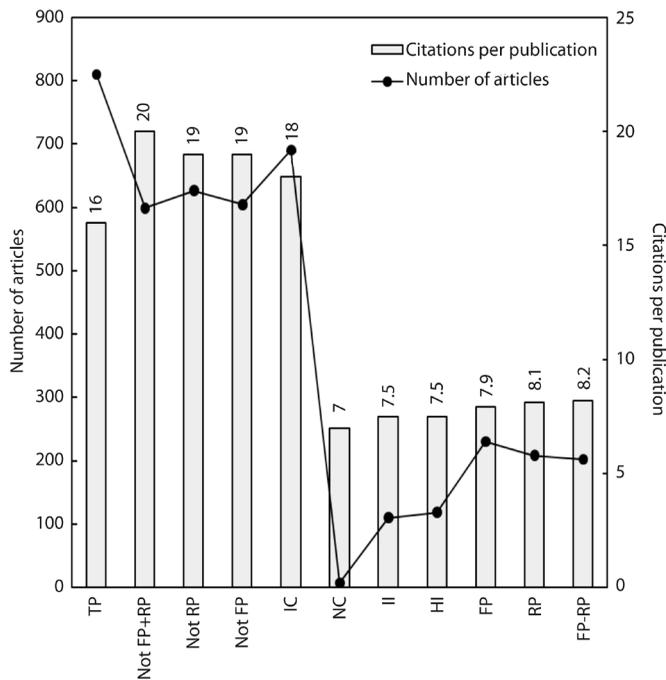

Fig. 5. Number of articles and citations for Honduras independent and collaborative papers. TP: total articles, Not FP+RP: both first and corresponding authors are not from Honduras, Not RP: corresponding author is not from Honduras, Not FP: first author is not from Honduras, IC: internationally collaborative papers, NC: nationally collaborative papers, II: institutional independent papers, HI: Honduras independent papers, FP: first author is from Honduras, RP: corresponding author is from Honduras, FP+RP: both first and corresponding authors are from Honduras.
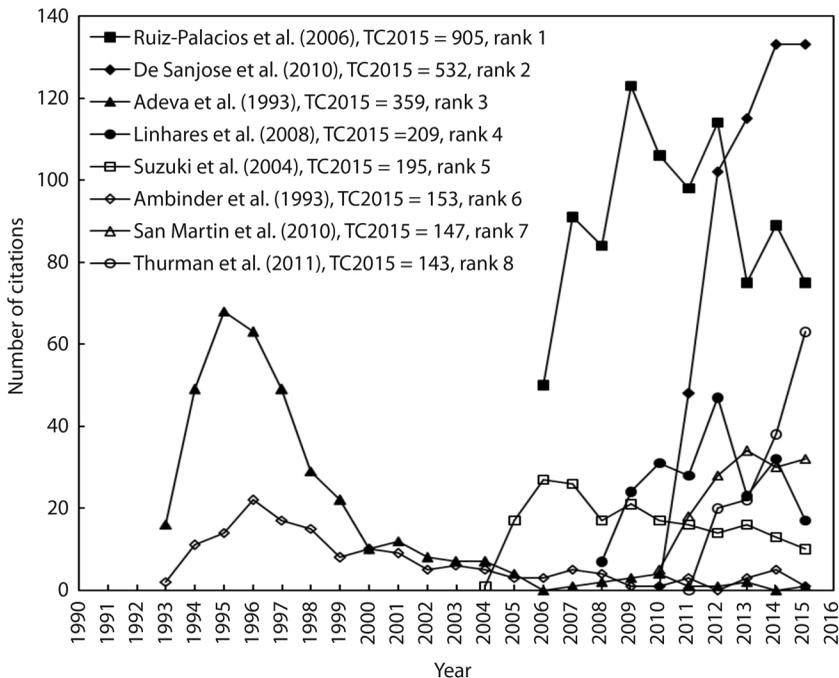
Fig. 6. Number of SCI-EXPANDED citations per year for the top five articles from Honduras.

Finally, the historical trend in collaboration, according to the database, shows a continuous but slow growth of collaboration with Mexico and Brazil, and three stages of collaboration with the USA: small before 1988, more significant from 1990 to 2007, and a rapid increase from 2008 to the present (Fig. 7).

DISCUSSION

With only eight indexed academic journals (Latindex.org), Honduras is the Spanish language Central American country with less scientific journals. Our finding that nearly 95 % of the Honduras articles in the SCIEXPANDED are in English, suggests that articles in this language have the greatest visibility in the database, similar to other Central American countries studied previously (Monge-Nájera & Ho, 2012, 2015).

Unlike neighboring Nicaragua, which has a series of highly cited book chapters, Honduras follows the normal pattern: most of its publications are articles and most of the citations

in the SCIEXPANDED are for articles. Articles are normally valid for bonuses and positions in the scientific community, and fit the Honduras government's interest in developing science (Santa & Herrero, 2010).

The countries with which Honduras publishes (e.g. Mexico, other Central American countries) follow the geographic and cultural affinity model, i.e. researchers tend to collaborate with colleagues that have similar culture or that are geographically close. This pattern has been found for other Central American countries (Monge-Nájera & Ho, 2012, 2015). Collaboration with the USA often results from international health projects that search for counterparts in tropical countries; and collaboration with European countries such as Sweden results from Central American students getting their advanced degrees in Europe (Monge-Nájera & Ho, 2012, 2015).

The pattern of citation of Honduras articles, with a peak in the 4th year, was different from other countries, for example stroke-related research in Taiwan (Chuang, Huang, & Ho,
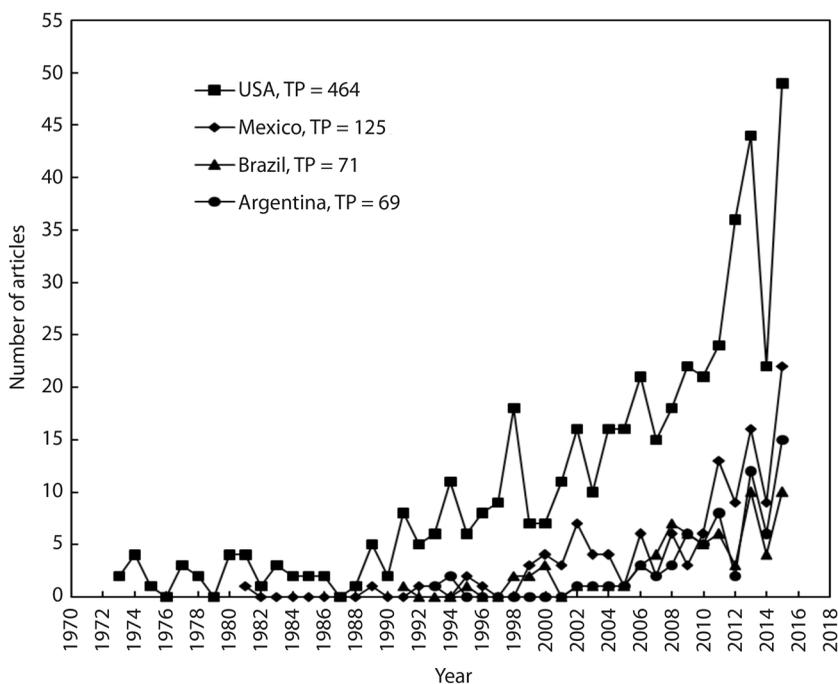
Fig. 7. Number of articles per year for the top four countries publishing with Honduras.

2007), independent research in Slovakia and the Czech republic (Fiala & Ho, 2016), and general articles in Panama, with peak shifts in the 2nd year and 4th years (Monge-Nájera & Ho, 2015; Chuang et al., 2007; Fiala & Ho, 2016).

The focus of Honduran scientists in health and agriculture problems is typical on the less developed countries; on this respect Honduras is more similar to its closest neighbor, Nicaragua, than to smaller but more developed Central American countries like Panama and Costa Rica (Monge-Nájera & Ho, 2012, 2015). An atypical result is the article on the deuteron, which has been cited over 300 times and had a Honduran scientist as part of a large international research team. This study could not be done in a small country such as Honduras, but international research collaboration allows scientists from small laboratories to have a greater level and impact in their work, and represents a valid example for other Latin American scientists.

Overall, the situation of scientific research and output in Honduras is improving, with more

articles and citation in the SCIEXPANDED, and this positive trend should help produce, in Salomón's (2014) own words, "enormous long-term benefits for Honduras and its people".

RESUMEN

Publicaciones hondureñas en el Science Citation Index Expanded: instituciones, temáticas y autores. Honduras es el segundo país más grande de Centroamérica, pero el 63 % de su población vive en la pobreza y es la nación centroamericana con menos revistas científicas. A pesar de que se ha incluido en estudios generales sobre la ciencia de América Latina, no existen estudios bibliométricos específicos sobre la productividad científica de Honduras, por lo que este es el primer estudio formal sobre las instituciones, los campos y autores más productivos de Honduras. Usamos la Colección Núcleo de Ciencia del *Science Citation Index Expanded* para recoger los datos bibliográficos, hallando que no incluye publicaciones hondureñas de 1903 a 1972, por lo que solo analizamos el período de 1973 a 2015. Hallamos un total de 1 146 publicaciones con 13 tipos de documentos. Casi el 95 % de los artículos en la base de datos están en Inglés, lo que sugiere que los artículos en esta lengua tienen la mayor visibilidad en esa base de datos, similar a lo informado sobre otros países de América Central. Los países con los que Honduras

pública (por ejemplo, México, otros países de América Central) siguen el modelo de afinidad geográfica y cultural; es decir, los investigadores tienden a colaborar con colegas que tienen culturas similares o que están geográficamente cerca. Este patrón se ha observado también en otros países de América Central. El enfoque de los científicos hondureños en los problemas de salud y agricultura es típico en los países menos desarrollados; en este sentido, Honduras es más similar a su vecino, Nicaragua, que a vecinos más pequeños pero más desarrollados, como Panamá y Costa Rica. En general, la situación de la investigación y la producción científica en Honduras está mejorando, con más artículos y citas en el SCI-EXPANDED. Esta tendencia positiva debería, con el tiempo, traer beneficios al pueblo de Honduras.

Palabras clave: Web of Science, América Latina, productividad científica, autores e instituciones más productivas, áreas de investigación.

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