SUPPLEMENT

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Thirty years of research in tropical medicine: historical trends for the world and for the *Revista de Biología Tropical* (1990-2020)

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ABSTRACT

Introduction: The importance of tropical medicine cannot be overstated, since by the end of the 2030s, most humans will live in the tropics and will need protection from tropical diseases. Nevertheless, until now, there are no bibliometric studies about tropical medicine as a whole; all previous studies are limited to diseases, countries or particular journals, and are often limited to brief periods of time. Here we present an analysis of historical trends for the world and for the *Revista de Biología Tropical* in celebration of the journal's 70th anniversary.

Objective: To assess geographic and historical trends in the study of tropical medicine included in a general database, the Web of Science and from a detailed analysis of one journal of particular importance for the field in the neotropical region.

Methods: We limited our data to journals covered by the Web of Science category "tropical medicine" in the Science Citation Index Expanded (data updated 19 January 2022) and the Journal Citation Report on 30 June 2021.

Results: We retrieved 69 480 articles, of which 44 % resulted from international collaboration with 194 participating countries; articles may reach 17–21 citations each, and the countries with outstanding results in the database include USA, Brazil, UK, Kenya and Switzerland. Research focus changes as diseases such as HIV, Dengue and tuberculosis become more or less important over time, but overall there was much research on *Plasmodium*, leishmaniasis and schistosomiasis. The journal *Revista de Biología Tropical* has significantly increased the number of topics covered, but still publishes studies about tropical biomedical subjects.

Conclusions: While countries with large research budgets have a large presence in this database, lower income tropical countries like Brazil and Kenya have done a remarkable contribution in the field of tropical medicine. The *Revista de Biología Tropical* has been publishing quality research about tropical medicine for the last seven decades.

Key words: scientometrics; research in the tropics; international collaboration on health research; contributions of tropical science; future health issues.

RESUMEN

Treinta años de investigación en medicina tropical: tendencias históricas para el mundo y para la *Revista de Biología Tropical* (1990-2020)

Introducción: La importancia de la medicina tropical no se puede subestimar, pues para fines de la década de 2030, la mayoría de los humanos vivirán en los trópicos y necesitarán protección contra las enfermedades

tropicales. Sin embargo, hasta el momento no hay estudios bibliométricos sobre la medicina tropical en su conjunto; todos los estudios previos se limitan a enfermedades, países o revistas particulares y, a menudo se limitan a períodos breves de tiempo. Acá presentamos un análisis detallado de tendencias históricas en el mundo y en la *Revista de Biología Tropical*, para celebrar los 70 años de la revista.

Objetivo: Evaluar las tendencias geográficas e históricas de la medicina tropical usando los artículos científicos incluidos en la base de datos *Web of Science*. Además de un análisis detallado de una revista de particular importancia en la región neotropical.

Métodos: Limitamos nuestros datos a las revistas cubiertas por la categoría "medicina tropical" en el *Science Citation Index Expanded* (datos actualizados el 19 de enero de 2022) y el *Journal Citation Report* del 30 de junio de 2021.

Resultados: Identificamos 69 480 artículos, de los cuales el 44 % resultó de la colaboración internacional con 194 países participantes; los artículos pueden llegar a 17–21 citas cada uno, y los países con resultados destacados en la base de datos incluyen EE. UU., Brasil, Reino Unido, Kenia y Suiza. El enfoque de la investigación cambia a medida que enfermedades como el VIH, el dengue y la tuberculosis se vuelven más o menos importantes con el tiempo, pero en general hubo mucha investigación sobre *Plasmodium*, leishmaniasis y esquistosomiasis. Aunque se ha diversificado, Biología Tropical aun publica sobre temas biomédicos del trópico.

Conclusiones: Mientras que los países con grandes presupuestos de investigación tienen buena presencia en esta base de datos, países tropicales como Brasil y Kenia han hecho una contribución notable en el campo de la medicina tropical, dentro del cual *Biología Tropical* ha estado presente con un alto nivel de calidad durante siete décadas.

Palabras clave: cienciometría; investigación en los trópicos; colaboración internacional en investigación en salud; contribuciones de la ciencia tropical; temas de salud futuros.

INTRODUCTION

This article was written in celebration of 70 years of the *Revista de Biología Tropical*, an international journal published by the University of Costa Rica, but covers both the history of tropical medicine in the journal, and the world-wide trends of the field in the last thirty years. The journal was established as part of a movement to modernize the country that started in the mid-20th century (Gutiérrez, 1986); the idea of the journal was first proposed in 1949 by Alfonso Trejos Willis (Zeledón, 2015) and in its early years it mostly published tropical medicine contributions originating in the Hospital San Juan de Dios and the University of Costa Rica (Girolami, 1988; Gutiérrez, 2002). Over the years, the journal grew significantly in other fields of biology, like marine biology, and the health-related content became a smaller percent of content in each issue but remained stable in total numbers at around 80 publications per decade (Gutiérrez, 2002).

Tropical medicine is relatively a recent concept, a field that has been studied under that name for only about a century (Keiser & Utzinger, 2005); the concept was born from the need that European empires had to control disease in the invaded African lands (Packard, 2012). Its importance is clear: at the end of the 2030 decade, most humans will live in the tropics and will need protection from tropical diseases (Wilkinson, 2014).

An early attempt to study the bibliometrics of research in tropical medicine reported a high concentration of articles in relatively few journals, and the predominance of the English language in the sample (Brennen & Davey, 1978); however, the study was based on a handful of American and European journals and considered only a brief period (1972-1975), making any generalizations unwarranted.

Decades passed before another study, which covered the period 1996-2003 and only one European journal, provided new information; unsurprisingly, this limited study found that Europe produced most of the papers published in the journal, but, surprisingly, also found that Africa was not far behind in number of articles, and that African authors were highly cited (Glover & Bowen, 2004). It also found that many papers were about Malaria, HIV/AIDS,

schistosomiasis, public health, health promotion, and health policy (Glover & Bowen, 2004).

At the turn of the century, American and European journals specializing in tropical medicine included four large publications: *Acta Tropica*, *American Journal of Tropical Medicine and Hygiene*, *Annals of Tropical Medicine and Parasitology*, and *Transactions of the Royal Society of Tropical Medicine and Hygiene* (Keiser & Utzinger, 2005). A new study reported that the number of publications and the size of research teams increased from 1950 to 2000, but that the funding available to tropical researchers was always far smaller than funding available to their colleagues in industrialized countries (Keiser & Utzinger, 2005).

A study that included both tropical and non-tropical biomedical research, and that covered from 1995 to 2003, found that most publications on infectious diseases were from Western Europe (39 %), while the United States led in preventive medicine, public health, and epidemiology. When adjusted for country wealth, Canada, the United States, and Australia were the main publishers, while developing countries had small research footprints. In the specific field of tropical medicine, Western Europe, Africa, and Latin America had the highest output (Falagas et al., 2006). A much smaller study from that time reported that, among Latin American countries, Chile and Brazil had the strongest presence in the scientific literature (Rodriguez-Morales & Mayta-Tristán, 2009).

The practical effect that research can have on health needs to be improved, and this can be done through *operational research* to close the implementation gap; thus, the simple number of publications cannot be equated with the advance in tropical health, according to a later study by Zachariah et al. (2012).

More recent research has been limited to particular diseases, like leishmaniasis, giardiasis, or Zika, or to particular regions, like Asia-Pacific, Brazil, or China. Leishmaniasis, endemic in 98 countries, has been studied intensively, with 3 380 publications from 1945-1980 to 8 267 from 2001-2010 in 1 846 journals; originally, the leading producers were USA, Brazil, and India, but in later years Brazil took the lead. By population, the most productive countries are Israel and Switzerland; by gross domestic product, Nepal and Tunisia; and by per capita income, India and Ethiopia (Ramos et al., 2013). In the case of *Giardia*, its inclusion in 2004 in the World Health Organization's Neglected Diseases Initiative seemed to favor an increase in output (Escobedo et al., 2015). The Zika virus increased greatly from 38 publications in 2015 to 1962 publications in 2017, led by the US (47 %) (Nasir & Ahmed, 2018).

The studies about particular regions found that Asia-Pacific research, published on the journal of the same name, had a mean of 6.6 citations per article and that the most frequent keywords were malaria, dengue, apoptosis, antioxidant, rate, invasion, *Anopheles stephesi*, and inflammation (Musa et al., 2020).

A recent study about tropical bioresearch in Brazil found that there was an emphasis on Basic biomedical research (30 % of publications) and a shortage of Health policy and systems (7 %) and Social sciences (3 %). Additionally, the main health problems did not match the most studied subjects: research output and funding were poorly correlated with disease burden. Much money was spent on diseases like leprosy, which are now minority diseases, and less funding was given to more important diseases like leishmaniasis and schistosomiasis (Fonseca et al., 2020).

Finally, a study of tropical medicine research in China (2010 to 2019) reported 3 372 articles, most from a state disease control center; it also found that Chinese research focused on parasites and had a significant component of international collaboration, done mostly with the USA (Li et al., 2021). Similar studies have been published recently (e.g. Ho, 2021; Juang et al., 2021), centering on particular specialties.

In this article, we present the first-ever study to consider all available fields and countries on the subject of tropical medicine; additionally, this study covers, in depth, a relatively long period (the most recent three decades).

MATERIALS AND METHODS

For the overall field analysis, we used the Web of Science category *tropical medicine* in the Science Citation Index Expanded (SCI-EXPANDED), from here on called *the database*, Web of Science Core Collection, Clarivate Analytics (data updated on 19 January 2022). The 2020 journal Impact Factor (IF2020) values were from the Journal Citation Report (JCR) on 30 June 2021. According to the definition of journal impact factor, it is best to search documents published in 2020 from SCI-EXPANDED after *IF2020* were presented. The SCI-EXPANDED indexes only a fraction of academic output, namely 9 531 journals across 178 Web of Science categories, and 23 of them are classified in the category of tropical medicine in 2020.

We used the relationship between the annual number of highly cited articles (*TP*) and yearly citations per publication (*CPP*year), to understand impact trends, as done recently for emergency medicine (Ho, 2021) and anesthesiology (Juang et al., 2021). We also used six publication indicators and citation indicators as detailed by Ho & Mukul (2021).

We also analyzed the distribution of words in titles, abstracts, author keywords, and *KeyWords Plus* in different periods to identify changes in research focus and ranked them according to the whole study duration and 10-year study period, according to Zhang et al. (2010) and Wang and Ho (2016).

The full record of SCI-EXPANDED and the number of citations in each year for each article were downloaded into Excel Microsoft 360 and checked. Additional coding was manually performed by the functions, for example, Counta, Concatenate, Match, Vlookup, Proper, Rank, Replace, Freeze Panes, Sort, Sum, and Len were applied. The journals' impact factors (*IF2020*) were taken from the Journal Citation Reports (JCR) published in 2020.

In the SCI-EXPANDED database, the corresponding author is designated as the *reprint author*; *corresponding author* will remain as the primary terminology instead of the reprint author. In a single-author article where authorship is unspecified, the single-author is considered both the first author and the corresponding author (Ho, 2014). Similarly, in an individually institutional article, the institution is both classified as the first-author institution and the corresponding-author institution (Ho, 2014). To have more accurate analysis results, affiliations were checked and reclassified. Affiliations in England, Scotland, Northern Ireland, Wales, Montserrat, Cayman Islands, Anguilla, and British Virgin Isl (British Virgin Islands) were reclassified as in the United Kingdom (UK). Affiliations in Hong Kong before 1997 were included with China (Fu et al., 2012). Affiliations in Zaire were reclassified as being from Dem Rep Congo (the Democratic Republic of the Congo) (Chuang et al., 2011). Affiliations in French Guiana and New Caledonia were reclassified as being from France. Affiliations in Sint Maarten were reclassified as being from the Netherlands. Affiliations in Greenland were reclassified as being from Denmark (Tchuifon Tchuifon et al., 2017). Affiliations in Senegambia were checked and reclassified as being from Gambia and Senegal respectively. Affiliations in USSR were checked and reclassified as being from Russia. Affiliations in W Ind Assoc St (West Indies Associated States) were checked and reclassified as being from Trinidad Tobago (Trinidad and Tobago) and the UK respectively. Affiliations in Czechoslovakia were checked and reclassified as being from the Czech Republic and Slovakia respectively (Lin & Ho, 2015). Similarly, Czechoslovak Acad Sci (Czechoslovak Academy of Sciences) was also checked and reclassified as Czech Acad Sci (Czech Academy of Sciences). Acad Med Sci USSR (USSR Academy of Medical Sciences) and Acad Sci were checked and reclassified under the heading of Russian Acad Med Sci (Russian Academy of Medical Sciences) (Chong et al., 2021) and Russian Acad Sci (Russian Academy of Sciences) respectively. Univ London London Sch Hyg & Trop Med in the UK was reclassified as London Sch Hyg & Trop Med (London School of Hygiene and Tropical Medicine).

Publications were assessed using following citation indicators:

- Cyear: the number of citations from Web of Science Core Collection in a particular year (e.g. C2020 describes citation count in 2020).
- TCyear: the total citations from Web of Science Core Collection received since publication year till the end of the most recent year (2020 in this study, TC2020) (Wang et al. 2011).
- CPPyear: citations per publication (CPP2020 = TC2020/TP), TP: total number of publications (Ho, 2013).

Six publication indicators were applied to evaluate publication performance of countries and institutions:

- TP: total number of articles.

IP: number of single-country or single-institution author articles.

- CP: number of internationally or inter-institutionally collaborative articles.
- FP: number of first-author articles.
- RP: number of corresponding-author articles.
- SP: number of single-author articles.

Word analysis was complicated by the inclusion of low value words, such as *report*, *conclusions*, and *significant*, as subject indicators in the Web of Science. We manually eliminated those cases.

For the analysis of publications in the *Revista de Biología Tropical*, we read the titles of all articles and communications published between 1953 and 2021 (the last full year available), and extracted documents that fit the criteria listed by Gutiérrez (2002), i.e. from the following tropical medicine fields: parasitology, microbiology, hematology, clinical chemistry, pathology, genetics, toxicology, and pharmacology.

RESULTS

Publication output: We retrieved 69 480 articles, an average of nearly 2 400 articles per year (1991 to 2020). For over a year, the database did not increase the number of yearly articles that it incorporated (1991-2004), but there was a steady increase afterwards, only interrupted in 2018 and 2019 (Fig. 1). The citations per paper increased from 1991 to 2003 and seemed to fall after that date, but these results might be due to a lag in citation processing (Fig. 1).

Journals: Nearly half (14 out of 37) journals, representing 2 972 articles, did not have IF_{2020} data, i.e. they were no longer listed under tropical medicine in 2020 (Table 1). Some changed titles and focus, for example, in 2012, *Annals of Tropical Medicine and Parasitology* became *Pathogens and Global Health*; and *Annals of Tropical Paediatrics* became *Paediatrics and International Child Health* (Table 1).

Articles published in the *American Journal of Tropical Medicine and Hygiene* (IF_{2020} = 2.345; rank 11th) had the highest CPP_{2020} (a mean of 28 citations per article) while 147 articles in the *Journal of Tropical Medicine* (IF_{2020} = 2.488; rank 10th) had the lowest *(*2.2). *PLoS Neglected Tropical Diseases* had the highest *APP* (8.9 authors per article) and *Tropical Doctor* the lowest *(*3.5). *Infectious Diseases of Poverty* (IF_{2020} = 4.520) with a CPP_{2020} of 8.7, and an *APP* of 8.2, ranked top (Table 1).

Output by countries and institutions: Author affiliations were available for 195 countries, 56 % of them single-country articles, the rest was international collaboration with a total of 194 participating countries.

The CPP_{2020} had an overall mean of 17 citations, with internationally collaboration leading to 21 citations, higher than single-country articles (14 citations) (Table 2).

The USA, Brazil and the UK dominated publication indicators in the database: USA with 23 % of total publications and 39 % of collaboration publications; Brazil with 22 % of single-country articles; 15 % of first-author articles; and 15 % of corresponding-author articles; the UK represented 16 % of single-author articles (Table 2).

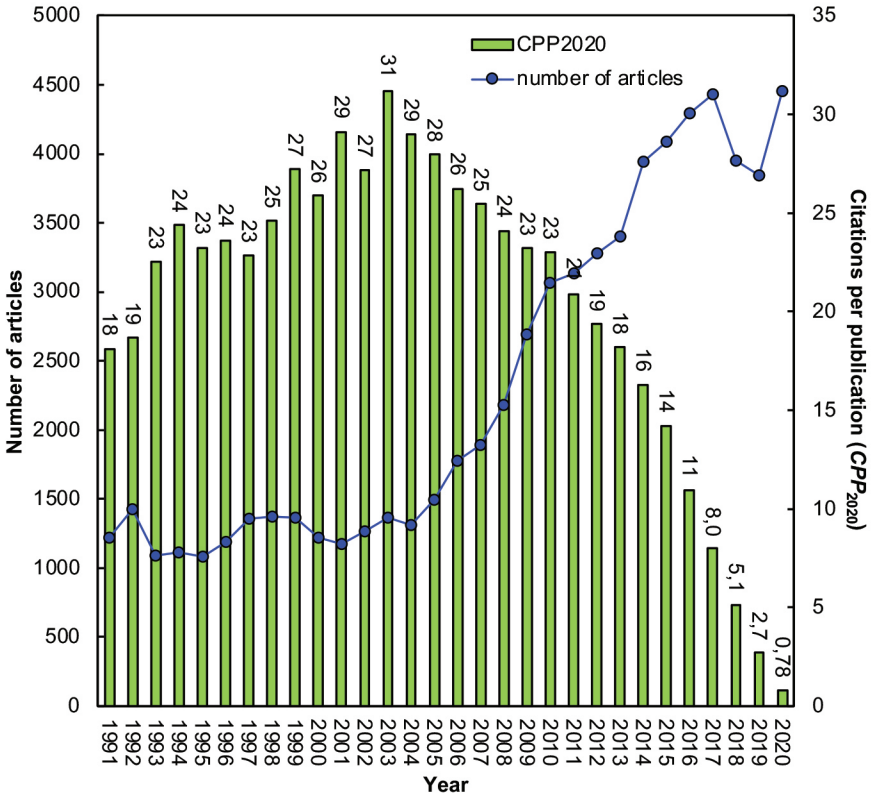

Fig. 1. Historical trend for tropical medicine: number of articles and citations the Web of Science.

Citations included in the web of science: For the citations included in this database, and comparing the top 20 countries, other remarkable countries are Switzerland with the highest CPP_{2020} for total articles, single-country articles, first-author articles, corresponding-author articles, and single-country articles, with a CPP_{2020} of 27, 27, 30, 27, and 26, respectively. Kenya had the highest CPP_{2020} for total articles and internationally collaborative articles with a CPP_{2020} of 27 and 29, respectively.

For the top eight productive countries, yearly publications had a steady growth for the USA; there was an intermediate growth for Brazil and the UK, and a more stable situation for India, France, China, Thailand and Switzerland (Fig. 2). The citation curves for the top cited articles, followed three main trends: most a soft up and down curve from 2000 through 2020; a few grew steadily from 2012 through 2020; and one had a clear peak around 2010 (Fig. 3). The growth trend applies to institutions and articles (Table 3, Table 4).

Concerning institutions, most (76 %) participated in inter-institutional collaborations (Table 5). The London School of Hygiene and Tropical Medicine in the UK took the leading position for three indicators with 4.1 % of articles, 5.1 % of inter-institutionally collaborative articles, and 3.5 % of single-author articles. The Fundación Oswaldo Cruz ("Fiocruz MS") in Brazil ranked top in other indicators, with 2.0 % of inter-institutionally collaborative articles, 1.6% of first-author articles, and 1.7 % of corresponding-author articles.

The WHO in Switzerland had the highest CPP_{2020} for *TP* and *RP* with 33 and 37 respectively. The University of Basel in Switzerland,

Table 1
The 23 journals in the Web of Science category of tropical medicine in 2020

Journal	*TP* (%)	*R* (IF_{2020})	APP	CPP_{2020}
American Journal of Tropical Medicine and Hygiene	10 409 (15)	11 (2.345)	7.2	28
PLoS Neglected Tropical Diseases	7 552 (11)	2 (4.411)	8.9	21
Malaria Journal	5 796 (8.3)	5 (2.979)	8.0	18
Parasites & Vectors	5 122 (7.4)	3 (3.876)	7.3	14
Memories Of the Oswaldo Cruz Institute	4 981 (7.2)	8 (2.743)	5.1	16
Acta Tropica	4 752 (6.8)	4 (3.112)	6.1	19
Transactions of the Royal Society of Tropical Medicine and Hygiene	4 310 (6.2)	12 (2.184)	5.9	24
Tropical Medicine & International Health	3 761 (5.4)	9 (2.622)	6.6	26
Journal of the Brazilian Society of Tropical Medicine	2 407 (3.5)	15 (1.581)	5.8	7.5
Tropical Doctor	2 340 (3.4)	20 (0.731)	3.5	5.1
Pathogens and Global Health	2 223 (3.2)	6 (2.894)	5.1	17
Journal of Tropical Pediatrics	2 197 (3.2)	18 (1.165)	4.8	11
Asian Pacific Journal of Tropical Medicine	1 958 (2.8)	17 (1.226)	4.9	8.2
Southeast Asian Journal of Tropical Medicine and Public Health	1 730 (2.5)	23 (0.267)	5.3	4.7
Leprosy Review	1 173 (1.7)	22 (0.537)	4.2	8.8
Revista Do Instituto De Medicina Tropical De Sao Paulo	1 127 (1.6)	13 (1.846)	6.0	7.7
Biomedical	1 078 (1.6)	19 (0.935)	4.8	4.4
Tropical Biomedicine	1 065 (1.5)	21 (0.623)	5.5	6.0
Journal of Venomous Animals and Toxins Including Tropical Diseases	644 (0.93)	7 (2.831)	5.4	6.2
Infectious Diseases of Poverty	615 (0.89)	1 (4.520)	8.2	8.7
Journal of Vector Borne Diseases	595 (0.86)	14 (1.688)	5.1	6.4
Asian Pacific Journal of Tropical Biomedicine	526 (0.76)	16 (1.545)	5.2	4.7
Journal of Tropical Medicine	147 (0.21)	10 (2.488)	5.4	2.2

TP: number of articles; %: the percentage of articles in total publications; IF_{2020}: journal impact factor in 2020; *R*: IF_{2020} rank in the Web of Science category of tropical medicine; *APP*: number of authors per publication; CPP_{2020}: number of citations (TC_{2020}) per publication (*TP*).

the Kenya Medical Research Institute in Kenya, the University of Oxford in the UK, and the Mahidol University in Thailand had the highest CPP_{2020} for their *IP*, *CP*, *FP*, and *SP* values, with 65, 33, 45, and 31 respectively.

Seven of the top 20 productive institutes had higher CPP_{2020} for their single-country articles than internationally collaborative articles, for example, the University of Basel in Switzerland, the University of California-San Francisco, and the Centers for Disease Control and Prevention in Maryland. However, the Kenya Medical Research Institute in Kenya, the Mahidol University in Thailand, and the Swiss Tropical and Public Health Institute increased their CPP_{2020} by international collaboration.

Research focus and development trends: Most articles included abstract keywords (95 %) and author keywords (55 %). "Malaria", "plasmodium falciparum", "epidemiology", and "Brazil" were the most-frequently used author keywords (1 000 articles or more). Considering the top twenty words on each list, about half of the words in the titles also appear in the abstracts; followed by around 40 % in Keywords Plus and around 35% in the author keywords (Table 5). There were also historical trends as research priorities changed: a typical new research focus was found from "*Aedes aegypti*", a term that was used as author keywords in 15 articles in the 1990s and in 450 articles in the 2010s. Similarly, the rank and percentage of articles with "dengue" in the author keywords

Table 2
Top productive countries.

Country	TP	TP		IP		CP		FP		RP		SP	
		TPR (%)	CPP_{2020}	*IPR* (%)	CPP_{2020}	*CPR* (%)	CPP_{2020}	*FPR* (%)	CPP_{2020}	*RPR* (%)	CPP_{2020}	*SPR* (%)	CPP_{2020}
USA	15 598	1 (23)	23	3 (9.5)	24	1 (39)	23	2 (13)	25	2 (14)	23	3 (12)	22
Brazil	11 517	2 (17)	15	1 (22)	12	4 (10)	21	1 (15)	13	1 (15)	13	2 (13)	13
UK	9 501	3 (14)	24	6 (3.4)	20	2 (27)	25	4 (6.0)	24	4 (6.4)	23	1 (16)	19
India	5 467	4 (7.9)	12	2 (11)	10	15 (4.1)	19	3 (6.8)	11	3 (6.7)	11	4 (7.0)	11
France	4 208	5 (6.1)	23	10 (2.2)	20	3 (11)	24	7 (3.0)	22	7 (3.2)	21	10 (2.0)	18
China	3 687	6 (5.3)	12	4 (6.0)	8.8	13 (4.5)	18	5 (4.5)	10	5 (4.7)	10	12 (1.7)	11
Thailand	3 618	7 (5.2)	18	5 (4.0)	9.1	6 (6.8)	24	6 (3.7)	15	6 (3.8)	14	9 (2.1)	19
Switzerland	3 054	8 (4.4)	27	23 (0.81)	27	5 (8.9)	27	13 (1.7)	30	13 (1.9)	27	8 (2.6)	26
Australia	2 682	9 (3.9)	23	13 (1.6)	24	7 (6.7)	22	10 (2.0)	24	9 (2.3)	22	11 (1.9)	21
Germany	2 456	10 (3.5)	20	18 (1.1)	19	8 (6.7)	20	12 (1.8)	20	12 (1.9)	19	16 (1.3)	18
Netherlands	2 277	11 (3.3)	24	27 (0.76)	18	9 (6.5)	24	14 (1.6)	23	15 (1.6)	22	7 (2.6)	12
Kenya	2 163	12 (3.1)	27	29 (0.6)	12	10 (6.3)	29	19 (1.2)	23	22 (1.2)	22	17 (1.2)	8.9
Colombia	1 950	13 (2.8)	12	7 (3.1)	7.9	26 (2.5)	18	8 (2.3)	10	8 (2.3)	10	17 (1.2)	10
Nigeria	1 929	14 (2.8)	12	8 (3.1)	9.1	27 (2.4)	16	9 (2.1)	10	11 (2.0)	10	5 (6.6)	8.5
Spain	1 828	15 (2.6)	18	16 (1.3)	18	14 (4.4)	19	15 (1.5)	18	14 (1.6)	18	39 (0.43)	18
Belgium	1 823	16 (2.6)	22	35 (0.46)	16	11 (5.4)	23	21 (1.2)	22	18 (1.3)	21	15 (1.4)	6.7
Tanzania	1 755	17 (2.5)	25	36 (0.42)	12	12 (5.2)	26	25 (0.91)	19	25 (0.87)	19	14 (1.4)	16
South Africa	1 647	18 (2.4)	18	15 (1.3)	13	17 (3.7)	20	20 (1.2)	17	20 (1.3)	16	12 (1.7)	8.4
Malaysia	1 608	19 (2.3)	12	9 (2.6)	8.7	33 (2.0)	16	11 (1.9)	10	10 (2.0)	10	21 (0.89)	13
Japan	1 557	20 (2.3)	16	19 (0.92)	14	16 (3.9)	17	16 (1.3)	16	16 (1.4)	16	45 (0.35)	13

TP: total number of articles; *TPR* (%): rank of total number of articles and percentage; *IPR* (%): rank of single-country articles and percentage in all single-country articles; *CPR* (%): rank of internationally collaborative articles and percentage in all internationally collaborative articles; *FPR* (%): rank of first-author articles and percentage in all first-author articles; *RPR* (%): rank of corresponding-author articles and percentage in all corresponding-author articles; *SPR* (%): rank of single-author articles and percentage in all single-author articles; CPP_{2020}: number of citations (TC_{2020}) per publication (*TP*).

went from 26 articles (rank 14th; 1.7 %) in the 1990s to 494 articles (rank 6th; 2.0 %) in the 2010s (Table 5).

A dominating subject was the epidemiology and control of malaria, caused by *Plasmodium falciparum* and other species of *Plasmodium*, particularly in children and in Brazil (Table 5). Malaria always was the most studied tropical disease, fluctuating around 240 articles per year from 1991 to 2002; after that, there was an "explosion" in the number of articles, reaching 962 articles in the year 2016 only, and with a small decrease from there to 2020, with 823 articles (Fig. 4).

Another leading subject is leishmaniasis or "Chagas Disease", caused by species of *Trypanosoma* transported by *Phlebotomus, Lutzomyia,* and others (Table 5). Leishmaniasis had under 200 articles per year from 1991 to 2006; afterwards it increased constantly and reached peaks of 423 articles in 2015 and 420 articles in 2020 (Fig. 4).

The third remarkable subject was schistosomiasis, a disease produced by trematodes, in which freshwater snails play a key role (Table 5). Schistosomiasis fluctuated between 100 and 200 articles per year in the study period; from 2007, the number of articles increased to reach 239 articles in 2020 (Fig. 4).

The human immunodeficiency virus, HIV, originated in tropical Africa and attacks the immune system of the human body, and can cause the acquired immunodeficiency syndrome, AIDS. The number of HIV and AIDS

Table 3
Top 20 productive institutions in the Web of Science category of tropical medicine

Institution	TP	TP		IP		CP		FP		RP		SP	
		TPR (%)	CPP	*IPR* (%)	CPP	*CPR* (%)	CPP	*FPR* (%)	CPP	*RPR* (%)	CPP	*SPR* (%)	CPP
London Sch Hyg & Trop Med, UK	2 825	1 (4.1)	27	7 (1.0)	29	1 (5.1)	27	3 (1.5)	28	3 (1.6)	27	1 (3.5)	30
Ctr Dis Control & Prevent, USA	1 977	2 (2.9)	31	10 (0.86)	40	2 (3.5)	30	5 (1.2)	33	5 (1.3)	31	9 (0.62)	18
Univ Sao Paulo, Brazil	1 934	3 (2.8)	15	3 (1.8)	12	3 (3.1)	16	4 (1.4)	16	4 (1.4)	15	8 (0.89)	17
Mahidol Univ, Thailand	1 842	4 (2.7)	20	2 (1.9)	8.6	4 (2.9)	22	2 (1.6)	16	2 (1.6)	15	11 (0.58)	31
Fiocruz MS, Brazil	1 754	5 (2.5)	19	1 (2.0)	17	5 (2.7)	19	1 (1.6)	19	1 (1.7)	18	4 (1.5)	21
Univ Oxford, UK	1 327	6 (1.9)	29	42 (0.26)	32	6 (2.4)	29	20 (0.32)	45	13 (0.43)	35	7 (0.93)	27
Univ Liverpool, UK	1 105	7 (1.6)	28	15 (0.63)	22	7 (1.9)	28	10 (0.56)	24	10 (0.56)	25	3 (1.6)	18
Univ Fed Minas Gerais, Brazil	1 094	8 (1.6)	16	6 (1.1)	12	9 (1.7)	17	6 (0.77)	14	6 (0.77)	14	9 (0.62)	15
Oswaldo Cruz Foundation, Brazil	1 037	9 (1.5)	14	18 (0.53)	10	8 (1.8)	14	9 (0.58)	14	8 (0.60)	15	18 (0.43)	1.6
Inst Trop Med, Belgium	818	10 (1.2)	21	49 (0.24)	17	11 (1.5)	21	11 (0.45)	24	12 (0.53)	22	15 (0.47)	9.3
Kenya Govt Med Res Ctr, Kenya	814	11 (1.2)	32	240 (0.072)	16	10 (1.5)	33	23 (0.29)	36	35 (0.26)	32	N/A	N/A
Swiss Trop & Publ Hlth Inst, Switzerland	747	12 (1.1)	20	1625 (0.006)	9.0	12 (1.4)	20	12 (0.43)	21	11 (0.56)	19	402 (0.039)	8.0
Univ Basel, Switzerland	744	13 (1.1)	19	1625 (0.006)	65	13 (1.4)	19	627 (0.025)	19	45 (0.23)	9.3	402 (0.039)	8.0
WHO, Switzerland	736	14 (1.1)	33	31 (0.32)	38	14 (1.3)	32	26 (0.26)	39	25 (0.28)	37	5 (1.3)	25
Inst Pasteur, France	694	15 (1.0)	26	26 (0.34)	22	15 (1.2)	26	19 (0.33)	30	18 (0.36)	27	24 (0.35)	10
Inst Oswaldo Cruz, Brazil	666	16 (1.0)	18	4 (1.3)	14	29 (0.85)	19	8 (0.63)	17	8 (0.60)	16	2 (2.1)	14
Univ Fed Rio De Janeiro, Brazil	665	17 (1.0)	13	20 (0.50)	8.8	17 (1.1)	14	14 (0.37)	12	15 (0.38)	12	11 (0.58)	11
University of Malaya, Malaysia	661	18 (1.0)	13	5 (1.2)	11	27 (0.88)	13	7 (0.69)	12	7 (0.73)	12	204 (0.078)	5.0
Johns Hopkins Univ, USA	640	19 (0.92)	27	58 (0.22)	30	16 (1.1)	27	17 (0.34)	30	20 (0.33)	27	24 (0.35)	28
Univ Calif San Francisco, USA	583	20 (0.84)	20	127 (0.12)	43	18 (1.1)	19	25 (0.28)	22	21 (0.33)	20	402 (0.039)	0

TP: total number of articles; *TPR* (%): the rank and the percentage of total articles in the total number of articles; *IPR* (%): the rank and the percentage of single-institute articles in the total single-institute articles; *CPR* (%): the rank and the percentage of inter-institutionally collaborative articles in the total inter-institutionally collaborative articles; *FPR* (%): the rank and the percentage of first-author articles in the total first-author articles; *RPR* (%): the rank and the percentage of the corresponding-author articles in the total corresponding-author articles; *SPR* (%): the rank and the percentage of the single-author articles in the total single-author articles; *CPP*: number of citations (TC_{2020}) per publication (*TP*); N/A: not available.

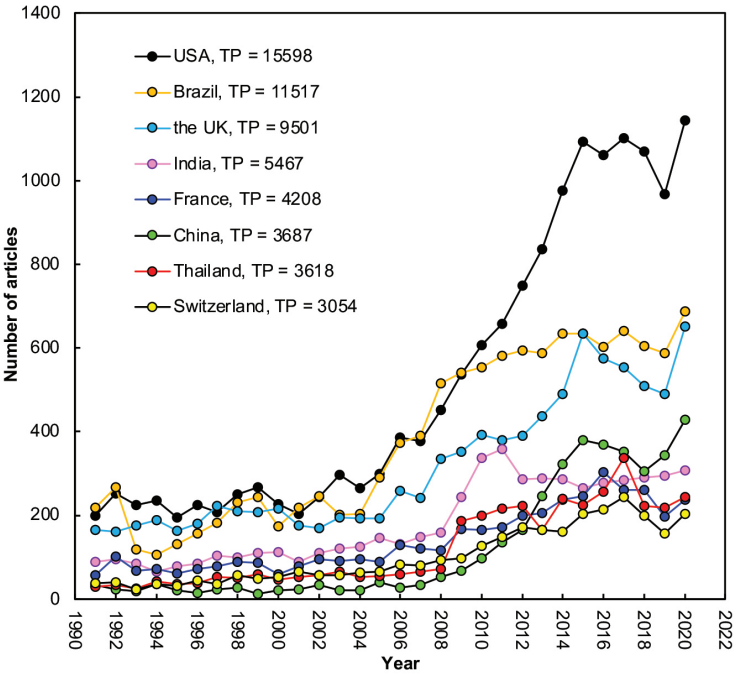

Fig. 2. Historical trend for the top eight productive countries with *TP* > 3.000.

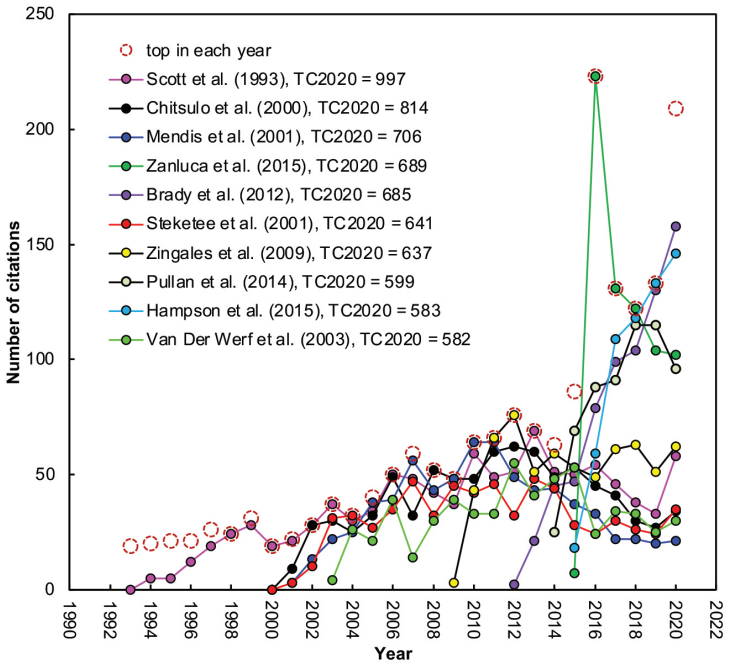

Fig. 3. The citation life of the top 10 most frequently cited articles in the Web of Science; citation lifespan can reach three decades.

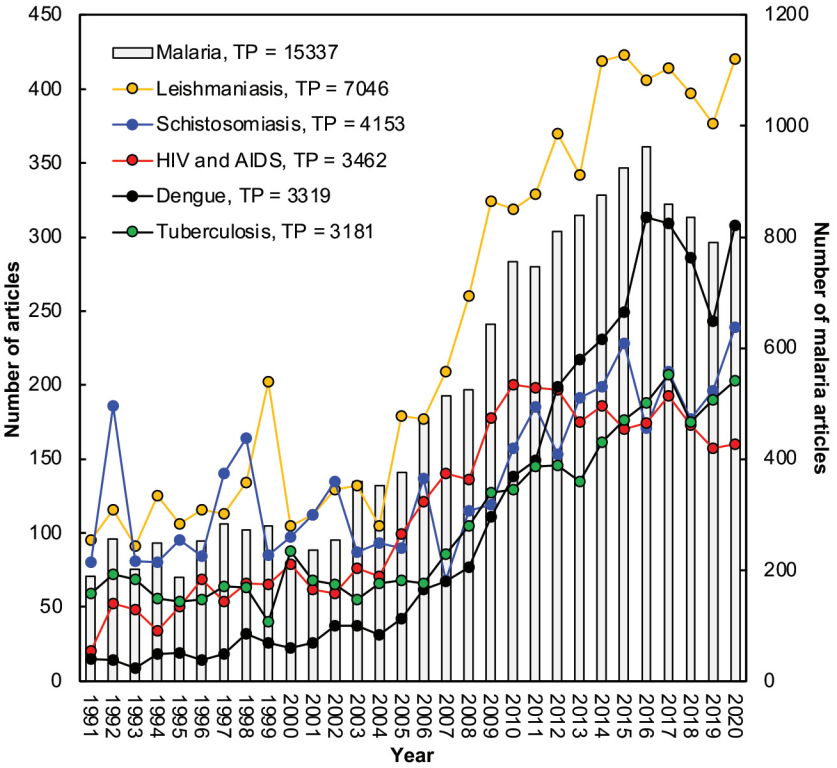

Fig. 4. Historical trend for the top six topics of "neglected tropical diseases" in the Web of Science. Malaria has its own scale (on the right side of graph) because the number of publications in this field is nearly three times more than any other disease in this category.

articles increased slightly from 1991 to 2004, after that, there was a sharply increase to reach a plateau in 2009 (Fig. 4).

The Dengue virus is transmitted to humans by mosquitoes of the genus *Aedes* and can potentially affect half of the world's population. Similarly, the number of Dengue articles increased slightly from 1991 to 2004; after that, there was an increase and a peak of 309 articles in 2017 (Fig. 4).

Tuberculosis is a potentially deadly disease caused by the bacterium *Mycobacterium tuberculosis*; it is transmitted from person to person and affects the lungs and, in later stages, other organs. Studies about tuberculosis fluctuated around 75 articles per year from 1991 to 2006; and increased afterwards to reach a peak of 207 articles in 2017 and 203 articles in 2020 (Fig. 4).

Considering the world production of articles in the eight fields of tropical medicine from 1990 to 2020, it is clear that productivity fluctuated around a stable mean from 1990 to 2000, but after the year 2000, there was an explosion in the number of publications covered by the database for Microbiology, Parasitology, Pathology and Genetics. There was little if any growth in the output for Toxicology, Pharmacology, Hematology and Clinical Chemistry (Fig. 5).

Historical trend in the *Revista de Biología Tropical*: Tropical medicine publications represented nearly all of the journal's contents in the first years, with a clear descending trend from 1953 through 1969; after that, the total contributions have remained relatively stable, with the normal oscillations of any field; the 2004 surge was caused by the publication, in that year, of a special issue about tropical medicine (Fig. 6). In total, the journal has published nearly 500 articles about tropical medicine.

Table 4

The top 15 most frequently cited articles with $TC_{2020} > 500$.

Rank (TC_{2020})	Rank (C_{2020})	Title	Country	Reference
1 (997)	15 (58)	Identification of single specimens of the *Anopheles gambiae* complex by the polymerase chain reaction	USA	Scott et al. (1993)
2 (814)	54 (34)	The global status of schistosomiasis and its control	Switzerland, China	Chitsulo et al. (2000)
3 (706)	171 (21)	The neglected burden of *Plasmodium vivax* malaria	Switzerland, USA, UK	Mendis et al. (2001)
4 (689)	6 (102)	First report of autochthonous transmission of Zika virus in Brazil	Brazil	Zanluca et al. (2015)
5 (685)	2 (158)	Refining the global spatial limits of dengue virus transmission by evidence-based consensus	UK, USA	Brady et al. (2012)
6 (641)	47 (35)	The burden of malaria in pregnancy in malaria-endemic areas	USA, Mozambique, Spain	Steketee et al. (2001)
7 (637)	12 (62)	A new consensus for *Trypanosoma cruzi* intraspecific nomenclature: Second revision meeting recommends TcI to TcVI	Brazil, USA, Colombia, UK, France, Argentina	Zingales et al. (2009)
8 (599)	8 (96)	Global numbers of infection and disease burden of soil transmitted helminth infections in 2010	UK, USA	Pullan et al. (2014)
9 (583)	3 (146)	Estimating the global burden of endemic canine rabies	UK, France, Tanzania, USA, Germany, Brazil, Cambodia, South Africa, St Kitts & Nevi, Switzerland, Canada	Hampson et al. (2015)
10 (582)	74 (30)	Quantification of clinical morbidity associated with schistosome infection in sub-Saharan Africa	Netherlands, Belgium, UK, Switzerland	Van Der Werf et al. (2003)
10 (582)	89 (27)	Parasite lactate dehydrogenase as an assay for plasmodium falciparum drug sensitivity	USA, UK	Makler et al. (1993)
12 (578)	47 (35)	The Alamar Blue® assay to determine drug sensitivity of African trypanosomes (*T.b. rhodesiense* and *T.b. gambiense*) in vitro	Switzerland	Räz et al. (1997)
13 (560)	347 (16)	Vivax malaria: Neglected and not benign	Australia, UK, Indonesia, Kenya, Thailand	Price et al. (2007)
14 (556)	38 (38)	The economic burden of malaria	USA, China	Gallup and Sachs (2001)
15 (525)	24 (45)	Anthropogenic environmental change and the emergence of infectious diseases in wildlife	USA, UK, Australia	Daszak et al. (2001)

TC_{2020}: the total number of citations from Web of Science Core Collection since publication year to the end of 2020; C_{2020}: the number of citations of an article in 2020 only.

DISCUSSION

The increase in the number of scientific publications in recent decades, has been found in practically all previous studies that use this particular database, the Web of Science (e. g. Jozi et al., 2022; Ranasinghe et al., 2022). However, this database only includes a small fraction of the world's science (Zhu & Liu, 2020), so we do not know if the trend reflects a real growth in the international scientific output, or just an increase in the number of journals included by the database (Zhu & Liu, 2020).

Table 5
Top 20 author keywords in articles in the Web of Science category of tropical medicine.

Author keywords	TP	1991–2020 Rank (%)	1991–2000 Rank (%)	2001–2010 Rank (%)	2011–2020 Rank (%)
Malaria	4 378	1 (12)	1 (13)	1 (10)	1 (12)
Plasmodium falciparum	1 829	2 (4.8)	2 (7.7)	3 (4.3)	2 (4.4)
Epidemiology	1 347	3 (3.5)	5 (4.2)	4 (4.2)	3 (3.2)
Brazil	1 130	4 (3.0)	3 (5.1)	2 (6.3)	16 (1.3)
Diagnosis	923	5 (2.4)	7 (4.0)	8 (2.9)	8 (2.0)
Chagas disease	833	6 (2.2)	11 (2.8)	6 (3.1)	11 (1.8)
Schistosomiasis	815	7 (2.1)	4 (4.6)	5 (3.2)	17 (1.3)
Prevalence	778	8 (2.1)	15 (2.0)	14 (2.1)	7 (2.0)
Trypanosoma cruzi	770	9 (2.0)	8 (3.4)	7 (2.9)	15 (1.4)
HIV	760	10 (2.0)	35 (1.0)	10 (2.3)	5 (2.1)
Children	738	11 (1.9)	10 (2.8)	13 (2.2)	12 (1.7)
Tuberculosis	725	12 (1.9)	18 (1.8)	11 (2.3)	10 (1.8)
Plasmodium vivax	709	13 (1.9)	27 (1.3)	29 (1.2)	4 (2.2)
Dengue	661	14 (1.7)	92 (0.53)	20 (1.6)	6 (2.0)
Risk factors	597	15 (1.6)	61 (0.74)	16 (2.0)	13 (1.6)
Schistosoma mansoni	597	15 (1.6)	9 (3.1)	9 (2.8)	43 (0.84)
Aedes aegypti	593	17 (1.6)	180 (0.31)	23 (1.4)	9 (1.9)
India	543	18 (1.4)	23 (1.7)	12 (2.2)	26 (1.1)
PCR	541	19 (1.4)	44 (0.88)	17 (1.7)	14 (1.4)
Visceral leishmaniasis	506	20 (1.3)	33 (1.0)	15 (2.0)	24 (1.1)

TP: total number of articles.

The fact that half of the specialized journals is no longer identified as tropical medicine journals, probably reflects editors' efforts to make their journals more general, and thus, to attract more authors, readers, and citations (see Summers & Wood, 2017).

The relative impact of journals in this database seem to reflect the fact that American journals are more extensively covered in the Web of Science than European journals, and that tropical journals are poorly covered (Calahorrano et al., 2020; Zhu & Liu, 2020).

It is surprising that half of the articles are published by single institutions, because in this field, local and international collaboration are common (Elhassan et al., 2022; González-Alcaide et al., 2017). A possible reason is that, frequently, the articles that reach the Web of Science are not from tropical countries; they are produced by powerful institutions in industrialized countries, and these institutions have less need of cooperating with others to obtain the necessary resources (Sagiyeva et al., 2018).

International collaboration articles normally have higher citation rates in all countries (Ho & Mukul, 2021); well-founded megaprojects usually address health problems of general interest, for which much research is published and, thus, many citations are accumulated.

The preeminence of the USA in this field results from two factors, the enormous scientific apparatus of that country, and its excellent coverage in the Web of Science, which is based in that country. The outstanding production of Brazil reflects the fact that Brazil is the scientific powerhouse of Latin America (González-Alcaide et al., 2017).

The outstanding production of Switzerland probably results from the establishment there of the World's Health Organization (www.who.int). The leading tropical countries, Kenya, Brazil and Thailand have in common that they

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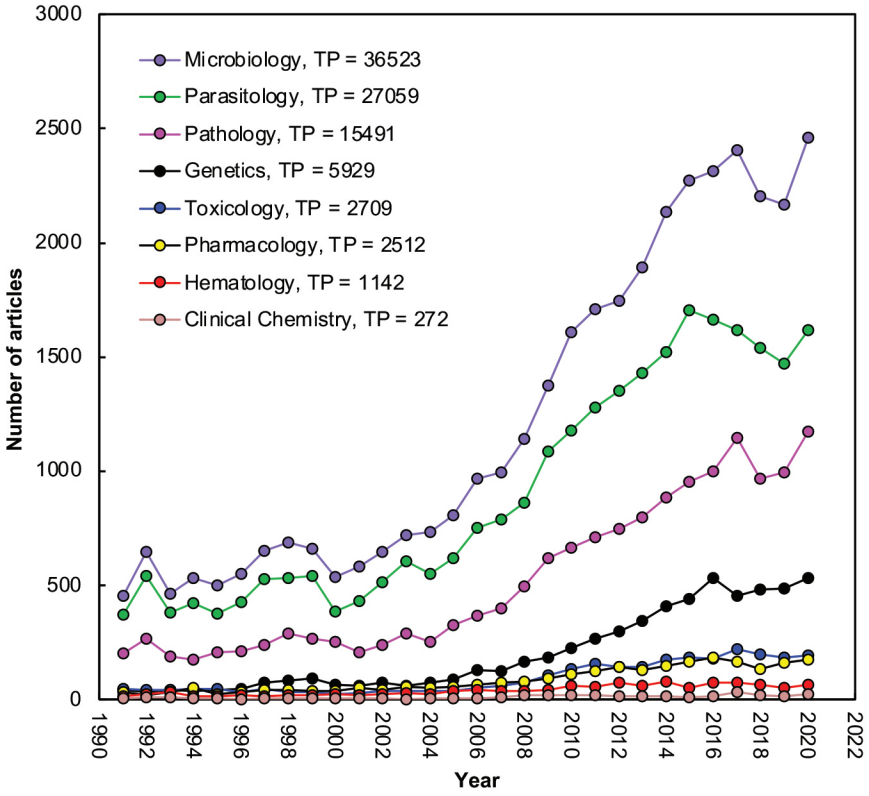

Fig. 5. Historical trend for the eight fields of tropical medicine considering all articles on the subject published by the Web of Science from 1990 to 2020.

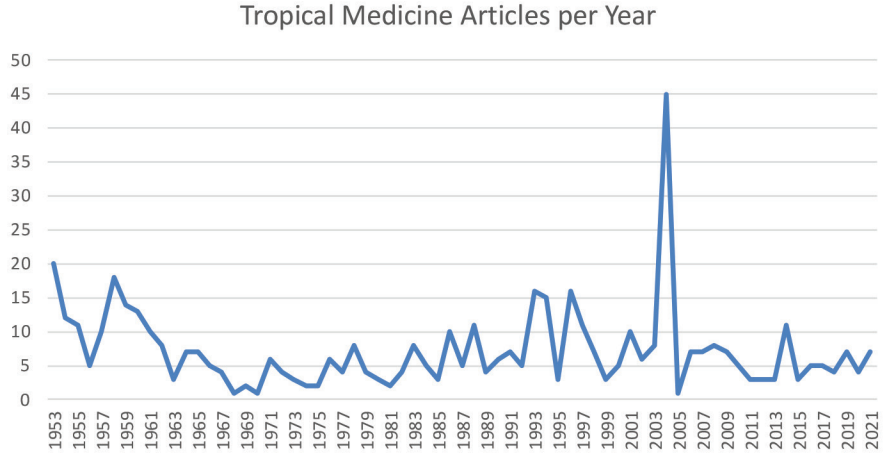

Fig. 6. Historical trend, by number of documents, of tropical medicine publications in the *Revista de Biología Tropical*.

are all large countries with respected academic institutions (González-Alcaide et al., 2017). These countries tend to be the ones where research continues to grow, while the stagnation of production in other large countries with tropical regions, like India, China, and Thailand, still needs to be explained.

An interesting question that does not seem to have been asked: Should scientometrics researchers use keywords in the titles, or keywords in the abstracts, or even how reliable Keywords Plus is. Our results indicate that overlap among these three keyword sources ranges from 35% to 50%, and thus, they are not interchangeable: they need to be analyzed separately.

Regarding keyword indicators of changes in scientific interest on particular diseases, the fact that malaria dominates research is not surprising because of its relative importance: in 2020, malaria caused an estimated 241 million clinical episodes, and 627 000 deaths (Centers for Disease Control and Prevention, 2022). The growth in the other diseases probably is just part of the overall growth that has characterized the Web of Science (Calahorrano et al., 2020; Nha-Trang et al., 2020; Ranasinghe et al., 2022); while the apparent reduction in interest on HIV and AIDS in recent years, probably reflects shifts in research interest as the AIDS epidemic was controlled (Wilson & Taaffe, 2017).

We cannot analyze in detail how the subjects published in the journal changed over 70 years, but the experience of one of the authors (JMN) as editor of the journal since the 1980s, is that there has been a general shift from classical fields like tropical parasitology, to other areas like genetics and pharmacology of tropical species. The same trend was found 20 years ago by Gutiérrez (2002). Despite this increase in the number of subjects, the *Revista de Biología Tropical* continues publishing a steady stream of tropical medicine articles until the present (Fig. 5).

In conclusion, our results indicate a two-decade long growth in the scientific productivity in all fields of tropical medicine, a growth that can only herald a better future for humanity and in which the *Revista de Biología Tropical* has played a role that exceeds expectations for a journal published in a country of only 52 000 km^2.

Ethical statement: The authors declare that they all agree with this publication and made significant contributions; that there is no conflict of interest of any kind; and that we followed all pertinent ethical and legal procedures and requirements. All financial sources are fully and clearly stated in the acknowledgements section. A signed document has been filed in the journal archives.

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REFERENCES

Brady, O. J., Gething, P. W., Bhatt, S., Messina, J. P., Brownstein, J. S., Hoen, A. G., Moyes, C. L., Farlow, A. W., Scott, T. W., & Hay, S. I. (2012). Refining the global spatial limits of dengue virus transmission by evidence-based consensus. *PLoS Neglected Tropical Diseases*, *6*(8), e1760.

Brennen, P. W., & Davey, W. P. (1978). Citation analysis in the literature of tropical medicine. *Bulletin of the Medical Library Association*, *66*(1), 24.

Calahorrano, L., Monge-Nájera, J., Wang, M. H., & Yuh-Shan, H. (2020). Ecuador publications in the Science Citation Index Expanded: institutions, subjects, citation and collaboration patterns. *Revista de Biología Tropical*, *68*(1), 98–107.

Centers for Disease Control and Prevention (2022). Malaria's Impact Worldwide. Centers for Disease Control and Prevention. https://www.cdc.gov/malaria/malaria_worldwide/impact.html

Chitsulo, L., Engels, D., Montresor, A., & Savioli, L. (2000). The global status of schistosomiasis and its control. *Acta Tropica*, *77*(1), 41–51.

Chong, Y. M., Long, X., & Ho, Y. S. (2021). Scientific landscape and trend analysis of keloid research: A 30-year bibliometric review. *Annals of Translational Medicine*, *9*(11), 945.

Chuang, K. Y., Chuang, Y. C., Ho, M., & Ho, Y. S. (2011). Bibliometric analysis of public health research in Africa: The overall trend and regional comparisons. *South African Journal of Science*, *107*(5/6), 54–59.

Daszak, P., Cunningham, A. A., & Hyatt, A. D. (2001). Anthropogenic environmental change and the emergence of infectious diseases in wildlife. *Acta Tropica*, *78*(2), 103–116.

Elhassan, M. M. A., Monge-Nájera, J., & Ho, Y. S. (2022). Bibliometrics of Sudanese scientific publications: Subjects, institutions, collaboration, citation and recommendations. *Revista de Biología Tropical*, *70*(1), 30–40.

Escobedo, A. A., Arencibia, R., Vega, R. L., Rodríguez-Morales, A. J., Almirall, P., & Alfonso, M. (2015). A bibliometric study of international scientific productivity in giardiasis covering the period 1971-2010. *The Journal of Infection in Developing Countries*, *9*(01), 076–086.

Falagas, M. E., Karavasiou, A. I., & Bliziotis, I. A. (2006). A bibliometric analysis of global trends of research productivity in tropical medicine. *Acta Tropica*, *99*(2–3), 155–159.

Fonseca, B. D. P., Albuquerque, P. C., & Zicker, F. (2020). Neglected tropical diseases in Brazil: lack of correlation between disease burden, research funding and output. *Tropical Medicine & International Health*, *25*(11), 1373–1384.

Fu, H. Z., Wang, M. H., & Ho, Y. S. (2012). The most frequently cited adsorption research articles in the Science Citation Index (Expanded). *Journal of Colloid and Interface Science*, *379*(1), 148–156.

Gallup, J. L., & Sachs, J. D. (2001). The economic burden of malaria. *American Journal of Tropical Medicine and Hygiene*, *64*(1–2), 85–96.

Girolami, E. (1988). Reseña histórica de la fundación de la *Revista de Biología Tropical*. *Revista de Biología Tropical 36*, 341–346.

Glover, S. W., & Bowen, S. L. (2004). Bibliometric analysis of research published in Tropical Medicine and International Health 1996–2003. *Tropical Medicine & International Health*, *9*(12), 1327–1330.

González-Alcaide, G., Park, J., Huamaní, C., & Ramos, J. M. (2017). Dominance and leadership in research activities: Collaboration between countries of differing human development is reflected through authorship order and designation as corresponding authors in scientific publications. *PloS one*, *12*(8), e0182513.

Gutiérrez, J. M. (1986). Algunas reflexiones sobre Clodomiro Picado Twight y su contribución al desarrollo de las ciencias médicas y naturales de Costa Rica. *Revista de Filosofía de la Universidad de Costa Rica 59*, 105–110.

Gutiérrez, J. M. (2002). Las publicaciones de investigación biomédica en la *Revista de Biología Tropical*. *Revista de Biología Tropical*, *50*(3–4), 941–949.

Hampson, K., Coudeville, L., Lembo, T., Sambo, M., Kieffer, A., Attlan, M., Barrat, J., Blanton, J. D., Briggs, D. J., Cleaveland, S., Costa, P., Freuling, C. M., Hiby, E., Knopf, L., Leanes, F., Meslin, F. X., Metlin, A., Miranda, M. E., Muller, T., … Dushoff, J. (2015). Estimating the global burden of endemic canine rabies. *PLoS Neglected Tropical Diseases*, *9*(4), e0003709.

Ho, Y. S. (2013). The top-cited research works in the Science Citation Index Expanded. *Scientometrics*, *94*(3), 1297–1312.

Ho, Y. S. (2014). Classic articles on social work field in Social Science Citation Index: A bibliometric analysis. *Scientometrics*, *98*(1), 137–155.

Ho, Y. S. (2021). A bibliometric analysis of highly cited publications in Web of Science category of emergency medicine. *Signa Vitae*, *17*(1), 11–19.

Ho, Y. S., & Mukul, S. A. (2021). Publication performance and trends in mangrove forests: A bibliometric analysis. *Sustainability*, *13*(22), 12532.

Ho, Y. S., Fahad Halim, A. F. M., & Islam, M. T. (2022). The trend of bacterial nanocellulose research published in the Science Citation Index Expanded from 2005 to 2020: A bibliometric analysis. *Frontiers in Bioengineering and Biotechnology*, *9*, 795341.

Jozi, Z., Abdi, S., & Shadi, S. (2022). Study of the world scientific output trends in the field of social services of public libraries in Scopus database with Scientometrics approach. *Journal of Knowledge-Research Studies*, *1*(1), 93–118.

Juang, G. D., Lin, S. M., & Ho, Y. S. (2021). Highly cited publications in the Web of Science category of anesthesiology in the Science Citation Index Expanded: A bibliometric analysis. *Journal of Scientometric Research*, *10*(2). 251–258.

Keiser, J., & Utzinger, J. (2005). Trends in the core literature on tropical medicine: a bibliometric analysis from 1952-2002. *Scientometrics*, *62*(3), 351–365.

Li, Z., Xue, J., & Zheng, B. (2021). Tropical Medicine in China: Bibliometric Analysis Based on Web of Science (2010–2019). *Journal of Tropical Medicine*, *2021*, 4267230.

Lin, C. L., & Ho, Y. S. (2015). A bibliometric analysis of publications on pluripotent stem cell research. *Cell Journal*, *17*(1), 59–70.

Makler, M. T., Ries, J. M., Williams, J. A., Bancroft, J. E., Piper, R. C., Gibbins, B. L., & Hinrichs, D. J. (1993).

Parasite lactate dehydrogenase as an assay for plasmodium falciparum drug sensitivity. *American Journal of Tropical Medicine and Hygiene*, *48*(6), 739–741.

Mendis, K., Sina, B. J., Marchesini, P., & Carter, R. (2001). The neglected burden of *Plasmodium vivax* malaria. *American Journal of Tropical Medicine and Hygiene*, *64*(1–2), 97–106.

Musa, T. H., Arbab, A. A. I., & Musa, H. H. (2020). Bibliometric analysis of Asian Pacific Journal of Tropical Medicine from 2008 to 2019. *International Journal of Public Health*, *9*(2), 129–136.

Nasir, S., & Ahmed, J. (2018). A bibliometric analysis of research on Zika virus indexed in web of science. *Advancements in Life Sciences*, *5*(3), 88–95.

Nha-Trang, N. T., Monge-Nájera, J., & Ho, Y. S. (2020). Bibliometrics of Vietnam Publications in the Science Citation Index: general trends and comparison with other tropical countries. *Revista de Biología Tropical*, *68*(4), 1221–1230.

Packard, R. M. (2012). Networks in Tropical Medicine: Internationalism, Colonialism, and the Rise of a Medical Specialty, 1890-1930. *Bulletin of the History of Medicine*, *86*(4), 693–694.

Price, R. N., Tjitra, E., Guerra, C. A., Yeung, S., White, N. J., & Anstey, N.M. (2007). Vivax malaria: Neglected and not benign. *American Journal of Tropical Medicine and Hygiene*, *77*(6), 79–87.

Pullan, R. L., Smith, J. L., Jasrasaria, R., & Brooker, S. J. (2014). Global numbers of infection and disease burden of soil transmitted helminth infections in 2010. *Parasites & Vectors*, *7*, 37.

Ramos, J. M., González-Alcaide, G., & Bolaños-Pizarro, M. (2013). Bibliometric analysis of leishmaniasis research in Medline (1945-2010). *Parasites & Vectors*, *6*(1), 1–14.

Ranasinghe, P., Monge-Nájera, J., Liyanage, C. K., & Ho, Y. S. (2022). Half a century of Sri Lanka research: Subjects, researchers, institutions, journals and impact (1973-2019). *Revista de Biología Tropical*, *70*(1), 40–53.

Räz, B., Iten, M., Grether-Bühler, Y., Kaminsky, R., & Brun, R. (1997). The Alamar Blue® assay to determine drug sensitivity of African trypanosomes (*T. b. rhodesiense* and *T. b. gambiense*) in vitro. *Acta Tropica*, *68*(2), 139–147.

Rodriguez-Morales, A. J., & Mayta-Tristán, P. (2009). Preliminary bibliometric evaluation of scientific publications produced in Latin America in the field of tropical and infectious diseases using SciELO. *The Journal of Infection in Developing Countries*, *3*(03), 247–249.

Sagiyeva, R., Zhuparova, A., Ruzanov, R., Doszhan, R., & Askerov, A. (2018). Intellectual input of development by knowledge-based economy: problems of measuring in countries with developing markets. *Entrepreneurship and Sustainability Issues*, *6*(2), 711.

Scott, J. A., Brogdon, W. G., & Collins, F. H. (1993). Identification of single specimens of the *Anopheles gambiae* complex by the polymerase chain reaction. *American Journal of Tropical Medicine and Hygiene*, *49*(4), 520–529.

Steketee, R. W., Nahlen, B. L., Parise, M. E., & Menendez, C. (2001). The burden of malaria in pregnancy in malaria-endemic areas. *American Journal of Tropical Medicine and Hygiene*, *64*(1–2), 28–35.

Summers, S. L., & Wood, D. A. (2017). An evaluation of the general versus specialist nature of top accounting journals. *Accounting Horizons*, *31*(2), 105–124.

Tchuifon Tchuifon, D. R., Fu, H. Z., & Ho, Y. S. (2017). Cameroon publications in the Science Citation Index Expanded: Bibliometric analysis. *Revista de Biología Tropical*, *65*(4), 1582–1591.

Wang, C. C., & Ho, Y. S. (2016). Research trend of metal-organic frameworks: A bibliometric analysis. *Scientometrics*, *109*(1), 481–513.

Wilkinson, A. (2014, June 29). *Expanding tropics will play greater global role, report predicts. State of the Tropics study aims to call attention to region.* Scienceinsider. www.science.org/content/article/expanding-tropics-will-play-greater-global-role-report-predicts

Wilson, D. & Taaffe, J. (2017). Chapter 8 Tailoring the Local HIV/AIDS Response to local HIV/AIDS epidemics. In K. K. Holmes, S. Bertozzi, B. R. Bloom & P. Jha. (Eds.), Major infectious diseases [3rd ed., Disease control priorities, pp. 157–178]. World Bank Group. https://www.ncbi.nlm.nih.gov/books/NBK525192/pdf/Bookshelf_NBK525192.pdf

Zachariah, R., Reid, T., Ford, N., Van den Bergh, R., Dahmane, A., Khogali, M., ... & Harries, A. D. (2012). The 2012 world health report 'no health without research': the endpoint needs to go beyond publication outputs. *Tropical Medicine & International Health*, *17*(11), 1409–1411.

Zanluca, C., Andrade de Melo, V. C., Pamplona Mosimann, A. L., Viana dos Santos, G. I., Duarte dos Santos, C. N., & Luz, K. (2015). First report of autochthonous transmission of Zika virus in Brazil. *Memórias do Instituto Oswaldo Cruz*, *110*(4), 569–572.

Zeledón, R. (2015). Origen de la Revista de Biología Tropical. *Revista de Biología Tropical, 63* (4), 1251–1254.

Zhang, G. F., Xie, S. D., & Ho, Y. S. (2010). A bibliometric analysis of world volatile organic compounds research trends. *Scientometrics*, *83*(2), 477–492.

Zhu, J., & Liu, W. (2020). A tale of two databases: The use of Web of Science and Scopus in academic papers. *Scientometrics*, *123*(1), 321–335.

Zingales, B., Andrade, S. G., Briones, M. R. S., Campbell, D. A., Chiari, E., Fernandes, O., Guhl, F., Lages-Silva, E., Macedo, A. M., Machado, C. R., Miles, M. A., Romanha, A. J., Sturm, N. R., Tibayrenc, M., & Schijman, A. G. (2009). A new consensus for *Trypanosoma cruzi* intraspecific nomenclature: Second revision meeting recommends TcI to TcVI. *Memórias do Instituto Oswaldo Cruz*, *104*(7), 1051–1054.