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Bats are the only flying Mammal: A Scientometric Analysis

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Abstract

Objectives: The paper explores five years of global research publications output on 'Bats'. The research study includes retrievement of various types of publication, authorship pattern; most cited authors with their respective countries and Hirsch index, highly cited publications with total citations and author's contribution, productivity and blow of leading institutions, identification of major participating countries contribution on bats and separated by continents Asia, Europe, North America, South America, Africa and Australia.

Methods: The requisite data retrieved from a renowned bibliographic database "Web of Science" published by Clarivate Analytics from 2016 to 2020 by means of searching the keyword 'bats', which is united with full records with cited reference. To obtain the scientometric results with citations using the softwares Histcite, VoS viewer and Biblioshiny.

Results: The global publications output on Bats research consisted of 10870 records during 2016 and 2020. The research publications inclined from 1778 published in 2016 to 2683 publications in 2020. There are 9826 institutions that contributed 2,585 journals from 162 countries published in 17 languages with a collaboration of 39655 authors. Most of the authors from China published multi authored papers and gained highest citations.

Conclusion: Bats are considered as a prime reason to spread some virus diseases like Nipha, Epola etc. so it is very much essential to ascertain the research output on bats to alarm the departments of Research and Development towards the enhancement of research.

Keywords: Bats, Mammal, Scientometrics, Nipha, Epola, Authorship, Histcite, Biblioshiny.

Introduction

Around the world, there are more than 1400 bat species available today. It is impossible to discuss or talk about all the bats species here. The size of the bat can be as large as a small dog or even can be small as a honey bee. Both are possible in the case of bat. The largest bat is the flying fox and its wingspan is up to two meters. The body weight of the flying fox is up to 1.5 kilograms. At the same time, the smallest bat is the bumblebee's bat which weighs only two grams. It is the world's smallest mammal. In the history of mankind the bats are closely associated with humans more than that of mice.

Roost is the name of the place of residence of bats. Unlike other mammals, bats need different kinds of residences or roosting conditions to live. According to the various seasons, the

bats move around various places to find their different kinds of roosts to meet up their needs. Some bats prefer hollow trees, some bats settle down in caves, some bats rest upon buildings and some live on hanging tiles and in roof spaces. It is interesting to know the three kinds of roosts of bats. in common, they have their roosts in trees, roosts in built structures and roosts in underground sites. Sometimes, bats may also roost in bat boxes. During the summer, female bats used to gather in a maternity roost to have their babies for several weeks. In winter, bats use hibernation roosts for their time. It is obvious that bats are not rodents. Usually bats never nibble on woods, wires and other bits and pieces in the buildings.

Nowadays, it is really sad to say that many species of bats are under threat. Many of the species of bats are endangered due various reasons. The role of bats in the ecosystems around the world is huge. The bats are known as indicator species in the United Kingdom. The growth or decreases in the population of bats reflect in the biodiversity. The transmission of virus from animals to humans happens due to the alterations done by human beings. The bats become close to human beings because of his attitude of destroying the roosts and disturbing the world of bats.

Mammals expanded antioxidant methods to protect against oxidative spoil in their routine life. Biochemical researches were carry out to examine Nrf2 in fruit bats on Old World and proved that the quantity of catalyses, which is synchronized by Nrf2, was appreciably lesser in the brain, heart and liver of Old World fruit bats despite high rank of Nrf2 protein in Old World fruit bats (Yin, 2016). Bats are normal hosts to frequent viruses and have early origins, its diverged from other ethereal mammals in early progression (Ng, Justin H. J, 2016), Bats acoustic signals go through the multifaceted interactions among morphology, ecology, social pressure, and phylogenetic history (Luo, Bo, 2017), Predators that chase using kill sounds can shrink the negative collision of noise by making use of quarry cues expressed through extra sensory systems (Gomes DGE, 2016).

Four special genotypes of corona-virus, three of which potentially new species, having less than ninety percent have nucleotide sequence identity with the majority has closely related explained viruses (Smith C. S, 2016), Insectivorous bats are likely to be the unique source, as a number of 2c corona-viruses have been depicted from various species in the family Vespertilionidae (Anthony S. J, 2017). High multiplicity of Corona-virus hosted by bats has improved in the last decade due to the more number of diseases caused by two zoonotic Beta-Corona-virus, SARS- Corona-virus and MERS- Corona-virus, that cause a number of respiratory diseases (De Sabato, Luca, 2019), two recent studies present initial imminent into a novel corona-virus that is related with an outbreak of human being respiratory illness (York A, 2020). 81 percent shared nucleotide uniqueness with human and civet SARS corona-virus, which was more remote than that observed for bat SL- corona-virus (Hu, Dan, 2018), the rapid MERS corona-viruses nucleocapsid protein discovered examine is clever to quickly detect ancestry C beta corona-viruses in bats (Woo, Patrick C. Y, 2018).

Literature Review

Singh etal, analyzed scientometric variables of 1007 records from scopus indexed journal articles on nipha virus in 2018. For obtaining on network visualization on nipha virus used by the softwares are VoS Viewer, Gephi and Sciences cape A small number of authors contributed high number of articles, 81 percent of the articles were in collaborative authorship. 81 countries were contributed, 525 records from North America continents and USA has 469 records. A total article published in 373 journals and ten core journals published more than thirty percent of the

articles. The inter continent collaboration of developed world nations with developing nations to deal with the publications of Nipha virus articles on the United States of America with Bangladesh.

Gupta, Ahmed and Gupta assessed the global publications of Nipha virus for twenty years. Sixty two countries published 1181 records during the study period of 1999-2018, every year got an average of 16.23 percentage of growth rate and 28.05 citations. The first three places occupied by the countries are USA, Australia and Malaysia, the broad subject areas are Medicine, Immunology and Microbiology respectively. 40.39 percent of articles shared in total publications were published in top twenty journals amongst 1077.

Laksham etal, analyzed open access research publications on coronavirus. 7381 records were retrieved in 17 types of sources from the web of science database in thirty two years from 1989-2020. During this period, single author records are very less than multi authored records and 24076 authors contributed from 127 countries. University of Hong Kong, China published 374 publications, 16 institutions got more than 2000 citations and 129 of them got more than 1000 citations. Journal of Virology published 1120 publications and the United States Department of Health Human Services funded 1740 publications.

Surulinathi M, Karthick M and Balasubramani R evaluated research performance on Hantavirus research publications between 1984 and 2020. Authors of 10152 from 122 countries published 3678 publications and the topic got 86204 Global Citation Scores. The records published in 19 types of sources (Articles 75.4 %) with 16 languages (English 93.8 %). The subject area Virology (25.56 %), the institution 'University of Helsinki' Finland produced highest 283 (9186 Citations) publications.

Sivankalai S and Badhusha KN assessed 15 years of records from the web of science core collection in the topic of Covid 19. The period 2005-2019, a total of 8037 records were published (average of 536) and the total growth rate is 13.45. The total records published in 13 sources, (6325 records are in articles) and 18 languages (7856 are in English language). The highest publications produced by the author Yuen KY (159 with h-index 53) and the institution University of Hong Kong (366 with 17489 citation scores). Using VoS viewer and present the graph of co-occurrence of author keyword and sources of citations.

Objectives of the study

The prime objective of this study is to study the performance and standing of entire Bats research publications of last five years (2016-2020), supported by a bibliographic database of Web of Science from Clarivate Analytics. This work focuses on the other related objectives such as distribution of research output on Bats in requisites of publications, authors, citations, Hirsch index. Publications output on countries, number of authors with Hirsch index, most cited authors, global institutions and citation score, major journals and highly cited papers.

Materials and Methods

The data were collected from the international bibliographic database of Web of Science in the version of 4.10 by the Clarivate Analytics covered Science Citation Index-Expanded (SCIE) and Social Sciences Citation Index (SSCI), in March 2021. The keyword using "Bats" in the core collection of database, the custom year range of 2016 to 2020 was chosen and getting the results of 10870 records downloaded from the database. Every 500 records were getting in a single time and chosen with full records, cited references with plain text. To analyze the results

after the records were downloaded from web of science database using Histcite software. It provides the following results like, records, authors, journals, cited references, words, yearly output, document type, language, institutions, institutions with subdivision and country. Microsoft Office-Excel using the result analysis on tables of this works with addition and percentage calculations. Using VoS viewer and Biblioshiny for getting graphs needed for this study.

Type of publications

Of the Global total publications output on bats research, the maximum records of 9099 (83.7%) come out in Journal Articles and the remaining are in twenty five different medium. Records of the following items, Review has 748 (6.9 %), Meeting Abstract has 300 (2.8%), Editorial Material has 221 (2.0%), Article in Early Access has 134 (1.2%), Article in proceeding papers has 80(0.7%), Letter has 74 (0.7%), Correction has 58 (0.5%), News Item has 55 (0.5), Book review has 24 (0.2%) , Reviews in Book chapter 19 (0.2) and Early access has 16(0.1%). Article in Data paper has 11 records (0.1%) and the remaining 13 items are below 10 records. Seven items of medium of communication have only one record and 4 items have two records only. Based on the citations, more records got more citations, Articles got 1, 02,865 citations followed by Reviews got 16, 988 citations. Following three of the items got more than 500 citations, Editorial Material (717), Articles in Proceedings Paper (661) and Reviews in Book Chapter (681). Among 26 of the medium, 8 of them do not get citations and 12 of them got below 100 citations during the study period.

Authorship pattern

Total of 10870 records, excluding 654 records (6.2 %) have been an outcome of collaborative authorship. The majority of the records of 1605 (14.77 %) were published by three authors followed by four authors published 1483 records (13.64) and 1342 records (12.35 %) were published by two authors. 1215 records are (11.18 %) were published by Five authors, 999 records (6.19 %) were published by Six authors, 611 records (7.07 %) were published Seven authors, 471 records (5.62 %) were published by eight authors, 387 records (4.33 %) were published by nine authors and 1722 records (15.22 %) were published by ten and more than ten authors respectively.

Table -1. Most Cited and significant Authors on Bats

Ranking	Name	Country	Affiliation	TP	TC	CPP	h-index
1	Chen J	China	Shanghai Jiao Tong University	20	8158	407.9	7
2	Zhan FX	China	Chinese CDC and Prevention	3	7830	2610.0	3
3	Shi ZL	China	Wuhan Institute of Virology, CAS	49	7286	148.7	19
4	Holmes EC	Australia	University of Sydney	24	6123	255.1	13
5	Chen Y	China	South China University of Technology	30	6055	201.8	12
6	Yang XL	China	Chinese Academy of Sciences, Wuhan	32	5728	179.0	14
7	Zhang W	China	Chinese Academy of Sciences,	37	5715	154.5	15

			Wuhan				
8	Zhou P	Singapore	Duke National University	22	5577	253.5	13
9	Li B	China	Chinese Academy of Sciences, Wuhan	31	5541	178.7	12
10	Zhu Y	China	Northwest A&F University, Shaanxi.	19	5309	279.4	10
11	Hu B	China	Chinese Academy of Sciences, Wuhan	14	5253	375.2	10
12	Zheng XS	China	Chinese Academy of Sciences, Wuhan	6	5228	871.3	5
13	Guo H	China	University of the Chinese Academy of Science, Beijing	7	5096	728.0	5
14	Shen XR	China	Chinese Academy of Sciences, Wuhan	5	5086	1017.2	5
15	Zhang L	China	Changchun University of Science and Technology	36	5057	140.5	11
16	Liu LL	China	Sun Yat- Sen University, Guangdong	5	5050	1010.0	4
17	Huang CL	China	Shanghai Jiao Tong University	4	5044	1261.0	3
18	Luo Y	China	Chinese Academy of Sciences, Wuhan	6	5030	838.3	5
19	Wang YY	Canada	University of Calgary, Alberta	5	4997	999.4	4
20	Zhao K	China	Sichuan Agricultural University,	7	4948	706.9	4

TP-Total Publications; TC- Total Citations; CPP-Citation per Paper

This table shows elaborately on most cited authors with their publications and h-index. Chen J tops the list of top 20 authors with Total Citation of 8158. Zhan FX, Shi ZL, Holmes EC, and Chen Y are in the next list with Total citations 7830, 7286, 6123 and 6055 respectively. Among 20 authors, first seven of them got more than 6000 citations, thirteen authors got citations between 5000 and 6000 and the remaining two are below 5000 citations. The maximum citations per paper (CPP) were attained by Zhan FX (2610.0), Huang CL (1261.0), Shen XR (1017.2), Liu LL (1010.0) and Wang YY (999.4).

Among top 20, based on the publications productivity, 9 authors published below ten publications, three authors published between 11 and 20, three authors between 21 and 30, four authors between 31 and 40 and one author published between 41 and 50 publications respectively. Zhan FX has published only 3 records and got Total Citations 7830.

The h-index is highest for Shi ZL (19) from Wuhan Institute of Virology, CAS. Zhang W (15) and Yang XL (14) come second and third highest from Chinese Academy of Sciences, Wuhan. They are followed by Holmes EC, University of Sydney and Zhou P, Duke National University, Singapore both are got 13, Chen Y, south China University of Technology and Li B, Chinese Academy of Sciences, Wuhan both are got the h-index 12 respectively.

The scientists from different institutions and countries were publishing the topic of Bats, this kind of analysis, among top twenty authors, there are seventeen from China, and the remaining are Australia, Singapore and Canada.

Table – 2. Top 20 Highly Cited publications on Bats

Rank	Titles	Authors	Month &Year	TC	NA
1	A pneumonia outbreak associated with a new coronavirus of probable bat origin	Zhou P, Yang XL, Wang XG, Hu B, Zhang L, et al.	Mar, 2020	4778	29
2	Genomic characterisation and epidemiology of 2019 novel coronavirus: implications for virus origins and receptor binding	Lu RJ, Zhao X, Li J, Niu PH, Yang B, et al.	Feb, 2020	3044	35
3	A familial cluster of pneumonia associated with the 2019 novel coronavirus indicating person-to-person transmission: a study of a family cluster	Chan JFW, Yuan SF, Kok KH, To KKW, Chu H, et al.	Feb, 2020	2585	21
4	A new coronavirus associated with human respiratory disease in China	Wu F, Zhao S, Yu B, Chen YM, Wang W, et al.	Mar, 2020	2127	19
5	Structure, Function, and Antigenicity of the SARS-CoV-2 Spike Glycoprotein	Walls AC, Park YJ, Tortorici MA, Wall A, McGuire AT, et al.	Apr, 2020	1577	6
6	The species Severe acute respiratory syndrome-related coronavirus: classifying 2019-nCoV and naming it SARS-CoV-2	Gorbalenya AE, Baker SC, Baric RS, de Groot RJ, Drosten C, et al.	Apr, 2020	1458	17
7	Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and coronavirus disease-2019 (COVID-19): The epidemic and the challenges	Lai CC, Shih TP, Ko WC, Tang HJ, Hsueh PR	Mar, 2020	1187	5
8	Origin and evolution of pathogenic coronaviruses	Cui J, Li F, Shi ZL	Mar, 2019	1160	3
9	The origin, transmission and clinical therapies on coronavirus disease 2019 (COVID-19) outbreak - an update on the status	Guo YR, Cao QD, Hong ZS, Tan YY, Chen SD, et al.	Mar, 2020	1023	9
10	Genomic characterization of the 2019 novel human-pathogenic coronavirus isolated from a patient with atypical pneumonia after	Chan JFW, Kok KH, Zhu Z, Chu H, To KKW, et al.	Jan, 2020	742	7

	visiting Wuhan				
11	Emerging coronaviruses: Genome structure, replication, and pathogenesis	Chen Y, Liu QY, Guo DY	Apr, 2020	740	3
12	Structural basis of receptor recognition by SARS-CoV-2	Shang J, Ye G, Shi K, Wan YS, Luo CM, et al.	May, 2020	648	9
13	A Review of Coronavirus Disease-2019 (COVID-19)	Singhal T	Apr, 2020	578	1
14	Broad-spectrum antiviral GS-5734 inhibits both epidemic and zoonotic coronaviruses	Sheahan TP, Sims AC, Graham RL, Menachery VD, Gralinski LE, et al.	June, 2017	534	23
15	Evolutionary history, potential intermediate animal host, and cross-species analyses of SARS-CoV-2	Li XG, Zai JJ, Zhao Q, Nie Q, Li Y, et al.	June, 2020	518	7
16	COVID-19 infection: Origin, transmission, and characteristics of human coronaviruses	Shereen MA, Khan S, Kazmi A, Bashir N, Siddique R	July, 2020	508	5
17	Transmission routes of 2019-nCoV and controls in dental practice	Peng X, Xu X, Li YQ, Cheng L, Zhou XD, et al.	Mar, 2020	442	6
18	Identifying SARS-CoV-2-related coronaviruses in Malayan pangolins	Lam TTY, Jia N, Zhang YW, Shum MHH, Jiang JF, et al.	July, 2020	395	29
19	Harris hawks optimization: Algorithm and applications	Heidari AA, Mirjalili S, Faris H, Aljarah I, Mafarja M, et al.	Aug, 2019	385	6
20	On the origin and continuing evolution of SARS-CoV-2	Tang XL, Wu CC, Li X, Song YH, Yao XM, et al.	June, 2020	376	12

TC - Total Citations; NA – Number of Authors

The list of most cited and influential articles with authors is shown in Table 2. The most cited research publications are arranged on the basis of the maximum number of Total citations along with the numbers of authors towards the contribution. A research article entitled, “A pneumonia outbreak associated with a new coronavirus of probable bat origin” was published in March, 2020 and it was authored by 29 authors including Zhou P, Yang XL, Wang XG, Hu b, Zhang L. The total number of citations of this research article is 4778. Among top 20 highly cited publications on Bat, only one paper crossed above 4000 citations. Following it, one paper was cited by more than 3000 times, 2 by more than 2000 times. Five research papers got citations between 1000 and 2000, seven research papers got citations between 500 and 1000 and the remaining got below 500 citations. In 2020, eighteen research papers were published, one was published in 2017 and another one was in 2019. Among the top 20 highly cited research articles, only one article published by a single author (Singhal T) and the remaining are multi

authored articles. There are four articles authored by 2-5 authors, seven articles by 6-10 authors, three articles by 11-20 authors and five articles by more than 20authors.

Table -3. Highly prolific countries on Bats

Ranking	Countries	Records	TGCS	Continent
1	USA	3562	45213	North America
2	Peoples R China	1524	41222	Asia
3	Germany	1082	14186	Europe
4	UK	1039	13170	Europe
5	Brazil	791	5459	South America
6	Australia	646	13779	Australia
7	Canada	596	5796	North America
8	France	523	7697	Europe
9	India	498	5326	Asia
10	Japan	482	4347	Asia
11	Spain	446	7110	Europe
12	Italy	410	5743	Europe
13	Mexico	337	2378	North America
14	Netherlands	311	5842	Europe
15	Switzerland	285	4295	Europe
16	South Africa	240	2126	Africa
17	Iran	193	2818	Asia
18	Poland	193	2273	Europe
19	Sweden	184	2499	Europe
20	Russia	175	2544	Europe

The highest records published on bats by top 20 countries with their citations to be tabulated in table 3. Among the top 20, European continent placed in the first place (10 records) followed by Asian continent (4 records) and the North American Continent. The remaining continents South America, Australia and Africa have published one record each. The highest number of records distributed by USA (3562) followed by China (1524), Germany (1082) and UK (1039). First four countries only published more than 1000 records, next four countries published more than 500 records and the remaining 12 countries published 100-500 records. Based on the citation, USA (45213) and China (41222) have got the highest citations than other countries, followed by Germany (14186), UK 13170) and Australia (13779). Thee the remaining 15 countries crossed below 10000 citations during the study period.

Continents wise publications output

The continent wise distribution of total research output on Bats research literature, the European continent placed in the first position among 43 (26.54 %) countries with the highest publication of 6293 records on Bats output and it's got along with a high of 84229 citation scores, followed by North American countries which placed in second position published 4702 publications from 17 (10.49 %) countries and it's got 54622 citations respectively. The continent

of Asia occupies third place with 4136 publications from 39 (24.07 %) countries and it's got 71591 citations, 14 countries (8.64 %) from South American countries with 1306 publications and it's got 10030 citations, 42 countries from (25.93 %) African countries with 858 publications and it's got 7636 citations and 8 countries from (4.94 %) Australian countries with 764 publications and it's got 15455 citations

Table - 4. Bats publications on European countries

Ranking	Countries	Records	Percent of 10870	Percent of 6293	TGCS
1	Germany	1082	10.0	17.19	14186
2	UK	1039	9.6	16.51	13170
3	France	523	4.8	8.31	7697
4	Spain	446	4.1	7.09	7110
5	Italy	410	3.8	6.52	5743
6	Netherlands	311	2.9	4.94	5842
7	Switzerland	285	2.6	4.53	4295
8	Poland	193	1.8	3.07	2273
9	Sweden	184	1.7	2.92	2499
10	Russia	175	1.6	2.78	2544
11	Belgium	168	1.5	2.67	1904
12	Denmark	152	1.4	2.42	2359
13	Portugal	141	1.3	2.24	1690
14	Austria	137	1.3	2.18	1775
15	Czech Republic	134	1.2	2.13	1134
16	Hungary	129	1.2	2.05	963
17	Finland	120	1.1	1.91	2037
18	Turkey	109	1.0	1.73	1070
19	Norway	90	0.8	1.43	985
20	Ireland	75	0.7	1.19	1149
21	Romania	61	0.6	0.97	569
22	Slovakia	54	0.5	0.86	503
23	Greece	51	0.5	0.81	899
24	Serbia	39	0.4	0.62	401
25	Slovenia	32	0.3	0.51	390
26	Bulgaria	29	0.3	0.46	146
27	Croatia	28	0.3	0.44	254
28	Ukraine	28	0.3	0.44	76
29	Georgia	16	0.1	0.25	129
30	Latvia	10	0.1	0.16	99
31	Cyprus	5	0.0	0.08	40
32	Estonia	5	0.0	0.08	6
33	Iceland	4	0.0	0.06	122
34	Albania	4	0.0	0.06	44
35	BELARUS	4	0.0	0.06	27
36	Lithuania	4	0.0	0.06	19
37	Luxembourg	4	0.0	0.06	56

38	Kazakhstan	3	0.0	0.05	9
39	Malta	3	0.0	0.05	4
40	Vatican	3	0.0	0.05	10
41	Bosnia & Herceg	1	0.0	0.02	1
42	Montenegro	1	0.0	0.02	0
43	North Macedonia	1	0.0	0.02	0
		6293	57.8	100.00	84229

The table 4 points out the analysis of the publishing rank of European continent in country wise on Bats research. The countries from European continent have research publications of bats higher than (43 countries) other continents. Developing countries have research and development of all fields, in this series, the countries of German and UK produced the highest number of research output on bats in this study period. The countries of German and UK published highest records of 1082 and 1039, received highest citations of 14186 and 13170. There are 16 countries producing the records by 100-1000, 12 countries by 10-100 and 13 countries by below 10 records. Citations on countries, 18 of them have crossed 1000 citations, 11 of them by 100-1000, 12 of them below 100 citations and two countries not yet cited.

Table - 5. Bats publications on North American countries

Ranking	Countries	Records	Percent of 10870	Percent of 4702	TGCS
1	USA	3562	32.8	75.75	45213
2	Canada	596	5.5	12.68	5796
3	Mexico	337	3.1	7.17	2378
4	Panama	138	1.3	2.93	943
5	Cuba	17	0.2	0.36	56
6	Guatemala	10	0.1	0.21	49
7	Dominican Rep	9	0.1	0.19	31
8	Laos	7	0.1	0.15	56
9	Jamaica	5	0.0	0.11	3
10	Honduras	5	0.0	0.11	7
11	Nicaragua	4	0.0	0.09	39
12	Bahamas	3	0.0	0.06	13
13	St Kitts & Nevi	3	0.0	0.06	12
14	Grenada	2	0.0	0.04	2
15	Haiti	2	0.0	0.04	20
16	Cayman Islands	1	0.0	0.02	2
17	Dominica	1	0.0	0.02	2
		4702	43.2	100.00	54622

Total of 4702 records crossed 54,622 citations from 17 countries of the North American continent. USA (3562) have published the highest records in the globe and this continent and the two countries of Cayman Island and Dominica published very low of one record. There are eleven countries published below 10 records, two countries by

10-20 records. Three countries published three digit records of 596, 337 and 138 by Canada, Mexico and Panama. 45213 citations received by USA, 5796, 2378 and 943 citations received by the countries Canada, Mexico and Panama. The remaining 8 countries received below 100 citations and 5 countries received below 10 citations.

Table - 6. Bats publications on Asian Countries

Ranking	Countries	Records	Percent of 10870	Percent of 4136	TGCS
1	Peoples R China	1524	14.0	36.85	41222
2	India	498	4.6	12.04	5326
3	Japan	482	4.4	11.65	4347
4	Iran	193	1.8	4.67	2818
5	Singapore	172	1.6	4.16	4107
6	South Korea	170	1.6	4.11	1277
7	Israel	152	1.4	3.68	1946
8	Malaysia	138	1.3	3.34	1102
9	Saudi Arabia	118	1.1	2.85	1573
10	Taiwan	112	1.0	2.71	2025
11	Vietnam	105	1.0	2.54	835
12	Thailand	90	0.8	2.18	876
13	Pakistan	82	0.8	1.98	404
14	Indonesia	41	0.4	0.99	244
15	U Arab Emirates	36	0.3	0.87	470
16	Bangladesh	32	0.3	0.77	227
17	Philippines	30	0.3	0.73	141
18	Jordan	28	0.3	0.68	960
19	Cambodia	22	0.2	0.53	174
20	Iraq	18	0.2	0.44	148
21	Sri Lanka	12	0.1	0.29	113
22	Lebanon	10	0.1	0.24	128
23	Brunei	9	0.1	0.22	38
24	Qatar	8	0.1	0.19	22
25	Myanmar	8	0.1	0.19	83
26	Palestine	8	0.1	0.19	698
27	Nepal	7	0.1	0.17	113
28	Armenia	6	0.1	0.15	27
29	Kuwait	5	0.0	0.12	39
30	Oman	5	0.0	0.12	9
31	Mongolia	4	0.0	0.10	43
32	Bahrain	2	0.0	0.05	3
33	Kyrgyzstan	2	0.0	0.05	3
34	Seychelles	2	0.0	0.05	24
35	Togo	2	0.0	0.05	14
36	Azerbaijan	1	0.0	0.02	3
37	North Korea	1	0.0	0.02	9

38	Tajikistan	1	0.0	0.02	0
		4136	38.2	100.00	71591

This table indicates the publishing positions according to country wise analysis of the Asian Continent research output on Bats. China has the highest productivity of 1524 records and 14 percent of world output, 36.85 percent of Asian countries, received 41, 222 citations and it stood first rank among 38 countries. Remaining countries produced below 500 records of bats research. Next to that India and Japan produced the records of 498 and 482, world output of 4.6 and 4.4 and received the citations of 5326 and 4347. Among 38 countries, the first eleven countries produced more than 100 records during the study period, next eleven countries by 10-100, remaining 16 countries produced below 10 records. India (5326), Japan (4347) and Singapore (4107) received highest citations next to China. Few of the countries received below 10 citations and the country Tajikistan has not gained even a single citation.

Table -7. Bats publications on South America

Ranking	Countries	Records	Percent of 10870	Percent of 1306	TGCS
1	Brazil	791	7.3	60.57	5459
2	Chile	122	1.1	9.34	1462
3	Colombia	102	0.9	7.81	651
4	Argentina	97	0.9	7.43	1057
5	Costa Rica	64	0.6	4.90	351
6	Peru	38	0.3	2.91	270
7	Ecuador	23	0.2	1.76	228
8	Venezuela	20	0.2	1.53	116
9	Uruguay	18	0.2	1.38	243
10	French Guiana	10	0.1	0.77	83
11	Bolivia	9	0.1	0.69	77
12	Trinidad Tobago	8	0.1	0.61	20
13	Paraguay	3	0.0	0.23	6
14	Suriname	1	0.0	0.08	7
		1306	12	100.00	10030

Twelve percent of publications produced by South American countries in the world research output on Bats research publications. Among the south American countries, Brazil produced 791 publications with 5459 citation value measured, 7.3 percent of world output, 60.57 percent of this continent and it stood first position; Chile and Colombia produced the records 122 and 102, with citations 1462 and 651. The country of Argentina received 1057 citations from 97 publications, 0.9 percent of the world and 7.43 percent of continent output. Out of 14 countries, only three countries produced more than 100 publications and four countries produced less than 10 publications, three countries crossed more than 1000 citations and five countries received below 100 citations during this study period.

Table - 8. Bats publications on African Countries

Ranking	Countries	Records	Percent of 10870	Percent of 858	TGCS
1	South Africa	240	2.2	27.97	2126
2	Egypt	106	1.0	12.35	1535
3	Algeria	57	0.5	6.64	668
4	Madagascar	49	0.5	5.71	263
5	Kenya	38	0.3	4.43	274
6	Ghana	35	0.3	4.08	133
7	Nigeria	27	0.2	3.15	150
8	Cameroon	25	0.2	2.91	219
9	Gabon	25	0.2	2.91	296
10	Congo	21	0.2	2.45	156
11	Uganda	19	0.2	2.21	185
12	Zambia	19	0.2	2.21	82
13	Swaziland	16	0.1	1.86	99
14	Cote Ivories	15	0.1	1.75	75
15	Tunisia	15	0.1	1.75	89
16	Ethiopia	14	0.1	1.63	113
17	Eswatini	12	0.1	1.40	82
18	Morocco	12	0.1	1.40	180
19	Tanzania	12	0.1	1.40	89
20	Mauritius	11	0.1	1.28	64
21	Senegal	10	0.1	1.17	149
22	Sierra Leone	8	0.1	0.93	158
23	Rep Congo	7	0.1	0.82	42
24	Mozambique	6	0.1	0.70	32
25	Sudan	6	0.1	0.70	50
26	Namibia	6	0.1	0.70	10
27	Zimbabwe	6	0.1	0.70	36
28	Botswana	5	0.0	0.58	11
29	Malawi	5	0.0	0.58	16
30	Burkina Faso	4	0.0	0.47	89
31	Cen. African Republic	4	0.0	0.47	35
32	Gambia	4	0.0	0.47	41
33	Comoros	3	0.0	0.35	12
34	Rwanda	3	0.0	0.35	25
35	Benin	2	0.0	0.23	11
36	Equator Guinea	2	0.0	0.23	10
37	Liberia	2	0.0	0.23	0
38	Uzbekistan	2	0.0	0.23	11
39	Yemen	2	0.0	0.23	11
40	Cape Verde	1	0.0	0.12	0
41	Sao Tome & Principle	1	0.00	0.12	9
42	Eritrea	1	0.0	0.12	0

		858	7.5	100.00	7636

Under developing countries from African continent, 42 of them contributed 858 records in the short period of five years from 2016 to2020. The first two countries, South Africa (240 publications) and Egypt (106 publications) published more than 100 publications and the remaining 40 countries were published below 100 publications. The country Algeria issued 57 records, which is followed by Madagascar 49 records, Kenya 38 records and Ghana 35 records respectively. There are two records brought out between 31 to 40, four records between 21-30, ten records between 11-20 and twenty two records between 1-10 records.

In the analysis based on citations among African countries, South Africa got 2126 citations, Egypt 1535 and Algeria got 668 citations. Four countries got more than 200 citations, eight countries got more than 100 citations and the remaining countries got below 100 citations. If the funding agencies contribute research scientists of African countries, the publications in this topic on Bats will increase.

Table -9. Bats publications on Australian Countries

Ranking	Countries	Records	Percent of 10870	Percent of 764	TGCS
1	Australia	646	5.9	84.55	13779
2	New Zealand	93	0.9	12.17	1361
3	Guinea	13	0.1	1.70	207
4	Fiji	4	0.0	0.52	8
5	New Caledonia	3	0.0	0.39	19
6	Solomon Islands	3	0.0	0.39	25
7	Papua N Guinea	1	0.0	0.13	25
8	Tonga	1	0.0	0.13	31
		764	6.9	100	15455

There are eight Australian countries that contributed 764 research publications on bats and got 15455 citations around the globe. Australia, New Zealand and Guinea got the first three places and they published 646, 93 and 13 records respectively. The countries, Fiji published 4 records, New Caledonia and Solomon Island published 3 records each and the remaining countries Papua N Guinea and Tonga published only one record each.

Publication Languages

English language is the common medium of publication to publish any research article around the world. 10870 records of bats research publications were published in seventeen languages during the study period. Among 17 languages, more than 10 thousand records were published in the English language, 6 languages by 10-50 publications, 10 languages by 1-10 publications. 10746 publications by English language followed by the languages of Spanish (35), Polish (19), Russian (14), German (12), French (11) and Portuguese (10). The remaining languages, Chinese has 7 records, 3 records each by Hungarian, Italian and Japanese, 2 records by Turkish, one records each by Croatian, Czech, Dutch, Malay and Slovak languages.

Mapping – VoS Viewer

Scientists from the Centre for science and technology studies, Leiden University's Van Eck and Waltman made a software tool on VoS Viewer. It is for constructing and envisaging scientometric networks on five 'types of analysis' with 'unit of analysis'. It shows co-authorship with Authors, organizations, countries, co-occurrences with keyword analysis, Citation and Bibliographic coupling with documents, sources, authors, organizations and countries, co-citations with cited references, cited sources and cited authors.

Once get on un-zipped Vos viewer from http://www.vosviwer.com and open it, file chosen and create, "create a map based on bibliographic data" and uploaded bibliographic database file (downloaded from web of science) then chosen co-authorship in type of analysis and organization in unit of analysis. After choosing it the process will give the result during running layout algorithms and cluster algorithms.

Co-authorship of Organizations (citations)

The minimum number of citation an organization is 5 and minimum number of citations of an organization is 0, of the 9547 organizations, 1317 meet the thresholds then it will show, for each of the 1317 organizations, the total strength of the **co-authorship** links with other **organizations** citations will be calculated. The organizations with the greatest total link will be selected. Number of organizations to be selected by 1000, there are 13 clusters of co-authorship from organizations citation. The first cluster of Red have 144 organizations, followed by the clusters indicates Green color (114), Blue (106), Olive (100), Violet (91), Sky blue (87), Sandy (67), saddle brown and orchid have each items (63), light salmon (61), light green (45), light blue (35) and khaki (24).

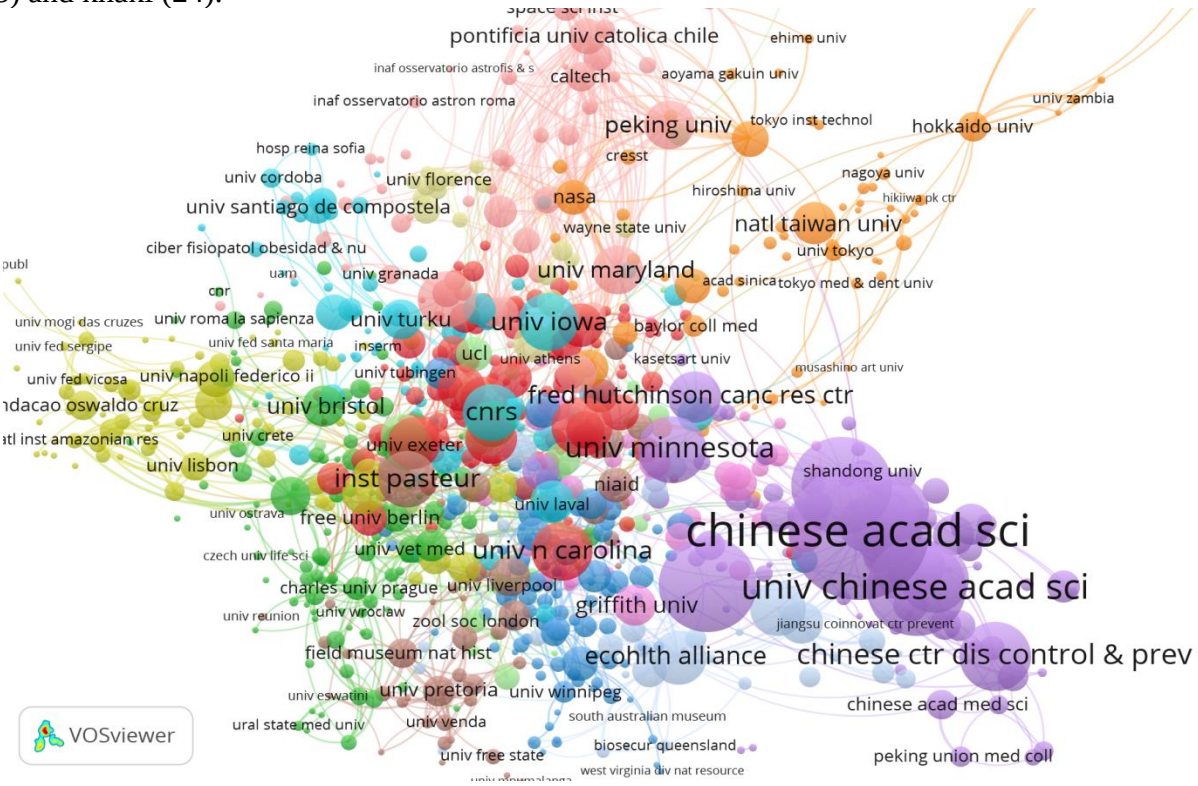

Figure 1.Co-authorship of organizations

Analysis of the above figure, 564 links of Chinese academy of Sciences have 221 documents with highest (13249) citations, followed by 520 links of Smithsonian tropical research institute have 157 documents with 1114 citations, 404 links of university of Maryland have 99 documents with 1731 citations, 353 links of University of Cambridge with 1389 citations, 340 links of pontifical Catholic university of Chile with 944 citations and 325 links of Peking university with 1735 citations.

Word Cloud - Author's keywords on bats

Data collected the five years of the period 2016-2020 on bats literature word cloud. Overall Author's Keywords (22478) analysis used biblioshiny tools for world cloud apply graphical parameters field author's keywords. Minimum number of keywords (50) using to measure frequency of author's keywords in bats literature. Creation of shape triangle - forward text contained colour random dark. In Fig.3, reflected the highly occurrence of the keywords bats(669), bat(370), bat algorithm (290), obesity(274), thermogenesis (219), sars-Cov-2 (167), Coronovirus (166), Covid (154), and rest of author's keyword occurrence below 150 indicated that very small Finally pointed out that Figure occurrence

Figure 2. Word cloud – Authors' keywords on Bats

Three-factor plots

Using Biblioshiny mapped the plots on three factors. Here three-factor plots of the relationship among Countries (left), Authors (center), and Affiliations (right) on bats in the above figure. Which shows that the researchers from top contributing countries (China, USA Germany, and United Kingdom and Singapore) Authors have contributed by Wang IF, Ricci C,

and Rensen PCN. Few Affiliations have contributed Leiden University, Smithsonian Tropical Research Institute than we have found that relationship in the above the Three-factor plots Wang IF highly Author relationship with countries like Singapore, USA, Australia, and China. The major block shows a greater link and relationship of countries, authors and universities.

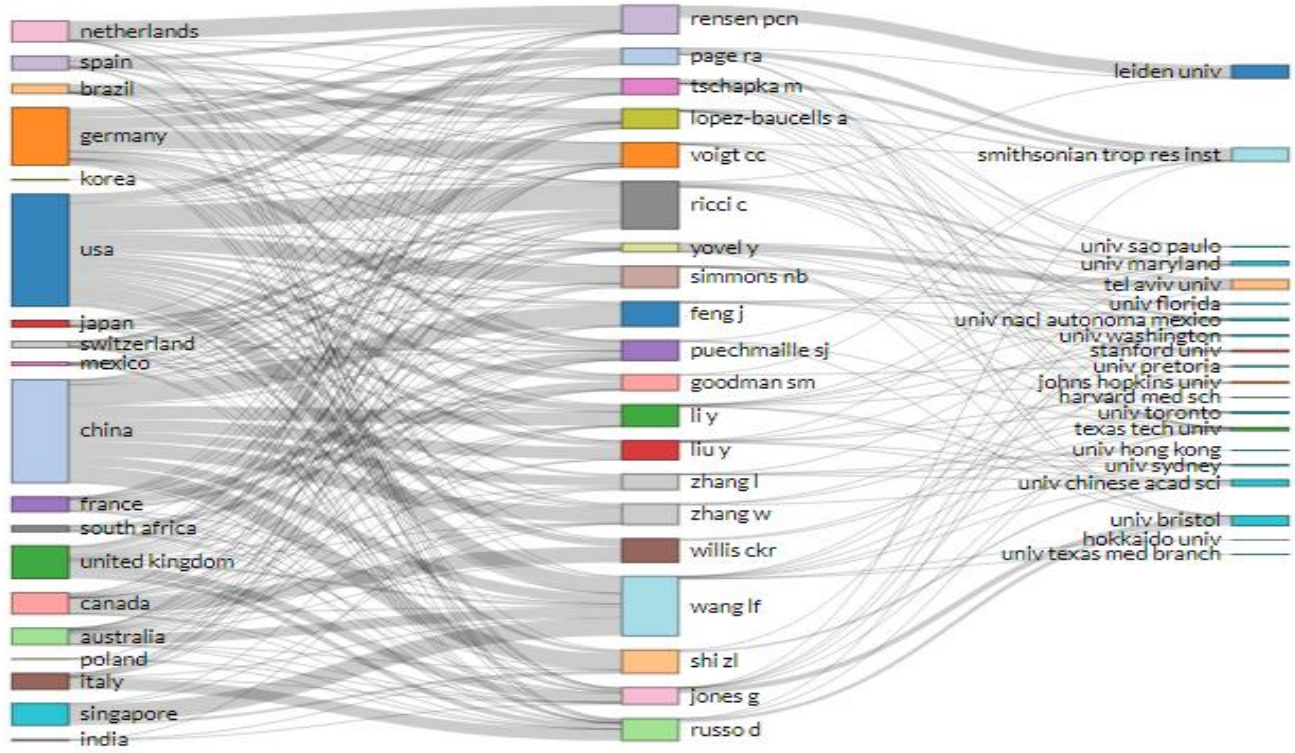

Figure 3.Three factor plots - Countries, Authors, and Affiliations on Bats

Conclusion

Outcomes of this study relating to the scientometric study of the research on 'bats' published and indexed in many fronts including the documents type, authors with h-index, continents with countries, the publication years, the most publishing, journals, and the subject areas. The results moreover provided valuable evidence on the citations made to the papers on the 'bats' including, Number of Citations and H-index.

The data downloaded from the web of science including Science Citation Index Expanded, Social Sciences Citations Index and Conference Proceedings Citations Index-Science. During the study period, 10870 publications are published and recorded 122801 Citations and 67477 authors from 9826 institutions were contributed in 2585 journals.

It is found that most of the records are in Articles, 5863 records out of 10870 are published in open access journals including 3762 green published. Web of science categorized the publications of bats under Zoology (1396), Ecology (1231) and Multidisciplinary Sciences (943), highly productive countries are United States of America (3605), China (1527), Germany (1093) and England (918). Total records published by 17 languages, few of the publications by Editors Kielian M(3), Metternleiter TC (3), Roossinck MJ(3), and Group of Authors Vision Consortium (4), Magic Collaboration (3), Prdict Consortium (3). Research areas in bats are

Environmental Sciences Ecology (1560), Zoology (1425), Science Technology other topics (1034) and Biochemistry molecular biology (609). Funding agencies from developed countries contributed more number of publications; USA, China, Europe, German and Japan are the top most funding countries on Bats.

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