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GLOBAL RESEARCH TRENDS IN ENTOMOLOGY DURING 2012 – 2016: AN ANALYTICAL STUDY

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Abstract

The present study explores the quantum of productivity in the field of Entomology. For this study, the data were downloaded from the 'Web of Science Core Collection' database and there were 1671 records contributed globally level over a period of five years i.e. 2012-2016. The study contributes to the different aspects of Entomology research, such as year wise distribution, country wise, authorship pattern, the degree of collaboration, and most prolific authors etc. The highest number of records was published in the year 2016, while lowest numbers of records was published in 2012. The doubling time for publications at the decreased level has been computed during 2013 - 2016. The frequency occurrence of words among the publications revealed that the word 'Diptera' is found more with 276 (16.5%). Lotka's law with regard to author productivity of Entomology research output was applied. It could be seen that the proportion of all output based on single contribution is important. The total numbers of publications in entomology with collaboration among the top 10 countries are presented. Largest contribution of USA was 307 (18.4%), followed by South Korea with 264 (15.8%).

Keywords: *Entomology, Relative growth rate, Authors collaboration, Country, Scientometrics*

INTRODUCTION

The term “Scientometrics” was originated from a russian term for the application of quantitative methods to the history of science, that lead to the quantitative aspects of science. It was suggested by Dolrov and Kormoni who often used with same meaning as the bibliometrics to denote to ‘the application of quantitative methods to history of science’. This term came into existence with the founding of the journal known as ‘Scientometrics’ by T. Braun in 1977, which originally published in Hungary and currently from Amsterdam, the Netherlands.

Scientometrics is used to mean the communication process in science including socio-cultural aspects, and appears to be almost synonymous like science of science with more emphasize on its quantitative aspects. It is also used as a generic term for a system of knowledge, which endeavors’ to study the scientific (and technological) system by using a variety of approaches within the domain of science and technology.

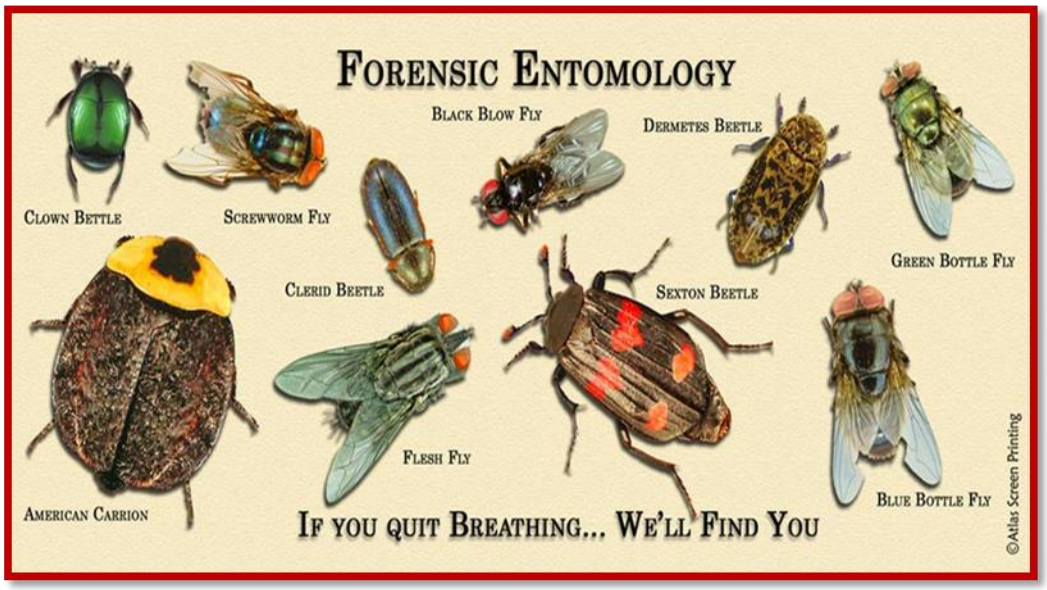
Scientometrics is mostly concerned with the quantitative features and characteristics of scientific research. It becomes the most emerging research areas in Library and Information Science. Investigation of scientific publications is a significant feature of research exertion in information science in recent times. The present study stresses the devotion on the scientometric investigation of the pattern of publication, authorship and country wise distribution using the keyword analysis.

Entomology is a branch of biology which mainly focuses on the study of insects, which gives an improved perception of the environment and biology. An insightful of entomology is required to concentrate the general economic sufferers in crops and health issues caused by insects. The study of insects is widely known as entomology. The study of insects includes their development, anatomy, physiology, life history, behavior, environment, and classification. Entomology gives people a better understanding of the environment, biology, and the world in which they live. An understanding of entomology becomes mandatory to reduce the extensive economic loss in crop damage and health problems caused by insects. Agricultural entomologists identifies the insects which affect

the production of foods and fibers. Experts in Agriculture involved to work in the areas of agronomy, animal science, horticulture, floriculture, forestry, and wood processing.

Entomologists are now familiar with the lessons of the past and aided by advances in insecticidal chemistry, biological and cultural control, and visionary for new technologies based on genetic modification of plants and animals. Entomologists face new challenges from invasive species which focused the increased movement of people and goods in the global economy. Global warming threatens to dramatically alter the geographic ranges of plant and animal species, including agricultural crops and their pests, as well as vectors of human and animal pathogens.

SAMPLE INSECTS



Available at - http://mrcatlee.weebly.com/entomology.html, accessed 10 August 2018

RELATED WORK

Neelamma, G., & Anandhalli, G. (2016) aimed at analyzing the research output in Botany. Citation analysis of all the journal articles of Botany was taken from Web of Science (on-line version database) for the period of ten years (2005-2014). A total of 12051 references was cited in 1183 records in 572 journals. The study elaborated on distribution of citations for

document type, language wise citations, and country wise publication of citations. Further, the study also listed out the most important journals in the field of Botany. The investigation showed that out of 12051 citations, research articles (61.96%) contribute the highest number of citations and it is the most chosen source of information preferred by researchers.

Jeyasekar, J.J., & Saravanan, P. (2014) attempted to bring out the development of Forensic Science literature, authors' productivity, the top position source journal, and the country-wise output. Data for the study were taken from the SCOPUS database. They have retrieved 13626, records and analyzed using Microsoft excel sheet. They considered three journals, such as Journal of Forensic Sciences, Forensic Science International, and Science & Justice which contribute almost half of the total forensic science literature. The study found that highest number of records was found from the United States of America which contributed 30% in Forensic Science.

Garg, K. C., & Tripathi, H. K. (2014) analyzed the scientific output of India in Crop Sciences as reflected in three different databases i.e. SCOPUS, CAB Abstracts and ISA (Indian Science Abstracts) during 2008-2010. It indicated that highest number of papers was published on rice and wheat crops. Agricultural universities and institutions under the aegis of Indian Council of Agricultural Research (ICAR) were the most dynamic institutions. Most of the papers was published in Indian journals with low impact factor. Environment and Ecology, Indian Journal of Agricultural Sciences and Research on Crops were the most chosen journals of the Indian scientists. The major research is focused on 'genetics and plant breeding' followed by 'soil, climate and environmental aspects' and 'agronomic aspects'. The authorship pattern reveals that co-authored papers accounted for 72% of the total output.

Niu, B., Loáiciga, H. A., Wang, Z., Zhan, F. B., & Hong, S. (2014) explored groundwater research among the top twenty institutions for collaborative papers. A bibliometric analysis was conducted to evaluate groundwater research from different perspectives during 1993–2012 and based on the Science Citation Index-Expanded (SCIE) database. They summarized the output on categorical, geographical, and institutional patterns, as well as research hotspots in global groundwater studies. Groundwater research experienced notable growth in the past two decades. "Environmental sciences", "water resources" and "multidisciplinary geosciences" were the three major subject categories. Ground water research is considered to be a major category in

environmental science and water resources in global level. United States was a leading country to global groundwater research with the largest number of independent and collaborative papers, i.e. 12 of the top 20 most active institutions.

Yaoyang, X., & Boeing, W. J. (2013) studied the sustainable and renewable energies, biofuels, and related research which have been expanded along with an exceptional growth of scientific knowledge. Based on the Science Citation Index Expanded from the Web of Science, a bibliometric evaluation of research output was carried out to map the research activities and tendencies of the global biofuel field. The results indicated that annual output of scientific articles topped during the past decade (2003–2012). The United States of America (USA) leads biofuels research and collaborated mainly with other productive countries (China, United Kingdom, Germany, Canada and South Korea). International collaborative publications were resulted in more citations than single country publication. Institutional collaborations became increasingly prevalent over a period of time and the 15 most productive institutions of USA tended to collaborate with each other. Most research publications on biofuels were appeared in the journals *Biomass and Bioenergy* and *Bioresource Technology*. Biofuels research was based on combination of multi-subject categories including "Energy and fuels", "Biotechnology and applied microbiology", "Chemical engineering", "Environmental sciences" and "Agricultural engineering". Keyword analysis has confirmed the production of biodiesel from microalgae as the mainstream of recent biofuels research. Biorefinery was the most common technology for conversions of biological feedstock and life cycle assessment which was the most popular tool of decision support to evaluate the sustainability of biofuel development.

Kalisdha, A., Balasubramani, R., Surulinathi, M., & Amsaveni, N. (2013) attempted to study on Indian contribution to medicinal plants research: A scientometric study. The objective of the study is to analyze the scientometric parameters for Medicinal plants research output in India. They have analyzed the productivity and Global Citation Scores of the scientists. It can be seen that during the period 1956-2012, a total of 12083, publications was published in india and the data has been reflected in Scopus online database. Since the researchers depend mainly on the Library and Electronic resources library provide more scholarly information and hence this kind of studies become relevant in identifying thrust areas of research.

Dutt, B., Kumar, S., & Garg, K. C.(2010) analyzed 2566 papers published during 1987 - 2008 and indexed Science Citation Index – Expanded which indicated a gradual rise in the quantum of output. About 80% of the papers appeared in journals originating from USA, the UK, the Netherlands, France and Germany. Total output came from 74 countries of which 17 countries contributed 87% of the total output. The highest number of publications came from USA, followed by India. However, in the later block (1998–2008) the proportion of output of both USA as well as India showed decline as compared to the first block (1987–1997). More than half of the scientific output is concentrated among the four sub-disciplines of Microbiology & Virology, Immunology & vaccine, Epidemiology and Entomology. Among the prolific institutions, the publication output of institutions from the US and Taiwan had higher impact. Of all the papers published, 17% did not receive any citations. Incidence of High Quality Papers, Citations per Paper (CPP) and Relative Quality Index (RQI) were more than the average. The proportion of co-authored papers increased significantly in 2008 compared to 1987. The proportion of popular authored papers was found from the Netherlands, Taiwan, China, Cuba, Brazil, France and Japan.

Sagar, A., Kademani, B. S., & Kumar, V. (2007) explored the growth of Mass Spectrometry research in Nuclear Science and Technology with regard to the publication output as reflected in International Nuclear Information System (INIS) database (1970-2005). A total of 10913, papers was published in various domains such as Chemistry, Materials and Earth Sciences (5286) (48.44%), Physical Sciences (2367) (21.69%), Engineering and Technology (1434) (13.14), Life and Environmental Sciences (1212) (11.11), other aspects of Nuclear &Non-Nuclear Energy (492) (4.51%) and Isotopes, Isotope and Radiation Applications (122) (1.12%). Only three papers were published in 1970. The highest number of papers (816) was published in 2004. United States topped the list with 2247, publications followed by Germany with 1333, publications, Japan with 820 publications, France with 525 publications, and India with 460 publications. As far as Authorship and collaboration is concerned multi-authored papers i.e 81.83 percent was collaborative and multidisciplinary in nature.

OBJECTIVES

- To analyze the year wise distribution of articles
- To study the Relative growth rate and Doubling time on the distribution

- To identify the authorship pattern of the contributions in Entomology
- To find out the top ten prolific authors in the chosen field
- To trace the keyword distribution of the articles

METHODOLOGY

Data for the study has been collected from Web of science Core Collection database published and maintained by Clarivate Analytics between 2012-2016. The data was used to find out the authorship pattern, relative growth rate, year wise publication and keyword analysis etc. in the field of Entomology. The collected data were analyzed using His cite software and VOS viewer for making the presentation lucidly. Lotka's law has also been applied in this study.

RESULTS AND DISCUSSION

Table-1 Year wise distribution of publications

S.No	Publication Year	Records	Percentage (%)	TLCS	TGCS
1	2012	270	16.2	402	1978
2	2013	292	17.5	403	2128
3	2014	376	22.5	268	1658
4	2015	339	20.2	116	967
5	2016	394	23.6	32	505
Total		1671	100	1221	7236

It can be identified that the maximum number of records i.e. 394(23.6%) was published in 2016 and the minimum number of records i.e. 270 (16.2%) was published in the year 2012.

Figure - 1 Year wise distribution of publication

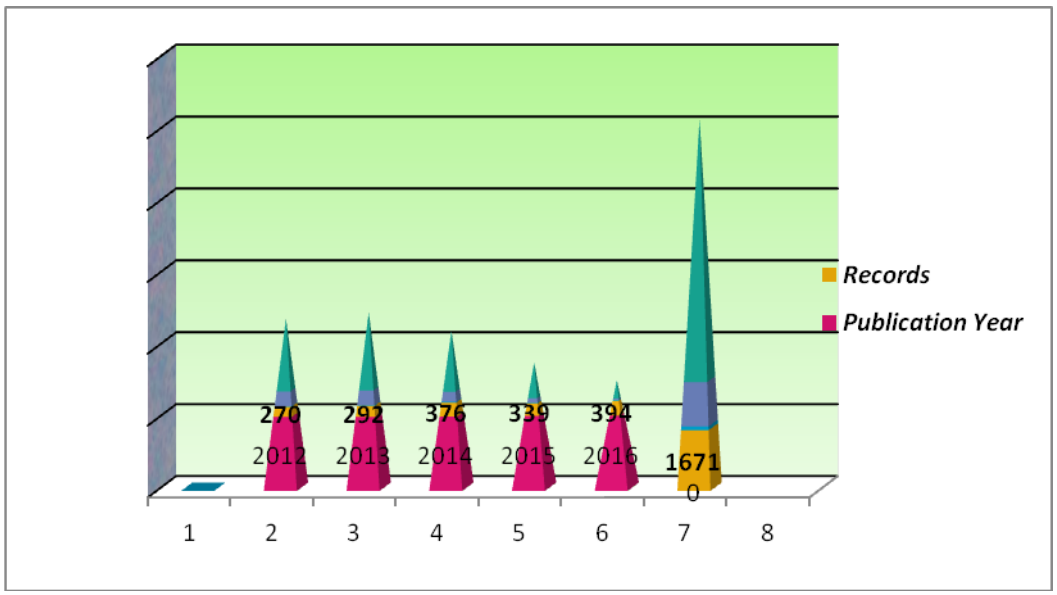


Table 2 - Authorship pattern

Year	1	2	3	4	5	6	7	8	9	10	Above 11	Total
2012	26	112	228	164	120	96	98	40	-	40	90	1014
2013	21	134	168	176	165	150	154	72	36	20	122	1219
2014	33	158	267	256	275	138	77	56	54	-	142	1458
2015	29	108	201	224	250	216	119	64	72	30	132	1448
2016	41	142	207	280	250	150	147	120	72	80	214	1703
Total	150	654	1071	1100	1060	750	595	352	240	170	700	6842
Percentage (%)	2.1	9.5	15.6	16	15.4	10.6	8.6	5.1	3.5	3.4	10.2	100

It reveals the authorship pattern of the articles published during the period of study. The highest number of articles was contributed by four authors with 1100 (16%) papers. The lowest number of articles was contributed by single authors i.e. 150 (2.1%) papers.

Table 3- Degree of Collaboration

Year	Total no. of articles	Total no. of authors	No. of single authors articles	No. of Multi authors Articles	Degree of collaboration
2012	270	1014	26	988	0.97
2013	292	1219	21	1198	0.98
2014	376	1458	33	1425	0.97
2015	339	1448	29	1419	0.97
2016	394	1703	41	1662	0.97
Total	1617	6842	150	6692	0.97

As far as the degree of collaboration is concerned keywords analysis on entomology is done. The formula given by K. Subramanyam (1982) was used.

$$C = \frac{N_m}{N_m + N_s}$$

$$C = \frac{6692}{6692 + 50} = 6842$$

The average value of C is C = 0.97

where, C = degree of collaboration

Nm = Number of multi- authored publications

Ns = Number of single- authored publications

It indicates that the degree of author collaboration is 0.97, which clearly shows its dominance upon multiple author contributions.

Figure – 2 Degree of Collaboration

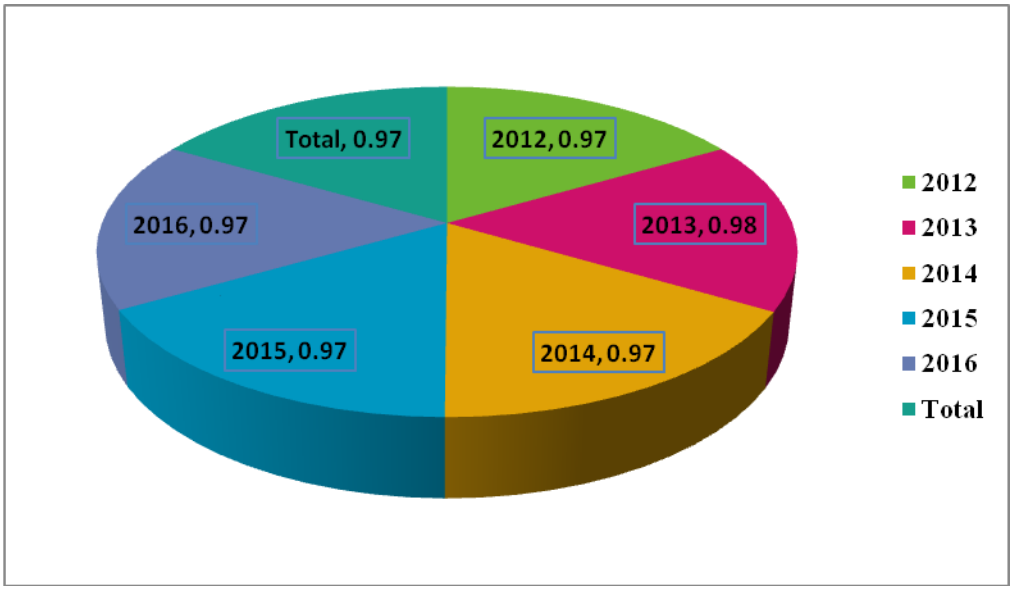


Table 4 - Relative Growth Rate and Doubling Time

Year	No .of .Articles	Cumulative No. of Articles	W_1	W_2	R(a) (W_2-W_1)	Mean R(a)1-2	Doubling Time	M Dt(a) 1-2
2012	270	270	-	5.59	-	0.55	-	0.56
2013	292	562	5.59	6.33	0.74		0.93	
2014	376	938	5.92	6.84	0.92		0.75	
2015	339	1277	5.82	7.15	1.33	1.44	0.52	0.48
2016	394	1671	5.98	7.52	1.54		0.45	
Total	1671					1.99		1.04

The growth rate is increased upto 1.54 in 2016. The mean doubling time for publications during the period was 1.04. The doubling time for publication got increased in 2013.

The relative growth rate is found increased with regard to number of publications or pages per unit of time. A specified period of interval can be calculated using the following equations.

$$R(1-2) = \frac{W_2 - W_1}{T_2 - T_1}$$

Where R (1-2) is mean relative growth rate over the specified period of interval.

W1 = LogW1: (Natural log of initial number of Publications/pages)

W2 = LogW2: (Natural log of final number of Publications/pages)

T2 – T1 = The unit difference between the initial and final time.

The corresponding doubling time for publications and pages can be calculated by using the following formula.

$$\text{Doubling time (Dt)} = \frac{0.693}{R}$$

Therefore,

$$\text{Doubling time for publications Dt (a)} \quad \frac{0.693}{R\,(a)}$$

Table 5 -Author wise distribution of publications

Rank	Author	Records	Percentage (%)	TLCS	TLCS/t
1	Lee S	44	2.6	13	3.07
2	Lee SH	34	2.0	13	3.82
3	Jin BR	26	1.6	18	5.13
4	Tomberlin JK	24	1.4	55	16.82
5	Lee KY	19	1.1	8	2.33
6	Amendt J	18	1.1	79	24.10

7	Park CG	16	1.0	9	2.83
8	Lee JH	15	0.9	5	1.40
9	Lee KS	15	0.9	14	3.90
10	Li ZZ	14	0.8	0	0.00
TLCS- Total local citation core, TGCS – Total global citation score					

It is understood that the top ten prolific authors (listed) are based on the number of publications. Lee S (44 records) and Lee SH (34 records) published the highest number of records in the field of entomology research during the study period. Li ZZ (14) published the lowest number of records.

Figure – 3 VOS viewer screen shot of Authors

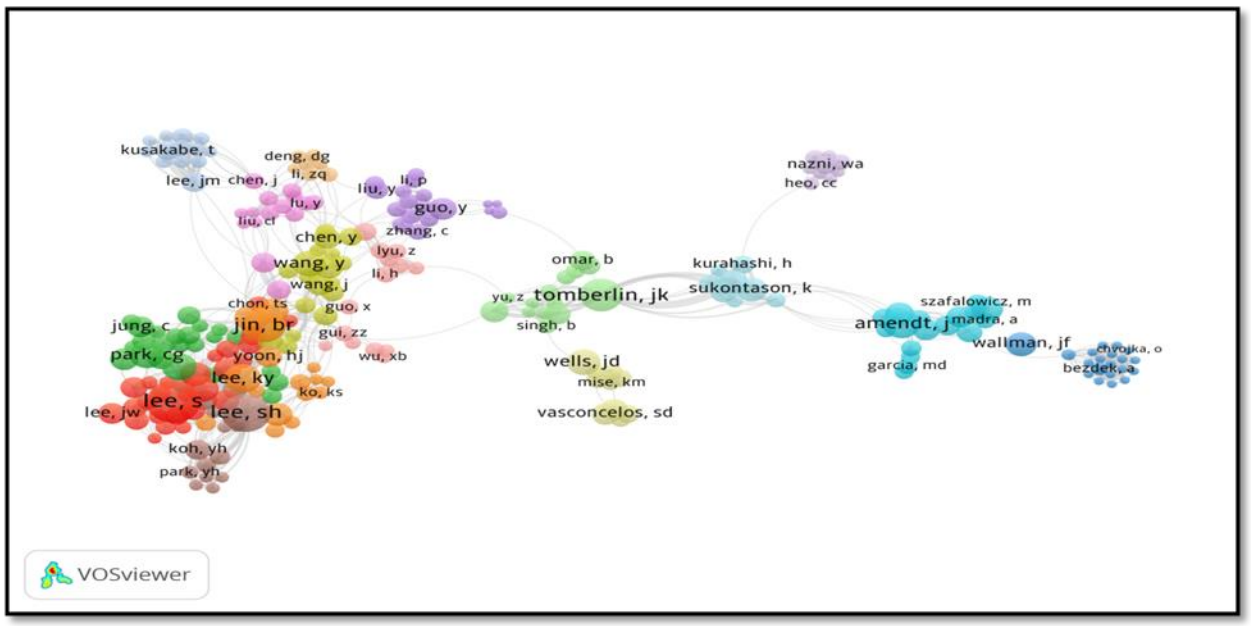


Table 6 – Keywords wise distribution

Rank	Word	Records	Percentage (%)	TLCS	TGCS
1	Diptera	276	16.5	420	1358
2	Species	243	14.5	192	735
3	New	197	11.8	40	294
4	Coleoptera	137	8.2	124	372
5	Calliphoridae	123	7.4	227	662
6	Entomology	121	7.2	127	420
7	Forensic	118	7.1	248	538
8	Hemiptera	108	6.5	29	186
9	Genus	107	6.4	15	143
10	Development	95	5.7	93	334
TLCS- Total local citation core, TGCS – Total global citation score					

As far as keywords appeared in entomology is concerned the word ‘Diptera’ is found high with 276 times (16.5%) frequent occurrence of words. The term ‘Species’ occurred in 243 (14.5%) publications, ‘New’ occurred in 197 (11.8%) publications, and followed by the word ‘Coleoptera’ with 137 (8.2%) and ‘Calliphoridae’ with 123(7.4%) ‘Entomology’ with 121(7.2%) and ‘Forensic’ with 118 (7.1%). ‘Hemiptera’ appeared in 108 (6.5%) and remaining keywords i.e. ‘Genus’ 107(6.4%) and ‘Development’ 95 (5.7%), were also noticed.

Figure – 4 VOS viewer screen shot of Keywords

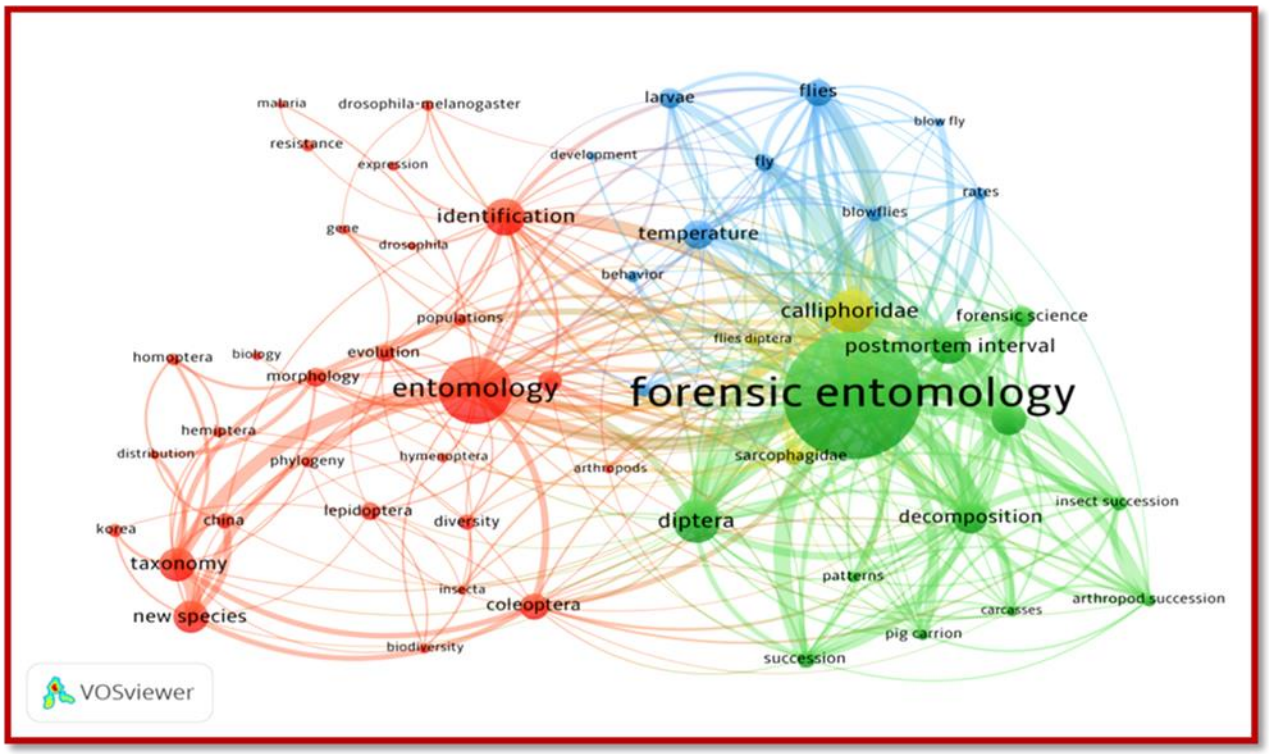


Table 7- Country wise distribution of publications

Rank	Country	Records	Percentage (%)	TLCS	TGCS
1	USA	307	18.4	187	1827
2	South Korea	264	15.8	93	762
3	Peoples R China	229	13.7	77	862
4	Brazil	178	10.7	123	571
5	UK	98	5.9	93	864

6	India	90	5.4	22	412
7	Australia	89	5.3	133	680
8	Japan	65	3.9	19	135
9	Poland	63	3.8	132	336
10	Germany	57	3.4	107	412
TLCS- Total local citation core, TGCS – Total global citation score					

The total numbers of publications with collaboration (period 2012 – 2016) among the top 10 countries are listed globally. Largest number 307 (18.4%) come from USA, followed by South Korea with 264(15.8%). Research output from Peoples R China was 229 (13.7%) followed by 178 (10.7%) from Brazil. UK produced 98 (5.9%), papers, India contributed 90(5.4%), articles and Australia published 89 (5.3%). Japan contributed 65 (3.9%) papers and lowest contribution of the records was seen from Poland (3.8%) and Germany (3.4%). It is noteworthy to mention that the USA published the highest number of the records among the top ten countries.

Figure - 5 Country wise distributions of publications

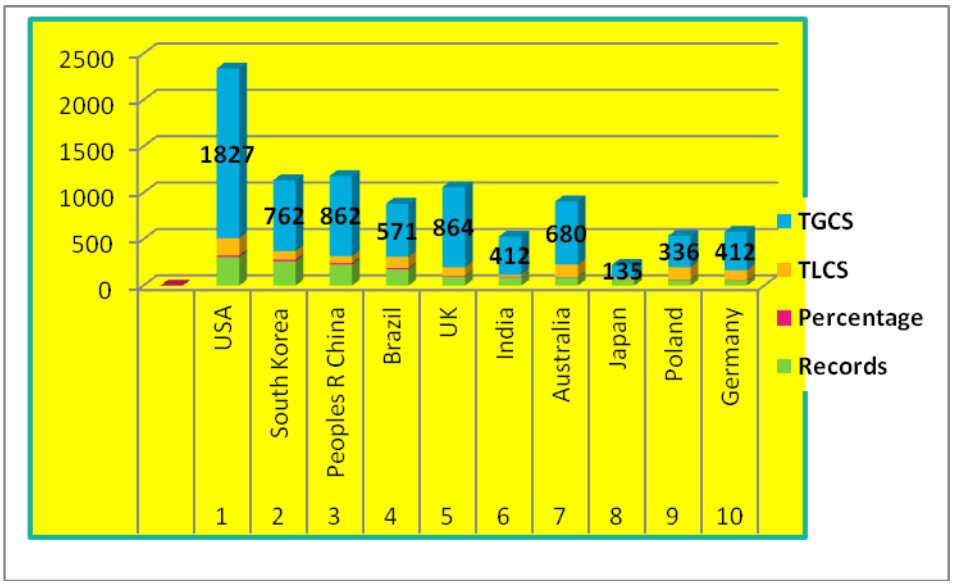


Table 8- Lotka's Law of Author productivity

X	Y	ΣX = log X	ΣY = log Y	ΣX*Y	ΣX*X
1	156	0	5.04	0	0
2	327	0.69	5.79	3.99	0.47
3	357	1.1	5.88	6.47	1.21
4	275	1.39	5.61	7.80	1.93
5	212	1.60	5.36	8.58	2.56
6	125	1.79	4.82	8.62	3.20
7	85	1.95	4.44	8.65	3.80
8	44	2.08	3.78	7.86	4.32
9	26	2.2	3.26	7.17	4.84
10	17	2.30	2.83	6.51	5.29
11	14	2.40	2.64	6.34	5.76
12	9	2.48	2.2	5.45	6.15
13	4	2.56	1.39	3.55	6.55
14	3	2.64	1.1	2.90	6.97
15	2	2.71	0.69	1.87	7.34
16	3	2.77	1.1	3.05	7.67
17	3	2.83	1.1	3.11	8.00

19	1	2.94	0	0	8.64
20	3	2.99	1.1	3.29	8.94
21	1	3.04	0	0	9.24
22	2	3.09	0.69	2.13	9.54
26	1	3.25	0	0	10.56
45	1	3.80	0	0	14.44
	1,671	52.6	58.82	97.34	127.88

Where N is the number of data pairs considered

X is the logarithm of x (x=number of articles) and

Y is the logarithm of y (y=number of authors)

$$n = \frac{N\sum XY - \sum X \sum Y}{N\sum X^2 - \left(\sum X\right)^2}$$

$$= \frac{23\,(97.34) - (52.6)(58.82)}{23\,(127.88) - (52.6)^2} = -4.9009$$

The constant C is calculated using the formula:

$$c = \frac{1}{[\sum_{1}^{p-1} \frac{1}{x^n} + \frac{1}{(n-1)(p^{n-1})} + \frac{1}{2p^n} + \frac{n}{24(p-1)^{n+1}}]}$$

$$c = \frac{1}{0.2718 - 0.0806 + 0.1189 - 24504.5}$$

Hence $c = \frac{1}{-24504.1899} = -0.00004080$

C = - 0.4080

Lotka's law has been applied to ensure the real productivity in Entomology research output. It is fact that the tabulated value (observed value) is more than expected value. Thus the present analysis clearly invalidates the Lotka's law and productivity is attributed to several factors.

The productivity Entomology Science research in India was verified so as to find out the conformity with Lotka's inverse square law using Pao's (1985) method. It showed that different number of authors 'n' value is 4.9009.

Therefore 'n' is substituted with the value -4.9009 and 'c' - 0.4080 (value) is used while 'p' is assumed to be 20 by replacing the values of 'n' and 'c' for the calculation and validation.

CONCLUSION

The present study was carried out on keyword which covered 1671 records during 2012 - 2016. The highest number of records i.e. 394(23.6%) was published in the year 2016 and the lowest number of records i.e. 270 (16.2%) was published in the year (2012). The authorship pattern reveals a significant difference between the number of single author and multiple authors. Entomology is considered to be one of the emerging research areas in Life Sciences. Basic entomology (also known as general, pure, fundamental, or theoretical entomology) deals with studies such as biochemistry, biogeography, cytology, ecology, insect development, ethology, genetics, histology, morphology (insect anatomy), pale entomology, physiology, reproduction, phylogeny and taxonomy. The field of entomology is in a constant flux that evolved like the insects. Entomology is in the true sense of multidisciplinary discipline in nature.

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