Examination of Bradford's Law in the Field of Zoology Literature: A Citation Study From 2005–2014

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Abstract

The purpose of this paper is to determine the materials cited in zoology literature during the year 2005–2014. Data were extracted from Web of Science (on-line version database) database. The study reveals that distribution of citations for document type, language wise distribution of citations and country wise distribution of citations. Further the study also lists out the most productivity journals in the area of zoology literature. The analysis of the results shows that out of 5332 citations, research articles (74.81%) contribute the highest number of citations and it is the most preferred sources of information used by researchers in the area of zoology. The USA (33.75%) is the most cited country in the world and the English language (98.59%) is the most preferred language in the world. Bradford's law well fitted into the given data set for the present study. Finally, it can be concluded that, The Significant research activity is being taking place in the field of zoology and it is one of the emerging research field in the biological sciences.

Keywords: *Zoology literature, citation analysis, journal ranking, Bradford's law of scattering, half-life, KS-test*

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INTRODUCTION

Journals are no doubt the most preferred source of information in any field of research due to the nascent information that they carry and faster delivery of research output. But the increasing subscription rates and budget constraints forcing libraries to select and subscribe only the popular journals from the huge number of journals published in different subject fields. Bibliometrics and citation analysis have emerged as the important tools for selection of popular journals in any area of research or subject. As Zafrunnisha (2012) [1] explains, bibliometric techniques are being used for a variety of purposes such as determination of various scientific indicators, evaluation of scientific output, selection of journals for libraries and even forecasting the potential of a particular field. Anyi *et al.* (2009) [2] are of the opinion that bibliometric analysis of single journal creates the portrait of that journal and indicates the quality, maturity and productivity of the journal in any field, in a country or region. It also informs us about the research orientation that it supports to disseminate and its influence on author's choice as a channel to communicate or retrieve information for their research needs.

Zoology is the aspect of science that deals with the study of the animals' evolution, habitat and behaviour. It is also concerned with every level of biological organization from the gene to the ecosystem, and with the structure, physiology, behaviour, genetics, development, distribution, and evolution of animals in all taxonomic groups. In a broad sense, zoology also deals with the interrelationships between humans and other animals. There is ample scope for students to obtain a broad education in zoology. It is a wide field offering many career opportunities for research, especially because there still is a great deal to learn about it. In this subject field research is increasing day by day. There is huge amount of information resources are available in the field of zoology. This has led to the explosion of information. Hence, selecting the appropriate periodicals can be a challenging job. As such it is necessary to find a solution to tackle with the growth of literature and changing needs of the users. To take a right decision in this

regard citation analysis study is important in any subject field (Importance of Zoology, 2012) [3].

Review of Literature

Bradford (1931) [4] published his first paper entitled 'Sources of information on specific subjects'. He observed and examined two bibliographies prepared in the Science Library (Britain) on Applied Geophysics (1928–1931) and Lubrication (1932–1937). Patra and Chand (2005) [5] used Bradford's law to identify core journals of biotechnology in India.

Nandi and Bandopadhyay (2010) [6] conducted case study on 'Zoological Research Contributions of the University of Burdwan in West Bengal: An analytical study'. Research productivity in zoology, authorship pattern and nature of collaboration among the zoology scholars are studied. Result reveals that authorship trend is towards multi authored papers and the degree of collaboration is 0.51. Similar study conducted by the same author Nandi and Bandopadhyay (2012) [7], in which an attempt has been made to study the comparative research performance of Botany and Zoology department of the University of Burdwan during 1960 to 2000. There were 160 theses and 189 research articles in the field of Botany and 236 theses and 251 research articles in Zoology were found. The degree of collaboration in botany and zoology is 0.70 and 0.51 respectively.

Suresh Kumar (2014) [8] in his study serves as a test of two formulations of Bradford's law, verbal and graphical, using 137120 articles published on Human-Computer Interaction (HCI) research in journals index in science citation index-expanded during 1987–2011. The data is divided in to five five-year spans so that comparisons can be made between the percentage errors in study of human computer interaction.

Neelamma and Gavisiddappa (2016) [9] have made an attempt to analyse the research output performance of Crystallography, which is covered in Web of Science on-line version database for the period of 1989–2013. A total of 1387195 references cited in 45320 articles in 2043 journals. The study elaborates on various bibliometric components such as distribution of citations by documents type, country wise publication of citations, further the study also list out the most productive journals in the field of crystallography. The analysis of the study reveals that out of 1387195 citations (83.83%) research articles contribute the highest number of citations and it is the most preferred sources of information used by researchers in the field of crystallography. Further, the Journal of Molecular Biology is the most cited journal in the field of crystallography. The USA is most cited country in the world. Finally, Bradford's law well fitted in to the given data set for the present study. Finally it can be concluded that, the significant research activity is taking place in the field of Crystallography. And it is one of the emerging research fields in the applied science.

Sudhier Pillai (2010) [10] paper gives a review of the scholarly contribution on the various facets of Bradford Law. In addition to the theoretical aspects of the law, review covers papers dealing with the application of the law in the various subject fields. A study on five year data of journals (2004–08) cited by the physicists at the Indian Institute of Science (IISC) Bangalore was carried out to examine in the applicable Bradford's laws of scattering, which includes 690 periodicals containing 11319 references collected 79 doctoral theses during the period of 2004–08. Ranked list of journals preferred, and physical review-B with 9.53% citations were the most preferred journals. The Bradford's multipliers were calculated and law found to be applicable with the value K as 1.2. The distribution of journals in three zones was made and the number of references in each zone was then estimated. The applicability of Leimkuhler model was also tested with the present data.

Neelamma and Anandhalli (2016) [11] present paper aims at analysing the research output performance of Botany literature. Citation analysis of all the journal articles published in the Botany literature, which covered in Web of Science (on-line version database) for the period of 2005–2014. A total of 12051 references cited in 1183 articles in 572 journals. The study elaborates on various bibliometric components such as distribution of citations for Document type, Language wise

distribution of citations, and Country wise publication of citations. Further the study also lists out the most productivity journals in the field of Botany Literature. The analysis of the results shows that out of 12051 citations, Research articles (61.96%) contribute the highest number of citations and it is the most preferred sources of information used by researchers in the field of Botany. The USA is the most cited country in the world and the English language is the most preferred language in the world. Bradford's law well fitted into the given data set for the present study. Finally it can be concluded that, The Significant research activity is being taking place in the area of Botany and it is one of the emerging research field in the biological sciences.

OBJECTIVES OF THE STUDY

Objectives of the study are:
- To find out the Bibliographical form wise distribution of citations.
- To know the Language wise distribution of citations.
- To find out the country wise distribution of articles.
- To prepare a ranked list of journals in order of their frequency of citations.
- To examine the applicability of Bradford's law of scattering in the field of zoology.

METHODOLOGY

Data for the present study is downloaded using principal keywords like author, citation wise, document type, country wise, related to zoology subject from web of science core collection online version database. A total of citations were extracted from records which is scattered in journals pertaining for the period of 2005–2014 and it is used as a main source of data for the present study. It covers wide range of articles including research articles, books, reviews case studies, letters, news items, proceeding, etc. Web of Science is indexing, online database published by Thomson Reuters to meet the objectives of the present study, necessary data was collected in the form of bibliometric components, such as Bibliographic wise, Language wise, Country wise distribution of citations, most cited journal etc. Finally, given data set was organized, tabulated and analysed with the help of MS-Excel and Statistical Package for Social Science (SPSS). A rank list of most cited journals were prepared and finally Bradford's law was tested. The data is presented in the form of tables and graphs for the purpose of interpretation and discussion.

Data Analysis and Interpretation

The present citation study has covered only Zoology literature which is indexed by Web of Science online database. A total of citations are collected from articles from journals for the period of ten years (2005 to 2014). The data has been analysed and presented in the form of tables and graphs to facilitate the interpretation in the following sections.

Table 1: *Bibliographic Form Wise Distribution of Citations.*

Sl. No.	Bibliographic Type	Citations	Cum Citations	% age	Cum % age
1	Articles	3989	3989	74.812	74.812
2	Reviews	785	4774	14.722	89.535
3	Article; Proceedings Papers	275	5049	5.158	94.692
4	Letters	164	5213	3.076	97.768
5	Editorial Materials	64	5277	1.200	98.968
6	News Items	21	5298	0.394	99.362
7	Review; Book Chapters	14	5312	0.263	99.625
8	Database Reviews	12	5324	0.225	99.850
9	Biographical-Items	5	5329	0.094	99.944
10	Software Reviews	2	5331	0.038	99.981
11	Book Reviews	1	5332	0.019	100.000
		5332		*100*	

Table 1 shows the distribution of citations in different bibliographical forms in the field of zoology. It is observed from the Table 2 that the journal contributes the highest number of citations accounting for 74.8% of the total citations. This indicates that the Articles are the most profusely cited source of information by the zoology researchers. Review are the next most cited source accounting for 14.72% of the total citations and Proceeding papers are the third most cited source accounting for 5.15% of the total citations. The next preferred sources of information for zoology users are the letters (3.07%) followed by editorial material (1.20%) and News-Item (0.39%) respectively (Figure 1).

Table 2 shows the language wise distribution of citations. It is found that most of the research articles (5257–98.59%) in the field of Zoology were published in English language, it is because of the fact that English is an international language and moreover, majority of Science and Technology literature is being (70%) published in English language only.

Hence, majority of the articles reported in English language. Further, meagre amount of articles are also being published in other language like, Portuguese (27–0.51%), Spanish (22–0.41%), German (9–.17%), French (8–.15%), Russia (6–.11%), Czech, Japanese and Polish (1–.02%) respectively. The analysis of results shows that English is considered as one of the major language for dissemination and communicating the research output in the area of zoology.

Fig. 1: Document Type Distribution of Citations.

Table 2: Language Wise Distribution of Citations.

Sl. No.	Language	Citations	Cum Citations	% age	Cum% age
1	English	5257	5257	98.59	98.59
2	Portuguese	27	5284	0.51	99.10
3	Spanish	22	5306	0.41	99.51
4	German	9	5315	0.17	99.68
5	French	8	5323	0.15	99.83
6	Russian	6	5329	0.11	99.94
7	Czech	1	5330	0.02	99.96
8	Japanese	1	5331	0.02	99.98
9	Polish	1	5332	0.02	100.00
10	Chinese	0	5332	0.00	100.00
11	Croatian	0	5332	0.00	100.00
12	Italian	0	5332	0.00	100.00
13	Korean	0	5332	0.00	100.00
14	Turkish	0	5332	0.00	100.00
15	Ukrainian	0	5332	0.00	100.00
		5332		*100*	

Table 3: *Country Wise Distribution of Citations.*

Sl. No.	Country	Citations	Cum Citations	% age	Cum % age
1	USA	1800	1800	33.758	33.758
2	UK	590	2390	11.065	44.824
3	Canada	579	2969	10.859	55.683
4	Peoples R China	328	3297	6.152	61.834
5	Germany	281	3578	5.270	67.104
6	France	268	3846	5.026	72.131
7	Brazil	200	4046	3.751	75.881
8	Switzerland	160	4206	3.001	78.882
9	Italy	130	4336	2.438	81.320
10	Mexico	120	4456	2.251	83.571
11	Netherlands	91	4547	1.707	85.278
12	Australia	82	4629	1.538	86.815
13	Japan	74	4703	1.388	88.203
14	Unknown	68	4771	1.275	89.479
15	Denmark	56	4827	1.050	90.529
16	Sweden	40	4867	0.750	91.279
17	Spain	38	4905	0.713	91.992
18	Poland	34	4939	0.638	92.629
19	Israel	29	4968	0.544	93.173
20	South Africa	25	4993	0.469	93.642
21	Austria	23	5016	0.431	94.074
22	New Zealand	21	5037	0.394	94.467
23	India	20	5057	0.375	94.842
24	Norway	19	5076	0.356	95.199
25	Czech Republic	18	5094	0.338	95.536
26	Panama	17	5111	0.319	95.855
27	Russia	15	5126	0.281	96.137
28	Slovakia	14	5140	0.263	96.399
29	Argentina	11	5151	0.206	96.605
30	Portugal	10	5161	0.188	96.793
31	Belgium	9	5170	0.169	96.962
32	Hungary	9	5179	0.169	97.131
33	Pakistan	8	5187	0.150	97.281
34	Greece	8	5195	0.150	97.431
35	Finland	8	5203	0.150	97.581
36	Ireland	8	5211	0.150	97.731
37	Colombia	7	5218	0.131	97.862
38	Estonia	7	5225	0.131	97.993
39	Croatia	7	5232	0.131	98.125
40	Chile	7	5239	0.131	98.256
41	Serbia	7	5246	0.131	98.387
42	Bulgaria	6	5252	0.113	98.500
43	Costa Rica	6	5258	0.113	98.612

| Sl. No.	Country	Citations	Cum Citations	% age	Cum % age
44	Iceland	6	5264	0.113	98.725
45	Malaysia	5	5269	0.094	98.818
46	Indonesia	5	5274	0.094	98.912
47	Ukraine	5	5279	0.094	99.006
48	Turkey	5	5284	0.094	99.100
49	Peru	4	5288	0.075	99.175
50	Saudi Arabia	4	5292	0.075	99.250
51	Nicaragua	4	5296	0.075	99.325
52	Singapore	4	5300	0.075	99.400
53	Serbia Monteneg	3	5303	0.056	99.456
54	Jamaica	3	5306	0.056	99.512
55	Rep of Georgia	3	5309	0.056	99.569
56	Ecuador	3	5312	0.056	99.625
57	Kenya	3	5315	0.056	99.681
58	Romania	2	5317	0.038	99.719
59	Taiwan	2	5319	0.038	99.756
60	Tunisia	2	5321	0.038	99.794
61	Bangladesh	2	5323	0.038	99.831
62	South Korea	2	5325	0.038	99.869
63	Vietnam	1	5326	0.019	99.887
64	Algeria	1	5327	0.019	99.906
65	Slovenia	1	5328	0.019	99.925
66	Zimbabwe	1	5329	0.019	99.944
67	Cote Ivoire	1	5330	0.019	99.962
68	Mali	1	5331	0.019	99.981
69	Ethiopia	1	5332	0.019	100.000
		5332		*100*	
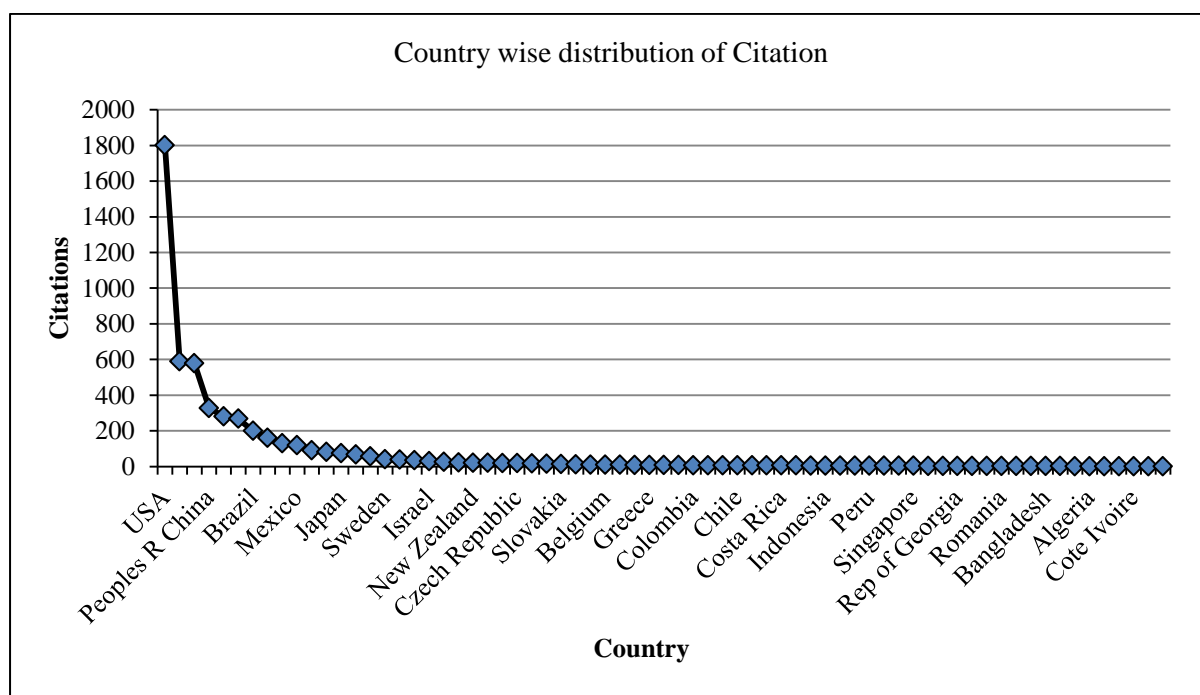
Fig. 2: Country Wise Distribution of Citation.

The geographical distribution of contribution is presented in Table 3, which gives the country wise distribution of contributions of research output Figure 2. There are about 5332 research contributions made by 69 countries of the world in the field of zoology during the study period. Out of total 5332 citations, USA contributed highest number of citations constituting 33.75% percent of the total contribution. UK (125–11.065%) found to be the next highest contributor to the total contribution. However, none of the countries, other than the Canada (579–10.85%), People R China (328–6.152%), Germany (281–5.270%) and France (268–5.026%) have contributed more than five percent to the total publications in the field of Zoology during the study period. Furthermore, it is evident that only three top ranked countries have altogether made significant Contribution nearly (50%) contributions. Further, analysis of data indicates that 75 present of the contribution are made by top seven countries and remaining only 25 percent of the contributions are from 62 countries in the area of zoology literature. The overall analysis of data indicates that 50 present of the research in the field of zoology is only reported from the top three countries in the world namely the USA, the UK, and Canada respectively.

Table 4: *Rank list of Journals in Botany.*

Sl. No.	Ranking	Journal	Citations	Cum Citation	%Age	Cum %
1	1	Current Zoology	1770	1770	33.20	33.20
2	2	Journal of the Acoustical Society of America	330	2100	6.19	39.38
3	3	Zootaxa	264	2364	4.95	44.34
4	4	Journal of Applied Ecology	160	2524	3.00	47.34
5	5	Revista Mexicana De Ciencias Geologicas	132	2656	2.48	49.81
6	6	Methods In Ecology And Evolution	118	2774	2.21	52.03
7	7	Journal of Evolutionary Biology	111	2885	2.08	54.11
8	8	Global Change Biology	105	2990	1.97	56.08
9	9	Physical Review E	73	3063	1.37	57.45
10	10	Physical Review B	69	3132	1.29	58.74
11	11	IBIS	60	3192	1.13	59.86
12	12	Applied Physics Letters	54	3246	1.01	60.88
13	13	Zoology	52	3298	0.98	61.85
14	14	American Journal of Primatology	48	3346	0.90	62.75
15	15	Genesis	46	3392	0.86	63.62
16	16	Journal of Anatomy	44	3436	0.83	64.44
17	17	Journal of Zoology	41	3477	0.77	65.21
18	17	Memorias Do Instituto Oswaldo Cruz	41	3518	0.77	65.98
19	18	Plos One	40	3558	0.75	66.73
20	18	Developmental Biology	40	3598	0.75	67.48
21	19	Insect Systematics &Evolution	34	3632	0.64	68.12
22	19	Journal of Biological Education	34	3666	0.64	68.75
23	20	BMC Bioinformatics	33	3699	0.62	69.37
24	21	Phytoparasitica	31	3730	0.58	69.95
25	22	Proceedings of the National Academy of Sciences of the United States of America	30	3760	0.56	70.52
26	23	Journal of Archaeological Science	29	3789	0.54	71.06
27	23	Behavioural Brain Research	29	3818	0.54	71.61
28	23	VLDB Journal	29	3847	0.54	72.15
29	24	Astronomy &Astrophysics	27	3874	0.51	72.66

Sl. No.	Ranking	Journal	Citations	Cum Citation	%Age	Cum %
30	24	Physical Review D	27	3901	0.51	73.16
31	25	Journal of Vertebrate Paleontology	25	3926	0.47	73.63
32	26	Zoological Studies	23	3949	0.43	74.06
33	26	Canadian Journal of Zoology	23	3972	0.43	74.49
34	26	Virus Research	23	3995	0.43	74.92
35	27	Zookeys	22	4017	0.41	75.34
36	27	Organisms Diversity and Evolution	22	4039	0.41	75.75
37	27	Ecological Engineering	22	4061	0.41	76.16
38	27	Biology &Philosophy	22	4083	0.41	76.58
39	27	SIAM Journal on Discrete Mathematics	22	4105	0.41	76.99
40	28	Annales Zoologici	21	4126	0.39	77.38
41	28	Contributions to Zoology	21	4147	0.39	77.78
42	28	Journal of Ethnobiology and Ethnomedicine	21	4168	0.39	78.17
43	28	Journal of Phycology	21	4189	0.39	78.56
44	29	Pesquisa Agropecuaria Brasileira	20	4209	0.38	78.94
45	29	Canadian Journal of Zoology-Revue Canadienne de Zoologie	20	4229	0.38	79.31
46	29	Biological Journal of the Linnean Society	20	4249	0.38	79.69
47	29	journal of Pediatric Gastroenterology and Nutrition	20	4269	0.38	80.06
48	29	Theory Of Computing Systems	20	4289	0.38	80.44
49	30	Journal Of The History Of Biology	19	4308	0.36	80.80
50	30	Chaos	19	4327	0.36	81.15
51	30	Oxford Journal Of Archaeology	19	4346	0.36	81.51
52	30	Zoomorphology	19	4365	0.36	81.86
53	31	Journal Of Experimental Biology	18	4383	0.34	82.20
54	32	Pakistan Journal Of Zoology	17	4400	0.32	82.52
55	32	Molecular Ecology Resources	17	4417	0.32	82.84
56	32	Trends In Plant Science	17	4434	0.32	83.16
57	33	Neotropical Entomology	16	4450	0.30	83.46
58	33	Mechanizing Mathematical Reasoning: Essays in Honour of Jorg H Siekmann on the Occasion of His 60th Birthday	16	4466	0.30	83.76
59	34	Revista De Biologia Tropical	15	4481	0.28	84.04
60	35	Oriental Insects	14	4495	0.26	84.30
61	35	Annual Review Of Marine Science, Vol 5	14	4509	0.26	84.56
62	36	Nucleic Acids Research	13	4522	0.24	84.81
63	37	European Journal Of Soil Biology	12	4534	0.23	85.03
64	37	Environmental Biology Of Fishes	12	4546	0.23	85.26
65	37	Eurasia Journal of Mathematics Science and Technology Education	12	4558	0.23	85.48
66	37	Fertility and Sterility	12	4570	0.23	85.71
67	37	Molecular Phylogenetics and Evolution	12	4582	0.23	85.93
68	37	Parasitology Research	12	4594	0.23	86.16
69	37	Public Understanding of Science	12	4606	0.23	86.38
70	37	Studies on Ethno-Medicine	12	4618	0.23	86.61
71	38	Raffles Bulletin of Zoology	11	4629	0.21	86.82

Sl. No.	Ranking	Journal	Citations	Cum Citation	%Age	Cum %
72	38	British Journal for the History of Science	11	4640	0.21	87.02
73	38	ISIS	11	4651	0.21	87.23
74	38	Zoological Science	11	4662	0.21	87.43
75	38	Brazilian Journal of Biology	11	4673	0.21	87.64
76	38	Theory in Biosciences	11	4684	0.21	87.85
77	38	International Journal Of Bifurcation And Chaos	11	4695	0.21	88.05
78	38	Tourism Management	11	4706	0.21	88.26
79	39	7 Journals with 10 Citations	70	4776	1.31	89.57
80	40	5 Journals with 9 Citations	45	4821	0.84	90.42
81	41	10 Journals with 8 Citations	80	4901	1.50	91.92
82	42	8 journals with 7 Citations	56	4957	1.05	92.97
83	43	10 Journals with 6 Citations	60	5017	1.13	94.09
84	44	15 Journals with 5 Citations	75	5092	1.41	95.50
85	45	18 Journals with 4 Citations	72	5164	1.35	96.85
86	46	18 Journals with 3 Citations	54	5218	1.01	97.86
87	47	35 Journals with 2 Citations	70	5288	1.31	99.17
88	48	44 Journals with 1 Citations	44	5332	0.83	100.00
89	49	104 Journals with 0 Citations	0	5332	0.00	100.00
			5332		100	

The ranked list provides unbiased data regarding the potentiality of journals that are useful to specialized readers in selecting the ones more relevant to their field, and to keep themselves abreast of new developments in their specialisation. From Table 4 it is shown that the journal with the highest number of citations occupies the highest rank and thus obviously the most important journal in the field of botany while the least important titles are placed at the bottom of Table. The top 89 journals are arranged in order of their ranks from Table 4. It can be ascertained that the *Current Zoology* occupies the first rank as the most preferred journal having been cited 1770 times. *Journal of the Acoustical Society of America* scores the second highest with 330 citations, followed by third and fourth rank *Zootaxa*2 64 citations and *Journal of Applied Ecology* with 160 citations respectively. The first ten journals in the rank list together accounts for 58.74% of the total citations.

Bradford's Law
Bradford's law serves as a general guideline to librarians in determining the number of core journals in any given field. It states that journals in a single field can be divided in to three zones each zone, containing the same number of citations (Bibliometric Laws, 2012) [12]:

a. Core journals on the given subject, relatively few in number that produces approximately one-third of all the articles.
b. A Second zone, containing the same number of articles as the first, but a greater number of journals.
c. A third zone, containing the same number of articles as the second, but a still greater number of journals.

The mathematical relationship of the number of journals in the core to the first zone is a constant 'n' and the second zone of relationship is n^2. Bradford expressed this relationship as $1:n:n^2$.

The number of journals in each Bradford's zone can be calculated from multiplier constant k that is called Bradford constant using the formulation of Egghe (1986),

$$k = (e^y \times Y_m)^{1/p}$$

Where γ is Euler's number having value .57772

Y_m is the number of citation of rank one journal
Y_m=1770
P is Bradford group or number of zones i.e.
p=3

So that
$$k = (2.719^{0.57772} \times 1770)^{1}/_{3}$$
K=14.66066
Using k we can calculate different Bradford groups. The nucleus zone r_0 can be defined as:
$$r_0 = \frac{T(k-1)}{(k^p - 1)}$$
Where, T represents the total number of journal in this study that is 352.
So
$$r_0 = \frac{108(14.66066 - 1)}{(14.6606^3 - 1)}$$
r_0=0.468352
$$r_0 = .468352$$
First zone $r_1 = r_0 \times K = 0.468352 \times 14.66066 = 6.866349$

Second zone $r_2 = r_0 \times k^2 = .468352 \times 14.6606652.52^2 = 100.7394$

This theoretical distribution of Bradford's law makes it possible to test the exact fit of Bradford's law to the data in the present study. Using this distribution, the number of citations can be drawn, as shown in the Table 5.

It is observed from Table 4 that there are 1 journal in the nuclear zone and they are the most productive journal devoted to zoology articles which published in Web of Science Database with sharing 1770-(33.19%) of total cited journals. The next zone represented by 16 journals which sharing 1748-(32.78%) of total cited journal, and the last zone has is represented by 335 journals which share 1814 (34.02%) of total cited journals. The Bradford's constant k is 14.66066 for the zone II and III respectively.

Table 5: Bradford's Group and their Number of Journals.

Zone	No. of Journals	Citations	Cum No. of Journals	Cum No. of Citations
I	1(0.039)	1770 (33.19)	1(1)	1770
II	16 (1.47)	1748(32.78)	16 (7)	3518
III	335(98.14)	1814 (34.02)	335 (101)	5332
	352 (100)	*5332 (100)*		

Table 6: Distribution of Cited Journals.

Rank	No of Journals	Cum No of Journals	Citations	Total no of Citations	Cum. No. of Citations	Log N	% of Citations	% of Total Journals
1	1	1	1770	1770	1770	0.000	33.196	0.284
2	1	2	330	330	2100	0.693	39.385	0.284
3	1	3	264	264	2364	1.099	44.336	0.284
4	1	4	160	160	2524	1.386	47.337	0.284
5	1	5	132	132	2656	1.609	49.812	0.284
6	1	6	118	118	2774	1.792	52.026	0.284
7	1	7	111	111	2885	1.946	54.107	0.284
8	1	8	105	105	2990	2.079	56.077	0.284
9	1	9	73	73	3063	2.197	57.446	0.284
10	1	10	69	69	3132	2.303	58.740	0.284
11	1	11	60	60	3192	2.398	59.865	0.284
12	1	12	54	54	3246	2.485	60.878	0.284
13	1	13	52	52	3298	2.565	61.853	0.284
14	1	14	48	48	3346	2.639	62.753	0.284
15	1	15	46	46	3392	2.708	63.616	0.284
16	1	16	44	44	3436	2.773	64.441	0.284
17	2	18	41	82	3518	2.890	65.979	0.568
18	2	20	40	80	3598	2.996	67.479	0.568
19	2	22	34	68	3666	3.091	68.755	0.568
20	1	23	33	33	3699	3.135	69.374	0.284

| Rank	No of Journals	Cum No of Journals	Citations	Total no of Citations	Cum. No. of Citations	Log N	% of Citations	% of Total Journals
21	1	24	31	31	3730	3.178	69.955	0.284
22	1	25	30	30	3760	3.219	70.518	0.284
23	3	28	29	87	3847	3.332	72.149	0.852
24	2	30	27	54	3901	3.401	73.162	0.568
25	1	31	25	25	3926	3.434	73.631	0.284
26	3	34	23	69	3995	3.526	74.925	0.852
27	5	39	22	110	4105	3.664	76.988	1.420
28	4	43	21	84	4189	3.761	78.563	1.136
29	5	48	20	100	4289	3.871	80.439	1.420
30	4	52	19	76	4365	3.951	81.864	1.136
31	1	53	18	18	4383	3.970	82.202	0.284
32	3	56	17	51	4434	4.025	83.158	0.852
33	2	58	16	32	4466	4.060	83.758	0.568
34	1	59	15	15	4481	4.078	84.040	0.284
35	2	61	14	28	4509	4.111	84.565	0.568
36	1	62	13	13	4522	4.127	84.809	0.284
37	8	70	12	96	4618	4.248	86.609	2.273
38	8	78	11	88	4706	4.357	88.260	2.273
39	7	85	10	70	4776	4.443	89.572	1.989
40	5	90	9	45	4821	4.500	90.416	1.420
41	10	100	8	80	4901	4.605	91.917	2.841
42	8	108	7	56	4957	4.682	92.967	2.273
43	10	118	6	60	5017	4.771	94.092	2.841
44	15	133	5	75	5092	4.890	95.499	4.261
45	18	151	4	72	5164	5.017	96.849	5.114
46	18	169	3	54	5218	5.130	97.862	5.114
47	35	204	2	70	5288	5.318	99.175	9.943
48	44	248	1	44	5332	5.513	100.000	12.500
49	104	352	0	0	5332	5.864	100.000	29.545
	352			*5332*				*100.000*
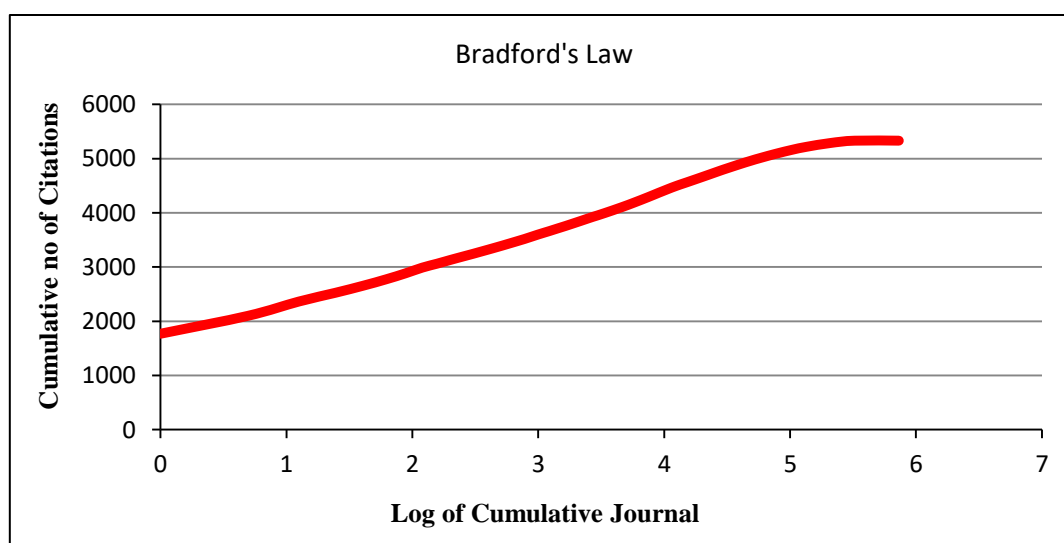
Fig. 3: Bradford's Law of Scattering.

**Distribution of cited journals by decreasing frequencies of citations**

The graphical and interpretation of the Bradford's law of scattering has been applied to the literature of Zoology. Table 6 represents journals arranged in decreasing frequency of citations. To testing the applicability of Bradford's law of scattering, a graph is plotted by taking the cumulative number of citations on "Y" axis and log of cumulative number of journals on "X" axis. It is observed that the resulting bibliography starts rising in a nature and then follows the linear curve indicating the observance of Bradford's law of scattering (Figure 3). The year of publication the age of the journal and Citations were collected and cumulative citations, percentages of citations, percentage of cumulative citations and tail arrangement were worked and tabulated for the purpose of interpretation.

Table 7 depicts the age-wise distribution of the cited literature in the field of zoology. The 56.33% of cumulative citations have been distributed in the age period of 1–5 years. The maximum number of citation are five years old (18.02%) followed by four years old (16.63%) and three year old (14.68%). The number of citations decreased as the age increased (Figure 4).

Table 7: Citation Frequency Distribution of Zoology Journals.

Year	Age	Citations	Cum Citations	Tail	Citations %	Cum Citation %
2014	0	51	51	5332	0.956	0.956
2013	1	322	373	5281	6.039	6.995
2012	2	783	1156	4959	14.685	21.680
2011	3	887	2043	4176	16.635	38.316
2010	4	961	3004	3289	18.023	56.339
2009	5	810	3814	2328	15.191	71.530
2008	6	526	4340	1518	9.865	81.395
2007	7	298	4638	992	5.589	86.984
2006	8	391	5029	694	7.333	94.317
2005	9	303	5332	303	5.683	100.000
		5332			*100*	
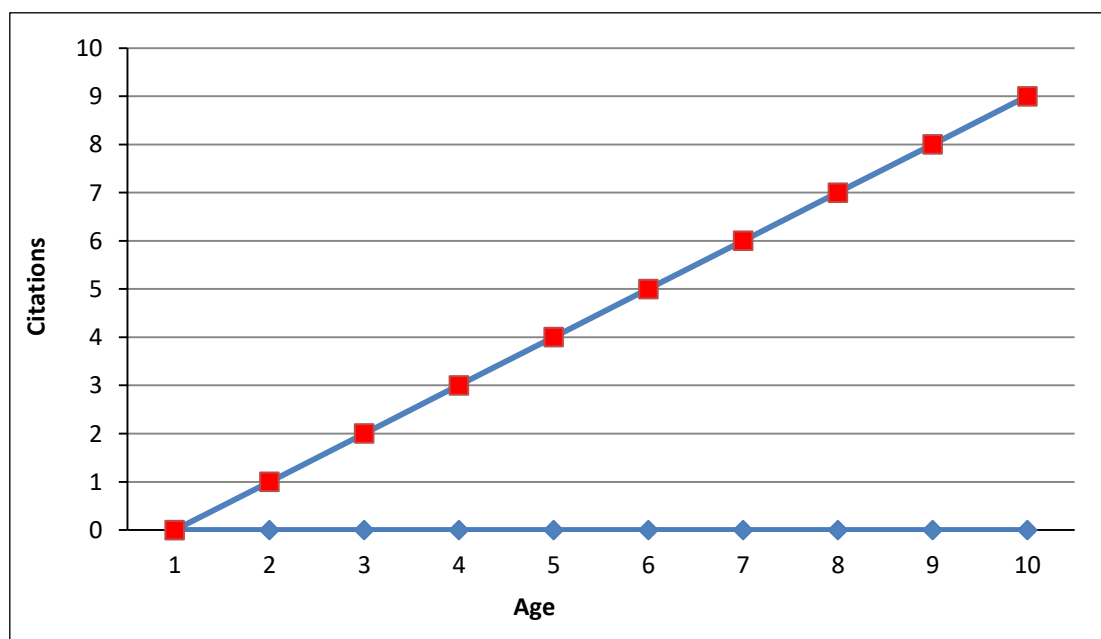
Fig. 4: Age Wise Distribution of Citations.

Kolmogorov-Simrnov Test (K-S Test), is applied in order to test the exponentially of the distribution by using the formula.

$E(X) = 1 - e^{-(\emptyset X)}$

$\emptyset = \left(\frac{1}{\bar{X}}\right)$

$\bar{X} = mean$

X= 1, 2, 3, 4……n

The estimated values are presented in column 5 of Table 8

Mean= 6.266823

Dmax=F(x)-E(x)=0.25861

Ks value is = 1.63/sqrt(n)

Ks= 0.543333

According to this test, the maximum deviation is observed and estimated values. D is calculated as follows: -D= F(x)-En(x).

At the 0.01 level of significance, the K-S Statistics is equal to D value does not exceed ks value hence it conform the statistically that the distribution of the data follows negative exponential distribution Table 8.

Citing Half-life and Average Age of Journal Citations

The cited half-life is a measure of the rate of decline of the citation curve. It is the number of years that the number of current citations takes to decline to half of its initial value (Amin and Mabe, 2000) [13].

Taking the data from Table 9, we measure the average age of journal citation (AC_a) in zoology from 2005 to 2014 by dividing sum of scores of citations using a simple formula:

$$ACa = \frac{\sum C_a x\ C_n}{\sum C_n}$$

Where: AC_a= Average Age of Citations

C_a = Age of Citation

C_n = Number of citations

Applying the formula mentioned above, average age of citations (AC_a) from the obtained data set of Zoology from 1989-2013 is calculated as:

$$ACa = \frac{24448}{5332} = 4.5851$$

Table 8: Test of Exponentially of Citation Distribution.

Ho: The Distribution of the Data does not Follows Negative Exponential (Hypothesis).							
X	f(x)	xX f(x)	x2f(x)	Estimation	Fx	Cumulative	Difference
0	51	0	0	0	0.001713	0.001713	-0.00171
1	373	373	373	0.147421	0.012525	0.014238	0.133183
2	1156	2312	4624	0.273109	0.038818	0.053056	0.220054
3	2043	6129	18387	0.380268	0.068603	0.121659	0.25861
4	3004	12016	48064	0.47163	0.100873	0.222532	0.249098
5	3814	19070	95350	0.549523	0.128073	0.350604	0.198919
6	4340	26040	156240	0.615933	0.145735	0.49634	0.119593
7	4638	32466	227262	0.672552	0.155742	0.652082	0.020471
8	5029	40232	321856	0.720825	0.168872	0.820954	-0.10013
9	5332	47988	431892	0.761981	0.179046	1	-0.23802
	29780	186626	1304048	0	1		0.25861

Table 9: Half-Life Period and Average Age of Journal Citations.

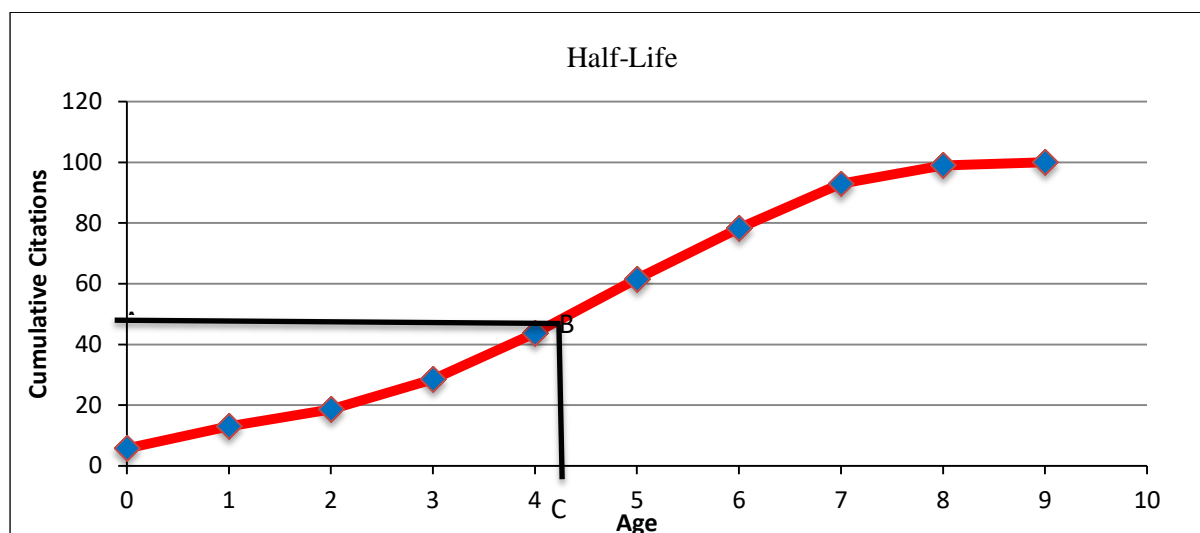| Year	Age	Citations	Cum Citations	score of citation ca X cn	percentage	Cum % Age
2005	0	303	303	0	5.68	5.68
2006	1	391	694	391	7.33	13.02
2007	2	298	992	596	5.59	18.60
2008	3	526	1518	1578	9.86	28.47
2009	4	810	2328	3240	15.19	43.66
2010	5	961	3289	4805	18.02	61.68
2011	6	887	4176	5322	16.64	78.32
2012	7	783	4959	5481	14.68	93.00
2013	8	322	5281	2576	6.04	99.04
2014	9	51	5332	459	0.96	100.00
		5332		24448	100	

Fig. 5: Journal Citing Half-life.

Hence, it is understood that through the half-life of the citations in Zoology fall within years (half-life =4.5851) of publications of respective journals, Figure 5 the average age of cited journals is a bit higher than the half-life of citations because Zoology authors have cited many articles published way back to more than 10 years (Table 9).

FINDINGS AND CONCLUSION

Citations play a vital role in identification and retrieval of earlier works. Librarians are expected to know enough about key subjects in order to assist patrons with their research needs. Zoology literature has been published 1029 articles during the period of study. In total citations have been cited and the maximum number of contributions are published in the form of articles and majority of the publications are published in English language which accounts for 98.59%. In case of geographical contribution study found that the USA is the highest contribution of citations followed by the UK. Journal of Zoology is the highly quoted journal in the field of zoology literature. D value does not exceed ks value hence it conform the statistically that the distribution of the data follows negative exponential distribution.

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