

Full Length Research Paper

The pattern of using information by research scholars in zoology: A bibliometric study

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Citations of 24 doctoral dissertations in Applied Zoology submitted to Kuvempu University since its inception were analysed to study the information use pattern of research scholars. The study also analysed the principal bibliographic forms, the journal used and their distribution according to country of origin and chronological scattering. The application of Bradford's Law of scattering to the literature of botany reveals an exponential trend when plotted on the graph. The study shows that the distribution pattern of citations by type of documentary sources shows that periodicals are highly cited (75.52%). Books are considered as the second major source, which accounts for 17.25%. In other words, periodicals and books together constitute 92.77% while other forms of sources are negligible. Team research prevails in the field of Biotechnology. The degree of collaboration is found to be 0.66. The study shows that United States occupied top position with 1,679 citations (32.69%), followed by India (1,303; 25.37%) and then the United Kingdom (842; 16.39%). It is evident from the result of the study that the journal, Journal Mutation Research (212; 5.46%) occupies first in the rank list of journals, followed by the Journal of Bombay Natural History Society 74 (1.90%) and Aquaculture 70 (1.80%); Journal Fish Biology 67 (1.72%) scores the highest number of citations among the most cited periodicals.

Key words: Bibliometric analysis, applied zoology, bibliography, authorship pattern, core journals, mutation research, aquaculture.

INTRODUCTION

Library is a dynamic instrument of education, an agency for the transfer of knowledge. It builds the bridge between knowledge and the seekers of information. We are living in information era. In this era of science, research is carried out in different disciplines. Information and its resources are the life blood of any organization or a nation, and thus an essential element in the research developmental process. Information has been considered an important resource, as it plays a vital role in all spheres of man's activities. Information is an essential raw material for all human endeavors in a complex modern society. It is recognized as a prerequisite of scientific, socio- economic and cultural development of any nation for this is inevitable to provide the right information to right user at the right time in the right form.

The first need of a scientist, technologist and technician

is that they must be aware of what is currently going on in their respective field of work. So bibliometric study has now become a well established part of information research; and quantitative approach to the description of documents and examination of services is gaining ground both in research and practice (Mubeen 1994).

In recent years, bibliometric techniques have been used widely to identify the characteristics of journals, literature of many different subject areas; but most often, researchers have concentrated on the use of these techniques on the research from various branches of science (Pillai 2007). Applied zoology is the branch of biology that focuses on the structure, function, behavior and evolution of animals.

Humans have been fascinated by the other members of the animal kingdom throughout history. In early Europe,

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they gathered up and catalogued descriptions of strange animals from distant lands or deep seas, such as are recorded in the *Physiologus* and in the works of Albertus Magnus. His work was based largely on the writings of Aristotle. Magnus' *De animalibus libri XXVI* is not the only volume of his commentaries on Natural History, but it remains one of the most extensive studies of zoological observation published before modern times. The disciplinary study of zoology also found root in Arabia and China. Afro-Arab scholar Al-Jahizz (781 to 868) wrote the *Book of Animals*, a predecessor to *The Origin of Species*. Two great Chinese authors in this field were Su Song (1020 to 1101) and Shen Kuo (1031 to 1095) of the Song Dynasty period, yet there were many others.

Objectives

They are as follows:

1. To determine the year wise distribution of thesis submitted in applied zoology.
2. To trace out the average number of references per thesis.
3. To determine the characteristics of sources of information used by the applied zoology scientists, taking their PhD theses as samples,
4. To find out the nature of authorship pattern and degree of collaboration.
5. To determine the chronological distribution of citations used by applied zoology researchers.
6. To find out the subject wise break-up.
7. To study the distribution of documents, according to their country of origin.
8. To prepare a rank list of journals in order of their frequency of citation which may help librarians document list and research workers in the selection and acquisition of most useful documents.
9. Rank with country wise distribution of cited journals.
10. To apply Bradford's Law to the journal citations.

METHODOLOGY

Literature, cited in the Ph.D. thesis in applied zoology, is the basic source of information to access the information used by the researchers. Accordingly, the bibliographical reference cited at the end of the Ph.D thesis is taken as the source data for the present study. The Ph.D. thesis submitted to Kuvempu University, Jnana Sahyadri in the subject of Applied Zoology will be studied. The data needed for the application of bibliometric analysis were collected from the in-house database prepared from the theses submitted to the University Library. All the data pertaining to this study were recorded on 5" x 3" slips, and the same slips were sorted according to the objectives of the study, with the necessary tables prepared.

Scope and limitation of the study

The present study is conducted with the aim of tracing the growth of the PhD output of Applied Zoology Departments of Kuvempu

University. The Doctoral Dissertations submitted to the Applied Zoology Departments of Kuvempu University were considered as the data base for the present study.

Analysis

The analysis is a process of summarizing or transforming raw data into useful information. Citation studies attempt to study the characteristics of subject literatures. The investigations of such kind of studies are found to be useful to manage the information resources and services in libraries and information centers.

To achieve the objectives of the present study these data covered only the applied zoology subjects. A total number of 5135 citations are collected from 24 theses in the field of applied zoology and have been presented and analyzed to facilitate interpretation and conclusions in the following sections.

Year wise distribution of submission of thesis

At first glance, Table 1 and Figure 1 reveals that between years 2002 to 2009, the output of the Ph.D. level research works from this university has been showing an increasing trend. It is clearly evident from the study that a maximum number of 8 (33.36%) theses were submitted in the year 2008, followed by 4 (16.66%) in the year 2005, 3 (12.50%) each in the years 2004, 2006 and 2007, respectively. 1 (4.16%) of each theses were submitted in the years 2002, 2003 and 2009, respectively.

Average number of citations per thesis

Table 2 gives the average number of citations per dissertation submitted by the researcher of applied zoology. It is clearly observed from the study that on an average 213.95 citations per thesis were used by the applied zoology researchers. Further, it is observed from the table that the highest average numbers of citations per thesis, that is 301, were found in the year 2009 and the lowest average number of citations, that is, 184 was found in the year 2002.

Distribution of citations according to bibliographic forms

Table 3 and Figure 2 shows the distribution of citations among different documentary forms such as journals, books and monographs, conference proceedings, thesis, reports, websites, patents, news papers, etc. used by researchers. It is observed from the table that the journals have the highest number of citations accounting for (75.52%) percent of the total citations. It shows that the researchers in the field of applied zoology are mainly concentrating on journals for collecting information. It is the most preferred source of information used by them. Books are the second highest group (17.25%).

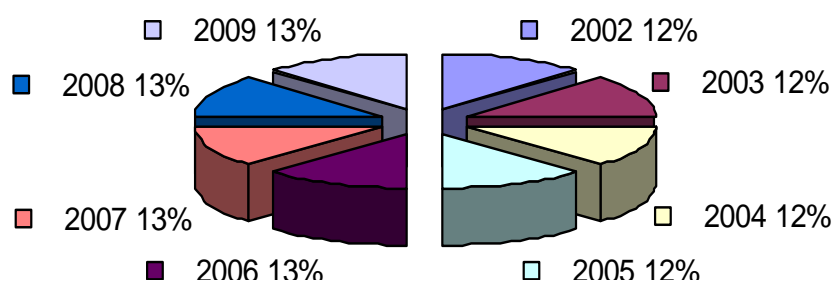
Periodicals and books together contribute the highest number of citations than the other form of documents such as conference proceedings, thesis etc. In other words, books and periodicals together constitute 92.77% of all the citations cited by the research scholars (Kannappanavar and Vijayakumar, 2001).

The next source of information for researchers is the conference proceedings accounting for 3.42%. The next sources of information for research scholars are thesis and dissertations. These amounts to 1.73% of all citations followed by reports, web, patents, newspapers, which together constitute 2.08% of all citations.

The relatively high percentage of citations of journals and low percentage of citations to news paper and unpublished monographs, etc. indicates that journals are the most preferred channel

Table 1. Year wise distribution of submission of thesis.

Year	No. of thesis	Percentage (%)
2002	1	4.16
2003	1	4.16
2004	3	12.50
2005	4	16.66
2006	3	12.50
2007	3	12.50
2008	8	33.36
2009	1	4.16
Total	24	100.00

**Figure 1.** Year wise distribution of submission of thesis.**Table 2.** Average number of citations per thesis.

Year	Total no. of dissertations	Total no. of citations	Average citations per dissertations
2002	1	184	184.00
2003	1	219	219.00
2004	3	482	160.66
2005	4	734	183.05
2006	3	590	196.66
2007	3	851	283.66
2008	8	1774	221.75
2009	1	301	301.00
Total	24	5135	213.95

Table 3. Distribution of citations according to bibliographic forms.

Bibliographic form	Citation	Cumulative citation	Percentage (%)	Cumulative percentage (%)
Journal	3878	3878	75.52	75.52
Book and Monograph	884	4762	17.25	92.77
Conference Proceeding	176	4938	3.42	96.19
Thesis	89	5027	1.73	97.92
Report	92	5119	1.79	99.71
Web	10	5129	0.19	99.90
Patent	04	5133	0.07	99.97
Newspaper	02	5135	0.03	100.00
Total	5135		100.00	

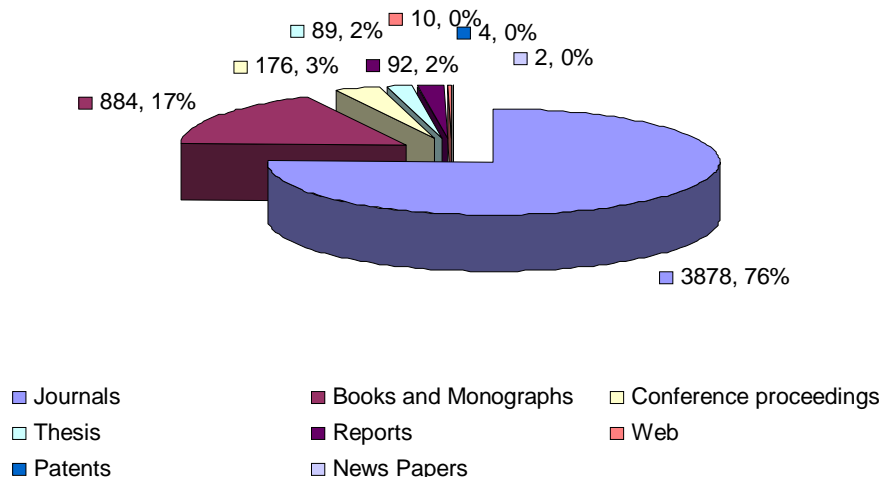


Figure 2. Distribution of citations according to bibliographic forms.

Table 4. Authorship pattern in applied zoology.

No. of author	Total citation	Percentage (%)	Foreign author	Percentage (%)	Indian author	Percentage (%)
1	1727	33.63	1247	24.28	480	9.34
2	1648	32.02	1017	19.80	631	12.28
3	814	15.85	541	10.53	273	5.31
4	396	7.71	281	5.47	115	2.23
5	225	4.38	176	3.42	49	0.95
6	82	1.59	71	1.38	11	0.21
7	62	1.24	54	1.05	08	0.15
>8	68	1.32	57	1.11	11	0.21
Anonymous	56	1.09	00	00	00	00
Corporate	47	0.99	00	00	00	00
URLs	10	0.19	00	00	00	00
Total	5135	100.00	3444	67.04	1578	30.68

of information. From the table we can observe that journal and books are the most important source of information when compared to other source of information.

Authorship pattern in applied zoology

Table 4 clearly indicates that out of 5135 citations, the maximum citations are written by single authors with 1727 (33.63%); two authors, 1648 (32.02%); third place is occupied by three authors with 814 (15.85%); fourth place, by four authors with 396 (7.71%); fifth place, by five authors with 225 (4.38%); six place, by six authors with 82 (1.59%); and 62 (1.24%) citations are written by seven author, and the remaining 68 (1.32%) citations are contributed by eight and the above authors; anonymous, corporate, URLs authors together constitute 113 citations.

Collaborative research is the common phenomenon in the field of science and technology in general and applied zoology, in particular. According to Derek Desollo price, and meadows investigations have pointed out that there has been a consistent trend towards increased collaboration. The collaborative research is a well recognized feature of modern science, and there has been a consistent trend towards increased collaboration in all branches of science during the present century. There is an attempt made to

know whether the trend towards increased collaboration is in applied zoology or not.

By analyzing Table 4 it is observed that majority of the cited documents were by two and more authors. That means the collaborative research is prevailing in applied zoology subject. Furthermore, the table shows that 33.63% of all the citations are in favor of single authors and remaining 66.37% of citations in favour of team research. Degree of collaboration among authors is measured by the following formula, given by K. Subramanyam:

$$C = \frac{NM}{NM+NS}$$

Where C = degree of collaboration; NM = No. of multi author papers; NS = No. of single author papers.

$$\frac{3408}{3408 + 1727} = \frac{3408}{5135}$$

In present study the degree of collaborative:

$$C = 0.66.$$

Table 5. Authorship pattern of journal citations.

No. of author	Total citation	Percentage (%)	Foreign author	Percentage (%)	Indian author	Percentage (%)
1	1097	28.28	829	21.39	268	6.91
2	1372	35.37	836	21.59	536	13.82
3	697	17.97	467	12.04	230	5.93
4	340	8.76	244	6.29	96	2.47
5	190	4.89	155	3.99	35	0.90
6	73	1.88	65	1.67	08	0.20
7	59	1.57	52	1.34	07	0.18
>8	50	1.28	45	1.16	05	0.12
Total	3878	100.00	2693	69.47	1185	30.53

Table 6. Chronological distribution total citations.

Period	No. of citation	Cumulative citation	% of citation	% cumulative citation
1800-1849	05	05	0.09	0.09
1850-1899	16	21	0.31	0.04
1900-1909	14	35	0.27	0.68
1910-1919	27	62	0.52	1.20
1920-1929	36	98	0.70	1.90
1930-1939	37	135	0.72	2.62
1940-1949	65	200	1.26	3.89
1950-1959	155	355	3.01	6.91
1960-1969	377	732	7.34	14.25
1970-1979	708	1440	13.78	28.04
1980-1989	1135	2575	22.16	50.14
1990-1999	1662	4237	32.36	82.51
2000-2009	898	5135	17.48	100.00
Total	5135		100.00	

Authorship pattern of journal citations

Table 5 clearly shows the authorship pattern of the journal citations. It is observed from the table that out of 3,878 citations, 1,372 (35.37%) are in favour of two authors, of which 21.59% are of foreign authors and remaining, Indian authors. It is observed from the table that overall, 69.47% of citations are in favour of foreign authors and 30.53% of the citations are in favour of Indian authors. This clearly shows that the zoology researchers are in need of foreign literature more as compared to Indian literature (Kannappanavar and Vijayakumar, 1999).

Chronological distribution of total citations

Table 6 and Figure 3 reveal the number of citations scattered during a particular year. It is easy for identification of subject interest or development in a year. Table 6 provides data regarding use of references by applied zoology researchers in preparation of their dissertations.

In Table 6 the citations are divided into 13 groups, each comprising a time span of 50 years from 1800 up to 1899; followed by the time span of 10 years from 1900 up to 2009. Each group's citation is very high during 1990 to 1999 (32.36%) and low during 1800 to 1849 (0.09%). This clearly shows that the zoology researchers are in need of recent literature for their study and research.

Chronological distribution of journal citations

Table 7 indicates the chronological distribution of journal citations. The maximum number of citations 1248 (32.18%) are covered during the period of 1990 to 1999, followed by the period 1980 to 1989, accounting for 859 (22.15%). This shows that the research scholars are in need of the literature published in 1980, 1990 and 2000. That means nascent literature is very much useful for the research scholars in zoology and allied subject.

Subject wise distribution of citations in applied zoology

In this present era, it is very difficult to find out particular required information due to the existence of multidisciplinary subjects. Thus to overcome this problem, subject wise distribution is helpful for finding out right information at the right time. Table 8 shows the subject wise distribution of total number of citations in the field of applied zoology.

Table 8 clearly shows that Entomology (13.38%), Animal Physiology (7.99%), Animal Genetics (7.86%), Ecology (6.13%), Fish Diversity (5.93%), Ornithology (5.15%), and Plant Insect Interaction (4.89%) contribute 51.33% of the total citation; the remaining subjects altogether contribute 48.67% of the total citations. This clearly shows that the above mentioned subjects are more important to Zoologists.

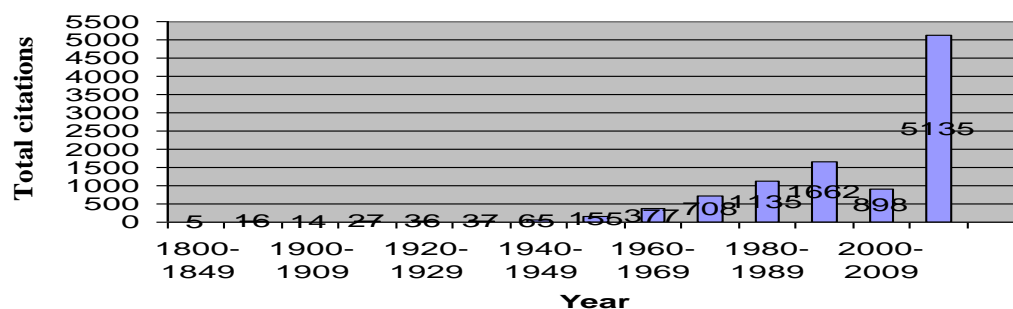


Figure 3. Chronological distribution of total citations.

Table 7. Chronological distribution of journal citations.

Period	No. of citation	Cumulative citation	% citation	% cumulative citation
1800-1849	01	01	0.02	0.02
1850-1899	06	07	0.15	0.18
1900-1909	07	14	0.18	0.36
1910-1919	15	29	0.38	0.74
1920-1929	28	57	0.79	1.46
1930-1939	27	84	0.69	2.16
1940-1949	49	133	1.17	3.42
1950-1959	121	254	3.19	6.54
1960-1969	271	525	6.98	13.53
1970-1979	541	1066	13.95	27.48
1980-1989	859	1925	22.15	49.63
1990-1999	1248	3173	32.18	81.82
2000-2009	705	3878	18.17	100.00
Total	3878		100.00	

Geographical distribution of citations

Country vs. bibliographic form wise distribution of cited documents: It is an evident from Table 9 that the literature of Zoology is distributed among many countries. USA alone contributes 32.69% of the total citations, followed by India which contributes 25.37%; UK, 16.39%; Netherlands, 7.36%; Canada, 2.00%; Germany, 2.06%; Japan, 1.79%; India, USA and UK together contribute 74.45% of total citations. The remaining 25.55% of citations are distributed among 28 countries. 36 different countries have contributed one citation each in the study. Further, we are unable to identify the country of publication for the 170 citations.

Core journals

The phenomenal growth of publications, diverse nature of the users requirements, inter and multi-disciplinary nature of research, escalating cost of documents juxtaposed with the limited financial resources are forcing librarians to think more and more in terms of quantitative techniques for decision making processes. The progress of research in science and technology or social science is impeded unless new knowledge generated by research flows freely, quickly and timely among the scientific and technical communities.

Major position of the library budget is spent towards subscription of periodicals. Libraries may never mind to spend enormous

amount for subscription of periodicals. But how many readers utilize these periodicals is a question of concern. There is usually a small group of readers who use the periodical collections.

Rank list of journals in applied zoology

Table 10 provides an overall rank list of journals in the field of applied zoology prepared on the basis of the number of grand total of citations of individual journals counted in the source documents. Rank list connotes a list of core journals arranged in the descending order of the number of citations. From the table, 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 applied zoology, while the least important titles are placed at the bottom of the table.

The table has been arranged in eight columns. The first column indicates the running serial number of the entries. The second column provides the actual rank of the journal in order of its importance, which is based on the grand total of citations in the source documents. Naturally, the serial numbers and the number of ranking order will change as two or more journals may occupy the same rank and hence the same rank number, but their serial number will differ from one another as each journal has its own separate serial number. Column three indicates the titles of the ranked journals. Column four indicates the number of times the journal has been cited in the source documents. The fifth column

Table 8. Subject wise distribution of citations in applied zoology.

Subject	No. of citation	Cumulative citation	Percentage (%)	Cumulative (%)
Entomology	519	519	13.38	13.38
Animal physiology	310	829	7.99	21.37
Animal genetics	305	1134	7.86	29.23
Ecology	238	1372	6.13	35.13
Fish diversity	230	1602	5.93	41.29
Ornithology	200	1802	5.15	46.44
Plant insect interaction	190	1992	4.89	51.33
Toxicology	140	2132	3.61	54.94
Aquatic biology	132	2264	3.40	58.34
Cytogenetics	127	2391	3.27	61.61
Pisciculture	120	2511	3.09	64.70
Pesticide effect	110	2621	2.83	67.53
Biodiversity	87	2708	2.24	69.77
Butterfly ecology	80	2788	2.06	71.83
Evaluation	80	2868	2.06	73.89
Insect diversity	80	2948	2.06	75.95
Sericulture	80	3028	2.06	78.01
Reproductive biology	65	3093	1.67	79.68
Genetic engineering	60	3153	1.54	81.22
Resistance mechanism	60	3213	1.54	82.76
Animal behaviour	55	3268	1.41	84.17
Butterfly diversity	50	3318	1.28	85.45
Microbiology	50	3368	1.28	86.73
Taxonomy	42	3410	1.08	87.81
Adoption biology	40	3450	1.03	88.84
Pest control	40	3490	1.03	89.87
Water management	40	3530	1.03	90.90
Food habitat	38	3568	0.97	91.87
Biochemistry	35	3603	0.90	92.77
Chemical control	30	3633	0.77	93.54
Social behaviour	30	3663	0.77	94.31
Water ecology	30	3693	0.77	95.08
Water quality	30	3723	0.77	95.85
Hurdle technology	26	3749	0.67	96.52
Behaviour study	25	3774	0.64	97.16
BT- Cotton	24	3798	0.61	97.77
Agronomy of coffee	20	3818	0.51	98.28
Coffee cultivation	15	3833	0.38	98.66
Ethology	15	3848	0.38	99.04
Control management	12	3860	0.37	99.41
Diversity	10	3870	0.30	99.71
Population dynamics	08	3878	0.29	100.00
Total	3878		100.00	

provides the cumulative citations. Percentage of each journals citation is presented in column six. Column seven provides the cumulative percentage. Column eight provides the country of origin.

There are 988 journals arranged in order of their ranks. From the Table 10 it can be ascertained that the Mutation Research published from Netherlands occupies the first rank as the most preferred journal having been cited 212 times. Journal of Bombay

Natural History Society (India) occupies the second rank getting 74 citations, followed by Aquaculture (U.K.) with 70 citations, Journal of Fish Biology (U.K.) with 67 citations, Journal of Food Science (USA) with 53 citations, Proc. Indian Academy Science (India) with 50 citations, Nature (U.K.) with 48 citations, Environment Ecology (U.S.A.) with 44 citations, Current Science (India) with 44 citations, Indian Journal of Fisheries (India) with the 41 citations, Journal of

Table 9. Geographical distribution of citations.

Country	Citation								Total	Percent (%)
	Journal	Book	Proceeding	Thesis	Report	URL	Patent	Newspapers		
USA	1240	356	53	06	22	00	02	00	1679	32.69
India	818	258	92	76	57	00	00	02	1303	25.37
UK	643	187	02	04	05	00	01	00	842	16.39
Netherlands	361	16	01	00	00	00	00	00	378	7.36
Canada	92	05	04	01	01	00	00	00	103	2.00
Germany	90	13	02	00	00	00	01	00	106	2.06
Japan	78	12	01	00	01	00	00	00	92	1.79
France	34	03	00	00	00	00	00	00	37	0.72
China	33	02	01	00	00	00	00	00	36	0.70
Australia	32	00	01	00	00	00	00	00	33	0.64
Italy	31	05	02	00	01	00	00	00	39	0.75
Russia	28	00	00	00	00	00	00	00	28	0.54
Brazil	24	00	01	00	00	00	00	00	25	0.48
Philippines	21	00	00	00	00	00	00	00	21	0.40
Switzerland	21	06	02	00	01	00	00	00	30	0.58
Denmark	18	00	01	00	00	00	00	00	19	0.37
S. Africa	16	03	01	00	02	00	00	00	22	0.42
Korea	14	00	00	00	00	00	00	00	14	0.27
Egypt	12	00	00	00	00	00	00	00	12	0.23
Poland	12	00	00	01	00	00	00	00	13	0.25
Ireland	11	00	01	00	00	00	00	00	12	0.23
Taiwan	08	00	01	00	00	00	00	00	09	0.17
Bangladesh	07	00	00	00	00	00	00	00	07	0.13
Belgium	07	00	00	00	00	00	00	00	07	0.13
Spain	06	00	00	00	00	00	00	00	06	0.11
C. Republic	05	00	00	00	00	00	00	00	05	0.09
New Zealand	05	00	00	00	00	00	00	00	05	0.09
Pakistan	05	01	00	00	00	00	00	00	06	0.11
URLs	00	00	00	00	00	10	00	00	10	0.19
O. Countries	36	17	10	01	02	00	00	00	66	1.28
Un-identified	170	00	00	00	00	00	00	00	170	3.31
Total	3878	884	176	89	92	10	04	02	5135	100.00

Economic Entomology (USA) with 38 citation, Animal Behavior (U.K.) with 35 citations, Entomon (India) with 34 citations. The first ten journals in the ranking list together account for 19.11% of the total citations. The table also shows that the first 50 journals out of the total of 988 ranked journal cover 41.12% of citations, while the remaining 938 journals together account for 58.88% of citations (Biradar 2006).

Thus, it is noted that a few journal yielded more citations and more journals yielded a few citations. A single concentration in a few journals is evident. Therefore 'Core' or productive journals can be identified on the basis of the ranked lists.

Ranked countries of journals

The journals are analysed according to their country of origin and the result of the ranked countries are shown in Table 11. It has been observed that U.S.A. is the leading country with 26.51% of the total journals cited. India has a contribution of about 15.68% and the U.K., 14.06%. It can be inferred from the analysis that U.S.A,

India, and U.K. are the prominent countries in applied zoology.

Production of journals in applied zoology

In order to measure the productivity of journals, the total of 3878 citations were divided into four equal categories of citations each. The number of cited journals for each group is given in Table 12. It is observed from Table 12 that the first groups of citations are to the first 18 journals on the rank list, thus signifying their high rate of productivity. The average productivity of each journal in the first group/category was 54.11 articles, where it has considerably gone down to 1.22 articles in the fourth category. This marked difference easily confirms the decreasing productivity of individual journals in the rank list.

Bradford's zones for applied zoology

It is observed from Table 13 that there are 31 journals in the

Table 10. Rank list of journals in applied zoology.

Rank no.	Journal title	No. of citation	Cumulative citation	Percent (%)	Cumulative (%)	Country
1	Mutation Research	212	212	5.46	5.46	Netherlands
2	Journal of Bombay Natural History Society	74	286	1.90	7.36	India
3	Aquaculture	70	356	1.80	9.16	UK
4	Journal Fish Biology	67	423	1.72	10.88	UK
5	Journal of Food Science	53	479	1.44	12.32	USA
6	Proc. Indian acad. Science	50	529	1.28	13.60	India
7	Nature	48	577	1.23	14.83	UK
8	Environment Ecology	44	621	1.13	15.96	USA
8	Current Science	44	665	1.13	17.09	India
9	Indian Journal Fisheries	41	706	1.05	18.14	India
10	Journal of Economic Entomology	38	744	0.97	19.11	USA
11	Animal Behavior	35	779	0.90	20.01	UK
11	Journal Coffee Research	35	814	0.90	20.91	India
12	Entomon	34	848	0.87	21.78	India
13	Journal of Environmental Biology	33	881	0.85	22.63	India
14	Evolution	32	913	0.82	23.45	USA
15	Trans. American fish. Soc.	31	944	0.79	24.24	USA
16	Fishery Technology	30	974	0.77	25.01	India
17	Hydrobiologia	29	1003	0.74	25.75	Netherlands
17	Heredity	29	1032	0.74	26.49	USA
18	Canada Journal Fish. Aquat. Science	28	1060	0.72	27.21	Canada
19	Genetics	26	1086	0.67	27.88	USA
19	Mutagenesis	26	1112	0.67	28.55	UK
20	Ecology	24	1136	0.61	29.16	UK
20	Newsletter for Birdwatchers	24	1160	0.61	29.77	India
21	Journal of Food Protection	23	1183	0.59	30.36	USA
22	Environ Toxicol Chem.	22	1205	0.56	30.92	USA
22	Indian Journal of Experimental Biology	22	1227	0.56	31.48	India
23	Proc. Natl. Acad. Sci. USA	21	1248	0.54	32.02	USA
23	Science	21	1269	0.54	32.56	USA
24	American Nutrition	20	1289	0.51	33.07	USA
24	Conservation Biology	20	1309	0.51	33.58	USA
25	Drosophila. Information Service	19	1328	0.48	34.06	USA
25	General and Comparative Endocrinology	19	1347	0.48	34.54	USA
25	Indian Journal Entomology	19	1366	0.48	35.02	India
25	Journal of Aquatic Animal Health	19	1385	0.48	35.50	USA

Table 10. Contd.

25	Oriental Insects	19	1404	0.48	35.98	USA
26	Indian Journal Environ. Health	18	1420	0.46	36.44	India
27	Annual Review of Entomology	17	1439	0.43	36.87	USA
27	Environmental Entomology	17	1456	0.43	37.30	USA
27	Journal of Biological Chem.	17	1473	0.43	37.73	USA
28	Molecular Ecology	16	1489	0.41	38.14	UK
28	Rec. Indian Mus.	16	1505	0.41	38.55	India
29	Environ. Health Perspect	15	1520	0.38	38.93	USA
29	Entomologia Exp. Appl.	15	1535	0.38	39.31	Netherlands
29	Journal of Entomological Research	15	1550	0.38	39.69	India
29	Journal exp. Zool	15	1565	0.38	40.07	USA
30	Bull. Environ. Contam. Toxicol.	14	1579	0.36	40.43	USA
30	Journal Animal Ecology	14	1593	0.36	40.79	UK
31	Advance in Biosensors	13	1604	0.33	41.12	USA
31	Indian Coffee	13	1619	0.33	41.45	India
31	Insect Environment	13	1632	0.33	41.78	UK
31	Water Research	13	1645	0.33	42.11	
32	Environ Pollution	12	1657	0.30	42.41	Netherlands
32	Journal of Biological Control	12	1669	0.30	42.71	USA
32	ICLARM	12	1681	0.30	43.01	Philippines
32	Journal of Insect Physiology	12	1693	0.30	43.31	UK
32	Matsya	12	1705	0.30	43.61	India
32	Applied Entomology Zoology	12	1717	0.30	43.91	Japan
33	Canadian Entomology	11	1728	0.28	44.19	Canada
33	Cytologia	11	1739	0.28	44.47	Japan
33	Canadian Journal Zoology	11	1750	0.28	44.75	Canada
33	Copeia	11	1761	0.28	45.03	USA
33	Environ. Biol Fishes	11	1772	0.28	45.31	Netherlands
33	Experiential	11	1783	0.28	45.59	Switzerland
33	FAO Fisheries Technical Paper Rome	11	1794	0.28	45.87	Italy
33	Journal of Agric. Food chemistry	11	1805	0.28	46.15	USA
33	Geobios	11	1816	0.28	46.43	India
33	Int. Rev. Ges. Hydrobiol	11	1827	0.28	46.71	Germany
33	Pestic. Biochem. Physiol.	11	1838	0.28	46.99	USA
34	Aquatic Toxicology	10	1848	0.26	47.25	Netherlands
34	Ecol. Appl.	10	1858	0.26	47.51	USA
34	Journal Inland Fish Soc India	10	1868	0.26	47.77	India

Table 10. Contd.

34	Journal Wildlife Management	10	1878	0.26	48.03	USA
34	Journal Bacteriology	10	1888	0.26	48.29	USA
34	Mysore Journal of Agric. Sci.	10	1898	0.26	48.55	India
34	Oecologia	10	1908	0.26	48.81	Germany
35	Arch. Environ Contamination Toxicol.	9	1917	0.23	49.04	USA
35	Canadian Journal Biochem. Physiol.	9	1926	0.23	49.27	Canada
35	Environ. Mol. Mutagen.	9	1935	0.23	49.50	USA
35	Food Science Technology	9	1944	0.23	49.73	USA
35	Genetics in Aquaculture	9	1953	0.23	49.96	USA
35	Indian Journal of Agricultural Science	9	1962	0.23	50.19	India
35	Journal of Mys Univ.	9	1971	0.23	50.42	India
35	Oikos	9	1980	0.23	50.65	Denmark
35	Proc. Roy Soc London	9	1989	0.23	50.88	UK
36	American Zoology	8	1997	0.20	51.08	USA
36	Aquatic Living Resources	8	2005	0.20	51.28	France
36	American Midland Naturalist	8	2013	0.20	51.48	USA
36	Biological Conservation	8	2021	0.20	51.68	UK
36	Behav. Genet.	8	2029	0.20	51.88	USA
36	Behaviour	8	2037	0.20	52.08	USA
36	Bull. of Entomological Research	8	2045	0.20	52.28	UK
36	Environmental Research	8	2053	0.20	52.48	USA
36	Genetika	8	2061	0.20	52.68	Russia
36	Indian Forester	8	2069	0.20	52.88	India
36	Int. Journal of Food Microbiology	8	2077	0.20	53.08	Netherlands
36	Int. Journal Acad Ichthyol	8	2085	0.20	53.28	Russia
36	Journal mar. Boil. UK	8	2093	0.20	53.48	UK
36	Journal Appl. Ichthyol.	8	2101	0.20	53.68	Russia
36	Journal mol. Biol.	8	2109	0.20	53.88	UK
36	Journal Fish Res. Bd. Canada	8	2117	0.20	54.08	Canada
36	Journal Wat. Poll. Control fed.	8	2125	0.20	54.28	USA
36	Journal Exp. Biol.	8	2133	0.20	54.48	UK
36	Mar. Biotechnol.	8	2141	0.20	54.68	USA
36	Pest Management in Horticultural Ecosystems	8	2149	0.20	54.88	
36	Poll research	8	2157	0.20	55.08	USA
36	Water Science and Technology	8	2165	0.20	55.28	
36	Zoos Print Journal	8	2173	0.20	55.48	
37	Acta Horticulturae	7	2180	0.18	55.66	Belgium

Table 10. Contd.

37	Applied Environmental Microbiology	7	2187	0.18	55.84	USA
37	Am. Fish. Soc. Beth. Med.	7	2194	0.18	56.02	USA
37	Bulletin de la Entomological d Egypt	7	2201	0.18	56.20	Egypt
37	Comp. Physiol. Ecol.	7	2208	0.18	56.38	India
37	Crop Protection	7	2215	0.18	56.56	UK
37	Diversity and Distributions	7	2222	0.18	56.74	UK
37	EMBOJ	7	2229	0.18	56.92	UK
37	Ecological Monograph	7	2236	0.18	57.10	USA
37	FAO Plant Protection Committee Bull	7	2243	0.18	57.28	Italy
37	Indian Journal Zoology	7	2250	0.18	57.46	India
37	Indian Journal of Plant Protection	7	2257	0.18	57.64	India
37	Journal of Insect Behaviour	7	2264	0.18	57.82	USA
37	Journal Bioscience	7	2271	0.18	58.00	France
37	Journal Cell. Science Suppl.	7	2278	0.18	58.18	Japan
37	Journal Fish Science China	7	2285	0.18	58.36	China
37	Rec. Zool. Surv. India	7	2292	0.18	58.54	India
38	Ann. Rev. Ecol. Syst.	6	2298	0.15	58.69	USA
38	Advance Insect Physiology	6	2304	0.15	58.84	USA
38	Biol. Zbl.	6	2310	0.15	58.99	USA
38	Biochem. Biophys. Acta	6	2316	0.15	59.14	China
38	Bioscience	6	2322	0.15	59.29	USA
38	Ecology of Freshwater Fish	6	2328	0.15	59.44	Denmark
38	Chromosoma	6	2334	0.15	59.59	Germany
38	Cancer Research	6	2340	0.15	59.74	USA
38	Food Technology	6	2346	0.15	59.89	USA
38	Gerpetology	6	2352	0.15	60.04	USA
38	Indian Journal Ecology	6	2358	0.15	60.19	India
38	Indian Journal Comp. Animal Physiol.	6	2364	0.15	60.34	India
38	Journal Fresh Water Biology	6	2370	0.15	60.49	USA
38	Journal Lipid Soc	6	2376	0.15	60.64	USA
38	Journal of Aquatic Food Product Technology	6	2382	0.15	60.79	USA
38	Journal of Toxicol. Environ health	6	2388	0.15	60.94	USA
38	Journal Mammol.	6	2394	0.15	61.09	USA
38	Journal of Applied Ecology	6	2400	0.15	61.24	UK
38	My Forest	6	2406	0.15	61.39	India
38	Molecular General Genetics	6	2412	0.15	61.54	Germany
38	Molecular biol. Evol.	6	2418	0.15	61.69	USA

Table 10. Contd.

38	Nucleic Acids Res.	6	2424	0.15	61.84	UK
38	North American Journal Fish. Manag.	6	2430	0.15	61.99	USA
38	Syst. Zool.	6	2436	0.15	62.14	
38	Uttar Pradesh Journal Zool.	6	2442	0.15	62.29	India
39	Acta Ichthyologica et Piscatorial	5	2447	0.13	62.42	Poland
39	Annu. Rev. Biochem.	5	2452	0.13	62.55	USA
39	Annu. Rev. Pharmacol. Toxicol.	5	2457	0.13	62.68	USA
39	Auk	5	2462	0.13	62.81	USA
39	Bull. Am. Mus. Nat. his.	5	2467	0.13	62.94	USA
39	Acta Entomologica Sinica	5	2472	0.13	63.07	China
39	Annot. Zool. Japan	5	2477	0.13	63.20	Japan
39	Acta Botanica Indica	5	2482	0.13	63.33	India
39	Australian Journal Zoology	5	2487	0.13	63.46	Australia
39	Ann. Rev. Physiology	5	2492	0.13	63.59	USA
39	Asian Journal of Micro. Biotech. Env. Sci.	5	2497	0.13	63.72	India
39	Aqua Fish. Management	5	2502	0.13	63.85	UK
39	Biology of Reproduction	5	2507	0.13	63.98	USA
39	Bangladesh Journal of Zoology	5	2512	0.13	64.11	Bangladesh
39	Boil. Bull.	5	2517	0.13	64.24	USA
39	Biological Abstract	5	2522	0.13	64.37	USA
39	Biotechnology Advances	5	2527	0.13	64.50	USA
39	Biochem. Pharmacol.	5	2532	0.13	64.63	USA
39	Biochemistry	5	2537	0.13	64.76	USA
39	Carcinogenesis	5	2542	0.13	64.89	USA
39	Cell	5	2547	0.13	65.02	USA
39	Canada Field Nat	5	2552	0.13	65.15	Canada
39	Chemosphere	5	2557	0.13	65.28	UK
39	Cell Tissue Research	5	2562	0.13	65.41	Germany
39	Cistruz Subtropical Fruit Journal	5	2567	0.13	65.54	USA
39	DNA repair	5	2572	0.13	65.67	USA
39	Develop Growth and Differents	5	2577	0.13	65.80	Australia
39	Environ. Monitor. Asses.	5	2582	0.13	65.93	Netherlands
39	Environmentalists	5	2587	0.13	66.06	USA
39	Ecolo. Entomology	5	2592	0.13	66.19	UK
39	Entomophaga	5	2597	0.13	66.32	Netherlands
39	Entomologists Newsletter	5	2602	0.13	66.45	Brazil
39	Endocrinol	5	2607	0.13	66.58	USA

Table 10. Contd.

39	Fresh Water Biology	5	2612	0.13	66.71	UK
39	Food Chemistry	5	2617	0.13	66.84	UK
39	Food Microbiology	5	2622	0.13	66.97	UK
39	Genome Research	5	2627	0.13	67.10	USA
39	Genes Development	5	2632	0.13	67.23	USA
39	Hum. Exp. Toxicol.	5	2637	0.13	67.36	UK
39	Human Reprod.	5	2642	0.13	67.49	UK
39	Himachal Journal Environ. Zool.	5	2647	0.13	67.62	India
39	Indian Journal Heredity	5	2652	0.13	67.75	India
39	Indian Journal Environ. Ecoplan	5	2657	0.13	67.88	India
39	Int. Rev. Cytol.	5	2662	0.13	68.01	USA
39	International Journal of Microbiology	5	2667	0.13	68.14	Korea
39	Int. Journal Ecol. Env. Sci.	5	2672	0.13	68.27	India
39	Int. Journal Radiat. Biol.	5	2677	0.13	68.40	UK
39	Journal of Res. Punjab Agric Univer.	5	2686	0.13	68.53	India
39	Journal Herpetol.	5	2687	0.13	68.66	USA
39	Journal Genet	5	2692	0.13	68.79	India
39	Journal Hydrobiol	5	2697	0.13	68.92	India
39	Journal Chem. Ecology	5	2702	0.13	69.05	USA
39	Journal of Aphidology	5	2707	0.13	69.18	India
39	Journal Nat. Conservation	5	2712	0.13	69.31	India
39	Journal of Comp. Psychology	5	2717	0.13	69.44	USA
39	Journal Advance Zool.	5	2722	0.13	69.57	India
39	Journal of Tropical Ecology	5	2727	0.13	69.70	UK
39	Journal Zoology London	5	2732	0.13	69.83	UK
39	Journal Research Lipid	5	2732	0.13	69.96	USA
39	Journal of Animal Science	5	2742	0.13	70.09	USA
39	Mammalia	5	2747	0.13	70.22	France
39	Phytochemistry	5	2752	0.13	70.35	UK
39	PLACROSYM	5	2757	0.13	70.48	
39	Proc. Zool. Soc. London	5	2762	0.13	70.61	UK
39	Planter's Chronicle	5	2767	0.13	70.74	India
39	Pestology	5	2772	0.13	70.87	
39	Physiology zoology	5	2777	0.13	71.00	USA
39	Rev. Environ. Contam. Toxicol.	5	2782	0.13	71.13	
39	Theor. Applied Genetics	5	2787	0.13	71.26	Germany
39	Toxicol. Letters	5	2792	0.13	71.39	Ireland

Table 10. Contd.

39	Trends in Ecol. Evol.	5	2797	0.13	71.52	UK
39	Zool Surv. of India	5	2802	0.13	71.65	India
40	25 Journal with 4 citations each	100	2902	2.58	74.23	
41	41 Journal with 3 citations each	123	3025	3.17	77.40	
42	154 Journal with 2 citations each	308	3333	7.95	85.35	
43	545 Journal with 1 citations each	545	3878	14.65	100.00	
	Total	3878			100.00	

nucleus and they are the most productive journals devoted to applied zoology, sharing 3.14% of total cited journals. The next zone is represented by 148 journals which share 14.97% of total journal, and the last zone is represented by 809 journals which share 81.89% of total cited journals. Each zone has approximately one-third of the total citations. Table 14 and Figure 4 also reveal the same results and hence the journal data fit well with Bradford's Law of distribution. Hence the journals distribution as per the Bradford's Law reveals the ratio of 31:148:809.

Bradford formulated a simple mathematical model to describe reference scattering. Cole statistically explained that "by plotting the cumulative fraction of total reference against the logarithm of the cumulative fraction total of titles, an approximately linear curve is obtained and the slope of this curve gives a reference scattering which may be characteristics of the study".

Distribution of cited journals by decreasing frequencies of citations

The graphical and verbal interpretation of the Bradford's Law of Scattering has been applied to the literature of applied zoology. Table 14 represents journals arranged in decreasing frequency of citations. To testify the applicability of Bradford's Law of Scattering, a graph is plotted by taking the cumulative number of citations on the "y" axis and the log of cumulative number of journals on the "x" axis. It is observed that the resulting bibliography starts rising in an exponential nature and then follows the linear curve, indicating the observance of Bradford's Law of Scattering. Here, it is observed that an experimental curve (continuous line) is closely in association with the theoretical line (dotted line) up to about 4,000 citations and then starts dropping as shown in Figure 4.

FINDINGS OF THE STUDY

1. Average Citations: the average number of citations per thesis is 213.95 by the Applied Zoology researchers.
2. Distribution of citation format: Periodicals are highly cited (75.52%). Books are considered as second major source, which accounts for 17.25%. In other words periodicals and books together constitute 92.77% next to other forms of sources which are negligible.
3. Authorship pattern: Single author contribution is more (33.63%) as compared to others. Team research prevails in the field of Biotechnology. The degree of collaboration is found to be 0.66.
4. Study also shows that authorship pattern of journal citations indicates that out of total number of 3878 citations, 1372 (35.37%) are contributed by two authors.
5. Chronological distribution: 17.48% of citations refer to current literature i.e. for 2000-2009 and 32.36% citations referred to 1990-1999, 22.16% citations to 1980 to 1989, 13.78% citations to 1970-1979. These sequences got the largest number of citations that is 85.78%.
6. Further it is observed from the study that the maximum number of citations 1248 (32.18%) are covered during the period of 1990-1999, of total citations, followed by the period 1980-1989 accounting for 859 (22.15%).

7. Subject Wise Distribution: Entomology (13.38%), Animal Physiology (7.99%), Animal Genetics (7.86%), Ecology (6.13%), Fish Diversity (5.93%), Ornithology (5.15%), and Plant Insect Interaction (4.89%) contribute the 51.33% of the total citation; the remaining subjects together contribute 48.67% of the total citations.

8. Geographical distribution: United States predominates in country wise distribution of citations (1679; 32.69%), followed by India (1303; 25.37%) and United Kingdom (842; 16.39%). It may be observed that these three countries have been well developed in the field of Applied Zoology.

9. Core Journals: It is evident from the result of the study Mutation Research (212; 5.46%) occupies the first rank in the ranked list of journals followed by Journal of Bombay Natural History Society (74; 1.90%), and Aquaculture (70; 1.80%); Journal Fish Biology (67; 1.72%) scores the highest number of citations among the most cited periodicals.

10. U.S.A., India and U.K are ranked as the first, second and third country in dissemination of information in the field of Applied Zoology.

11. Productivity of cited journals: the first 25% of the citation are covered by the first 18 journals with an average productivity of 54.11 citations per journal. The average productivity has gone down considerable to 1.22 articles in the fourth group. This shows the concentration of more number of

Table 11. Ranked countries of journals.

Country	Rank	Count	Percentage (%)
USA	1	262	26.51
India	2	155	15.68
UK	3	139	14.06
Netherlands	4	44	4.46
Germany	5	39	3.99
Japan	6	31	3.19
Canada	7	20	2.03
Brazil	8	16	1.61
Australia	9	15	1.51
China	10	14	1.41
France	11	13	1.31
Italy	12	10	1.01
S. Africa	13	09	0.91
Switzerland	13	09	0.91
Korea	14	07	0.70
Poland	14	07	0.70
Russia	14	07	0.70
Denmark	15	05	0.50
Taiwan	15	05	0.50
Other Countries	00	58	5.87
Un-identified	00	123	12.44
Total		988	100.00

Table 12. Production of journals in applied zoology.

No. of citation	Citation (%)	No. of journal covered	Journal (%)	Average production of journal
974	0 - 25	18	1.82	54.11
988	26 - 50	65	6.57	15.20
1063	51 - 75	206	20.86	5.16
853	76 -100	699	70.75	1.22
3878	Total	988	100.00	3.92

Table 13. Bradford's zones for applied zoology.

No. of citation	No. of journal	Cumulative no. of citation	Cumulative no. of journal
1289	31 (3.14)	1289	31
1293	148 (14.97)	2582	179
1296	809 (81.89)	3878	988

for the need based collection developed in the field of applied zoology.

SUGGESTIONS

The present study is based on the citations cited in Ph.D thesis in Applied Zoology submitted to Kuvempu University. Similar type of investigations may be carried out

covering the thesis in Applied Zoology from other universities also, so as to generalize the findings of the study and gain an in-depth knowledge of the characteristics of the literature used by the researchers in the field.

As far as citations from other forms of documents are concerned, conference proceedings, reports, thesis are least used because of the inadequacy of information on these documents. Further they are not easily available

Table 14. Distribution of cited journals by decreasing frequencies of citations.

No. of journal	Cumulative no. of journal	Log of cumulative journal	No. of citation	Total citation	Cumulative citation	% of cumulative citation	% of cumulative journal
1	1	0.00	212	212	212	5.46	0.10
1	2	0.30	74	74	286	7.37	0.20
1	3	0.47	70	70	356	9.17	0.30
1	4	0.60	67	67	423	10.90	0.40
1	5	0.69	56	56	479	12.35	0.50
1	6	0.77	50	50	529	13.64	0.60
1	7	0.84	48	48	577	14.87	0.70
2	9	0.95	44	88	665	17.14	0.90
1	10	1.00	41	41	706	18.20	1.01
1	11	1.04	38	38	744	19.18	1.11
2	13	1.11	35	70	814	20.99	1.31
1	14	1.14	34	34	848	21.86	1.41
1	15	1.17	33	33	881	22.71	1.51
1	16	1.20	32	32	913	23.54	1.61
1	17	1.23	31	31	944	24.34	1.72
1	18	1.25	30	30	974	25.11	1.82
2	20	1.30	29	58	1032	26.61	2.02
1	21	1.32	28	28	1060	27.33	2.12
2	23	1.36	26	52	1112	28.67	2.32
2	25	1.39	24	48	1160	29.91	2.53
1	26	1.41	23	23	1183	30.50	2.63
2	28	1.44	22	44	1227	31.64	2.83
2	30	1.47	21	42	1269	32.72	3.03
2	32	1.50	20	40	1309	33.75	3.23
5	37	1.56	19	95	1404	36.20	3.74
1	38	1.57	18	18	1422	36.66	3.84
3	41	1.61	17	51	1473	37.98	4.14
2	43	1.63	16	32	1505	38.80	4.35
4	47	1.67	15	60	1565	40.35	4.75
2	49	1.69	14	28	1593	41.07	4.95
4	53	1.72	13	52	1645	42.41	5.36
6	59	1.77	12	72	1717	44.27	5.97
11	70	1.84	11	121	1838	47.39	7.08
7	77	1.88	10	70	1908	49.20	7.79
9	86	1.93	9	81	1989	51.28	8.70
23	109	2.03	8	184	2173	56.03	11.03
17	126	2.10	7	119	2292	59.10	12.75
25	151	2.17	6	150	2442	62.97	15.28
72	223	2.34	5	360	2802	72.25	22.57
25	248	2.39	4	100	2902	74.83	25.10
41	289	2.46	3	123	3025	78.00	29.25
154	443	2.64	2	308	3333	85.94	44.83
545	988	2.99	1	545	3878	100.00	100.00

citation in a few journals.

12. This study confirms that the journal use pattern of Applied Zoology researchers fits well with the Bradford's Law of Scattering.

13. The findings of the study have great implication and

accessible due to many restrictions. It is suggested that concerned authorities should make an attempt to overcome these restrictions by compiling proper cataloging, bibliography, abstracting and indexing services.

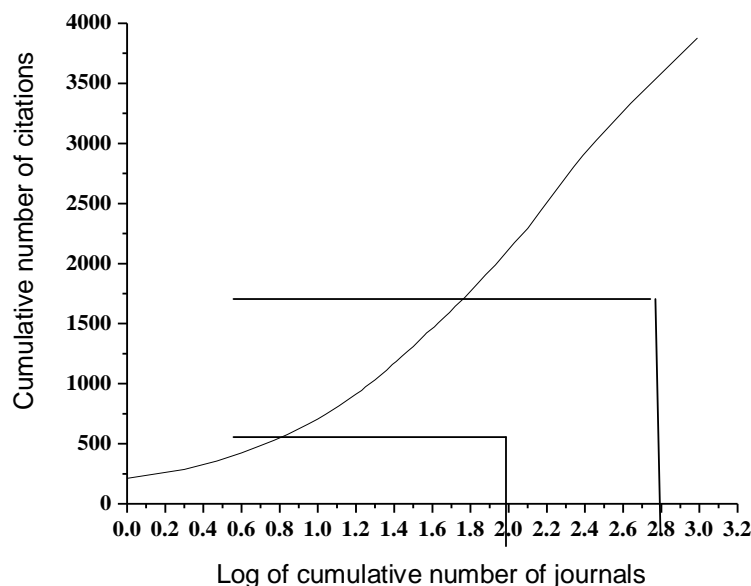


Figure 4. Bradford's law.

The acquisition policy of the university libraries should be examined in the light of the growing demands of the research scholars.

The University Grants Commission (UGC) should also extend helping hand to the university libraries in getting access of more and more number of e-Journals under its UGC-infonet programme, and other forms of reading materials.

Orientation programme should be arranged for the research scholars from time to time in order to enable them to explore the resources of the university library and keep them abreast of the available resources in the libraries.

Conclusion

Citation studies do provide some guide lines for librarians and information scientists in the decision making process in their acquisition policy. The exponential growth of knowledge, ever escalating costs of documents and limited allocations of budget are some of the factors that are leading librarians and information managers to adopt statistical and mathematical techniques for decision making process.

No doubt, these findings are much helpful to librarians while taking decisions regarding collection development, removing out dated documents and also maintaining the need based collection in the library.

The study also has serious implication on calling for the construction of citation indexes that will be web based at different levels especially institutional level being narrowed down to departmental level to ease citation practices of students, faculties and research scholars.

These citation indexes will also facilitate citation analysis study which entails a manual and painful process or count. This will save the rigorous and time-wasting exertions as encountered in this study during the process of data collection. The index will help to correct the anomalies of the ISI's databases that cite more of USA and UK journals thus contributing to the low impact factor of our national and local journals. At least, this will boost our national and local citations towards achieving international visibility and influence.

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