

USAGE OF PERIODICAL LITERATURE
IN VETERINARY SCIENCE (L'USAGE
DE LA LITTÉRATURE PÉRIODIQUE
DANS LES SCIENCES VÉTÉRINAIRES)

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ABSTRACTS

Usage of the periodical literature in veterinary science was examined using secondary review literature, Advances in Veterinary Science and Comparative Medicine, as a source of the study. It is seen that utilization of the periodical literature in this field was maximized within 10 years of publication, that the size of the periodical literature in this field doubles approximately every 20 years, and that the publishing age of the periodicals seems to have an effect on the aging patterns of the literature. (L'auteur s'est servi d'une revue secondaire de littérature, Advances in Veterinary Science and Comparative Medicine, pour examiner l'usage de la littérature périodique dans les sciences vétérinaires. Voici les conclusions de l'étude. La plupart de l'utilisation de cette littérature se produit pendant les dix années après la publication. Le volume de la littérature périodique de ce sujet se double chaque vingt ans. Enfin, il semble que l'âge de publication des périodiques affecte la tendance vieillissante de la littérature.)

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INTRODUCTION

The study reported here was conducted at the University of Guelph Library, Guelph, Ontario. While reviewing the usage of periodicals at the Veterinary Science Division of the Library in 1973/74, the need for the development of a comparative measure of the utilization of the periodical literature in the field was recognized. In spite of the reported shortcomings of citation analysis, for example, as noted by Subramanyam, K. (1975), the analysis of references cited in the secondary review articles in the field provides a reasonable measure of the usage of periodicals by world researchers and/or scholars. Consequently, Advances in Veterinary Science and Comparative Medicine, being a major source for such review articles, was chosen as a source for this study. The study of a 5 year period of review articles was considered necessary in order to cover all aspects of veterinary science, thus the years 1970 - 1974 were arbitrarily selected.

METHODS AND RESULTS

References listed at the end of each of the articles in the Advances in Veterinary Science and Comparative Medicine for the period 1970 - 1974 were collected, and each was classified and recorded by kind, i.e., periodicals, non-periodicals, and unpublished. If an item was, or appeared to be, a periodical, it was recorded, together with such information as the year of the review article and the number of times that periodical title was cited for each year of its publication life. All items so recorded were carefully identified, and the starting date and country of origin of each was added to the record. All other items now identified as non-periodical were regrouped with non-periodicals.

Of the total citations recorded, 5619, or 82.5 percent, were to the periodical literature, and were provided from a total of 743 periodical titles. From these, 110 titles were selected for further study by applying the citation frequency criteria '10 times or more'. The selected 110 periodical titles provided 4350, or 76 percent, of all citations to the periodical literature.

The first step was to investigate the possibility of a relationship between the number of citations to a given periodical and the number of years it had been in publication. The results here were negative; no relationship was observed to exist. A strong relationship, however, was seen to exist between the age of articles cited and the number of citations for articles of that age. For example, a linear correlation coefficient between the number of citations and the age of the articles in those 110

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periodicals was determined to be .95 for the articles 2 - 20 years old and .71 for the articles 20 - 40 years old. Citations to the articles with age 0 and 1 year were excluded for this calculation, since maximum citation occurs when article approaches its second year.

The next step was to examine aging patterns of the citations to those 110 periodicals. In order to permit the study of the effects of the age of the periodicals on the aging patterns of the literature, those 110 periodicals were grouped by their publishing age, i.e., 'fewer than 10 years', '11-25 years', '26-40 years', and 'more than 40 years'. Using 1972 as a base year, because 1972 is the median of 1970 - 1974, comparative studies on the aging patterns of articles in each of these periodical groups were conducted. These were accomplished by plotting the cumulative number of citations against the age of articles on the semi-logarithmic scale. Some interesting observations resulting are; a) aging patterns of the literature in more recent periodicals tend to be erratic, b) literature in older periodicals decays more slowly than does that in more recent periodicals, and c) different aging patterns, depending on the period in which they were published, are shown for the literature in the periodical group 'more than 40 years', thus articles published during the current 20 years decay more rapidly than do those published during the previous 20 years. While the present study does not attempt to offer reasons for these phenomena, it is worth noting that the period of slow decay corresponds approximately with that period of history covering the depression and the Second World War.

Finally, the aging-, utility-, and growth factors of the literature in those 110 periodicals were calculated by following the suggestions of Brookes, B. C. (1970) and Line, M. B. (1970). The resultant aging factor of .8925 yields a half-life to the literature of 6.1 years, the utility factor of 9.3, and a growth factor of 3.6 percent per year.

SUMMARY

The results of this study suggest that the periodical literature in veterinary science is centered on a relatively small number of heavily used titles. In general, most of the periodical literature makes its contribution within 10 years of publication, and maximum citation is observed when the literature enters its second year. Although citation frequency does not display any correlation with the publishing age of a periodical, it does show a strong relationship to the age of individual literature, and those articles in older periodicals tend to age more gradually than do those in

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the more recent periodicals.

The periodical literature in veterinary science appears to have a longer half-life than does that of the physical sciences as reported by Chen, C. C. (1972), or the medical sciences as reported by Williams, J. F. and V. M. Pings (1973). The apparent aging factor of .8925 suggests that 85 percent of the periodical literature needs of the users can be met by a back-run of 17 years.

It should be emphasized that the results of this study are not intended to be definitive, and should be applied in any other context with due care.

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CITATION STATISTICS OF PUBLICATIONS IN THE MARINE SCIENCES

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ABSTRACT

An analysis of the citation statistics of some 450 major publications by staff of the Bedford Institute of Oceanography from its founding in 1962 up to and including 1974 is presented. The *Science Citation Index* was used as the source of the citation data. Included in the results are data on self-citations (i.e. when an author cites his/her own work) and the distribution of citations among papers. The performance of this institute is compared with the performance of selected marine science research centres in other countries by determining the average number of 1971, 1972, 1973, and 1974 citations per 1970 publication for each establishment. (Les statistiques sur les citations de quelque 450 publications importantes par les personnel de l'Institut océanographique de Bedford, depuis sa fondation en 1962 jusqu'à 1974 inclusivement, sont analysées. La source des données sur les citations est le *Science Citation Index*. Les statistiques comprennent les citations autonomes (c.-à-d. lorsque l'auteur cite un de ses textes) et la répartition des citations parmi les textes. On compare le rendement de notre institut au rendement de certains centres de recherche sur les sciences marines d'autres pays en établissant, pour chaque établissement, la moyenne des citations parues en 1971, 1972, 1973, et 1974 par rapport à une publication de 1970.)

INTRODUCTION

In the sciences one measure of the quantity of output is the number of published papers. A measure of "relevance" is the number of citations of these papers. This study is concerned with citations of papers in oceanography, a field that has undergone rapid growth in recent years. The *Science Citation Index (SCI)*, which lists all citations appearing in approximately 2600 major scientific and technical journals, was used as the source of the citation data. There are few reports in the literature of citation studies in the marine sciences field. This paper presents data on the citations to the published output of (a) a new Canadian research centre, the Bedford Institute of Oceanography (BIO) during its first 12 years, and (b) other research institutes in the marine sciences. The results are of an interim nature; minimum interpretation is attempted at this stage.

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CITATIONS AND SCIENTIFIC QUALITY

Garfield (1970) notes that "because a citation indicates a relationship between a part or the whole of a cited paper and a part or the whole of the citing paper, the *SCI* tells how each brick in the edifice of science is linked to all the others." Indeed, citation analysis has found application in the history and sociology of science in addition to retrieval and other uses in library and information science. In particular it has been used to measure current scientific performance. Cole and Cole (1967) note that the number of citations may be taken to represent the relative scientific significance or "quality" of papers in each field. Their studies on American physicists have suggested that citation frequency correlates highly with other measures of research achievement. The use of citations in this way has, as one might expect, produced some controversy e.g. Croom (1970), McGervey (1974). Some of the problems are: work of the highest significance often becomes common knowledge very quickly and is referred to in papers without being cited; citations may be critical rather than positive; the significance of scientific work is not always recognized by contemporaries with the result that new ideas are sometimes ignored or resisted. Cole and Cole (1974) emphasize that sociologists use citation analysis to study the *community* of scientists, not individual scientists *per se*. They note that "although counting citations is indeed a rough way to measure quality and influence, it has allowed us to address a whole range of substantive problems which, heretofore, were not negotiable because there was no adequate measure of research performance."

THE DATA BASE

Publications by staff of the Bedford Institute of Oceanography and the citations to these publications comprise the data base used in this study. The Institute is a Government of Canada establishment whose staff undertake a wide range of scientific research and surveys in the marine environment. The major publications are designated "contributions", and it is these that form the basis of this study. Basically, a contribution is a scientific paper by a staff member, which is accepted and published by a "reputable" periodical, i.e. a periodical that has an editorial board and maintains a peer review system. Other publications, such as chapters in books and conference papers, are considered for contribution status if they are reviewed in the same manner as journal articles. During the period from the opening of the Institute in 1962 through 1974 455 such contributions were designated. An analysis of these by year and type of publication is given in Table 1. The majority of the references are listed by Nicholls and Scott (1975).

A ranking of the periodicals by number of articles by BIO staff is given in Table 2. Under "papers, reports, special publications" the predominant series is Geological Survey of Canada Papers with 29 contributions.

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Year	Period- ical articles	Papers, reports, special pubs.	Conf. papers	Chapters, etc. in books, en- cyclopedias	TOTALS	
					Ann.	Cum.
1963	2	2	0	0	4	4
1964	11	2	0	0	13	17
1965	9	2	0	0	11	28
1966	10	5	1	3	19	47
1967	22	3	7	1	33	80
1968	20	3	0	1	24	104
1969	35	1	7	0	43	147
1970	43	1	2	1	47	194
1971	51	2	1	0	54	248
1972	59	5	9	2	75	323
1973	64	8	2	2	76	399
1974	35	10	10	1	56	455
TOTALS	361	44	39	11	455	-

Table I. Number of contributions by year and type of publication.

Rank	Title	No. of articles
1	J. Fish. Res. Board Canada	65
2	Can. J. Earth Sci.	56
3	Maritime Sediments	20
4	Limnology and Oceanography	18
5	Deep-Sea Res.	17
6	J. Geophys. Res.	15
7	Nature	11
8	Marine Biology	10
9=	J. Marine Res.	6
9=	J. Sedimentary Petrology	6
11	Chemical Geology	5
	6 Journals each contain 4 articles	
	11 Journals each contain 3 articles	
	12 Journals each contain 2 articles	
	51 Journals each contain 1 article	

Table 2. Ranking of periodicals in order of number of articles by BIO staff.

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The citations of all contributions as recorded in *SCI* through 1974 were extracted. Excluding papers published during 1974, there were 1513 citations of 399 publications, an average of 3.79 citations per publication. Comparable figures for the average number of citations per paper through 1968 were 0.64, and through 1971 were 2.29, which may provide one indicator of the growth in stature of the scientists at the Institute. A breakdown of the 1974 figures by type of publication is given in Table 3, which shows that papers published in periodicals receive on average more citations than those appearing in other types of publication. It should be noted that the Canadian Journal of Earth Sciences, an important journal as far as BIO is concerned, was not scanned by *SCI* until 1969.

Type of publication	No. of publications	No. of citations	Citations per publication
Periodicals	326	1427	4.38
Other	73	86	1.18
All publications	399	1513	3.79

Table 3. Citations by type of publication, 1963-1974.

An examination was made of the distribution of citations among papers (i.e. the proportion of papers cited zero, 1, 2.... times). The citations of all existing periodical contributions for each of the years 1972, 1973, and 1974 were extracted, and the average distribution determined. The results are given in Table 4. It will be noted that 47 percent of the papers are not cited at all in a given year; whereas the top 10 percent of the papers receive 43 percent of the citations. This is in keeping with the general findings of Menard (1971) in the earth sciences, and Price (1965) in all fields.

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No. of times cited (a)	1972		1973		1974		Annual average, 1972-74	
	No. of papers	%	No. of papers	%	No. of papers	%	No. of papers	%
0	91	45	112	43	164	50	122	47
1	49	24	72	27	71	22	64	24
2	27	13	24	9	39	12	30	11
3	10	5	29	11	25	8	21	8
4	7	4	10	4	7	2	8	3
5	8	4	7	3	11	3	9	3
6+ (b)	11	5	8	3	9	3	9	4
TOTALS	203	100	262	100	326	100	263	100

(a) Citations of 1972 papers during 1972, 1973 papers during 1973, and 1974 papers during 1974 are excluded.

(b) Average no. of times cited = 7.25.

Table 4. Proportion of papers cited various times during 1972, 1973 and 1974; periodical articles only.

The sample was analysed for self-citations, i.e. where an author cites his own publications. It was found that 195 (or 13 percent) of the 1513 citations were self citations. Matheson (1972) determined the proportion of self-citations for United Kingdom university chemistry departments; on the basis of 11 departments studied he found the proportion to be 31 percent. Menard (1971) quotes figures of 12 percent and 13 percent in the earth sciences. The sample was then analysed for citations by other staff of the Institute; it was found that a further 186 (or 12 percent) of the 1513 citations were in this category.

COMPARISON WITH OTHER INSTITUTES

It is not a simple matter to use the figures given in Table 3 as a basis of comparison with other institutes. Garfield (1972) notes that the average article in *SCI* is cited about 1.67 times a year. Based on the 5 years 1970 through 1974, each contribution was cited on average 1.05 times a year. Here it should be noted, we are comparing citations in a particular field with citations in the whole of science. Cole and Cole (1967) acknowledge that comparison between different fields presents difficulties. In the present study, therefore, a comparison was made within the marine sciences field.

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Several ways of making such a comparison were considered. Larabi (1970) of Centre national d'études spatiales (CNES) in a study of the efficiency of 6 French laboratories undertaking basic research in the space field made a comparison on the basis of the number of citations to publications of these laboratories during the period 1961-68 in 14 selected journals, published in English and French. Westbrook (1960) undertook a similar investigation in the ceramics field, which was international in nature, but used fewer journals and restricted the period to one year. This approach was rejected, largely because of the difficulty of selecting a relatively small sample of journals that would equally pertain to the various institutes being compared. The method selected was that used by Matheson (1972) in a study to establish centres of excellence among United Kingdom university chemistry departments. In this method one year's published output of the various centres being compared was selected for examination, and the number of citations to these papers during the following year was determined. In our case the published output during 1970 was selected for study, but citations were examined over a four-year period (1971-74), instead of over one year. The comparison was made with 7 marine science research centres in 5 countries. These were selected on the basis of the following criteria: (a) that they undertake a similar range of research to that at BIO; (b) that they are roughly of the same size; (c) that they were established before 1970; (d) that they are identifiable in the *SCI Corporate Index* (see below). Lists of publications for the various institutes were taken from the 1970 *Corporate Index* of *SCI*, which lists alphabetically by their authors' organizational affiliations the references to all source items processed during the year. Since these source items comprise journals only, the list of BIO publications as obtained from this index did not correspond with the publications in the original data base, which included books, conference papers, reports, etc. Also, not all of the journal articles listed in *SCI* were designated contributions by the Institute. Since the lists of publications for the other institutes were based on the *SCI Corporate Index* it was decided to use this source of data for BIO also. In order to increase the objectivity of the analysis self-citations (i.e. where an author cites his own publications) were excluded. The results of the comparison are given in Table 5.

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Institute	Year estab.	No. of papers in 1970 (a)	Av. no. of citations per 1970 paper in the yr. shown. (b)				
			1971	1972	1973	1974	1971-74
Univ. Tokyo, Ocean Res. Inst., Nakano & Tokyo	1962	11	1.27	1.73	1.91	1.91	1.71
Scripps Inst. of Oceano- graphy La Jolla, Calif.	1903	64	1.34	1.92	1.86	1.69	1.70
Woods Hole Oceanographic Inst., Woods Hole, Mass.	1930	128	1.71	2.04	1.56	1.30	1.65
Bedford Inst. of Oceano- graphy, Dartmouth, N.S.	1962	43	1.12	1.47	1.07	0.81	1.12
Inst. Oceanographic Sci., Godalming, U.K.	1949	32	0.75	1.41	1.25	1.00	1.10
Univ. Rhode Island, Grad. School Oceanography, Narragansett, R.I.	1961	33	1.09	0.97	0.97	1.21	1.06
Inst. Océanographique, Paris, France	1906	16	1.19	0.50	0.31	0.00	0.50
National Inst. of Oceano- graphy, India	1966	14	0.50	0.57	0.43	0.29	0.45
Mean	-	-	-	-	-	-	1.38

(a) As given in 1970 Science Citation Index Corporate Index

(b) Excluding self citations

Table 5. Average number of citations per 1970 paper in 1971, 1972, 1973, and 1974 for selected marine science research centres.

The results show that for the years considered the newer University of Tokyo Ocean Research Institute is on a similar level (1.65 - 1.75 citations per paper) to the established Woods Hole and Scripps Institutes. The Bedford Institute of Oceanography and the Graduate School of Oceanography, University of Rhode Island, which were founded at about the same time and are similar in size and subject coverage, are at about the same level (1.05 - 1.15 citations per paper); the older Institute of Oceanographic Sciences, U.K., is also at this level. It is interesting to note that the first 3 institutes in the list each have academic programs, whereas BIO and the Institute of Oceanographic Sciences, U.K., do not.

DISCUSSION

The results of the study on citation distribution are in general agreement with other studies known to have been undertaken on this

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topic, i.e. that in any given year a large proportion of all existing papers (in this case 47 percent) are not cited at all, whereas a small proportion receive a large number of citations (in this case 4 percent received an average of 7.25 citations). In a related study of citations of articles published in the frequently cited journal *Physical Review* in 1963 (Cole and Cole, 1972) it was found that 80 percent of all the articles were cited four times or less; 47 percent, once or never during 1966. It is perhaps relevant to note here that, on the average, every scientific paper ever published is cited about once a year. This figure was derived by Price (1965) from the average rate of literature expansion (7 percent) and the average number of citations (15) in a paper. This yields 105 citations to each 100 papers existing at that time.

The study of self-citations yielded a result (13 percent), substantially different the figure reported by Matheson (1972) (31 percent). Possibly this is accounted for by the difference in fields, but again there is a scarcity of information in the literature on this topic, and further studies are needed. Since citation analysis is being increasingly employed for a variety of purposes, see for example *New Scientist* (1975), it is suggested that in any application self-citations (and possibly citations by other members of the same institute) should be taken into consideration. As far as can be ascertained from the literature, this is rarely done at the present.

The comparison of the 8 institutes produced substantial differences in the number of citations per paper. It might be inferred that Table 5 provides a "league-table" of institutions, but such a conclusion is untenable for a variety of reasons. The period of time covered was very restricted; it is possible that a study (say) of the 1969 or 1971 pattern of publication would reveal an entirely different picture, particularly in the case of the smaller institutes. The controversy surrounding the validity of citation counting as a measure of the value of research work has already been considered in this paper. Additionally, the results of the comparison could be affected by: the inclusion of review articles, which tend to be widely cited (in the present study it was noted that such articles receive on average 10 citations per year); differences in emphasis in the various subfields (within the broad field of oceanography) among institutes being compared, since it has been suggested that workers in active and crowded research areas receive more citations than those in more esoteric disciplines; the inclusion of citations by other members of the same institute (refer to the previous paragraph). From the above it will be evident that more detailed studies are required before a ranking can be established with any degree of confidence.

It has been suggested (Merton, 1971) that "a little citation counting can be a dangerous thing." Certainly wherever studies involving individuals are concerned, e.g. in deciding promotion and tenure, there

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has been controversy. As a means for comparing groups working in the same subject field, however, citations may have more value, providing one indicator of performance. The present study claims to do no more than this.

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