JOURNAL PRODUCTIVITY IN FISHERY SCIENCE
AN INFORMETRIC ANALYSIS

THESIS SUBMITTED IN PARTIAL FULFILMENT OF
THE REQUIREMENT OF THE DEGREE OF

DOCTOR OF PHILOSOPHY

UNDER THE FACULTY OF TECHNOLOGY
IN COCHIN UNIVERSITY OF SCIENCE AND TECHNOLOGY

By

S. GIRIJAKUMARI

DEPARTMENT OF COMPUTER SCIENCE
Cochin University of Science and Technology
COCHIN-682 022

Feb: 1997

DECLARATION

I hereby declare that the thesis entitled **"Journal Productivity in Fishery Science - An Informetric Analysis"** has not previously formed the complete basis for the award of any degree, diploma, associateship, fellowship or other similar titles or recognition and the thesis is my own original work.

Girijakumari S

Cochin - 22

GIRIJAKUMARI. S

CERTIFICATE

This is to certify that the thesis entitled **"Journal Productivity in Fishery Science - An Informetric Analysis"** is the bonafide record of the work carried out by **Mrs. Girijakumari. S** under my guidance and supervision and that no part thereof has been presented for the award of any other degree.

(**Dr. C.V. Rajan Pillai**)
University Librarian
Cochin University of Science
and Technology
Cochin - 682 022

Cochin - 22

C O N T E N T S

Page No.

LIST OF TABLES

LIST OF FIGURES

ACKNOWLEDGEMENT

I wish to express my gratitude to **Dr.C.V.Rajan Pillai,** University Librarian, Cochin University of Science and Technology for his constant help and encouragement, valuable guidance and supervision throughout this research work.

My sincere thanks are due to Dr. **M. Devaraj,** Director, Central Marine Fisheries Research Institute for providing me with facilities to carry out the research work. I also wish to thank **Dr. K.J.Mathew,** Senior Scientist and Officer-in-charge (L&D), CMFRI.

I also express my thanks to **Dr. Paulose Jacob,** Head, Department of Computer Science, Cochin University of Science and Technology for the help given to me from time to time.

I am very much grateful to **Mr.M.Srinath, Mr. V. Balan, Mr.T.V.Sathyanadan** and **Mr. P. Pavithran** of Fishery Resources and Assessment Division, CMFRI, Cochin for their help during the course of this study.

My sincere thanks are due to **Dr. (Mrs) Mary Manissery** and **Mrs. T.S.Naomi,** Scientists, CMFRI, for their valuable suggestions and help.

I also would like to thank my colleagues at CMFRI, Cochin University Library Staff, Kerala University Library Staff and DRTC, (Bangalore) Library Staff who all helped me at various stages of the study.

CHAPTER - 1

INTRODUCTION

Knowledge is a human resource which has the ability to consolidate the valuable results of human thinking and civilization through different times. It is the totality of understanding of nature and its features for improved quality of life of human society. Because of this, knowledge has been increasing in volume, dimension and directions. The term 'information' and 'knowledge' are often used as if they are interchangeable. Information is 'potential knowledge' which is converted into knowledge by the integration of memory of human beings. In modern times there is a confusion on knowledge usage. Therefore an understanding of the concept 'knowledge' is needed for formulation of strategies in information science.

'Information' is defined as a thing, a process and an unobservable mental state of process. In real world we observe aspects of phenomena as 'facts' and represent them by 'data' to create 'information' and this is communicated to recipient as 'knowledge' and used for creating new facts thus forming a continuous process. Before the invention of printing, knowledge was in the form of personal knowledge and disseminated through discussions. By the invention of printing, knowledge became depersonalised and 'documents' became channel for dissemination of knowledge. The universe of knowledge is expanding rapidly with application of modern technologies. Knowledge is needed for many reasons - curiosity for new information, problem solving and decision making.

The dissemination of knowledge has been a matter of grave concern in Library and Information Science development due to 'knowledge explosion' or 'knowledge fragmentation'. The vast store of knowledge has been organised by human society in an external memory in the form of various sources so that they can be utilised in times of need. Organisation of knowledge in spite of its exponential growth is a great task and should take into consideration the needs of the users. Information science is to help the users find their way in the present environment of scientific knowledge which developed due to the advancement of technologies. Knowledge based organizations procure, organise, maintain, analyse, create, present, distribute and apply information for which they acquire various types of knowledge. There is need for clear statement of policy for management of information and knowledge.

In the 17th century, scientists developed an interest in working together and they began to form associative gatherings to communicate research results to one another and the world at large. The modern journal is a direct result of this development. The first journals published were 'Journal des Scavans' and 'The Philosophical

Transactions' which started in 1665 [1]. By the end of 17th century, about thirty scientific and medical journals were published. In the 18th century, the specialized journal became common. The problem of proliferation of literature was tackled by scholars narrowing their fields of interest by increasing their degree of specialization. Thus research papers with the characteristic system of citation took shape in the 19th century. The papers were of high quality giving account of original investigations.

Research in any field is not complete without getting information about similar research done elsewhere in the world. The trend of research has grown to global collaboration. Hence a number of international conferences, symposia, seminar etc., are being conducted every year on different topics of science. Scientists attending international training programmes are increasing. Thus the advancement of science from "little science to big science" occurs by "standing on the shoulders of giants" as put forward by Price [2]. Accordingly the growth of scientific journals also became exponential along with the growth of research. Journals which were first published by professional societies only have to compete with commercially published profit making titles. At present the journals in science and technology field is about one lakh, as covered in the Ulrich's International Periodical Directory, 33rd edition. The trend shows that other documentary forms like reports, thesis, patents and films are also increasing. Although the amount of literature grows, the time one has to read them remains the same. So there has to be an effective method of selection for dissemination of literature. Another factor which necessitates selection is the increasing cost of scientific publication. Along with growth of literature there is a scatter of literature. In many scientific fields, due to interdisciplinary research the results published in journals are peripheral to the subject. This also stresses the need for selection of literature by applying scientific methods.

Growth of knowledge in Fishery science, can be traced back to prehistoric times when man used fish as food. Next man learned to catch fish using traps and nets in lakes and rivers. Gradually, by improvement in equipments fishing extended to seas. Mechanisation of fishing in the 19th centuary brought about revolutionary changes and now application of computer for various operations have become common. All these developments led to increased fish catch which is estimated as 98.7 million tonnes all over the world and India's share is 4.2 million tonnes in 1992 [3]. Similar to other scientific disciplines, specialization in Fishery science has enabled the origin of specialized journals as communication vehicles. Results of research are published as reports, bulletins, thesis and scientific journals. Special publications to meet specific needs are also coming out. Some of the earlier publications are the Canadian publications - one, progress report for Pacific coast states and another for Atlantic Coast states.

Exponential growth of scientific and technical literature occurred during second half of the 20th centuary. In Fishery science also many new technological developments during this period enabled the publication of journals exclusively on the subject. Thus journals on subjects like fishery management, Aquaculture, Fish Pathology, Fish economics etc originated. This can be associated with the knowledge explosion or fragmentation in Fishery science.

As in other scientific research, journal literature forms the major communication system in Fishery science. Research in this area is important as it is international in scope and economically important to many coastal countries whose export earnings depend on fish and its products. Due to the growth and scatter of journal literature, information transfer in fishery science is to adopt new methods and techniques. Many such methods for measuring information have been introduced in library and information science. This helps in evaluation of the use of information. Citation studies are widely used for measures of information in journal literature. Informetric Analysis is currently applied in such citation studies. This enables proper selection of literature for planning information services. Eventhough citation studies in different science disciplines were conducted, no study has been done so far in Fishery science.

1.1 Relevance of the Topic

Literature is in abundance, but the user do not know where and how to search for it. In this context the librarian or information scientist has a vital role to play in helping the researchers to select suitable literature for their work. But this role is not clearly understood by librarians or researchers even in developed countries. Most of the scientists depend on information retrieval services for getting journal literature needed for their work. These are usually costly and may be useful for a section of researchers. Librarian must know about evaluative methods which can be applied to assess the particular needs of researchers in their organisation.

Many libraries acquire books and journals without a definite procurement policy. This creates a problem in organizations where huge amounts are spent on research and libraries are expected to support research work. As the present trend is escalating cost of books and journals, low or steady library budget and increased demand, the librarians are faced with the problem of proper management of library collection. The acquisition and information services are to be planned in such a way that the materials are put to the maximum use. Otherwise a library spending crores on its budget without proper 'use' is a real waste of funds. To avoid such wastage, scientific planning by evaluative studies is essential. Citation analysis is done by many evaluators in different fields especially science, engineering and mathematics to assess the value of journals [4, 5, 6, 7]. By the starting of 'Science Citation Index' by Institute of Scientific Information (USA), a practical means of conducting citation analysis was found. Even then plain citation counting was not fully accepted as a criteria for effective journal selection. This led to many studies which proposed use of 'Impact Factor' and 'Immediacy Index' as modified citation weights [8, 9]. It is based on the number of citations received by journal articles in a particular period for articles published in the journal over a certain period.

Application of informetric methods to evaluate scientific journals yields data which can be of help to librarians, information scientists and researchers. Role of journal in the advancement of research is revealed by this type of studies. The present study focuses on journals belonging to the subject Fishery science. Research in Fishery science is being sponsored by international, national and regional organizations.

Study of fishes is known as 'ichthyology'. Earlier ichthyological studies were concerned with biology and related topics. Fishing is considered as an age old profession. Many ancient paintings and engravings indicating fishing were discovered in modern times. By the mechanisation of fishing methods, research on fisheries developed. Fish and its products control the economy of countries like India which has a vast area of coastline. Along with this, the literature on the topic also increased. Thus fishery science developed into a well established discipline which is considered equal to Agriculture. Administration of fisheries comes under Ministry of Agriculture in many countries and in some under Ministry of Agriculture and Fisheries. Increase in literature and increased research activities have made it impossible for any library to purchase all the relevant literature. This leaves no choice except a judicious selection policy for a library specialising in the topic. It is seen that research results are being published as scientific papers in journals, which explain new techniques or products. So researchers depend on this type of literature more than on books and other materials. Information dissemination which satisfies the clientele in a research library is possible only if adequate and relevant literature, published is made available. To select relevant literature, the application of scientific technique is essential. Citation studies is the only accepted method which enables meticulous selection of literature, now practiced all over the world.

Lack of citation analyses in Fishery science is a major hindrance which has to be tackled effectively for the benefit of the end users. Fishery science as such is a diverse field which have inter-disciplinary link with subjects like Physics, Chemistry, Statistics, Economics etc. So the results based on fishery research may be coming out in a wide variety of subject journals. Therefore citation study of selected journals is an effective tool which can be used successfully in any library attached to an organization specializing in fishery science research.

1.2 The Topic

The title of the topic studied is "Journal productivity in Fishery science: An informetric analysis". The keywords in the title are explained as follows for the purpose of this study.

Journal Productivity

Journals are publications issued at regular intervals such as weekly, monthly or quarterly. Journals are published on professional, technical, trade and agricultural topics and are issued by commercial publishers or sponsored by an organisation. Journal productivity is based on distribution pattern of citations in different journals during the period of study and the ranking of journals according to the decreasing number of citations received. Productivity is a measure of any commodity produced. In the present study journal productivity means a measure of journals produced using informetric methods.

Fishery science

Fishery science is a fast developing area which concerns with study of fishes. In the present context it relates to all exploited aquatic animal resources of commercial importance to man. Fishery science has two different meanings. First it is a body of scientific knowledge pertaining to the fisheries and their environment. It is also called Fisheries science, Fishery biology or just Fisheries. Second, it is a profession that expands and uses the body of scientific fishery knowledge to obtain optimum benefits for society from the living resources of the waters. In this sense, it includes research of many kinds and application to problems of the fisheries and aquatic environment [10]. The scope of the term Fishery science is limited for the purpose of this study as given above.

Informetrics

Informetrics is the "use and development of a variety of measures to study and analyse several properties of information in general and documents in particular" [11]. It covers all quantitative studies on information science including bibliometrics and scientometrics.

1.3 Scope

The scope of the study is to evaluate the journals in Fishery science based on the citations received by them. The year of study is taken as 1993 as it is the nearest possible year of starting this research in which all issues of sample journals were available. The geographical area to which the journals belong is not restricted as the subject is an internationally developing one. If journals in one area is only taken, the results may be biased. Moreover in fisheries libraries the need is the judicious selection of internationally important journals which are costly. The cost is increasing due to depreciation in value of rupee and the enhancement of price by publishers every year. Journal citations are the variable taken for study as they represent the use made by those citing them.

Limitations

There are some limitations to this study which are taken into account for in the design of the study. Selecting the primary journals for the study is difficult as there are numerous journals and the selection may not represent all areas of specialisation of the subject. To overcome this limitation, the number of occurrence of leading journals in a secondary service is considered to select the samples for the study. Another limitation is the format of the citation. Journal abbreviations were given in different forms by various authors. So after completing the entries, corrections had to be made for preparing a uniform index of cited journals. In some journals like 'Journals of Fish

Biology', the full title is given in citations which is a good practice. Change of title was also another limitation. In such cases same journal came in two places in the index and total of the two were taken as number of citations received by the journal. (Eg. Journal du Conseil changed to ICES Journal of Marine Science). To determine subject of article, some dealt with more than one area so that articles have to be grouped under more than one subject. Name of individual authors were not taken in study of productivity as it may not be accurate as only 5 sample journals were studied and some of the authors may have papers published in other journals also in the same year.

1.4 Objectives

The major objective of the study are:

a) to identify and prepare a comprehensive list of journals in Fishery science.

b) to assess the development of Fishery science in terms of journal articles.

c) to study journal citation pattern and author production using bibliometric laws.

d) to study distribution of types of citations.

e) to study whether journal citations conform to 80/20 rule.

f) to study obsolescence or aging of journals.

g) to study geographical distribution of cited journals.

1.5 Other Dimensions

This study concentrates on certain selected journals of Fishery science. Earlier studies showed that to get a higher accuracy in result, there should be a certain amount of increase in the number of samples selected. As the number of journals in Fishery science is increasing with the enhanced output of research, it is impossible to study citation of all journals. Therefore a selection of samples became inevitable. Moreover, Fishery science also incorporates the methods used in other scientific fields and it is expanding in different directions and consequently in the output of published materials. Some of the earlier research findings are becoming obsolete now. Greater emphasis is laid on studies on the application of aquaculture, physiology, ecology, economics, pathology, etc. The present study throws light on the main fields of fishery research as well as the important primary sources through which the results are being published. It reveals the trend of authorship and journal publication. The study will be of great help in formulating an acquisition policy of journals for library collection development. It gives a guide-line to plan the information service giving priority to those titles with top ranks. The study can be conducted at intervals, say about 10 years so that the list may be revised including newly published journals. The present work can be used as the basis for identifying less used or obsolete journals. Another important dimension of the study is to identify the major areas of research in Fishery science and their current trends.

1.6 Hypotheses

The following hypotheses were formulated and tested in the course of the study.

a) The number of journals in Fishery science shows an increase.

b) The number of articles, published also shows an increase.

c) The pattern of citation received by journals is according to bibliometric laws. Number of authors producing articles also conform to bibliometric laws.

d) The citations of journal articles are more in number than other types of publications.

e) The percentage of articles receiving more citations in the subject conform to 80/20 rule.

f) Journals become obsolete quickly in this field.

g) Most journals are published from developed countries.

1.7 Methodology

Collecting, organizing and analysing data were done on the basis of established informetric methods. Sample of 5 journals was selected first and from these the data needed for the study were recorded in computer using CDS/ISIS programme. The data was sorted to prepare tables and figures which formed the basis for analyses. The analyses were done to test the validity of hypotheses based on objectives. Various informetric distributions like Lotka's, Bradford's, Bookstein's, Gompertz's and Leimkuhler's were used in analysing the data.

1.8 Layout of the Thesis

After completing the analyses and formulating results of the study, the format of the thesis was determined. The thesis is divided into different chapters mentioned below.

CHAPTER 1 - INTRODUCTION

This gives an overview on the topic of research. Introduction gives the relevance of topic, define the problem, objectives of the study, hypothesis, methods of data collection, analysis and layout of the thesis.

CHAPTER 2 - FISHERY SCIENCE - STUDY OF ITS STRUCTURE AND DEVELOPMENT

This chapter provides a detailed account of the subject Fishery science and its development. A comprehensive outline is given along with definition, scope, classification, development and sources of information.

CHAPTER 3 - INFORMETRIC ANALYSIS

Method of study used in this research and its literature review form the content of this chapter. Genesis and development, literature review, informetric laws, applications of informetric methods in citation analyses and recent trends in the subject are explained in detail. The literature review covers almost all important aspects of the topic from origin upto the period of this study.

CHAPTER 4 - DATA COLLECTION AND ORGANIZATION

Details of the method adopted for collecting samples for the study, data collection and organization of the data are given. The methods are based on availability of data, period and objectives of the research undertaken.

CHAPTER 5 - ANALYSES OF DATA

The description, analyses and the results of the study are covered in this chapter. The figures and tables which form part of the interpretation of data are also included in this chapter.

CHAPTER 6 - FINDINGS AND CONCLUSIONS

The culmination of the study results in the formulation of certain findings and the conclusions drawn are explained in this chapter. Suggestions for further study and areas of application of the study are also identified.

The last part of the thesis consists of a bibliography listing 513 documents including the literature related to the topic of research.

References:

1. Garfield,E. 1981. Has scientific communication changed in 300 years? Essays of an Information Scientist, 4: 396.

2. Price,D.J.S. 1961. Little Science, big science. Columbia University Press, New York. p. 1.

3. FAO 1993. FAO Yearbook of Fishery Statistics, FAO, Rome p.8-9.

4. Brown,C.H. 1956. Scientific serial characteristic and list of most cited publications in Mathematics, Physics, Chemistry, Geology, Physiology, Botany, Zoology and Entomology. Association of College and Reference Libraries, Chicago Monograph No. 16 p. 1-15.

5. Adewole,S. 1987. Selecting livestock periodicals through citation analysis technique. Information Processing and Management, 23(6): 629-638.

6. Aziagba,P.C. 1993. Scientific journal selection based on the study of a local journal. Information Processing and Management, 29(1): 83-93.

7. Garfield,E. 1988. Science citation Index, Journal Citation Reports 1987, a bibliometric analysis of science journals in the ISI database, ISI press, Philadelphia.

8. Tomer,C. 1986. A statistical assessment of two measures of citation the impact factor and immediacy index. Information Processing and Management 22(2): 251-258.

9. Brooks,T.A. 1990. Literature core zones adjusted by impact factors. Journal of Information Science, 16: 51-57.

10. Royce,W.E. 1984. Introduction to principles of Fishery science. Academic Press, London. p.1.

11. Ravichandra Rao,I.K. and Neelameghan,A. 1992. From Librametry to informetrics: an overview and Ranganathan's contributions. Libri, 42(3): 243.

CHAPTER - 2

'FISHERY SCIENCE': STUDY OF ITS STRUCTURE AND DEVELOPMENT

2.1 Introduction

Knowledge has an endless growth. It is constantly growing. A thorough awareness of the various ways in which subjects originate and develop and also the structure they assume is a prerequisite for designing classification of knowledge. Therefore the function of the information scientist to explore into the structure and growth of subjects and to design system for an effective storage and quick retrieval of information is gaining relevance and gathering momentum. The research team at Documentation Research and Training Centre, Bangalore has developed a methodology to study the structure and development of subjects, and using this methodology, the subject Fishery science is analysed as given below.

2.2 Outline of the Subject

Fishes are cold blooded animals typically with backbones, gills and fins and are primarily dependent on water as a medium to live in. The study of fish and its natural history is known as 'Ichthyology'. By the development of marine biology and industrialisation, studies relating to fishes also expanded from natuhistory to methods of fishing, stock, culture etc. Thus the science of study of fishes developed into Fishery science and is recognized as a multidisciplinary field under Zoology.

As the trend to develop fisheries is increasing all over the world, Fishery science has become an important field of research. To improve fisheries, the support of scientists and technologists is important. The improvement will depend on quality of research and development undergoing in research organizations throughout the world.

2.3 Definitional Analysis

A comprehensive and well accepted definition for Fishery science is not available as it is an emerging subject area. Earlier concept of Ichthyology from which Fishery science has developed, is defined in popular dictionaries, encyclopaedia and handbooks. Some of them are given below.

2.3.1 Dictionaries

2.3.1.1 Mc-Graw Hill Dictionary of Scientific and Technical terms. Ed.4. Mc-Graw Hill Book Company, New York 1989.

Ichthyology - A branch of vertebrate zoology that deals with the study of fishes.

Fish - The common name for the cold blooded aquatic vertebrates belonging to the groups Cyclostomata, Chondrichthyes and Osteichthyes.

2.3.1.2 The New Illustrated Oxford dictionary Vol.1, Oxford University Press, London, 1978.

Ichthyology - The study of fishes.

Fish - Animal living exclusively in water (strictly) one class of vertebrate aquatic animals having gills throughout life and usually fins.

2.3.2 <u>Encylopaedia</u>

2.3.2.1 Mc Clane's New Standard Fishing Encyclopaedia and International Angling guide. Holt Rinehart Winston, New York, 1974.

Ichthyology - the study of fishes.

Fish (usage) - Although plural of fish is fishes. The singular term has been accepted to mean all fish.

2.3.2.2 Encyclopaedia Americana, American Corporation, New York, 1973.

Ichythyology is a branch of Zoology that is concerned with fishes, their structure, classification, ecology and distribution.

Fish - An aquatic vertebrate (backboned) animal that typically breathes by means of gills and moves by means of fins.

2.3.2.3 Encyclopaedia Britannica, Encyclopaedia Britannica Inc., Chicago 1985.

Ichthyology - Scientific study of fishes, including, as is usual with a science that is concerned with large groups of organisms, a number of specialised subdisciplines eg.taxonomy, ethology, ecology and physiology.

Fishes - The term fish is applied to a variety of cold blooded aquatic vertebrates of several evolutionary lines. It describes a life form rather than taxonomic group.

2.3.2.4 Pandey, A.K. and Sandhu G.S. Encyclopaedia of Fish and Fisheries of India. Anmol Publications, New Delhi Vol.1 1992.

Ichthyology - the study of fishes a branch of natural history.

Fish - are backboned animals which breathe through gills and have fins.

2.3.3 <u>Handbooks or Textbooks</u>

2.3.3.1 Jhingran, V.G. Fish and Fisheries of India Ed.3 Hindustan Publishing Corporation (India), Delhi, 1991.

Fishes - are cold blooded aquatic vertebrates which breathe by means of pharyngeal gills, propelling and balancing themselves by means of fins.

Fishery Science - Fisheries in its own right is a multidisciplinary science.

2.3.3.2 Lagler, K.F. Ichthyology Ed.2 John Wiley & Sons, New York, 1977.

Ichthyology - The study of fish - pure and applied aspects of science of ichythyology.

Fish - Fishes are cold blooded animals typically with backbones, gills and fins and are primarily dependent on water as a medium in which to live in.

2.3.3.3 Sharma, V and Grover, S.P. An introduction to Indian Fisheries. Bishen Singh Mahendrapal Singh, Dehra Dun. 1982.

Ichythyology - the study of fishes is dealt with under heads - taxonomy, morphology, embryology, ecology. histology, physiology, endocrinology etc.

Fish - is a cold blooded vertebrate adapted to aquatic mode of life.

2.3.3.4 Royce, W.F. Introduction to the fishery sciences, Academic Press, London. 1972.

Fishery Science - is the scientific study of the use of living resources of the waters. Part of fishery science is concerned with biological, physical and chemical aspects of the process of organic production;

part with the distribution and abundance of resources; part with the effects of fishing. It is an applied science including study directed at basic understanding as well as study designed to provide a background for decisions.

2.3.4 Consolidated Definition

Most of the aforesaid definitions of 'Ichthyology' are primarily concerned with identification and nomenclature of fishes. No publication even the world famous encylopaedias or technical terms dictionary try to update the definition according to recent developments. Royce (2.3.3.4) gives an advanced definition which can be taken as the consolidated definition. Thus Fishery science in the broad sense is the study of exploited aquatic animal resources for the purpose of generating an increased benefit to man.

2.4 Terminological Development

According to Norman [1] the term fish originated from the Greek word 'Ichthys' meaning Jesus Christ, son of God, saviour. Fish was an early christian symbol adopted sometime in the second century A.D. In 'Bhagavata Purana', Matsya Avatar the fish incarnation of Vishnu whose function was to save mankind is described. It is known that about 71% of earth's surface is covered by water. Fish is a vital food all over the world and it provides employment and export earnings to many. Fishing is one of the oldest employments. Primitive methods of fishing were reported from China and Japan. Fishing is also linked with water transport. Earlier raft and canoes used for fishing were used for transport also.

Fishes were in existence from about 5 million years ago. Aristotle is said to be the founder of Ichthyology according to early history of fishes. In his work "Historia animalium" a large portion deals with fish. Early Ichythyologists concentrated mostly on systematics and natural history of fishes. The applied aspects of fishery science developed later in 19th century. Fishery science, which comprises study of fishes and other commercially important aquatic organisms, developed recently, has two roots-in the development of marine biology and in the industrialization of fisheries' [2]. Development in marine biology started by the expeditions began with the survey voyages of James Cook. The science of oceanography started with the Challenger Expedition in 1872. The collections made by the expeditions were at first examined in Universities. Later, separate Marine Laboratories were established. When decrease in yield occurred after industrialization of fishery, scientific advice was needed to explore new fishing grounds and to investigate reasons for change in catches. By the world-wide expansion of fisheries research a number of organizations were formed in many parts of the world especially under Food and Agriculture Organisation (FAO). Developments such as Laws of the Sea Conference which enforced Exclusive Economic Zone (EEZ) for coastal states also influenced fishery science studies. More international collaboration on research contributed to the development of aquaculture, environmental studies, fisheries management etc. Fisheries administrators and managers are relying more on advice from scientific researchers. This enhances the development of Fishery science.

Earlier developments in fish science and technology took place in many European countries due to fishery exhibitions which created an awareness in the minds of the public. By the beginning of 20th century, there developed a relation between applied science and industries. Fishery science research also became more applied with special concern for problems of fishermen. The term fishery science became popular and established in the place of ichthyology.

2.5 Scope of the subject

The study of aquatic sciences is divided mainly into marine and freshwater sciences which are collectively called 'Oceanography' and 'Limnology' respectively. These studies are of importance to Fishery science which is an applied science. Oceanography and Marine biology studies such as hydrology, planktonology, productivity etc help to understand the reasons for fluctuations in fish landings. Similar to aquatic science, fishery science is divided into marine fisheries and fresh water fisheries (inland) based on the type of water. A third division, brackish-water fisheries which belongs to either fresh or marine origin is also described [3]. Fishery science has thus developed all over the world based on these strong foundation of the aforesaid branches of aquatic sciences.

2.5.1 Divisions and subdivisions

2.5.1.1 Freshwater fisheries (Inland)

Freshwater includes rivers, reservoirs, lakes, tanks and ponds. Studies show that world's freshwater resources are mainly from Asian countries such as China, India etc. Freshwater fisheries depend on ecological features such as Physico-chemical and hydrobiological conditions. Recently research on unexploited brackish water areas such as mangroves is also being conducted extensively.

2.5.1.2 Marine fisheries

Marine fisheries all over the world include studies on resources from oceans namely Atlantic, Pacific, Indian and the adjacent seas. Developments in Marine fisheries also show an increasing trend all over the world.

Both freshwater and marine fisheries are further divided based on the distribution. Thus there is the pelagic fishes which belong to the upper part of the water and demersal which belong to bottom part. Two divisions of fisheries commonly referred to in research organisations are capture and culture fisheries.

International Standard Statistical Classification on Aquatic Animals and Plants (ISSCAAP) divides commercially important aquatic species as follows [4]. Food fishes such as some crustaceans and molluscs, are also grouped under fishes.

Code	Division
1.	FRESHWATER FISHES.
11.	Carps, barbels and other cyprinids.
12.	Tilapia and other cichlids.
13.	Miscellaneous freshwater fishes.
2.	DIADROMOUS FISHES.
21.	Sturgeons, paddlefishes etc.
22.	River eels.
23.	Salmons, trouts, smelts etc.
24.	Shads etc.
25.	Miscellaneous diadromous fishes.
3.	MARINE FISHES.
31.	Flounders, halibuts soles etc.
32.	Cods, hakes, haddocks etc.
33.	Reeffishes, basses, congers etc.

34. Jacks, mullets, sauries etc.

35. Herrings, sardines, anchovies etc.

36. Tunas, bonitos, billfishes etc.

37. Mackerels, snocks, cutlassfishes etc.

38. Sharks, rays, chimaeras etc.

39. Miscellaneous marine fishes.

4. CRUSTACEANS.

41. Freshwater crustaceans.

42. Sea-spiders, crabs.

43. Lobsters, spiny rock-lobsters etc.

44. Squat lobsters.

45. Shrimps, prawns etc.

46. Krill, planktonic crustacea etc.

47. Miscellaneous marine crustaceans.

5. MOLLUSCS

51. Freshwater molluscs.

52. Abalone, wrinkles, conches etc.

53. Oysters.

54. Mussels.

55. Scallops, pectens etc.

56. Clams, cockles, arkshells etc.

57. Squids, cuttlefishes, octopuses.

58. Miscellaneous marine molluscs.

6. WHALES, SEALS AND OTHER AQUATIC ANIMALS.

61. Blue Wahles, fin whales etc.

62. Sperm whales, pilot whales etc.

63. Eared seals, hair seals, walruses etc.

64. Miscellaneous aquatic mammals

7. MISCELLANEOUS AQUATIC ANIMALS

71. Frog and other amphibians.

72. Turtles.

73. Crocodiles and alligators.

74. Sea squirts and other tunicates.

75. Horseshoe crabs and other arachnoids.

76. Sea urchins and other echinoderms.

77. Miscellaneous aquatic invertebrates.

8. MISCELLANEOUS AQUATIC ANIMAL PRODUCTS.

81. Pearl, mother-of-pearl, shells etc.

82. Corals.

83. Sponges.

9. AQUATIC PLANTS

The major divisions of fishery science where active research is going on include fishery biology, ecology, stock(management), physiology, reproduction, genetics, pathology, pollution, technology, aquaculture and marketing. They are briefly examined below.

2.5.1.3 Fishery biology

Earlier studies were mainly on systematics and taxonomy of fishes. When fish catch began to decrease other areas of the subject developed. Thus the food and feeding habits, length-weight relation and other similar biological studies were started by research workers.

These studies help in assessing the areas of fish occurrence, habitat etc.

2.5.1.4 Fish stock management (resource assessment)

The need to increase the fish resource led to the management of fisheries. New methods of fish stock estimation were introduced, using statistics. The establishment of Food and Agriculture Organisation led to many developments in fish stock management. FAO has a separate fisheries division which publishes data on fish landings and products from all over the world.

The increased demand for fish due to the growth of population and rise in per capita consumption has necessitated the establishment of an effective management system. Earlier, fish have been considered to belong to no one and so all waters were free and open to fishing. Later, need for authority over territorial sea was recognized and the limit of 200 mile Exclusive Economic Zone (EEZ) was set by the International Convention of Law of the Sea. Management of fisheries by laws becomes prominent when it is found that the abundant stock is reduced by overfishing.

2.5.1.5 Fishery Ecology

Ecology is a broad, complex and very young science which is a branch of biology with inter-relationships among organisms and with their environment. As fish lives in water, the factors which affect it include salinity, temperature, food availability, productivity etc. Ecological studies include pattern of distribution, population dynamics, age composition interspecies relations, food chains, production efficiency etc.

2.5.1.6 Fish Physiology

Physiological aspect of various functions like growth, feeding, nutrition, behaviour etc. are important in fishery science. It is also helpful in aquaculture practices where selection of species and rearing of fish are to be done carefully.

2.5.1.7 Fish reproduction

Different reproductive processes such as maturity, fecundity, spawning and development form an important division of study. These studies help in protecting the vulnerable species, culture and predicting the fishery.

2.5.1.8 Fish genetics

With the development of fish culture, genetic studies of fish are also gaining importance. Genetic studies have enabled evolving new hydrid fishes, artificial fertilization, selecting fishes for culture, identification of population etc.

2.5.1.9 Pollution and Fisheries

Fishes are vitally affected by the media in which they live. The physical, chemical and biological changes in waters affect the fish population. Physical and biological aspects are studied in ecology. Due to industrialization, discharge of chemical waste into natural waters is increasing. These chemicals cause pollution which is sometimes fatal to aquatic life. Studies concerning pollution and its effect on fisheries are important for management of species.

2.5.1.10 Fish Pathology

Studies of disease of fish - causes and prevention form the pathology of fishes. Causes for disease vary and the kinds of diseases are many. Their prevention and control are important in increasing fish yield and in fish culture.

2.5.1.11 Fish Technology

Fishery technology is the application of the fish science to the industrial art of fishing, fish handling and processing. Development of fishery practices began by the mechanisation of crafts and gear. Use of electronic and other gadgets for locating fishing grounds helped to improve fisheries. For processing and handling many new mechanised methods are applied. Even the fishing vessels are having equipments for processing and preserving fish. This division is a fast growing field with many new subdivisions such as 'industrial fisheries'[5].

2.5.1.12 **Aquaculture**

The controlled farming of aquatic organisms is called aquaculture. Fish farming was practised in China in 2000 B.C. Subdivisions of aquaculture can be broadly segregated by the type of water in which it is practised. Freshwater or inland aquaculture and marine or mariculture. Fresh water aquaculture includes culture of organisms both in fresh and brackishwaters. This has developed in countries with well developed freshwater resources. Mariculture or marine aquaculture originated in Indonesia around 1400 A.D. Culture of marine organisms is done generally in habitats like edge of the sea, inshore bays, covers, inlets and in floating cages or in open sea. Besides finfishes, cultivable organisms include shrimp, crab, oyster, cephalopod, sea turtle and sea cucumber. More emphasis is given in countries for culture of prawn as it is an important export item [6].

2.5.1.13 **Export of Aquatic Products (Marketing)**

Developments in fisheries and aquaculture has led to increase in export items such as preserved fish and prawn, fish meal, oil, pearl, coral, turtlemeat and seacucumber. Export of ornamental fishes and equipments for aquarium also have developed as an industry. India is one of the major countries exporting marine products to many countries. The export trend shows an increase every year.

2.5.1.14 **Fishery Economics**

Economic problems of fisheries management and aquaculture are of recent origin. Measures for management are to be taken with due consideration for economic problems of those involved in fisheries. Similarly aquaculture practices also have to be designed with reference to economic aspects.

2.5.2 **Applications**

Fishery science is an applied science including basic studies as well as studies of new technological developments. After the second world war, the need for food supply increased. Thus new methods and equipments for fishing were made use of to increase the fish catch. Earlier there were no restrictions in fishing but the need to conserve the resources which showed depletion, resulted in the formulation of International Law of Fisheries at the third Conference on Law of the Sea held in Geneva in 1958. Management of fishery was done scientifically which included limiting the fishing zone for coastal states to 200 mile EEZs [7]

Aquaculture developed applying modern methods and techniques. Improved methods of culture results in increased production of cultured fishes. Fishery science helped the development of fish industry. Export of fish and other marine products increased and it has become a major income for those involved in the industry. Improved methods of processing, preserving and quality control have produced better products for export. Thus fishery science has become capable of diagnosing the state of fisheries as a 'bio-technico-economic social system' [8].

2.5.3 Tool Subjects

As the subject fishery science is interdisciplinary, it is a synthesis of a number of scientific disciplines, concerned with fish as food - mainly Physics, Chemistry, Statistics, Microbiology, Oceanography, Limnology, Marine biology and Economics. These subjects help in developing fishery science directly or indirectly.

Studies of oceanography and limnology are concerned with physical, chemical and biological features of oceans and freshwater which enable fishery scientist to study the factors affecting the production of fishes. Similarly marine and freshwater biology deal with structure, physiology, behaviour etc of aquatic fauna and flora, which help fishery scientists to identify and understand the relationship among aquatic organisms.

Application of Physics and Chemistry is useful in the physical and chemical properties of the environment and fish processing techniques. Microbiology is applied in quality control studies of fish and marine products, fishery environment and culture. Economics is applied in fisheries and also in aquaculture. Statistics is applied to fishery science in stock estimates, yield models, export of products and aquaculture. Application of law for fisheries management is also of importance when over-exploitation leads to depletion of resources. Engineering is applied mainly in fishing and aquaculture and is concerned with fishing gears, equipments, construction of culture ponds and other equipments.

2.6 Classification Systems

Fishery science showed rapid growth after 19th century. So the classification schemes developed earlier do not give separate consideration for this subject.

However, an analysis of the subject in various classification schemes is given below.

2.6.1 Document general classification

General studies on fish such as taxonomy and biology are given under Zoology. Fish technology and aquaculture are classified as applied science in most classification schemes.

2.6.1.1 Colon Classification, 6th Ed.

K92	-	Pisces
KZ332	-	Fish breeding (Animal husbandry)

2.6.1.2 Dewey Decimal Classification, 20th Ed.

597	-	Pisces (fishes). Ichthyology.
639	-	Fish breeding.

2.6.1.3 Universal Decimal classification

597	-	Pisces (Fishes) Ichthyology
639	-	Hunting, Fishing, Breeding
639.2	-	Fishing

2.6.2 Document Special Classification

AGRIS

MOO	-	Fisheries

2.6.3 Abstracting Journals

2.6.3.1 Aquatic Science and Fisheries Abstracts.

63	-	Ichthyology
204	-	Practical aspects of fisheries
212	-	Aquaculture
235	-	Fishable stocks

2.6.3.2 Biological Abstracts

Chordata General and systematic Zoology

Wildlife Management, Aquatic

2.6.4 Thesauri & Subject Headings

2.6.4.1 Sears List of Subject Headings

Fishes	-	567, 597
Fishing	-	799.1
Fish Culture	-	639
Fisheries	-	639
Aquaculture	-	639

2.6.4.1 Root Thesaurus

HY	-	Fisheries
HYH	-	Aquaculture
EYT. H	-	Pisces = Fishes

2.6.5 Rank in Universe of Subjects

Array of Order 1 - Natural Science

Array of order 2 - Biology

Array of order 3 - Zoology

Array of order 4 - Chordata

Array of order 5 - Pisces (Fishes)

2.7 Development of the Subject

2.7.1 Landmarks

The oldest written record about fishes is by Aristotle (384-322 B.C.) in which the anatomy, physiology and reproductive biology of fishes are given. Record about fishes are found in the work "Auslandiche Fishe" by Bloch published in 1785. A valuable study of ichthyology is given in Cuvier and Valenciennes work "Historie Naturelle des poisons" published during 1828-1849. Many contributions on systematics and fisheries research were published afterwards. Among these, "Day's Fishes of India" and Munroe's "Fishes of India and Ceylon" give exclusive description with photographs of Indian fishes. The latest catalogue on fishes of commercial interest has been published by FAO as "species identification sheets for fishery purposes" since 1970 [6].

The subject fishery science developed by mid 19th century when a number of expeditions like 'Challenger', 'Valdivia' etc. and a number of marine laboratories were built in various parts of the world. The need to increase fish yield necessitated fisheries administrators and managers to rely on scientific researcher for advice. This helped in proper utilization of available resources and conservation of stock.

Another landmark in the history of Fishery science is the International Convention of Overfishing which was held in 1946. After this, many commissions were established especially by FAO. These commissions became centres for scientific forums but the problem of overfishing continued. This is due to developments in techniques of fishing which increased yield of fish and no limit was imposed on fishing area. This led to the Law of the Sea

Conference which established the 200 mile EEZ as limit for fishing by coastal nations. Still the need to control over-exploitation of some stocks like prawn is causing problem. This has to be managed by each coastal country using proper fishery management policies.

Development of aquaculture is an important event in Fishery science. This increased the production of cultured species. Development of artificial feeds, disease control methods, genetically improved species and artificial fertilization are factors which made aquaculture popular. With the development of recreational fishing, culture of ornamental fishes also increased. Research and developments have increased export of fish and fish products.

2.7.2. Trends in the Subject

Fisheries is an integrated activity directed towards food production and changes in the availability of the resources have affected the catch, processing and marketing. The need to exploit potential fishery resources has focused renewed attention on fish stocks which were neglected or underexploited and on technologies to make use of their exploitation to the maximum possible. Research organizations all over the world have a key role to play in this area. Change in resource availability may be due to stock collapses, increased fishing costs, global resources limitation and extended fisheries jurisdiction. Reaction to these changes have affected industry and resource management.

Future challenges in the field are in fisheries management, food supplies from fisheries, technological requirements and lack of exploitation of unconventional resources. Organizations like FAO have strengthened their capacity to help developing countries in matters of fishery planning and in various technical fields associated with rational exploitation and utilization of fishery resources. Collaboration of Research Institutes in developing countries with those in developed countries will be beneficial for development of Fisheries science in future.

Major areas of research in fisheries science can be broadly divided into capture and culture fisheries. Based on this, research organizations also constitute their departments. Eventhough there exist two divisions of fisheries based on the type of water into freshwater and marine, the research methods and techniques associated with both are similar. Research is being conducted in all the divisions of the subject with emphasis on management, culture and technology.

Fish biology research is more fundamental and is useful in identification, occurrence and taxonomy studies. Research on stock management applies mostly statistical methods for prediction of potential yield such as extrapolation of present trends in catches, extrapolation of resource estimation of a known area to the whole world, estimation of primary production and production at each successive stage. In addition to collection of statistics about stock, formulation of laws and implementing them are important in resource management. Scientific researchers and managers have great responsibility in proper exploitation and management of resources.

Fish ecology research is important in culture and stock management as the ecological factors affect mainly production and aquaculture. Recently stress and its effect on fisheries and bioenergetics of fish are studied as part of ecology.

Effect of pollution on fisheries is an active field of research as it plays an important role in managing the resources. Pollution due to sewage, industrial waste, mining and agricultural waste are increasing and threatening the very existence of many aquatic forms. Fish mortality and diseases due to toxic effects show an upward trend. Measures like legislation in use of pesticides and treatment of wastewater before discharge from factories are introduced in many countries.

Research on fish physiology is a very important field. Physiological aspect covers growth, feeding, nutrition, behaviour etc. It is useful in many areas of fishery science.

In aquaculture, preparation and utilisation of artificial feed helps a lot in culturing fish. Research on growth, reproduction, and behaviour are useful in fishing and selecting fish for culture. Toxic effects of fishes are also part of physiological research. Some toxic materials produced by fish are found beneficial as drugs as they have pharmacological properties like anesthetics.

Research on fish genetics has ushered in a new era of artificial breeding by pituatory gland or hormone injection, hybridization etc. These studies are of immense use in mass producing fish fry for culture in seed farms.

Fish pathology deals with causes and control of diseases. Identifying the causes and introducing control measures are valuable in aquaculture and also for wild stocks when an outbreak of disease is reported. New varieties of fish which are disease resistant are also being introduced.

Fish processing and technology are active fields of research as export of fishes has grown as an industry.

Developments in better means of preservation and distribution have been accompanied by an evolution in the processing of fish products before being delivered to the consumer. A new branch of industrial fisheries concerned with the use of fish products for purposes such as medicine, human food, making paint, ink etc, have evolved. Researchers have an important task of showing how the new fish and shell fish products can be used to the maximum effect. Fish technologists have a key role to play in helping developing countries to make greater use of their fish resources and reduce considerable waste by spoilage or pests. The contribution of fishery scientists on the technology of fishing and properties of fish as food have made possible increase of fish catch and export of fish products.

Aquaculture research has resulted in world-wide increase in fish production by culture. This growth is largely due to the new technologies developed for aquaculture purposes. Artificial breeding and fish seed production in hatcheries in the place of earlier method of collecting fry from natural waters enhance the output of culture products. Research and practice on polyculture or mixed farming are also gaining momentum. Intensive aquaculture, where culture of fish is done along with agriculture, horticulture, piggery, duckery etc. is another area of fruitful research. The hobby of aquarium fish keeping has led to research on culture and export of ornamental fishes [9].

Aquaculture has led to the development of many scientific disciplines. The choice of culture organisms concerns genetics; transport and protection of animals concerns engineering; care of young concerns ecology and microbiology; nutrition concerns physiology and biochemistry; control of disease pathology etc. Thus many new fields of fishery science research based on modern technologies are leading towards genetic engineering and biotechnology applications.

2.7.3. Trends in Education

'Fishery Science, in the broad sense is the study of exploited aquatic animal resources for the purpose of generating an increased benefit to man' [10]. Fishery education is a diversified field. Fisheries and aquaculture, traditionally based on biology are among the earliest known agricultural activities of man. Ichthyology, the study of fishes emerged as a field distinct from biology and is concerned with taxonomy and natural history of fishes.

Fishery education in leading fishing nations has been evolved to suit their specific needs. In Norway, there are several fisheries schools for training processing technologists but there is no higher level institutions.

'In U.S., Institutes impart instruction in fisheries with strong emphasis on research concerning fisheries resources, fish population dynamics, aquaculture and food science. Canada and England also have graduate and Post graduate courses in fisheries education. In Poland there are fisheries schools and higher level training establishments for management of personnel. In Japan there is an elaborate system of fishery education integrated in the National Education System' [11].

Educational programmes in fishery science are of different kinds depending upon the nations and institutions involved. In most countries formal education in universities is combined with education of the public through extension programmes. In U.S. these extension programmes are part of land-grant University system. Research, teaching and extension in US are supported by Sea Grant Program, a co-operative federal-state-University effort.

In India, fishery education started with training given by fishery Institutes such as Central Inland Fisheries Research Institute establishing Inland Fisheries Training Unit (IFTU) and by Central Marine Fisheries Research Institute. In 1958 a committee of fisheries education was set up which recommended establishment of Central Institutes for education. Then the Central Institute of Fisheries Education (CIFE) and

Central Institute of Fisheries Operatives (CIFO - renamed as Central Institute of Fisheries and Nautical Engineering - CIFNET) were set up in Bombay in 1961 and Madras in 1968 respectively [11]. Later, Agricultural Universities began to establish fisheries colleges in different states. In-service training is offered by fisheries departments.

Higher Education in fisheries is based on Biology, Chemistry, Physics, Economics, Statistics etc. Students usually start by taking courses in these basic sciences and proceed to applied sciences like fisheries. Many colleges and Universities in developed and developing countries have programmes leading to graduate and post graduate degree in fisheries science. Specialisations leading to doctorate degrees are awarded in most countries. Many students from developing countries are obtaining advanced degree from developed countries under the International Technical Assistance Programme. Admission to Higher education in fisheries is generally on graduation or through entrance examination. The administration of fisheries colleges and research and extension organizations are by ministry of agriculture which enables coordination between education and research.

Higher education in fishery science is becoming more international due to the serious concern for expanding world food requirements. International collaboration of scientists, educationists and institutions is increasing. Food and Agricultural Organization also provides assistance in world wide education in fishery science.

2.8 Source of Information

Recent developments in fishery science and technology have resulted in increase in the number of research organizations all over the world. This has led to publication of research papers in the form of reports, bulletins etc in addition to journals, books and reviews. Literature in fishery science grows parallel to the growth of research in the field. The sources of information in fishery science can be divided into documentary, institutional and human sources.

2.8.1 Documentary Sources

Documentary sources are divided into Primary, Secondary and Tertiary.

Primary sources include journals, proceedings, research bulletins, patents, official publication, theses and dissertation. Some examples are:-

1. Indian Journal of Fisheries published by Central Marine Fisheries Research Institute, Kochi.
2. Journal of World Aquaculture Society published by World Aquaculture Society. USA.

Secondary sources are textbooks, reference books (dictionaries, encyclopaedias, hand books), abstracting journal, review serials and guide books. Few examples are noted below:

1. Everhart, E.H. etal. Principles of fishery science. Comstock Publishing Associated, New York 1975.

2. Holt, S.J. Multilingnal vocabulary and notation for fishery dynamics. FAO, Rome, 1960.

3. Aquatic Science and Fisheries Abstracts, FAO, Rome, Tertiary sources include annual review on the subject. Annual Review of Fish diseases. Prentice Hall, London.

2.8.2. Institutional Sources

These include both national international institutions doing research on the area. some international agencies collect and evaluate facts about resources and provide the information through publication, press release and special presentation. Institutions also conduct seminars symposia and workshops on special topics. These are also published as proceedings. Some institutes also provide data regarding fish resources to those who need it.

Eg.1. International - Inter-American Tropical Tuna Commission (IATTC)

2. National - Central Marine Fisheries Research Institute (India) NMLRDC

2.8.3 Human Sources

Earlier, information in the form of expert opinion formed source of information. Some institutes and organizations provide consultancy service for fish technology, export and aquaculture. Details about such individuals and firms can be obtained from who's who or directories.

Eg:World directory of hydrobiological and fisheries institutions, Washington D.C. American Institute of Biological science 1963.

2.8.4 Other Sources

These include computer databases, films, networks, etc. with the development of new technologies, online databases can be accessed to get the relevant information quickly.

Eg:AGRIS (Agricultural Information System)

ASFIS (Aquatic Science and Fisheries Information System)

2.9 Information Transfer Process

Channels of communication are necessary for information transfer process. This includes producer, processor and receiver who interact in an environment All these are necessary in any field of research. The result is secondary and tertiary publication. In an information service, to transfer information quickly to those who need it, new devices are to be found.

In an information system, the author, editor and publisher have responsibilities. Author does basic and applied research and send the result as articles for publishing. Author has to see that the results are authentic and are supported by proper evidence. The editor, mostly journal editor has to see that the articles are properly edited. Publisher has the responsibility to see that the journal does not publish any substandard material. The information thus produced is used by different types of users. Journals and abstracts are mostly used by research workers, textbooks by students, journals and books by teachers. An effective information transfer system has to cater to the needs of all the different type of users.

2.10 Conclusion

Because of active research in the field, the literature in fishery science is increasing in terms of publications, mainly in the form of journals, reports, technical notes and reviews. So it is important that any information centre in this subject field has to do judicious selection of journals for organizing better information services to the users. Citation studies which evaluate the use of journals in a subject helps a lot in journal selection. A study of the subject, its structure and development as done in this chapter will be of great help in designing an user friendly information system in Fisheries science. The study of the structure and development bring out the limitation in mapping of fishery science in popular classification system now available in the profession.

References

1. Norman,J.R. 1963. History of fishes. Ed.2 Earnest Benn, London, p.455.

2. Cushing,D.H. 1988. The Provident sea. Cambridge University Press, Cambridge, p.186 - 195.

3. Royce,W.E. 1984. Introduction to Fishery Science. Academic Press, London.

4. FAQ. 1993. Year book of fishery statistics. Vol.76. Catches and landings. FAQ, Fome. p.8-9.

5. Jhingran,V.G. 1991. Fish and Fisheries of India. Ed.3 Hindustan Publishing corporation (India), New Delhi. p.727.

6. Allsopp,W.H.L. 1985. Fishery Development Experiences. Fishing New Books Ltd., London.

7. Connell,J.J. 1980. Advances in fish science and Technology. Fishing News Books Ltd., London, p.9-29.

8. Rothschild,B.J. Ed. 1983. Global fisheries, perspectives for the 1980's, Springer Verlag, New York, p. 247-275.

9. Bal,D.V and Rao,K.V. 1990. Marine fisheries of India. Tata Mc Graw Hill Publishing Company, New Delhi. 472.

10. The International Encyclopaedia of higher education. Jossey Bass Publishers, San Francisco.vol. 2, 222-234 Vol. 4, 1740 - 1746.

11. Agarwal.S.C. 1990. Fishery Management. Ashish Publishing House, New Delhi.

CHAPTER - 3

INFORMETRIC ANALYSIS

3.1 Genesis & Development

Evolution of the concept informetrics can be traced back to the introduction of the term 'Statistical bibliography' [1] by Hulme in 1923 to denote the application of quantitative methods to library and bibliographic works. After Hulme, Gosnell used the term in his thesis to 'emphasise on the quantitative aspect than qualitative' [2]. Raisig also claimed that there was potential utility of statistical bibliography as a method of analysing information needs [3].

Statistical bibliography originated from two terms, statistics and bibliography. 'Statistics' is derived from the word 'status' meaning, state, position, standing. Websters dictionary defines it as "facts or data of a numerical kind, assembled, classified and tabulated so as to present information about a subject" [4]. Bibliography is derived from 'biblion' meaning 'book' and 'graphos' meaning 'to write'. Webster's dictionary defines it as "a list of authors writings or the literature dealing with a certain subject or author" [4]. Hulme defines bibliography as the "science of organization of knowledge" [1]. Statistics and bibliography combined to form statistical bibliography, which generally denotes quantitative methods in Library Science.

In 1948 S.R. Ranganathan suggested the use of 'librametry' to refer to 'quantitative research in libraries' [5]. He also recommended the application of statistical and mathematical techniques in Indian libraries to improve their day to day activities and services. In 1969, Pritchard used the term 'bibliometrics' instead of statistical bibliography to denote the "application of mathematical and statistical methods to books and other media of communication" [6]. He considered statistical bibliography as a misnomer as it may be misinterpreted as bibliography of statistics. Fairthorne described bibliometrics as the "quantitative treatment of properties of recorded discourse and behaviour appertaining to it" [7]. The term bibliometrics was accepted widely instead of statistical bibliography after the publication of Pritchard's paper in 1970 [8]. Bibliometrics consists of two terms 'biblio' meaning book and 'metrics' meaning science of meter ie. measurement. Bibliometric studies are limited to recorded information. Pritchard defines it as follows:

"The definition and purpose of bibliometrics is to shed light on the process of written communication and of the nature and course of a discipline (in so far as this is displayed through written communication) by means of counting and analysing the various facets of written communication".

The British standard glossary of documentation terms explained bibliometrics "as the study of the use of documents and patterns of publication in which the mathematical and statistical methods have been applied" [9]. Potter defines it as "the study and measurement of the publication patterns of all forms of written communication and their authors" [10]. Sengupta describes it as "organization, classification and quantitative evaluation of publication patterns of all macro and micro communication along with their authorships by mathematical and statistical calculus" [11].

According to Hertzel, "Bibliometrics the science of recorded discourse - which uses specific methodologies, mathematical and scientific, in its research - is a controlled study of communication. It is the body of a literature, a bibliography quantitatively or numerically or statistically analysed - a statistical bibliography; a bibliography in which measurements are used to document and explain the regularity of communication phenomenon" [12].

Bibliometric studies fall in two broad groups - descriptive (productivity count) and evaluative (literature usage count). Descriptive studies may concern geographic, time or discipline. Evaluative cover references or citations. According to Nicholas and Ritchie "Bibliometrics provide information about the structure of knowledge and how it is communicated" [13]. They divided the bibliometric studies into two groups those describing the characteristics or features of the literature (descriptive) and those examining relationships formed between component of a literature (behavioral). Evaluative studies use the references to literature used by research workers in a field. The scope of bibliometrics include studying the relationship within a literature or describing a literature, focusing on consistent patterns involving authors, monographs, journals or subject.

Bibliometrics has grown into a vast subject involving researchers from different branches of human knowledge. Thus synonymous terms like 'Scientometrics' coined by Russians to application of statistical methods to science emerged. FID developed the term 'informetrics' to mean measure and quantify information. It also established a committee on informetrics. Brookes, at the international conference on bibliometrics and informetrics held at Ontario in 1989, suggested that 'Informetrics' is the appropriate term to cover all the "quantitative studies related to information science" [14]. Thus it is seen that informetrics evolved from earlier terms like statistical bibliography, librametry, bibliometrics and scientometrics. Informetrics is "the study of quantitative aspect of information in any form, not just records or bibliographies, and in any social group, not just scientists. Thus it looks at the quantitative aspects of informal or spoken communication, as well as recorded, and of information needs and uses of the disadvantaged, not just the intellectual elite. It can incorporate, utilise and extend the many studies of measurement of information that lie outside the boundaries of both bibliometrics and scientometrics" [15].

As the term bibliometrics is expanded into informetrics, the definitions, descriptions and regularities also applies to informetrics. Informetrics is defined as "use and development of a variety of measures to study and analyse several properties of information in general and documents in particular" [16]. According to Lancaster, "Informetrics covers all quantitative analyses of information transfer, whether or not they involve the published literature" [17]. Scientometrics, the term used by Russians to quantitative studies of science is considered a term related to informetrics. "Scientometrics is the study of quantitative aspects of science as a discipline or economic activity. It is part of the sociology of science and has application to science policy-making. It involves quantitative studies of scientific activities, including among others, publication, and so overlaps bibliometrics to some extent" [15]. From the definition the scope of scientometrics is limited to studies of science, whereas the informetrics studies are spread over all fields of knowledge. Because of the wider scope of informetrics a series of international conferences in the topic which discuss the emerging methods and applications for research in this field are organised. According to Lancaster, the subject has grown from simple data analysis to well defined subject involving applied statistics, modelling, simulation, cluster analysis, study of citation network etc.

3.2 Literature Review

One of the first papers based on significant statistical data was by Cole and Eales in 1917 [18]. Statistical analysis of literature on comparative anatomy is done using publication counts and graphic illustrations in the paper. This paper came out before the subject bibliometrics was formed as a seperate discipline or even before formation of the concept statistical bibliography. The study by Hulme in 1923 is considered as the first analytical account on growth of literature. In this, the productivity of scientific literature was critically evaluated for a period of time and came to the conclusion that the decline and rise of scientific literature are influenced by population change, political and economic movements. Another importance of the paper was that for the first time the term statistical bibliography was used in scientific literature in 1923.

Later in 1926, scientific productivity formula which later became known as Lotka's law was published [19]. Gross and Gross wrote a paper based on the studies of references in "Journal of American Chemical Society" [20]. From their study it was decided to make use of a number of specific periodicals needed for a college library. This was the beginning of the first recorded study of citation analysis and later remained as a model for further studies.

Bradford, in 1934, published a paper on scattering which later came to be known as Bradford's law of scattering, the first important law to appear in informetrics research [21]. Bradford, while investigating on 300 abstracting and indexing journals stumbled upon the fact that "out of 750,000 articles, only 250,000 are dealt with and the remaining 500,000 are missed". This led to further investigation by using a bibliography on applied Geophysics (1928-1931) and Lubrication (1931-1932) compiled by Lancaster Jones. From this, Bradford established a hypothesis that "to a considerable extent, the references are scattered throughout all periodicals with a frequency, approximately related inversely to the scope" [22], Bradford's law is discussed in detail in his book "Documentation" published in 1948.

The next contribution to bibliometrics was by Zipf, G.K. when he put forward the relation between rank and frequency of word usage in his book published in 1935 [23]. This later came to be known as Zipf's law of word frequency. By using M.L. Hanley's "Index of words for James Joyce's Ulysses", Zipf studied the frequency and that lead to the formation of law.

Fussler, in a classic paper in 2 parts discussed "the importance of literature of various subject fields to research in Chemistry and Physics" and the temporal span of the literature, the principal forms of the literature, the national origins of the literature used in the United States, and some attention is devoted to the more important serial titles" [24].

Garfield, in 1955 presented the concept "Impact factor" [25]. The influence of a journal or an article during a specific period was termed impact factor. Garfield further stated that journals can be ranked by frequency and by impact of citations for science policy studies. "Impact is a measure of relationship between citations and articles published" [26]. Another method to measure journals or articles cited is by 'Immediacy index' which indicates how quickly they are cited. These values are published in Journal Citation Reports. Narin used measure of 'influence' of a journal [27] by calculating citation ratio between two journals ie. the extent to which one cites the other.

Kessler stated 'bibliographic coupling' [28, 29] as a new method for grouping technical and scientific papers. A paper reviewing bibliographic coupling was published by Weinberg in 1974 [30] which referred to Kessler's paper as 'classic paper in bibliographic coupling'.

A paper on epidemic theory, a technique explaining the transmission of ideas by means of literature was published by Goffman and Newill in 1964 [31].In this, an 'infectious disease epidemic' is compared to 'intellectual epidemic'. The purpose of this was to help to describe the publication activity within a given discipline to determine the necessity for an information retrieval system. This model depends on the rate of change over time of 3 groups - infectives, susceptibles and removals. Susceptibles are those who have not yet contributed paper to literature but may do so in future. Infectives are those who have contributed earlier and are no longer contributing articles. Removals are those who are neither infective nor susceptibles. This can be applied to clusters of papers - an original paper being infective and papers which cite original - susceptible.

The next important paper in chronological order is by Pritchard in 1969 in which the term 'bibliometrics' was first suggested instead of statistical bibliography [6]. Small, describes relation between two documents by a new kind of coupling - "co-citation" which is "the frequency with which two items of earlier literature are cited together by later literature" [32].

After 1970, a proliferation of papers appeared on various methods and applications. Earlier papers were mainly on theoretical and empirical aspects. Theoretical papers accepted mathematical formula rather than empirical data to study various distributions. Vickery examined Bradford's analysis and found there is difference in verbal and graphical expressions of the law [33]. Kendall took into account the references in operational research and came across a relation between Bradford and Zipf distribution [34]. Leimkuhler analysed Bradford's law and suggested that the 'law of scattering' predicts the number of references for a given portion of journals while the 'distribution' gives emphasis on the number of journals required to obtain a given portion of reference [35]. Brookes criticised the above work and opined that it is theoretically possible but practically difficult to apply [36]. Yablonsky examined in detail the bibliometric and scientometric core-scatter distributions and concluded that there exist a close similarity [37] between these two parameters. According to Haitun [38] Zipf's distribution is basic to all the other distributions. Bookstein suggests that the three informetric distributions as unified models [39, 40, 41]. Egghe gives more importance to the studies on the classical bibliometric laws and the similarity and difference between them [42] while Rousseau discuss the relation between informetric laws and how they differ [43] in certain vital aspects.

Literature on empirical studies are based on two types of studies - probability (prediction) and evaluation. Some important papers of similar nature are by Pratt [44] Drott [45] Lawani [46] Goffman and Morris [47] Brookes [48] and Egghe [49].

A third group of papers which describe mathematical models are of importance in the field. Some examples are Brooke's logarithmic model, [50] Price's Cumulative Advantage Distribution, [51] Bookstein's model linking Bradford, Lotka and Zipfs laws, [52] Coile's model of Scientific productivity, [53] Hubert's model for journal productivity, [54] Sengupta's model providing an offsetting weightage formula, [55] Naranan's power law model, [56] O'Neill's model pointing to limitations of Bradford distribution, [57] Schorr, [58] Voos [59] and Subramanyam [60] on Lotka's law, Wilkinson's model pointing out ambiguity of Bradford's law, [61] Worthen's contagion model, [62] Vlachy's work on lotka's law, [63] Ravichandra Rao [64] and Tague's [65] negative binomial model. Earlier models developed by Bradford, Lotka and Zipf have not applied any Goodness-of-fit tests to check the validity of data. Later studies mentioned above applied tests like Chi-square and Kolmogorov-Smirnov tests to accept the models. Some other work applied regression models to test the data.

A new method ie. explicativity developed by Good I.J. is explained by Tague [66] in her paper as a new method to test models to data. At present models suggested by Brookes and Bookestein, Ravichandra Rao and Tague have gained wider applications in information studies than any other models.

After the starting of journal 'Scientometrics' in 1977 edited by Tibor Braun, many papers related to informetrics are published in this journal. A number of review papers on Informetrics which give an overview of the subject and explain the key concepts form a major part. Important among them are those of Broadus, [67] Hertzel [12] Bensman, [68] Lawani [69], Rao [70], Ikpaahindi [71] Narin [27] Zunde [72] White and Mccain [73]. Bibliographies on informetrics were complied such as by Pritchard and Wittig [74] Hjerppe [75] Schubert [76] and Sellen [77].

By the advancement of technology, informetric studies are conducted using data collected by online search. Papers by Oppenheim [78], Persson [79] Hibbs [80] Lancaster and Lee [81], Stefaniak [82] deal with online studies. This method might get more practical applications in future though it has some limitations at present, such as coverage of database, data retrieval method etc.

3.3 Informetric Laws

In many fields researchers find some regularities while counting events or tabulating size of things. These are often known as models, measures or laws and are derived from empirical observations or statistical inferences. Informetrics as such deal with the study of library and information dissemination processes by using quantitative treatment of the properties and behaviour of knowledge. In such studies some theoretical formulations and generally valid laws are discovered. These laws may loose their validity or change when there is an alteration in the existing environment. In informetrics this type of large scale changes are unlikely to take place. Therefore these laws remain valid eventhough some new changes are suggested by later researchers. The three classic laws in informetrics are Lotka's law of Scientific productivity (based on Author productivity in terms of papers published), Bradford's law of scattering (based on distribution of articles over various journals) and law of word occurrence (ranking of word frequency in a text). These laws and several new models based on these are discussed below.

3.3.1 **Lotka's law**

Lotka in 1926 formulated the law of frequency distribution of authors in relation to number of articles produced. This became known as the inverse square law of scientific productivity. It states that the relation between frequency distribution of 'y' persons making 'x' contributions in $x^n y = c$. The value of constant when n = 2 was then calculated. Lotka explained the phenomenon as follows:-

"In the cases examined, it is found that the number of persons making 2 contributions is about one fourth of making one, the number making 3 contributions is about one-ninth etc the number making n contribution is about $\frac{1}{n^2}$ of those making one, and the proportion of all contributions, that make a single contribution is about 60 per cent" [19].

Lotka studied counts of chemists, and their publications based on data from Chemical Abstracts and Auerbach's bibliography on Physics. The law was termed Lotka's law by 1949 and the applicability to other disciplines was tested only by 1973. Murphy studied the applicability in humanities and found it was fit to this field [83], Voos, in 1974 measured productivity of authors in the field of information science and found that "the relationship in this field is $\frac{1}{n^{3.5}}$ instead of Lotka's $\frac{1}{n^2}$" [59]. In 1974 Schorr, applied the law to library science and showed that Lotka's law does not apply to the field of library science. In 1975 Schorr studied map librarianship and concluded that the law fits in this field. But Coile showed that Schorr's calculation was wrong as the law does not fit to map librarianship [84].

Pao, states that several studies have assumed the inverse square relation as the basis for testing, and others derived the value of constant 'c' from the percentage of single paper contributors which cannot be traced back to Lotka's assumptions. "Therefore, a uniform method should be agreed upon by those attempting a test. Comparison and generalisation on author productivity may be possible only if compatible data are available and results are significant" [85].

There have been many analytical approaches different from Lotka's law for scientific productivity. Narin, concluded that "scientific talent is highly concentrated in a limited number of individuals" [27]. Dennis, found a close correlation between quantity of scientific publication and achievement of eminence. Price, concluded that the number of elite in science is small compared to total number of scientists. According to Price an elite mean an eminent scientist producing scholarly writing. Bookstein, suggested a theoretical model which is a generalised version of Lotka's law [39], $f(x) = \frac{k}{x^{\alpha}}$ where

k and α are constants. According to this, the number of authors with x papers is proportional to $1/x^{\alpha}$.

Some recent studies on author productivity by Pao, Nicholls and Griffith used the version of Lotka's law by Bookstein, in their studies and estimated the values of n rather than using n = 2. They counted authors and suggested a goodness-of-fit test for the model. Nicholls showed that the generalised version is "surprisingly well fitting and stable" [86] and Pao concluded "overwhelming conformity" [87] to this model.

Price suggested that "Half of the scientific papers are contributed by the square root of the total number of scientific authors" [88]. This became known as Price's square root law and was proved to be invalid both theoretically and empirically [89] by further studies conducted by Nicholls.

While applying Lotka's law, the problem of crediting authorship to multiauthored paper occurs. Originally Lotka counted only first author in multiauthored paper. Bookstein discusses this in a paper and concluded that "if Lotka's law holds for one accounting method, it will hold for any other one in which the change in the typical amount of credit given to authors per paper may vary from author to author but does not depend strongly on how much the authors published. If this is true, the investigator can give any reasonable system of assigning credit to authors while studying author productivity [90].

In author productivity studies it is seen that the number of single paper producers are more. This aspect has been given a thorough scrutiny by many others. It is shown that authors who are more productive are having more collaborative studies than single paper producers. Because of the transdisciplinary nature of research topics, there is more scope for multiauthored paper than single authored paper. Jointly authored papers are cited more times than a single authored paper. Lawani has shown that "citation rate and quality of paper (as judged by a form of peer review) both correlate positively with number of authors per paper" [91]. In addition to collaboration, individual productivity is affected by working environment, motivation, reward system etc.

3.3.2 Bradford's Law

This law is the most prominent informetric law as it is applied to the control of literature. Bradford discovered the scattering phenomenon while studying the extent to which literature in a discipline is scattered over a range of journals. This was published in his classic article in 1934 [21]. Earlier, he was working on the necessity for standard bibliographical methods to avoid duplication and waste of time, money and to give better information service. While studying 300 abstracting and indexing journals duplication and omission of articles were found. This finding led to further investigation of two bibliographies on Applied Geophysics and Lubrication. For both subjects, tables giving number of journals producing corresponding number of articles were listed and then arranged them in the decreasing order of productivity. The list was found to have three zones each having the same number of references. The number of journals in one zone when divided by number of journals in the preceeding zone was found to be a constant which is known as Bradford multiplier. In the data studied it was approximately 5. Using the data Bradford constructed two graphs. One plotting the logarithm of cumulated number of journals against cumulated number of articles. He observed that the later part of the curve was close to a straight line and observed that "the aggregate of references in a given subject, apart from those produced by the first group of large producers, is proportional to the logarithm of number of sources concerned when these are arranged in the order of productivity" [21]. Based on this observation another graph was constructed to develop an algebraic relation for the straight portion of curve. From this the law was originated which states that:

"If scientific journals are arranged in the order of decreasing productivity of articles on a subject, they may be divided into a nucleus of periodicals more particularly devoted to the subject and several groups of zones containing the same number of articles as the nucleus, when the number of periodicals in the nucleus and succeeding zones will be as $1:n:n^2$ [21].

Bradford's law received wide attention after the publication of his book in 1948 in which the law is discussed in detail. In the book he also used the same data as in the first paper in which the law was presented. Since then the law had been used in various studies and mathematically is expressed as:

$F(x)=a+b\log x$ where $F(x)$ is the cumulated number of references contained in first x most productive journals, 'a' and 'b' are constants.

Bibliographic studies in a number of fields confirm that the dispersion of articles in a set of journals conform to the statistical distribution of the type described by Bradford. But arriving at a mathematical expression for this distribution led to many articles on the topic.

In 1948 Vickery published a paper based on analyses of 1600 periodical references. He found that Bradford's law was not in total agreement with his algebraic expression. Vickery concluded that the relation which Bradford discovered only "fits the upper portion of the observed curve" [33]. Cole, also took a new look at reference scattering in which he plotted the cumulative fraction of references against the logarithm of the cumulative fraction of titles and he named the slope obtained as "reference-scattering coefficient" [92].

Leimkuhler was the first to give a theoretical expression to the scatter of journals, which was found to be the inverse function of the Bradford distribution. Leimkuhler's Bradford distribution is given as

$$F(x) = \frac{\ln(I + \beta x)}{\ln(I - \beta x)}$$

where x denotes the fraction of documents in a collection which are most productive, F (x) denotes the proportion of total productivity contained in the fraction x. The parameter β is related to the subject and completeness of collection [35].

Brookes gave a simplified form of this formulation as this required much tedious computation for practical use. The new form is $B(r) = a + k \log r$, where B (r) represent total number of articles published in journals upto rank r, a and k are constants. This became the widely used formulation of Bradford's law [93].

Wilkinson in 1972 suggested that the formula provided by Brookes and Leimkuhler did not describe the same phenomenon. The error was due to Bradford's graphical representation of his Applied Geophysics data and the verbal expression of the law. Wilkinson observed that Leimkuhler derived his distribution from Bradford's verbal representation and Brookes from the graphical representation [61]. In comparative tests Brookes formulation conformed more closely to empirical data.

Naranan modelled the dynamic process of accumulation of articles in journals in terms of a power law distribution assuming that number of articles and journals grow exponentially [94].

This assumption was not found valid as Bradford's law fits even when articles and journals do not grow exponentially. Brookes suggested that Naranan's analysis is more valid for Lotka's law than for Bradford's law.

Lawani, in a study of literature of agriculture found the distribution conformed to Bradford's law. The curve obtained was linear with a Groos droop [95] for journals of lowest rank. This was a point of controversy. Brookes viewed that this was due to the incomplete bibliography. But O'Neill concluded that the Groos droop is not due to the incomplete bibliography but is a part of Bradford distribution [96].

Goffman and Morris applied Bradford's law to a study on library acquisitions. They stated that "Bradford's law should apply to the use of periodicals in a library as well as to the dispersion of articles among journals" [47]. They showed that the distribution of both circulating periodicals and their users obey the law. Hence the smallest core of journals which must belong to the library's collection can be defined. This core should consist of a minimal nucleii of periodicals circulating in the library plus the minimal nucleii of journals devoted to the subjects of most interest to the library's nucleus of users. As the funds allow successive zones of periodical corresponding to circulation and user interest can be added. As a result the library collection can be maintained in an orderly fashion and viable state thus providing its patrons with the most potentially usable material for the funds at disposal.

Fasler, in a comment on the above wrote that it was the most promising method but with a warning that "before it is possible to discontinue a journal subscription, it is necessary to make sure that such action will not cause great inconvenience [97]. In 1975 pope claimed that "the area in which Bradford's distribution has the greatest potential is in collection development" [98].

In 1977 Brookes did a complete re-evaluation of the law and stated that "the analysis of Bradford's law has hitherto been applied to theoretical models which are too static, too deterministic and too physical. All Bradford data are derived by observing the activities of a set of sources over some appropriate period of time and by noting these activities, as measured in terms of the numbers of items each source accounts for in that time. Thus the Bradford's law is concerned with:

1) a finite set of active sources whose activities are made to manifest with the generation or consumption of a specified type of item.

2) observation of those activities over a specific sampling period.

3) items of some homogenous kind which are discrete and countable [50].

Statistical distributions depend on relationships between the number of active sources, the range and intensity of their activities, and the period of observation which provides the sample data. All Bradford distributions are samples of some ongoing activity but all too often, the sample data have been regarded as constituting a total population. Brookes was a major writer on Bradford's law. In one paper he states that a new statistical theory based on both Bradford and Zipf's laws together "provide the most convenient analytical instrument for the exploration of social science data" [48].

A general formulation of the law is given by Asai [99] in which five types of laws formulated by earlier papers are combined and made into one. This paper provides a non-linear regression technique for estimating the slope, intercept and "shift in a straight line to log rank" of the Bradford curve. Chen and Leimkuhler [100] noted that Asai's formulation treats rank as a continuous variable without gaps which lessens the realism of the model. They suggest the 'index approach' to rectify this. They also identify two parameters that affect the shape of Bradford curve (non-linear) in least productive and most productive zones. Drott and Griffith have shown that the linear slope of Bradford curve is related to the number of articles plotted and the intercepts are related to the number of journals [101].

Karmeshu et al derives a rationale for Bradford's law based on random subdivision of papers over the field of journals and on individual scientific productivity [102]. Bradford's law and other statistical laws are explained by Price as cumulative Advantage Distribution of the success-breeds-success type [51]. He obtains a relation of the form $F(n) = (m+1)\, \beta\, (m+2)$ when n is number of successes m is a constant and β a Beta function.

A few examples are:

a) A journal which has been used is more likely to be used again.

b) An Article in a journal cited many times is more likely to be cited again.

c) An author of many papers is more likely to publish again than one who is less prolific.

Ravichandra Rao also supports this but shows that the negative binominal distribution describes this phenomenon better than cumulative advantage distribution [103]. In statistics this is generally described by a hyperbolic distribution function known as Yule distribution. This is shown to vary with sample size. Yule characteristic

$$k = \frac{1+(\text{sample variance} - \text{mean/mean})^2}{\text{Number of Classes}}$$

Garfield advances a measure of concentration of articles in journals [104]. This Bradford phenomenon shows a gradual concentration of articles to a few core journals in a subject. This is due to the explosion of literature and number of journals. Bradfords law enables to do a literature search among numerous journals and saves the users from 'documentary chaos'.

Maia and Maia show that there is no ambiguity in Bradford's theory of distribution [105]. It is also verified that in the Bradford's experiment the verbal and graphical expressions are in agreement showing that there is no ambiguity. Earlier, Wilkinson also studied the ambiguity of Bradford's law and concluded that a documentation researcher has no means to decide which formulation (verbal or graphical) should be used. O' Connoor and Voos also examine the relation between theory and empirical laws [106]. Another paper by Drott also studies the theoretical and empirical development of Bradford's law [107]. But Bookstein in a recent paper discussed the various informetric laws as the different versions of a single regularity and explored the consequences of demanding that informetric laws are resilent to ambiguity [90].

Burrell studied the Bradford phenomenon and opines a stochastic process termed 'Waring process' which conforms to the general features of Bradford's law [108]. In another work he examined the dynamic nature of bibliometric processes by analysing a bibliography compiled over an extending period of time using Bradford and Leimkuhler curves. The theoretical and practical importance of stochastic processes to model these systems are also given [109].

Recently, Aparna Basu attempted to find a theoretical foundation for Bradford's law and suggests a modified log-linear two parameter model to explain journal productivity [110].

3.3.3 Zipf's Law

Zipf, explained this law in 1935 based on the frequency of occurence of words in a text. It states that "if the number of words occurring once in a given sample is taken as x, the number of different words occurring twice, three times, four times, 'n' times in the sample is respectively

$$\frac{1}{2^2} \quad \frac{1}{3^2} \quad \frac{1}{4^2} \quad \cdots\cdots\cdots\cdots\cdots\cdots \quad \frac{1}{n^2}$$

of x". From this zipf developed a formula $ab^2=k$ where a is the number of words occurring b times.

Zipf explained the law as a consequence of a general "principle of least effort" in his book published in 1949 [111]. Zipf applied his principle to study Hanley's Index of words for James Joyce's Ulysses' and found a clear - cut correlation between rank (r) and frequency (f) of word, which is represented as rf = C. When the law is applied exactly, a hyperbola is obtained while plotting the frequencies against rank.

Many studies were conducted on Zipf's law. Wyllys, expressed it as "one of the most puzzling phenomenon in bibliometrics" [112], Simon, in a paper observed the fitness of the Yule distribution to a number of empirical data including word frequency [113]. Hill, wrote a group of papers on Zipf's law. Mandelbrot, published several observations on the generalizations of Zipf's law. In 1975 Wyllys presented a paper at the 38th Annual meeting of ASIS, which gives that "inclined towards mysticism, Zipf not only leaped to the conclusion that the true slope of rank frequency curve was -1, but also claimed that this regular slope resulted from some fundamental force of nature" [114].

Hubert, reviewed the law and its development in later work. Fedorowicz applied the distribution of indexing terms in inverted files of bibliographic databases using Zipf and other models [115, 116]. In another paper by Tague and Nicholls, attempts in relating the law to file design and general bibliometrics is done [117]. The simple Zipf size-frequency distribution for tokens is presented as $g_x = a/x^b$ where g_x is the number of type with x tokens, a is the number of types with single token and b dispersion of token over types.

Zipf's law, like other informetric laws can be related to the forms of description traditional in statistics like cumulative distribution function. It is also observed that Pareto's law in economics which relates the income and number of people are a variant of Zipf's law.

3.3.4 Informetric distributions Lotka-Bradford-Zipf relation

Number of studies have been made regarding the theoretical and practical implications of the informetric laws. These led to the study of relationship between the different laws. Earlier relation between Bradford and Zipf's law were explained by researchers like Kendall, that these two are almost equivalent. He supported the idea that Bradford distribution is really Zipfian and provided a more refined statistical explanation for the straight line observed by Bradford. Leimkuhler also agreed with Kendalls theory that the two laws were essentially two different angles of looking at the same thing. Brookes studied the Bradford-Zipf phenomenon and says that "the near identify of Zipf's and Bradfords laws are not immediately obvious because, in practice, the most marked deviation of empirical data from the mathematical expectations of

Bradford's law are likely to occur among most productive journals of the nucleaus" [36]. Journals also lack statistical unity as they are not issued at regular intervals and number of articles per issues also vary.

Garfield writes that "while each 'law' applies to a different specific phenomenon, they all tend to demonstrate one thing that a few (journals, scientists etc.) account for the many (articles, citations etc)" [104]. He relates the Pratts index which measure the degree of concentration of papers in a subject to Bradford's law. Many theories unifying the various statistical distributions are put forward. Garfield proposes a theory of 'concentration' which points out that for any field of science, articles are concentrated essentially within the same highly cited or multidisciplinary journals. Price proposed a unifying conceptual model for Bradford, Zipf, Lotka and other statistical laws by the theory of "cumulative advantage processes" which is based on success-breeds-success phenomenon [51]. Ravichandra Rao also supports this phenomenon in the case of use of documents.

All the informetric distributions are claimed to be essentially one by authors like Yablonsky [37], Bookstein [39, 40, 41]. Haitun [38] considered Zipf's as fundamental distribution. Brookes [48], argues that a new statistical theory based on Zipfian distribution is needed for applications to social sciences. He proposes the use of

Bradford and Zipf law together for analytical exploration of social science data. In another paper he says that both Bradford's and Zipf's are rank-frequency distributions. He also opines that there remains a theoretical gap yet to be bridged as long as there remains some aspects in bibliometrics beyond the reach of techniques dependent on analysis of frequency distribution.

A common functional relationship between the three laws are derived by Chen and Leimkuhler using the data from Kendall's study of bibliography of operational research [119]. They also propose a more useful formulation for the three laws.

Egghe gives an inventory of bibliometric laws and develops the 'criteria by which they are the same or different (eg. asymptotically)' [42]. The informetric distributions are described as 'variants of a single distribution' by Bookstein [40]. These provide rich and diverse issues and approaches for research in the field.

Research in the field using the laws have shown close similarity or even identity between the models underlying the empirical distributions. However since Bradford's law deals with journal studies and Lotka's law with author studies it is easy to see the literatures as different forms of the same mathematical phenomenon. The advantage of informetric distribution is their simplicity and familiarity. But their use will depend on how well they assist in making decisions.

3.4 Citation Analysis

Informetric studies depend mainly on document units or written records of communication ie. books, journals, articles, reports etc which form the objects of studies. As the physical documents are difficult to handle in large quantities, the "document representations" are considered for informetric studies. Currently bibliographies and data bases or data from users are also used in the studies. These can be considered as secondary sources in informetric studies. The "document representations" are usually known as reference or citations. References are the acknowledgement one document gives to another while citations are acknowledgement one document receives from another. According to Weinstock "when a scientist or technologist publishes an article, he should refer to earlier articles which identify earlier researchers whose concepts, methods etc. were used by the author to develop his own article" [120].

Citation analysis is the most common technique which is considered an authentic tool for journal evaluation. It is based on the concept that articles citing an earlier work in scientific paper have much of their content in common. This has led to many studies including citation counts, impact factor, bibliographic coupling, co-citation and obsolescence. Citation studies are valid for assessing the quality of research produced by individuals and institutions. It also correlates to the use of libraries by researchers. According to Garfield, Citation analysis "provides a number of interesting and useful insight into the network of journals that function as primary, formal communication medium of science" [121].

"Citation analysis means the analysis of the citations or references which form part of the articles in journals" [70]. Citations in journal indicate the connection between two documents - one which cites and the other which is cited, whereas citations in secondary periodicals does not imply any connection between documents. The main objective of citation analysis is to evaluate and interpret citations received by articles, authors, institutions and other aggregates of scientific activities. It is also useful in measuring communication links in sociology of science.

Barker in his thesis noted that there are two types of citation studies - (a) studies based on productivity in all or part of scientific literature and (b) those reflecting the use of all or part of the literature [122]. In the first type the source may be major abstracting or indexing journals, review journals, bibliographies or data bases. The second type of citation study is based on literature used by an author. Use of Bibliographies or abstracts are not considered true citation studies as they are compiled for the purpose of use and do not represent actual use made by the users. True citation analysis deals with works cited as having actually been used.

Many arguments for and against the validity of citations by scientists are often given. Some such as too much self citation, negative citation, citing papers without seeing the original, citing to get favour of mighty and comfort lowly etc., are put forward against the validity of citation studies as actual use studies. But the honesty and integrity of the majority of the scientists who may not involve in such practices is to be given weight. In short, citations are the major tool for evaluating quality of research journals.

Many studies have found numerous reasons for citations to papers by the authors. Reasons for citations received by some highly cited papers given by Oppenheim and Renn [123] are:

1. Historical background
2. Description of other relevant work
3. Supplying information or data for comparison
4. Use of theoretical equation
5. Use of methodology
6. Theory or method not applicable or not the best one

Selection of source for citation studies are usually done by sampling as the collection of documents are usually too large. One main source of data for citation studies are the science citation Index (SCI) published by Institute of Scientific Information (ISI) from 1963 onwards. These citation indexes give a list of documents that have been given as source journals covered by the index. The cited documents are ordered alphabetically by the author. Thus citation index forms a structured list of all citations in a given collection of documents. From 1973 ISI started publishing Journal Citation Reports (JCR) which are also useful in citation studies. This gives three lists-first a list of most frequently cited Journals for the period covered by JCR; second a list of journals in which they are cited (source journal listing); a third part shows the list of citing journals to the frequently cited journals (reference journal listing). The use of SCI for citation studies has its own merits and demerits. Some problems are due to self-citation, multiple authorship, homonym, errors in bibliography etc.

Initially the collection characteristics such as form (monograph, journal etc), type (articles, notes, news etc), subject (specific subject), set of authors, institutions etc are to be determined for citation studies. Then the objects of the study such as references, citations etc are to be selected. Other parameters like sources detail, level of aggregation, variables to be studied, period of study, methods, approach and purpose are to be determined prior to the study. There is a large number of literature available on citation analysis. Some of the earlier work are those of Garfield [124] Tagliacozzo [125] and Hjerppe [126].

The first record of citation analysis is an article by Gross and Gross in 1927 in which the citation count is used to measure adequacy of a college library. Following this, a number of papers defining the importance and dispersion of the various segments of scientific literature came out. The publication of paper by Bradford analysing the importance of a small number of core journals for a specific subject became the basis for research afterwards. More attention was made on managing the rapidly growing scientific literature. Price made use of a number of literature counts to devise his outline of scientific enterprise. Citation counting began to attract more attention as a means of structuring scientific literature. Some of the important work which belong to this type are by Garfield [26], Mccain and Bobick [128] and Brown [129].

Citation counts are often taken as a measure of the use of journals though the validity of this assumption is often criticised. Scales [130] in a study of the most used journals in National Lending Library compared it with highly cited journals listed in JCR. She conlcuded that there is no relation between actual use and citations. Brown suggested that ranking of periodicals in a discipline also was made by selecting related secondary periodicals as source journals. Frequency of abstracts was taken to reflect the frequency of citation in a primary journal. This method also have limitations as the objective of the abstracting journal may be comprehensive to the subject coverage. Sengupta, in various studies suggest modifications like weightage formula [55], bibliometric parameters [131] and using annual review to collect source data [132] to eliminate the limitations in the use of raw citations. Recently informetric studies using data from on-line data bases are also suggested and attempted [133, 134]. The scope of studies based on citation analysis are vast. Some include ranking and evaluation, growth and decay, aging or obsolescence, clustering, bibliographic coupling, trend analysis etc. The most important and commonly used parameters among them are discussed below.

3.4.1 <u>Ranking & Evaluation</u>

Citation analysis is used commonly for preparing rank list of journals and evaluate journal in specific subjects. Earlier, most libraries relied on the judgement by the selection committee for deciding the journals for subscription. This usually depended on the utility in a local library. But for a library specialising in a discipline, utility alone may yield misleading data as the users turn out to be biased and the existing titles may be used repeatedly. Moreover if the funds are limited and the demand for titles are more, then the librarian may have to adopt some criteria to find the most relevant titles. The most journal ranking studies use more than one criteria to evaluate the journals related to specific disciplines. Ranking journals using citation analysing combined with 'impact factor' study are very useful in the present context.

This type of citation studies help to identify core periodicals and formulate a need based acquisition policy in a scientific library. It also enables to assess the quality of research journals. Evaluative studies may have some limitations as this depends on the sample selected which may be from geographically and linguistically limited area. To overcome this, the number of sources can be increased covering almost all areas. The method of streamlining acquisition of journals in research libraries by finding core journals is economical and practical. Bradford's law or the other models derived from this are usually applied for journal ranking studies. Some studies are also based on data collected from users in one or a group of similar libraries.

Journal citation studies show that journals are strongly connected through the references in the articles they contain. Thus the core titles may be the highly connected journals. Garfield has done a number of journal citation studies on various disciplines [135]. The most informetric studies are on journal citations or their use. This is because the journals are a major communication channel for research in science and other fields.

Citation analysis also enables to study the number of papers produced by an author (author productivity or scientific productivity) by an institution (institutional productivity) by a country, (national productivity), the number of citations received by an author and, major areas of a subject where active research is going on etc. Measuring science by this method is helpful in determining the science policy of industrialised countries as well as less developed countries of the world.

Author productivity studies are done by using Lotka's law which is based on the assumption that frequency of authors producing papers is constant. Some of the studies by Pao [136], Nicholls (89) and Gupta [137] tests the applicability of lotka's law and its generalized form. Tests such as chi-square and K-S statistical tests were used to test the applicability of the law. Other investigations on scientific productivity led to the Prices theory of cumulative advantage distribution according to which if an individual (scientist, journal) becomes successful (publish yields an article) at the first attempt, the possibility of success at subsequent attempts increases. However, a failure does not diminish the probability of success on the next attempt. According to

Bookstein [138] Lotka's law is invariant under the impact of society on the pattern of scientific productivity.

Prices success-breeds-success phenomenon can also be explained by the 80/20 rule. According to this 80% of items (articles, number of publications, number of citations received etc.) are accounted for by 20% of sources (authors, journals etc.) In other words 20% of journals receive 80% of citations or 20% authors contribute to 80% of literature. Egghe [139] shows that the 80/20 rule is much stronger if the underlying distribution is Lotka type.

3.4.2 Impact Factor (IF)

Citation frequency of a journal is not only a function of significance of the material it published but also the quantity of material it publishes. Thus the most cited journal may be the most productive journal also. In view of this relation between size and citation frequency, the size can be taken to assess the citation frequency. Thus the method of calculating "impact factor" or the influence of a journal article over a specific time was adopted in journal ranking studies. This method was first done by Garfield in the Journal Citation Report (JCR), a by product of Science Citation Index.

Journal Impact factor reflects the average citation rate per published article. It is calculated by dividing the number of times a journal has been cited by the number of articles it has published during some specific period of time.

$$IF = \frac{\text{Number of citations received in year 3 by articles published in year 1 and year 2.}}{\text{Number of articles published in Years 1 \& 2.}}$$

Ranking of journals based on impact factor tend to be different from ranking based on absolute citation. Impact factor shows the quality of the journals. Higher the impact factor, greater is its quality. Journals ranked according to their impact factor can also be used for journal selection in a library.

Some limitations of using impact factor may occur such as fixing impact of journals not covered by science citation Index. A method to overcome this is originated by INSDOC, which is used by Sen etal [140] in a paper. In this method

$$IF = \frac{X_1 + X_2}{Y_1 + Y_2}$$

where Y_1 and Y_2 are the number of papers published in a journal during two consecutive years, X_1 is the number of citations these papers receive by citation Index journals and X_2 is the number of citations these papers receive from the journal itself during consecutive year.

A new method of finding Discipline Impact Factor (DIF) formulated by Hirst [141] in which the citations made by a few core journals are taken for computing impact factor. This gives an indication of the impact to the discipline. In this method, first a candidate journal of a specific discipline is selected from the most cited list of titles. The discipline influence score is computed by

$$DIS_A = \frac{\text{No. of times } J_1 \text{ cited Journal A}}{\text{Total No. of times } J_1 \text{ cited all Journals}}$$

where DIS_A is the discipline influence score of journal A in the candidate journal set. J_1 a member of Discipline Journal set and 'n' is total number of journals in Discipline journal set.

A study by He and Pao demonstrated this discipline specific journal selection and compared the results with that of expert evaluation, impact factor and total citation ranking [142]. User's preference was found more close to Discipline influence score than the other two methods.

Using the method of measuring impact factor, the output of a scientist,scientific organization or scientific agency can be analysed. Individual impact is a measure of impact of an individual's published output [143]. Institutional impact help to evaluate the output of research organisations in a country, various nations [144] or of a specific agency [145]. Opinions are divided on the evaluation of impact factor. Some people consider it as a misleading indicator of true impact [146]. Still some think that the ranking and impact are relevant only in specific disciplines. In some subject, impact factor of journal varies from country to country [147]. Use of a normalised impact factor (NIF) is suggested by Sen and Kumar [148] to overcome differences among fields. This is given by adopting a 10-point weightage scale. The top ranking journal in each subject is given a weight of 10 and others are scaled down accordingly. This method is useful to study NIF at institutional or individual level.

Similar to impact factor, the 'immediacy index' and 'influence' are also suggested as measures to journal citation studies. Earlier, Garfield has shown that the newly published journals in a subject show high impact [26]. Immediacy index is a measure of how quickly the papers in journals are cited. It is calculated as follows:-

$$\frac{\text{Number of citations received in year X by items published in year x}}{\text{Number of items published in Year x}}$$

Tomer has shown that journals with high impact have high immediacy index [146].

Another measure of impact is the influence of a journal. This method is used by Narin [27] which involves complicated calculations which can be done by computer only. This involves finding citation ratio between two journals. From this data the influence weight can be calculated. The influence weight depends on the citation relationship of a journals with all the other journals in a database. Influence weight multiplied by average number of references give the influence per publication, the value is then multiplied by number of papers to get the total influence. This calculation is more refined than impact factor as it takes into account the interrelationship of journal citations.

Impact factor and Immediacy index are ratios. Impact factor is the ratio of number of citations which a journal receives in the course of a given year to the number of citable items published by that journal within the two preceeding calendar year. Immediacy Index is the ratio of number citations a journal receives in its most recent complete year of publication to the number of source items published during the same interval.

Ranking of journals based on informetric methods are found mostly to agree with the expert opinion. Some researchers are adopting new methods combined with citation studies to formulate list of journals more specific to different subjects. Sengupta has adopted three parameters to rerank periodicals in the field of biochemistry [131]. The parameters were (a) scientific interest of a paper based on a number of papers published (b) compactness of the information content in a scientific periodical (c) the scientific value of a paper in relation to compactness of presentation.

3.4.3 Aging or Obsolescence

Obsolescence is the process whereby the materials become no more useful or reliable. Aging or Obsolescence is also a measure of quality of a journal. It helps to assess the decline in use of a set of documents over time. Studies on aging are conducted in collection management aspects in specific libraries or in the journal references as the indicator of previously published work. The reasons attributed for aging of journals may be varied like changing scenario in scientific technique or extension of scientific knowledge etc. Rate of aging varies with discipline and is found as a characteristic of scientific and technical literature.

Aging studies are of two types-synchronous studies which use data of citations from a journal or a subject during a period to measure how old are the cited journals or compute 'median citation age'. In second type--diachronous studies, citation history of a document or subject from the beginning to the end of a period are studied and 'half-life', is calculated. It is seen that both types give different results.

According to Brookes the rate of obsolescence is related to the rate of growth of scientific literature and the number of contributions in the field [149]. If these measures are constant, then the rate of obsolescence also remains constant. Ravichandra Rao and Meera studied the relation between growth and obsolescence and remarked that "faster the growth of literature then quicker the obsolescence as well as the half-life" [150]. Wallace hypothesized that "those journals that were most productive would have short active lives and as the journal productivity decreased, the average active lives of the articles would increase". According to Griffith "half the total citedness of a volume of an average scientific journal would be exhausted within five years after the publication and more than 90% after 20 years" [151].

Obsolescence has been the concern of librarians for quite some time because of the overabundance of materials, lack of housing facility etc. By studying the aging, the 'half life' or the time during which one half of the literature currently active originated can be calculated. The half life and median citation age shows how far back in time one must go to account for the age of one half of the bibliographic references published in a journal in a particular year. Price studied the percentage of references to works published in the most recent five year period known as Price's Index [152]. He attributed the citation of recent papers to "Immediacy effect" due to the citation of ephemeral papers at the research front.

Aging pattern shows the characteristic of source selected. In social sciences highly cited journals aged the literature more quickly than a randomly selected sample of journals. Highly productive journals showed low median citation age and low productive showed high median citation age.

Line and Sandison [153] have criticized the study of aging using citation data or use data. They state that the growth of literature must be allowed for by calculating the density of the use for each title considered. Line calculated the density of use (use per metre of shelf) and found the evidence of increasing density of use with increase of age [154]. There was no aging found but the low citation density was attributed to the inaccessibility of the old volumes which were kept in the basement of the library.

In a study Christavao came to the conclusion that articles from developed countries aged the literature faster than articles from developing countries [155]. This indicates that the difference in aging is related to the international or local relevance of research topic. Aversa in a diachronous study using Journal Citation Reports data from 1972 to 1980, concluded that for one group of citations showed peak in the third year and declined thereafter while that for the highly cited group showed peak in the sixth year and then dropped off slowly [156]. Two types of aging pattern is related to the role of papers in subsequent research. Technical and experimental papers peaked later and aged less rapidly than papers with specific research findings. Obsolescence studies enable collection management in libraries, help in information generation, study of growth of literature etc.

3.4.4 Bibliographic coupling and clustering

In 1962 Kessler reported on bibliographic coupling between scientific papers. According to him a number of papers have a meaningful relation to each other when they have one or more references in common. When the unit of coupling is a single item of references in common then it is said to have similarity in content between the two papers. This study helps to identify related papers in a specific subject.

Clustering occurs when one item of paper is referenced by a number of journals. All these journals form a cluster. Carpenter and Narin studied clustering of journals in the disciplines of Physics, Chemistry and Molecular Biology [157]. This aids in classifying related journals more precisely based on their relationship. This is based on the assumption that journals which deal with the same subject area may have similar referencing pattern and the journals which deal with the same subject may refer to each other. Cluster studies are indicators of birth, growth and death of science and their social structure. Cluster studies were done by using bibliographic coupling but now this is replaced by co-citation, a measure developed by Small. Co-citation changes with time but bibliographic coupling is static.

3.4.5 Co-citation

Co-citation studies help in mapping of literatures. When one paper cited two other papers together it is implied that the two papers are related. If the papers are cited together by more authors, then their relation is clearly indicated. Earlier studies by Small, shows links between documents which are obtained by Co-citation counts [32]. Such documents are arranged in a cluster with the highly co-cited document in the centre of cluster. As new papers are published, the co-citation links also change. Co-citation analysis can be done by using data collected from databases in computer. It helps to form clusters of documents, authors etc. Another type of study co-citation context analysis enables to produce research reviews and Swanson gives the importance of such studies in information Science [158].

Clusters of cited documents are groups made evident by co-citation strengths. The strength of relationship is proportional to the number of times the papers are cited together. This technique is used in citation indexing in ISI databases.

Citation analysis have been applied in various disciplines successfully mainly for journal evaluation.

Though there are some limitations such as self-citation, multiple authorship, synonyms, merging or splitting of journal titles etc to such studies, the advantages are more. It helps to classify journals according to scientific importance based on their impact on research, measure scientific influence and productivity, enables proper management of collection in libraries, information retrieval in computerised services etc. Citation studies are becoming more easier and relevant by using online databases

3.5 Current Trends

Informetric techniques are used in the identification of trends in a subject and also in the study of scientific communication. Informetrics is accepted as a research area that gives additional understanding of the form and structure of scientific communication. Some of the uses are for studying

1) growth of a subject and its literature
2) evaluate quality of research of an individual, an organisation or a country
3) productivity of an individual scientist
4) study history of science and science policy
5) obsolescence or aging of scientific literature
6) evaluating individual journals or a group of journals especially for acquisition decisions.

7) identify users of different subjects
8) authorship trend of scientific literature
9) measure usefulness of SDI services
10) develop experimental models correlating or bypassing existing ones.

Of the informetric distributions, the most used is Bradford's law and its various refinements. It is used to assist in designing information systems, rationalizing library services and in making more economic and fruitful use of periodicals. Brookes gave the use of Bradford's law in -

1) computerised bibliographic search systems (Medlars)
2) management of special libraries
3) discarding of 'aged' periodicals
4) planning special library systems
5) subject bibliography compilation without difficulty.

The two characteristics of Bradford's law are its universality and stability. The universality states that the law holds for all subjects at all times. The stability means violation of conditions for the validity of the law such as narrow time span of bibliography or narrow subject definition is not affecting the law significantly.

Research on informetric techniques applied to various disciplines have been done which has led to an increase in number of papers on the topic. Most of the studies were conducted to evaluate the scientific publications, scientists, research organizations etc. Many reports on informetric laws and its applications are also found. Citations are observed to be valid measures of quality in most of the studies though some show citations are not true measure of quality. In such cases combination of other measures such as expert opinion, can also be taken into account for forming conclusions.

Recently informetric measures of research productivity and quality are applied by decision makers to enable proper utilization of available resources. Quantitative methods in science and technology assist in determining funding priorities for research in the present context of economic recessions. Quantitative studies using informetric methods are also taken as science policy indicators in many countries of Europe. Such studies are published in journals like 'Research policy' 'Scientometrics' and other publications [159]. The use of informetric methods in science policy decision-making has generated the same range and level of criticism as in the use of citation analysis. But these studies can be considered as one of the many sources of information for science policy indicators.

Applications of informetric methods has been necessitated by the information explosion. By the development of computer databases most of the studies are now done by gathering data online. Stefaniak gives review on works done in U.S. and Europe [82]. A variety of measures for downloading data are available on "The Bibliometrics Toolbox" created by Brooks [160].

As applied to library and information science, informetric analyses have also been used for book and periodical acquisitions, library use studies, weeding of obsolete materials etc. Now these methods are applied to evaluate the structure of literature in various disciplines. Thus the quantitative methods which were termed 'Bibliometrics' to denote 'written communication' have progressed to information science which makes the term 'informetrics' the most appropriate one in the present context. Informetrics has thus become very significant and effective tool in research for quantitative and qualitative measurement of human knowledge.

References

1. Hulme,E.W. 1923. Statistical bibliography in relation to the growth of modern civilization. Lectures, May 1922. Grafton, London, p.9.

2. Gosnell,C.F. 1943. The rate of obsolescence in College library book collection. Ph.D dissertation, New York University. p.16.

3. Raisig,L.M. 1962. Statistical bibliography in health sciences. Bulletin Medical Libraries Association 50: 450.

4. Websters New World Dictionary of American Language 1964. The World Publishing Company, New York, p.144.

5. Ranganathan,S.R. 1969. Librametry and its scope. DRTC Seminar 7, Paper DA.

6. Pritchard,A. 1969. Statistical bibliography or bibliometrics? Journal of Documentation, 25 (4) p.349.

7. Fairthorne,R.A. 1969. Empirical hyperbolic distributions. (Bradford-zipf-Mandelbrot) for Bibliometric description and prediction. Journal of Documentation, 35: 319.

8. Pritchard,A 1970. Computers, bibliometrics and abstracting services. Research in Librarianship. 15: 94-99.

9. British Standard Institution, 1916 British Standard Glossary of Documentation terms. Prepared under the direction of Documentation standards committee. p.7.

10. Potter,W.G. 1981. Introduction Library Trends, 30: p.5.

11. Sengupta,I.N. 1985. Bibliometrics, a bird's eyeview. IASLIC Bulletin, 30: 167-174.

12. Hertzel, Dorothy,H. 1987. Bibliometrics, history of the development of ideas in. In: Encyclopaedia of Library and Information Science 42: 144-219.

13. Nicholas,D and Ritchie,M. 1978. Literature and bibliometrics. Clive Bingley, London. p.9-11.

14. Brookes,B.C. 1990. Biblio-, Sciento-, Infor-metrics??? What are we talking about. In: Egghe, L and Rousseau, R, Ed. Informetrics 1989/90, Elsevier, Amsterdam. p. 31-43.

15. Tague,J. 1992. An introduction to informetrics. Information Processing and Management. 28 (1): 1-3.

16. Ravichandra Rao,I.K. and Neelameghan, A. 1992. From Librametry to informetrics. An overview and Ranganathan's contributions. Libri, 42: 242-257.

17. Lancaster,F.W. 1991. Bibliometric method in assessing productivity and impact of research. Sarada Ranganathan Endowment for Library Science, Bangalore. 52 p.

18. Cole,E.J. and Eales,N.B. 1917. History of comparative anatomy. Pt. I. Statistical analysis of the literature. Science Progress. p. 578-596.

19. Lotka,A.J. 1926. Frequency distribution of scientific productivity. Journal of Washington Academy of Science, 16: 317-325.

20. Gross,P.L.K. and Gross,E.M. 1927. College libraries and chemical education. Science, 66: 385-389.

21. Bradford,S.C. 1934 Sources of information on specific subjects. Engineering, 137: 85-86.

22. Bradford,S.C. 1948. Documentation. Crosby Lockwood, London. p. 85.

23. Zipf,G.K. 1935. The psycho-biology of language: an introduction to dynamic philology. Cambridge, MIT Press, Mass.

24. Fussler,H.H. 1949. Characteristics of the research literature used by Chemists and Physicists in the United States. Library Quarterly. pt I: 19-35 and pt II: 119-143.

25. Garfield,E. 1955. Citation indexes for science. Science, 122: 108-111.

26. Garfield,E. 1976. Significant journals of science. Nature, 264: 609-615.

27. Narin,F. 1976. Evaluative bibliometrics. Computer Horizons. Inc. Cherry Hill, N.J. p. 41-44.

28. Kessler,M.M. 1963. An experimental study of bibliographic coupling between technical papers. IEEE Transactions, p. 49.

29. Kessler,M.M. 1963a. Bibliographic coupling between scientific papers. American Documentation, 14: 10-25.

30. Weinberg,B.H. 1974. Bibliographic coupling-a review. Information Storage Retrieval, 10: 190.

31. Goffman,W and Newill,V.A. 1964. A generalization of the theory of epidemics-an application to the transmission of ideas. Nature, 204: 225-228.

32. Small,H. 1973. Co-citation in the scientific literature: A new measure of the relationship between two documents. Journal of American Society for Information Science, 24: 256-269.

33. Vickery,B.C. 1948. Bradford's law of scattering. Journal of Documentation. 4: 198-203.

34. Kendall,M.G. 1960. The bibliography of operational research. Operational Research Quarterly. 11: 31-36.

35. Leimkuhler,F.F. 1967. The Bradford distribution. Journal of Documentation, 23: 197-207.

36. Brookes,B.C. 1968. The derivation and application of Bradford - Zipf distribution. Journal of Documentation. 24: 247-265.

37. Yablonsky,A.I. 1980. On the fundamental regularities of the distribution of scientific productivity. Scientometrics, 2: 3-34.

38. Haitun,S.D. 1982. Stationery scientometric distributions. Pt. I-III Scientometrics 4: 5-25, 89-104, 181-194.

39. Bookstein,A. 1976. Bibliometric distributions. Library Quarterly, 46: 416-423.

40. Bookstein,A. 1990. Informetric distributions pt. I. Unified overview. Journal of American Society for Information Science, 41: 368-75.

41. Bookstein,A. 1991. Theoretical properties of informatric distributions. In: Ravichandra Rao, Ed. Informetrics 91 p. 17-35.

42. Egghe,L. 1988. On the classification of classical bibliometric laws. Journal of Documentation. 44: 53-62.

43. Rousseau,R. 1990. Relation between continuous versions of bibliometrics laws. Journal of American Society for Information Science, 41: 68-75.

44. Pratt,A.D. 1977. A measure of class concentration in bibliometrics. Journal of American Society for Information Science, 28: 285-292.

45. Drott,M.C. Mancall,J.C. and Griffith,B.C. 1979. Bradfords law and libraries. Present applications - Potential promises. ASLIB Proceedings 31: 296-304.

46. Lawani,S.M. 1973. Bradford's law and the literature of Agriculture. International Library Review, 5. 341-50.

47. Goffman,W and Morris,T.G. 1970. Bradford's law and library acquisitions. Nature, 221: 1205-1207.

48. Brookes,B.C. 1989. Towards informetrics: Haitun, La place, Zipf, Bradford and the alvey programme. Journal of Documentation, 40: 120-143.

49. Egghe.L. 1986. Methodological aspects of bibliometrics. Library Science, 25: 179-191.

50. Brookes,B.C. 1977. Theory of Bradford's law. Journal of Documentation, 33: 180-209.

51. Price,D.J.S. 1976. A general theory of bibliometrics and other Cumulative Advantage Process. Journal of American Society for Information Science, 27: 292-306.

52. Bookstein,A. 1979. Explanation of bibliometric laws. Collection Management, 3: 151-162.

53. Coile,R.C. 1977. Lotka's frequency distribution of Scientific productivity. Journal of American Society for Information Science, 28: 366.

54. Hubert,J.J. 1977. Bibliometric models for journal productivity. Social Indicators Research. 4: 441-473.

55. Sengupta,I.N. 1984. Weightage formula to rerank biochemical periodicals. International Library Review. 16: 447-458.

56. Naranan,S. 1971. Power law relations in science bibliography - a self consistant interpretation. Journal Documentation. 27: 83-97.

57. O'Neill,E.T. 1973. Limitations of the Bradford's distribution system - their benefits. Proceedings American Society for Information Science. 24: 177-178.

58. Schorr,A.E. 1974. Lotka's law and library science. Research Quarterly. 14: 32-33.

59. Voos,H 1974 Lotka and information science, Journal of American Society for Information Science. 25: 270-272.

60. Subramanyam,K. 1981. Lotka's law and library literature. Library Research. 8: 167.

61. Wilkinson,E.A. 1972. Ambiguity of Bradford's law, Journal of Documentation. 28: 122-130.

62. Worthen,D.B. 1973. Epidemic process and the contagion model. Journal of American Society for Information Science, 24: 343-346.

63. Vlachy,J. 1978. Frequency distribution of scientific performance: bibliography of Lotka's law and related phenomena, Scientometrics 1: 109-130.

64. Ravichandra Rao,I.K. 1980. Distribution of Scientific productivity and social change. Journal of American Society for Information Science 31: 111-121.

65. Tague,J. 1981. Success breeds success phenomena and bibliometric processes. Journal of American Society for Information Science, 32: 280-86.

66. Tague,J. 1991. How good is a model? Explicativity as a Goodness-of-fit measure. In: Ravichandra Rao, I.K. Ed: Informatrics 91: p. 484.

67. Broadus,R.N. 1987. Early approaches to Bibliometrics. Journal of American Society for Information Science, 38: 127-129.

68. Bensman,S.J. 1982. Bibliometrics laws and library usage as a social phenomena. Library Research, 4: 279-312.

69. Lawani,S.M. 1981. Bibliometrics: its theoretical foundations, methods and applications. Libri, 3: 294-315.

70. Ravichandra Rao,I.K. 1983. Quantitative methods for library and information science. Wiley Eastern, New Delhi, 271 p.

71. Ikpaahindi,L. 1985. An overview of bibliometrics its measurements, laws and their applications. Libri, 35: 163-177.

72. Zunde,F. 1984. Empirical laws and theories of information and software sciences. Information Processing & Management, 20: 5-18.

73. White,H.D. and Mccain.K.W. 1989. Bibliometrics. Annual Review of Information Science & Technology. 24: 119-186.

74. Pritchard,A and Wittig,G.R. 1981. Bibliometrics-a bibliography and index. Vol 1: 1874-1959.

75. Hjerppe,R. 1980. A bibliography of bibliometrics and citation indexing and analysis. Royal institute of Technology Library, Stockholm (TRITA-Lib-2013).

76. Schubert,A. 1983. Quantitative studies of science: A current bibliography. (Appears serially every year from 1983 onwards) Scientometrics.

77. Sellen, Mary,K. 1993. Bibliometrics - an annotated bibliography 1970-1990. G.K. Hall, New York. 169 p.

78. Oppenheim,C. 1985. Use of online databases in bibliometrics studies. In: Proceedings 9th International online information meeting. Learned Information Ltd. Oxford. 355-404.

79. Persson,O. 1986. Online bibliometrics - a research tool for everyman. Scientometrics 10: 69-75.

80. Hibbs,J.E., Bobner,R.R., Newman,I., Dye,C.M., and Benz,C.R. 1984. How to use online databases to perform trend analysis in research. Online, 8: 59-64.

81. Lancaster,F.W. and Lee,J.L. 1985. Bibliometric techniques applied to issues management, a case study. Journal of American Society for Information Science, 36: 389-397.

82. Stefaniak,B. 1987. Use of bibliographic databases for scientific studies. Scientometrics, 12: 149-161.

83. Murphy, Larry,J. 1973. Lotka's law in the humanities. Journal of American Society for Information Science, 24: 461-62.

84. Coile,R.C. 1976. Bibliometric studies of scientific productivity. Proceedings of Amerian Society for Information Science, 13: 20.

85. Pao,M.L. 1982. Lotka's test. Collection Management 4: 112.

86. Nicholls,P.T. 1987. The Lotka hypothesis and bibliometric methodology. Ph.D. Dissertation, University of Western Ontario, Canada 175 p.

87. Pao,M.L. 1986. An empirical examination of Lotka's law. Journal of American Society for Information Science. 37: 26-33.

88. Price,D.J.S 1963. Little Science, big science, Columbia University Press, New York 118 p.

89. Nicholls,P.T. 1988. Price's square root law: empirical validity and relation to Lotka's law. Information processing and Management, 24: 469-77.

90. Bookstein,A. 1990. Informetric distributions pt. II. Resilence to ambiguity. Journal of American Society for Information Science 41: 376-86.

91. Lawani,S.M. 1980. Quality, Collaboration and citations in cancer research. Ph.D. thesis, Florida State University Press.

92. Cole,P.F. 1962. A new look at reference scattering. Journal of Documentation, 18: 58.

93. Brookes,B.C. 1981. A critical commentary on Leimkuhler's exact formulation of Bradford's law, Journal of Documentation. 37: 77.

94. Naranan,S. 1970. Bradford's law of bibliography of science, an interpretation. Nature, 227: 1377.

95. Groos,V. 1967. Bradford's law and the Keenan-Atherton data. American Documentation 18: 46.

96. O' Neill,E.T. 1970. Journal usage patterns and their implications in the planning of library systems. Ph.D. Dissertation. Purdue University.

97. Fasler,A. 1970. Exceptions to Bradford's law (Correspondence) Nature, 227: 101.

98. Pope,A. 1975. Bradford's law and the periodical literature of information science. Journal of American Society for Information Science, 26: 212.

99. Asai,I. 1981. A general formulation of Bradford's distribution the graph oriented approach. Journal of American Society for Information Science, 32: 113-119.

100. Chen,Y.S. and Leimkuhler,F.F. 1987. Bradford's law, an index approach, Scientometrics, 11: 183-198.

101. Drott,M.C. and Griffith,B.C. 1978. An empirical examination of Bradford's law and the scattering scientific literature.

Journal of American Society for Information Science, 29: 238-246.

102. Karmeshu,N., Lind.C and Cano,V 1984. Rationale for Bradford's law. Scientometrics, 6: 233-241.

103. Ravichandra Rao,I.K. 1981, Documents and user distribution in transaction records of Canadian University Libraries. Ph.D. Thesis. University of Western Ontario, Canada.

104. Garfield,E 1980. Bradford's law and related statistical patterns, Current Comments, May 12. Reprinted in: Essays of an Information Scientist, 4: 476-483.

105. Maia,M.J.F. and Maia, M.D. 1984. On the unity of Bradford's law. Journal of Documentation, 40: 206-216.

106. O' Connor,D.O. and Voos,H. 1981. Empirical laws, theory construction and bibliometrics. Library Trends, 30: 9-20.

107. Drott,M.C. 1981. Bradford's law: theory empiricism and the gaps between, Library Trends, 30: 41-52.

108. Burrell,Q.L. 1988. Modelling the Bradford phenomenon Journal of Documentation, 44: 1-18.

109. Burrell,Q.L. 1992. The dynamic nature of bibliometric processes: a case study, In: Ravichandra Rao,I.K. Ed: Informetrics - 91. p. 97-129.

110. Basu, Aparna. 1992. On the theoretical foundations of Bradford's law. In: Ravichandra Rao, I.K. Ed. Informetrics - 91 p. 51-67.

111. Zipf, G.K. 1949. Human behaviour and the principle of least effort. An introduction to Human ecology, Addision - Wesley Press, Reading, Mass p. 24.

112. Wyllys, R.E. 1981. Empirical and theoretical basis of Zipf's law, Library Trends, 30: 53.

113. Simon, H.A. 1955. On a class of skew distribution functions. Biometrica, 42: 425.

114. Wyllys, R.E. 1975. Measuring scientific prose with rank frequency ('Zipf') curves, A new use for an old phenomenon. Information Revolution, 12: 30.

115. Fedorovicz, J. 1982. A Zipfian model of an Automatic Bibliographic system. An application of Medline. Journal of American Society for Information Science, 33: 223-232.

116. Federovicz, J. 1982a. The theoretical foundations of Zipf's law and its applications to the bibliographic database enviornment. Journal of American Society for Information Science, 33: 285-293.

117. Tague, J and Nicholls, P. 1987. The maximal value of a Zipf size variable. Sampling properties and relationship to other parameters. Information Processing & Management, 23: 155-170.

118. Brookes,B.C. 1988. Comments on the scope of bibliometrics. In: Egghe & Rousseau Ed: Informetrics 87/88, Elsiver p. 29-41.

119. Chen,Y.S. and Leimkuhler,F.F. 1985. A relationship between Lotka's law, Bradford's law and Zipf's law. Journal of American Society for Information Science, 37: 307-314.

120. Weinstock,M. 1971. Citation Indexes. In: Encyclopaedia of Library and Information Science. V. 5, Marcel Dekker, New York p. 15-40.

121. Garfield,E, 1979. Citation Indexing - its theory and applications in science, technology and humanities. Wiley New York, 274 p.

122. Barker,D.L. 1966. Characteristics of research literature used by chemists. Ph.D dissertation, University of Illinois.

123. Oppenheim,C and Renn, Susan,P. 1978. Highly cited old papers and the reasons why they continue to be cited. Journal of American Society for Information Science, 29: 226.

124. Garfield,E. 1972. Citation analysis as a tool in journal evaluation. Science, 178: 471-79 Reprinted in: Essays of an Information scientist, 1: 527-544.

125. Tagliacozzo,R. 1967. Citations and Citation indexes - A review. Methods Information Science, 6: 136-142,

126. Hjerppe,R. 1978. An outline of bibliometrics and citation analysis. Report TRITA - LIB- 6014. Royal Institute of Technology Library, Sweden, 82 p.

127. Price,D.J.S. 1965. Networks of scientific papers. Science, 149: 510-515.

128. Mc Cain,K.W. and Bobick,J.E. 1981. Pattern of journal use in a departmental Library Journal of American Society for Information Science, 32: 257-267.

129. Brown,C.H. 1956. Scientific serials charactristics and lists of most cited publications in Mathematics, Physics, Chemistry, Geology, Physiology, Botany, Zoology and Entomology. Association of College and Reference Libraries, Chicago, Monograph No. 16 p. 1-15.

130. Scales,P.A. 1976. Citation analysis as indicators of the use of serials, a comparison of ranked title lists produced by citation counting and from use data. Journal of Documentation, 32: 17-25.

131. Sengupta,I.N. 1986. Three New Parameters in bibliometric research and their applications to rerank periodicals in biochemistry. Scientometrics, 10 235-242.

132. Sengupta,I.N. 1990. Bibliometrics and identification of core periodicals. Herald of Library Science, 29: 226-247.

133. Moed,H.F. 1988. The use of on line databases for bibliometric analysis. In: Egghe & Rousseau, Ed Infometrics 1987/88. Elsevier p. 133-146.

134. Whitney, Gretchen 1992. Asian authorship in major international bibliographic databases. In: Ravichandra Rao, I.K. Ed: Informetrics-91. Sarada Ranganathan Endowment for Library Science, Bangalore p. 501-526.

135. Garfield,E. 1977. Essays of an information scientist. ISI press, Philadelphia. 4 V.

136. Pao,M.L. 1985. Lotka's law: a testing procedure: Information Processing Management, 21: 305-320.

137. Gupta,D.K. 1989. Lotkas law and its application to author productivity distribution in psychological literature of Africa 1966-1975 Pt II- Herald of Library Science, 28: 318-326.

138. Bookstein,A 1977. Pattern of scientific productivity and social change a discussion of Lotka's law and bibliometric symmetry. Journal of American Society for Information Science, 28: 418-427.

139. Egghe,L. 1986. On the 80/20 rule. Scientometrics, 10: 55-68.

140. Sen,B.K. Karanjai,A and Munshi,U.M. 1989. A method of determining the impact factor of a non-SCI journal. Journal of Documentation, 45: 139-141.

141. Hirst,G. 1978. Disciplinary impact factors a methcd for determining core journals lists. Journal of American Society for Information Science, 29: 171-172.

142. He,C and Pao,M.L. 1986. Discipline Specific journal selection algorithm. Information Processing and Managemnet, 22: 405-416.

143. Abdulla,S.B. and Lancaster,F.W. 1991. The contribution of scientists to the popular literature, their role as expert witnesses and their influence on their peers : a case study in the field of acid rain. Scientometrics, 20: 55-64.

144. Vinkler,P. 1990. Bibliometric analysis of publication activity of a Scientific Research Institute. In: Egghe & Rousseau, Ed: Informetrics 89/90. p. 309-33.

145. Arora, Kamalesh and Sen,B.K. 1991. Use of impact factor as a valid measure for evaluating the performance of scientific papers. In: Ravichandra Rao, I.K. Ed: Informetrics-91 p. 36-50.

146. Tomer,C. 1986. A statistical assessment of two measures of citation - the impact factor and the immediacy index. Information Processing & Management, 22: 251-258.

147. Arunachalam,S and Manorama,K 1989. Are citation-based quantitative techniques adequate for measuring science on the periphery? Scientometrics, 15: 393-408.

148. Sen,B.K. and Kumar,S. 1990. Evaluation of recent scientific research output by bibliometric method. Paper presented at the International conference on Science Indicators for developing countries, Paris, Unesco.

149. Brookes,B.C. 1970. The growth, utility and obsolescence of scientific periodical literature. Journal of Documentation 26: 283-284.

150. Ravichandra Rao,I.K. and Meera,B.M. 1992. Growth and obsolescence of literature an empirical study. In: Ravichandra Rao, Ed: Infometrics - 91, p. 377-394.

151. Griffith,B.C., Servi.D.N., Anker,A.L., Drott,M.C. 1979. The aging of scientific literature, a citation analysis. Journal of Documentation, 35: 179-196.

152. Price,D.J.S. 1970. Citation measures of hard science, soft science, technology and non science. In: Nelson C & Pollock, D. Ed. Communication among scientists and engineers. Lexington MA. Heath P. 3-22.

153. Line,M.B. and Sandison,A. 1974 'Obsolescence' and changes in the use of literature with time. Journal of Documentation, 30: 283-350.

154. Line,M.B. 1987. Relation between productivity and 'Obsolescence'. Journal of American Society for Information Science, 38: 307-308.

155. Christavao,H.T. 1985. The aging of literature of biomedical sciences in developed and developing countries. Scientometrics, 7: 411-430.

156. Aversa,E.S. 1985. Citation patterns of highly cited papers and their relationship to literature aging: a study of the working literature, Scientometrics, 7: 383-389.

157. Carpenter,M.P. and Narin,F. 1973. Clustering of Scientific journals. Journal of American Society for Information Science, 24: 425-36.

158. Swanson,D.R. 1988. Historical note: Information retrieval and the future of an illusion. Journal of American Society for Information Science, 39: 92-98.

159. King,J. 1987. A review of bibliometric and other science indicators and their role in research evaluation. Journal of Information Science, 13: 261-276.

160. Brooks, T.A. 1987. The bibliometrics tool box version 2.5 Software and documentation available from North City Bibliometrics, Seattle.

CHAPTER - 4

DATA COLLECTION AND ORGANIZATION

4.1 Source for data Collection

The main source for data collection for this study is the journals in Fishery science. Journals in Fishery science are scattered throughout India in libraries attached to the fisheries research Institutes and Colleges. First a survey was conducted to unravel the strength of periodical collection in the different Institutes. It showed that the Central Marine Fisheries Research Institute, Kochi is the Institute where the largest collection of journals in fishery science is available. Hence the data required for this study was collected from the Central Marine Fisheries Research Institute Library.

4.1.1 Central Marine Fisheries Research Institute (C.M.F.R.I.)

The Central Marine Fisheries Research Institute was established in 1947 by the Government of India under Ministry of Food and Agriculture with headquarters at Madras which was shifted to Mandapam Camp in 1967 and later to Kochi in 1971. From 1967 onwards the administration of the Institute is by the Indian Council of Agricultural Research. Important areas of fisheries research in the institute include resource assessment, monitoring environmental parameters and management, physiology, nutrition, pathology, technology development in aquaculture and transfer of technology to the end users. To effectively conduct the research activities 12 research centres and 28 field centres were established in different parts along the coastline of India, Lakshadweep and Andamans.

4.1.2 The Collection

The library at CMFRI, Kochi has a very rich collection of literature needed for research in Fishery science. The Collection mainly consists of books, journals, reports and theses. There are about 30000 back volumes of journals. The collection includes 300 current periodicals out of which 120 are subscribed and 180 received as exchange/complimentary basis. The Institute also publishes the following titles for dissemination of information produced by researchers in the Institute and other organizations in the field.

1. Indian Journal of Fisheries
2. CMFRI Bulletin
3. CMFRI special publication
4. Marine Fisheries Information Services

4.1.3 Periodicals

Periodicals occupy an integral part of collection of the Institute Library. Compared to the other centres in the field, most of the important journals in Fishery science are available in the institute library. But journals in related fields are also not neglected. Library has a very good collection of journals in the field such as Ecology, genetics, environmental science etc. Due to the increasing cost of journals, the number of foreign titles subscribed has been cut down from 150 to 80 during the last few years.

4.2 Choosing the sample

Sample for this study is selected by first preparing a list of journals in Fishery science abstracted in the international abstracting journal, Aquatic science and Fisheries Abstract for 1992. The list consists of 102 journals. As this number was high and citation study cannot be concentrated on all of them, about 5 titles were choosen by sampling.

4.2.1 Sampling Technique

The method used is random sampling from the list of journals abstracted in Aquatic Science and Fisheries Abstract (ASFA). Availability of the journals in CMFRI is checked. By this way 25 titles regularly available at CMFRI were first selected. Number of abstracts from these 25 titles in ASFA during 1992 was counted and the titles were arranged in the decreasing order of occurrence. Thus a list as shown below is prepared.

Sl.No.	Title	No. of Occurrence in ASFA 1992
1.	Canadian Journal of Fisheries and Aquatic Science	615
2.	Aquaculture	552
3.	Marine Biology	418
4.	Journal of Fish Biology	234
5.	Environmental Biology of Fishes	178
6.	Fishery Bulletin	163
7.	Marine Ecology	159
8.	Indian Journal of Marine Science	159
9.	Transactions American Fisheries Society	155
10.	Journal of Experimental Marine Biology and Ecology	145
11.	Aquatic Botany	134
12.	Bulletin of Marine Science	133
13.	Limnology and Oceanography	131
14.	Journal of Marine Biological Association UK	111
15.	Copeia	86
16.	Fishery Technology	75
17.	Journal of Marine Research	69
18.	Journal of World Aquaculture Society	66
19.	Australian Journal of Marine & Freshwater Research	65
20.	Mahasagar	61
21.	Journal of Fish Disease	48
22.	Indian Journal of Fisheries	45
23.	Matsya	22

24. Journal of Marine Biological Association of India — 20

25. Aquaculture and Fisheries management — 20

Out of these, 5 journals having highest frequency of occurrence compared to the others were selected as sample for detailed study. The year to which sample belong is fixed as 1993. All these journals are having wide subject coverage with almost all areas in Fishery science and are international in scope. The journals are of different frequency, four are monthly and one is having 32 issues per year. Thus a total of 80 issues were selected for the study.

Some of the issues were combined together i.e. issue number 1 and 2 published as one. Total number of articles appeared in 80 issues were 915 with 28565 citations as given below.

Sl. No.	Titles	No. of issues	No. of Articles	No. of Citations
1.	Aquaculture	32	296	7487
2.	Canadian Journal of Fisheries and Aquatic Science	12	221	8747
3.	Environmental Biology of Fishes	12	105	3647
4.	Journal of Fish Biology	12	191	4727
5.	Marine Biology	12	102	3957
	TOTAL	80	915	28565

4.3. Computer Programmes used

For collecting the data and analysis computer programmes were employed. The data include the 915 articles and the journal citations to these articles. As manual sorting of these large data is cumbersome, computer was used. The major programmes used are:

a) CDS/ISIS

CDS/ISIS is a library package widely used all over the country for library purposes mainly for information storage and retrieval. This programme was designed by UNESCO and named computerised Documentation Service/Integrated set of Information System (CDS/ISIS) and was initially distributed free to various organizations. Since India is also a member of UNESCO, the package is made available under NISSAT programme. This package enables the user to create, manipulate and utilize databases for different purposes. Using this package, database of articles and journal citations were prepared. The data collected from these databases were analysed and sorted to prepare different tables.

b) Lotus 1-2-3

Lotus 1-2-3 is an Electronic spreadsheet Package with facilities for tabulation, sorting and preparation of suitable graphs. Tables showing distribution of citation, journals and aging are prepared using this package.

c) SPSS (Statistical Package for Social Sciences)

Statistical analysis of the data was done using this package which contains various statistical tools for analysis of the data such as multiple regression analysis, curve fitting etc.

4.4 Standard Format

The unit of study is the articles and the citations to these articles. Articles include original research papers, review articles, brief technical note and short communications which are all included in this study. For each article, the following data elements were entered in computer.

1. Name of author/s
2. Journal name (Abbreviated)
3. Volume and Page No.
4. Keyword (Subject of title)
5. Total Number of Citations.

A sample entry from the computer is given below. Total of 915 entries were prepared.

Author	:	Baird, T.A.
Journal	:	Env. Biol. Fish
Keyword	:	Fish Physiology
Total Cit	:	22

Data collection for studying citations to articles in the 5 journals formed the main part of the work. Using the computer programme, entries for journal citations were added in computer giving the following elements.

1. Name of Author/s
2. Journal Name (Abbreviated)
3. Year
4. Volume
5. Page No.

A sample entry used for citation study is as given below. Standard form of abbreviation is used for the journal name as abbreviations in citations sometimes were not uniform. Total of 17459 entries were prepared. Proceedings issued by permanent organizations like Indian Academy of Science were treated as journals for collecting the data. Journals with parts like A, B, C were considered as one title without giving parts.

<u>Sample Entry:</u>

Authors(s)	:	Hillman, T.W.; Griffith, J; Platts, W.S.
Journal	:	Trans. Am. Fish. Soc.
Year	:	1987
Vol	:	116
Page No.	:	185-95

Most of the articles and citations were in English Language. Articles in German and French having abstract and titles in English were also identified rarely. Cited journal title in language other than English also were entered in the data.

4.5 Organization of Data

Data of articles was sorted to get author index, keyword index and cumulated total of citations. From the author index, number of authors having one, two three etc articles counted and a table was prepared. This is used for studying author productivity by using Lotka's law and K-S statistical test. (Table 5.3) Keyword index is used for preparing table showing subjectwise scatter of articles in 5 journals (Table 5.3.1). Table giving number of source and cited articles prepared (Table 5.3.2) to study the ratio between them.

Total number of journal citation studied is 17459. The data so collected was sorted by name of journal, author and year which gave the number of occurrence of these elements in the data. This study gives more emphasis on quantity like number of authors, number of journals, subject, age of citation etc.

By sorting the journals cited, an alphabetical index of 849 journals was prepared which shows the number of times each journal is cited (Annexure - I). Using this index a list of most cited journals i.e. with more than 10 citations was compiled (Table 5.1.1). Number of journals with less than 10 citations are about 664 and these were not considered to prepare the list because of their less usage. An alphabetical list of journals with year of publication, country of publication and periodicity were compiled (Table 5.1.2) to study the year-wise, country-wise distribution and publication periodicity. The data elements were taken from Ulrich's International Periodical Directory' and 'World list of Scientific Serials'. Using this data, most cited journals by year of origin (Table 5.1.3) and table showing country-wise distribution of journals (Table 5.6) were prepared.

From the data collected, rank distribution of journals (Table 5.1.1.1), Cumulative distribution of citations (Table 5.1.1.2.) decade-wise scatter of journals (Table 5.1.3.1), subject-wise scatter of most cited journals (Table 5.1.4) and distribution of citation by subject of cited journals (Table 5.1.4.1) were compiled. Graphs were plotted from these data showing Bradford distribution (Fig. 5.1.1.3), frequency distribution of citations (Fig. 5.1.1.4). Rank distribution of data was tested using various models like Gompert'z model - $f(x)=k.a^{bx}$, Booksteins model $f(x)=\frac{k}{x^{\alpha}}$ and Bradford's model $f(x)=a+b\log x$. Cumulative data checked using Leimkuhler's model - $R(r)= a \log(1+br)$.

For studying the aging of journals, citation frequency of 32 most cited journals for 10 years was tabulated and projected by graph (Table 5.5 and Fig 5.5.2). To

Calculate median citation age or period during which half the citations become obsolete, the formula used :

$$\bar{x} = \frac{\Sigma x f(x)}{\Sigma f(x)} = \frac{\text{Cumulative citation}}{\text{Total citation}}$$

Articles published in the 5 sample journals for 10 years previous to this study were counted and tabulated (Table 5.3.2) to analyse the pattern of production in these journals. The trend of publication of articles could be assessed from this data.

To study self citation, table showing self citation in 5 sample journals and yearwise scatter of self citation were prepared. (Table 5.1.5 and 5.1.5.1) The rate of self-citation was calculated from this data. Total citation and proportion of journal citation in the 5 journals were compared to study percentage of journal citation (Table 5.4).

By using different methods, the data required for this study was collected and organized as described above. Through the analysis of the data a total of 18 tables and 4 graphs were prepared. This formed the basis for informetric analysis to test the objectives and hypotheses and formulate major findings and conclusions.

CHAPTER 5

ANALYSIS OF DATA

5.1. Distribution Pattern of journals

5.1.1 Rank list of cited journals

Alphabetical list of cited journals is prepared by sorting data collected from citations of 5 journals taken as sample for the study. This list consists of 849 journals with their abbreviated name, and it also gives the number of times each journal is cited (Annexure - I). From this list, most cited journals (with more than 10 citations) are searched and ranked by the decreasing order of citations. Thus a list of 185 journals ranked according to the number of citations is prepared. The most cited 185 titles have 86 ranks based on the number of times they are cited.

This list of 185 journals form the core periodicals in fishery science consulted by research workers all over the world. These journals form about 22% of the total cited journals and are cited 15778 times which is about 90% of the total of 17459 citations. This list is helpful in acquisition of journal which enables better utilization of available funds, in determining policy for planning information services in special libraries, enables research workers

Table 5.1.1 RANK LIST OF MOST CITED JOURNALS

SL.NO. 1	NAME OF JOURNAL 2	NO. OF TIMES CITED 3	RANK 4
1.	Canadian Journal of Fisheries and Aquatic Sciences (Fmly: Journal of Fisheries Research Board of Canada)	2119	1
2.	Aquaculture	1516	2
3.	Journal of Fish Biology	918	3
4.	Transactions of the American Fisheries Society.	588	4
5.	Marine Biology.	549	5
6.	Comparative Biochemistry and Physiology	367	6
7.	Fishery Bulletin	358	7
8.	Nippon Suisan Gakkaishi (Fmly: Bulletin of Japanese Society of Scientific Fisheries)	343	8
9.	Canadian Journal of Zoology	332	9
10.	Marine Ecology	330	10
11.	Ecology	318	11
12.	Environmental Biology of Fishes	308	12
13.	Journal of Experimental Marine Biology and Ecology	281	13
14.	General and Comparative Endocrinology.	234	14
15.	Copeia	225	15
16.	Journal of Experimental Biology	198	16

1	2	3	4
17.	Limnology and Oceanography	170	17
18.	Journal of Marine Biological Association, U.K.	165	18
19.	Science	163	19
20.	Journal of Experimental Zoology	159	20
21.	Nature	154	21
22.	ICES Journal of Marine Science (Fmly: Journal du Conseil).	152	22
23.	American Naturalist	143	23
24.	Journal of Fish Disease	142	24
25.	Australian Journal of Marine and Freshwater Research.	138	25
26.	Progressive Fish Culturist	135	26
27.	Hydrobiologia	129	27
28.	Biological Bulletin	117	28
29.	Journal of World Aquaculture Society (Fmly: 1. Proceedings World Mariculture Society 2. Journal of world Mariculture Society).	116	29
30.	Journal of Animal Ecology	113	30
31.	Oecologia	104	31
32.	Bulletin of Marine Science	104	31
33.	Journal of Comparative Physiology	95	32
34.	American Zoologist.	92	33
35.	Evolution	92	33

1	2	3	4
36.	Animal Behaviour	84	34
37.	Journal of Nutrition	83	35
38.	Journal of Biological Chemistry.	81	36
39.	Proceedings National Academy of Science, USA.	79	37
40.	Journal of Zoology.	78	38
41.	Ecological Monographs.	77	39
42.	Fish Physiology and Biochemistry	77	39
43.	Freshwater Biology.	69	40
44.	Genetics	68	41
45.	Oikos	63	42
46.	North American Journal of Fisheries Management.	60	43
47.	Cell Tissue Research	59	44
48.	American Journal of Physiology	57	45
49.	Diseases of Aquatic Organisms	56	46
50.	Journal of Crustacean Biology	55	47
51.	Estuaries (Fmly: Chesapeake Science)	54	48
52.	Verhandlungen der Internationalen Vereinigung Fur Theoretische und angewandte Limnologie.	54	48
53.	Water, Air and Soil Pollution	53	49
54.	Aquaculture and Fisheries Management	51	50

1	2	3	4
55.	Netherlands Journal of Sea Research	50	51
56.	New Zealand Journal of Marine and Freshwater Research	50	51
57.	Biometrics	49	52
58.	Aquatic Toxicology	49	52
59.	California Fish and Game	48	53
60.	Journal of Morphology	48	53
61.	Water Research	48	53
62.	Journal of Plankton Research	46	54
63.	Journal of Shellfish Research	45	55
64.	Lipids	44	56
65.	Crustaceana	42	57
66.	Fisheries Research	42	57
67.	Physiological Zoology	42	57
68.	Japanese Journal of Ichthyology	42	57
69.	Analytical Biochemistry	40	58
70.	Archiv Fur Hydrobiologie	40	58
71.	Journal of North West Atlantic Fishery Science	38	59
72.	Estuarine and coastal Shelf Science (Fmly: Estuarine and Coastal Marine Science)	37	60
73.	Journal of Great Lakes Research	37	60
74.	Fish Pathology	37	60
75.	Biochemical Journal	37	60

1	2	3	4
76.	Journal of Animal Science	36	61
77.	Environmental Science and Technology	36	61
78.	Environmental Toxicology Chemistry	36	61
79.	Deep Sea Research	35	62
80.	Journal of Cell Biology	34	63
81.	Journal of Endocrinology	34	63
82.	Proceedings Royal Society of London.	34	63
83.	American Midland Naturalist	33	64
84.	Bulletin Environmental Contamination Toxicology	33	64
85.	Theoretical and Applied Genetics	32	65
86.	Journal of Wildlife Management	31	66
87.	Israel Journal of Aquaculture (Fmly: Bamidgeh)	29	67
88.	Developmental Biology	29	67
89.	Heredity	29	67
90.	Behaviour	28	68
91.	South African Journal of Marine Science	28	68
92.	Journal of Ichthyology	27	67
93.	Journal of Marine Research	27	69
94.	Journal of Heredity	27	69
95.	Behaviour Ecology and Sociobiology	27	69

1	2	3	4
96.	Reproduction, Nutrition, Development (Fmly: Annales de Biologie Animale, Biochimie, Biophysique)	27	69
97.	Ophelia	26	70
98.	Journal of Theoretical Biology	25	71
99.	Journal of Aquatic Animal Health	25	71
100.	Developmental and Comparative Immunology.	25	71
101.	Envrionmental Pollution	25	71
102.	Ambio	25	71
103.	Biochemica et Biophysica Acta	25	71
104.	Marine Fisheries Review	25	71
105.	Philosophical Transactions Royal Society of London	25	71
106.	Applied Environmental Microbiology.	24	72
107.	Biological Review	24	72
108.	Biometrika	24	72
109.	Pacific Science	24	72
110.	Aquacultural Engineering	23	73
111.	Bio Sciences	23	73
112.	Netherlands Journal of Zoology	23	73
113.	Biological Journal of Linnean Society (Fmly: Proceedings Linnean Society of London).	22	74
114.	Journal of Parasitology.	22	74

1	2	3	4
115.	Fisheries	21	75
116.	Journal of Applied Ichthyology.	21	75
117.	Journal of Geophysical Research	21	75
118.	Journal of Phycology	21	75
119.	Polar Biology	21	75
120.	Marine Environmental Research	21	75
121.	Archives of Environmental Contamination Toxicology.	20	76
122.	Canadian Journal of Biochemistry and Physiology A and B	20	76
123.	Endocrinology	20	76
124.	Experientia	20	76
125.	Journal of Molecular Evolution	20	76
126.	Oecologia (B)	20	76
127.	Malacologia	20	76
128.	Cybium	19	77
129.	Coral Reefs	18	78
130.	British Journal of Nutrition	18	78
131.	Journal of Acoustic Society of America	18	78
132.	Investigation Pesquera	18	78
133.	Systematic Zoology	18	78
134.	Analytical Chemistry	18	78
135.	Poultry Science	17	79

1	2	3	4
136.	Journal of Lipid Research	17	79
137.	Acta Hydrobiologia Sinica	17	79
138.	Marine Pollution Bulletin	17	79
139.	Helgolander Meeresuntersuchungen	17	79
140.	Sarsia	16	80
141.	Proceedings Zoological Society of London	16	80
142.	Zoological Journal of Linnean Society	16	80
143.	American Journal of Anatomy	16	80
144.	Journal of Ultrastructure Research	16	80
145.	Journal of Chromatography	16	80
146.	Aquatic Living Resources	15	81
147.	Zoologica	15	81
148.	Veterinary Immunology and Immunopathology	15	81
149.	Journal of Physiology	15	81
150.	Journal of American Statistical Association	14	82
151.	Biochemical Genetics	14	82
152.	Journal of Natural History	14	82
153.	World Aquaculture	14	82
154.	American Scientist	13	83
155.	Molecular Biology and Evolution	13	83

1	2	3	4
156.	Journal of Agricultural and Food Chemistry	13	83
157.	Parasitology	13	83
158.	Journal of Association of Official Analytical Chemists	13	83
159.	Microbial Ecology	13	83
160.	Journal of Muscle Research Cell Motility	12	84
161.	Holarctic Ecology	12	84
162.	Progress in Lipid Research	12	84
163.	Vision Research	12	84
164.	Australian Fisheries	12	84
165.	Canadian Field Naturalist	12	84
166.	Cancer Research	12	84
167.	Journal of Ecology	12	84
168.	Progress in Oceanography	11	85
169.	Finnish Fisheries Research	11	85
170.	Archives of Biochemistry and Biophysics.	11	85
171.	Journal of Science of Food and Agriculture.	11	85
172.	Biological Conservation	11	85
173.	Journal of Invertebrate Pathology	11	85
174.	Physiological Review	11	85
175.	Xenobiotica	11	85
176.	New York Fish and Game Journal	11	85

1	2	3	4
177.	Nature Canada	11	85
178.	Journal of Comparative Neurology	11	85
179.	Aquatic Botany	10	86
180.	Canadian Journal of Genetics & Cytology	10	86
181.	Genetica	10	86
182.	Journal of Histochemistry and cytochemistry	10	86
183.	Theoretical population Biology	10	86
184.	Quarterly Review of Biology	10	86
185.	Journal of Molecular Biology.	10	86
	TOTAL	15778	86

to know journals which are important in this field so that they can select journals for reference and publication of research results.

5.1.1.1 <u>Rank distribution of cited journals</u>

This table gives the number of cited journals arranged by decreasing number of citations. Number of journals cited less than 10 times is also counted to prepare this table. Data given are number of journals (X), cumulative number of journals (cum x), number of

Table 5.1.1.1.RANK DISTRIBUTION OF CITED JOURNALS

No.of Jnls x	Cum. Jnls (x)	No.of Cit (y)	Cum. Cit F(x)	log(x)	log(y)	Exp F(x)
1	1	2119	2119	0	7.658699	1812
1	2	1516	3635	0.693147	8.198364	3663
1	3	918	4553	1.098612	8.423541	4746
1	4	588	5141	1.386294	8.545002	5514
1	5	549	5690	1.609437	8.646465	6110
1	6	367	6057	1.791759	8.708969	6597
1	7	358	6419	1.945910	8.767017	7009
1	8	343	6758	2.079441	8.818482	7365
1	9	332	7090	2.197224	8.866440	7680
1	10	330	7420	2.302585	8.911934	7961
1	11	318	7738	2.397895	8.953898	8216
1	12	308	8046	2.484906	8.992930	8448
1	13	281	8327	2.564949	9.027258	8662
1	14	234	8561	2.639057	9.054972	8860
1	15	225	8786	2.708050	9.080914	9044
1	16	198	8984	2.772588	9.103200	9216
1	17	170	9155	2.833213	9.122055	9378
1	18	165	9319	2.890371	9.139810	9531
1	19	163	9482	2.944438	9.157150	9675
1	20	159	9641	2.995732	9.173780	9812
1	21	154	9795	3.044522	9.189627	9943
1	22	152	9947	3.091042	9.205026	10067
1	23	143	10090	3.135494	9.219300	10186
1	24	142	10232	3.178053	9.233275	10299
1	25	138	10370	3.218875	9.246672	10408
1	26	135	10505	3.258096	9.259606	10513
1	27	129	10634	3.295836	9.271811	10614
1	28	117	10751	3.332204	9.282754	10711
1	29	116	10867	3.367295	9.293485	10805
1	30	113	10980	3.401197	9.303830	10895
2	32	208	11188	3.465735	9.322597	11068
1	33	95	11283	3.496507	9.331052	11150
2	35	184	11467	3.555348	9.347228	11307
1	36	84	11551	3.583518	9.354527	11382
1	37	83	11634	3.610917	9.361687	11455
1	38	81	11715	3.637586	9.368625	11527
1	39	79	11794	3.663561	9.375346	11596
1	40	78	11872	3.688879	9.381937	11664
2	42	154	12026	3.737669	9.394826	11794
1	43	69	12095	3.761200	9.400547	11857
1	44	68	12163	3.784189	9.406153	11918
1	45	63	12226	3.806662	9.411320	11978
1	46	60	12286	3.828641	9.416215	12037
1	47	59	12345	3.850147	9.421006	12094

Table 5.1.1.1. Contd...

x	(x)	(y)	F(x)	log(x)	log(y)	F(x)
1	48	57	12402	3.871201	9.425613	12150
1	49	56	12458	3.891820	9.430118	12205
1	50	55	12513	3.912023	9.434523	12259
2	52	108	12621	3.951243	9.443117	12364
1	53	53	12674	3.970291	9.447307	12415
1	54	51	12725	3.988984	9.451323	12465
2	56	100	12825	4.025351	9.459151	12562
2	58	98	12923	4.060443	9.466763	12656
3	61	144	13067	4.110873	9.477845	12790
1	62	46	13113	4.127134	9.481359	12834
1	63	45	13158	4.143134	9.484785	12877
1	64	44	13202	4.158883	9.488123	12919
4	68	168	13370	4.219507	9.500768	13081
2	70	80	13450	4.248495	9.506734	13158
1	71	38	13488	4.262679	9.509555	13196
4	75	148	13636	4.317488	9.520468	13342
3	78	108	13744	4.356708	9.528357	13447
1	79	35	13779	4.369447	9.530900	13481
3	82	102	13881	4.406719	9.538276	13581
2	84	66	13947	4.430816	9.543019	13645
1	85	32	13979	4.442651	9.545311	13677
1	86	31	14010	4.454347	9.547526	13708
3	89	87	14097	4.488636	9.553717	13799
2	91	58	14153	4.510859	9.557681	13859
5	96	135	14288	4.564348	9.567175	14002
1	97	26	14314	4.574710	9.568993	14029
8	105	200	14514	4.653960	9.582868	14241
4	109	96	14610	4.691347	9.589461	14341
3	112	69	14679	4.718498	9.594173	14413
2	114	44	14723	4.736198	9.597166	14460
6	120	126	14849	4.787491	9.605687	14597
7	127	140	14989	4.844187	9.615071	14749
1	128	19	14998	4.852030	9.615672	14770
6	134	108	15116	4.897839	9.623509	14892
5	139	85	15201	4.934473	9.629116	14990
6	145	96	15297	4.976733	9.635412	15103
4	149	60	15357	5.003946	9.639326	15175
4	153	14	15413	5.030437	9.642966	15246
6	159	78	15491	5.068904	9.648014	15349
8	167	96	15587	5.117993	9.654192	15480
11	178	121	15708	5.181783	9.661925	15650
7	185	70	15778	5.220355	9.666371	15753
21	206	189	15967	5.327876	9.678279	16041
17	223	136	16103	5.407171	9.686760	16252
23	246	161	16264	5.505331	9.696709	16514
23	269	138	16402	5.594711	9.705158	16753
36	305	180	16582	5.720311	9.716073	17089
39	344	156	16738	5.840641	9.725436	17410
61	405	183	16921	6.003887	9.736310	17846
94	499	188	17109	6.212606	9.747359	18403
350	849	350	17459	6.744059	9.767610	19823

citations (y) cumulative citations (F(x)), log of cumulative journals (log x), log of cumulative citations (log y).

'Canadian Journal of Fisheries and Aquatic Sciences' is ranked first with 2119 citations which is about 12% of total citations received by core journals. Wide variation in number of citations received by top ranking journals is found. Difference in citation received by the first and the second rank is 603, the second and the third rank is 598 and the third and the fourth rank is 330. After this, the difference becomes less and after the 30th rank more than one journal has the same number of citations. Journals receiving more than 100 citations are 32 in number which have a total of 11,188 citations and which are 71% of the citations received by core journals. This indicates that articles relevant to fishery science are concentrated in a few journals while increasing number of less related journals are in circulation.

The data is tested by applying Bradford's theory of distribution according to which "if scientific journals are arranged in order of decreasing productivity of articles in a subject, they may be divided into a nucleus of periodicals more devoted to the subject and several groups or zones containing the same number of articles as the nucleus when the zones will be $1:n:n^2$ . . . ." It is seen that 5820 ($\frac{1}{3}$) citations are contained in 5.5 journals, 11640 citations in 37 journals and 17459 citations in 849 journals while the actual distribution may be as given below.

No. of citations (each 1/3)	Cum No.of citations	No. of journals (observed)	Cum.No. of journals	Ratio (observed)	Ratio (expected)
5820	5820	5.5	5.5	1	1
5820	11640	31.5	37	5.73	5.73
5819	17459	812	849	148	32.83

It is seen that n2 is to be 32.83 whereas here it comes to 148. This remarkable variation may be because the subject fishery science is an emerging area where transdisciplinary research is active so that articles will be scattered in journals peripheral to the subject like biology, biochemistry, oceanography, genetics, science etc. It can be concluded that articles of interest to specialist occurs not only in the periodicals specialising in the subject but also in other periodicals, which grow in number as the relation of their fields to that subject lessens and the number of articles on the subject in each periodical decreases.

5.1.1.2 <u>Cumulative distribution of journal citations</u>

This table shows cumulative distribution of journals in the increasing order of number of citations.

Table.5.1.1.2. CUMULATIVE DISTRIBUTION OF JOURNAL CITATIONS

S.No	Cit.(x)	Jnls(y)	Tot.Cit x.y	Cum.cit ≤ xy	Cum.Jnls. ≤ y
1	1	350	350	350	350
2	2	94	188	538	444
3	3	61	183	721	505
4	4	39	156	877	544
5	5	36	180	1057	580
6	6	23	138	1195	603
7	7	23	161	1356	626
8	8	17	136	1492	643
9	9	21	189	1681	664
10	10	7	70	1751	671
11	11	11	121	1872	682
12	12	8	96	1968	690
13	13	6	78	2046	696
14	14	4	56	2102	700
15	15	4	60	2162	704
16	16	6	96	2258	710
17	17	5	85	2343	715
18	18	6	108	2451	721
19	19	1	19	2470	722
20	20	7	140	2610	729
21	21	6	126	2736	735
22	22	2	44	2780	737
23	23	3	69	2849	740
24	24	4	96	2945	744
25	25	8	200	3145	752
26	26	1	26	3171	753
27	27	5	135	3306	758
28	28	2	56	3362	760
29	29	3	87	3449	763
30	31	1	31	3480	764
31	32	1	32	3512	765
32	33	2	66	3578	767
33	34	4	102	3680	770
34	35	1	35	3715	771
35	36	3	108	3823	774
36	37	4	148	3971	778
37	38	1	38	4009	779
38	40	2	80	4089	781
39	42	4	168	4257	785
40	44	1	44	4301	786
41	45	1	45	4346	787
42	46	1	46	4392	788
43	48	3	144	4536	790
44	49	2	98	4634	793
45	50	2	100	4734	795
46	51	1	51	4785	796
47	53	1	53	4838	797

Table 5.1.1.2. Contd..

S.No	(x)	(y)	x.y	≤xy	≤y
48	54	2	108	4946	799
49	55	1	55	5001	800
50	56	1	56	5057	801
51	57	1	57	5114	802
52	59	1	59	5173	803
53	60	1	60	5233	804
54	63	1	63	5296	805
55	68	1	68	5364	806
56	69	1	69	5433	807
57	77	2	154	5587	809
58	78	1	78	5665	810
59	79	1	79	5744	811
60	81	1	81	5825	812
61	83	1	83	5908	813
62	84	1	84	5992	814
63	92	2	184	6167	816
64	95	1	95	6271	817
65	104	2	208	6479	819
66	113	1	113	6592	820
67	116	1	116	6708	821
68	117	1	117	6825	822
69	129	1	129	6954	823
70	135	1	135	7089	824
71	138	1	138	7227	825
72	142	1	142	7369	826
73	143	1	143	7512	827
74	152	1	152	7664	828
75	154	1	154	7818	829
76	159	1	159	7977	830
77	163	1	163	8140	831
78	165	1	165	8305	832
79	170	1	170	8475	833
80	198	1	198	8673	834
81	225	1	225	8898	835
82	234	1	234	9132	836
83	281	1	281	9413	837
84	308	1	308	9721	838
85	318	1	318	10039	839
86	330	1	330	10369	840
87	332	1	332	10701	841
88	343	1	343	11044	842
89	358	1	358	11402	843
90	367	1	367	11769	844
91	549	1	549	12318	845
92	588	1	588	12906	846
93	918	1	918	13824	847
94	1516	1	1516	15340	848
95	2119	1	2119	17459	849

Number of citations (x), number of journals (y), total citations (x,y), cumulative citations (Σxy), cumulative journals (Σy) are given.

Journals with one citation is 350 (41% of total) which indicates scattering of articles related to the subject in different journals. The percentage of cumulative journals and citations shows that it does not follow the 80/20 rule. According to which 20% of journals must contain 80% of citations. But it is observed that 20% (178 Nos) of journals form 90% (15708) of citations or 80% (671 Nos) of journals contain only 10% (1751) of citations. This shows relevant articles in the subject are regularly published in a few journals which are cited frequently by research workers. The reason for this concentration may be due to the high value for the few journals among research personnel who constantly publish their results in these titles.

5.1.2 Alphabetical list of most cited journals

Most cited 185 journals are listed alphabetically providing details such as country of origin, number of citations, year of origin and periodicity.

This forms a general list of core journals in fishery science. Periodicity of the journals shows that monthly (57), bimonthly (34) and quarterly (62) are more in number, compared to journals of other periodicity.

Table 5.1.2 ALPHABETICAL LIST OF MOST CITED JOURNALS

Sl. No. 1	Title 2	Country of publn. 3	No. of Times Cited 4	Yr. of origin 5	Periodicity 6
01.	Acta Hydrobiologica Sinica	CH	17	1975	I
02.	Ambio	US	25	1972	BI-M
03.	American Journal of Anatomy	US	16	1901	M
04.	Amercian Journal of Physiology	US	57	1898	M
05.	Amercian Midland Naturalist	US	33	1909	Q
06.	American Naturalist	US	143	1867	M
07.	American Scientist	US	13	1913	BI-M
08.	American Zoologist	US	92	1961	Q
09.	Analytical Biochemistry	US	40	1960	13/yr.
10.	Analytical Chemistry	US	18	1929	M
11.	Animal Behaviour	UK	84	1953	Q
12.	Applied and Environmental Microbiology	US	24	1953	M
13.	Aquacultural Engineering	NE	23	1982	Q
14.	Aquaculture	NE	1516	1971	32/yr
15.	Aquaculture and Fisheries Management	UK	51	1970	M
16.	Aquatic Botany	NE	10	1975	8/yr
17.	Aquatic Living Resources	FR	15	1988	Q
18.	Aquatic Toxicology	NE	49	1981	M
19.	Archives of Biochemistry and Biophysics	US	11	1965	BI-M

1	2	3	4	5	6
20.	Archives of Environmental contamination Toxicology.	US	20	1972	BI-M
21.	Archiv fur Hydrobiologie	GER	40	1906	Q
22.	Australian Fisheries	AUS	12	1942	M
23.	Australian Journal of Marine and Fresh water Research.	AUS	138	1950	BI-M
24.	Behaviour	NE	28	1947	I
25.	Behavioural Ecology and Sociobiology	US	27	1961	2V/yr.
26.	Biochemical Genetics	US	14	1967	M
27.	Biochemical Journal	UK	37	1911	BI-M
28.	Biochimica et Biophysica Acta	NE	25	1947	M
29.	Biological Bulletin	US	117	1898	BI-M
30.	Biological Conservation	UK	11	1969	8/yr.
31.	Biological journal of Linnean Society.	US	22	1969	M
32.	Biological Review	CHK	24	1912	Q
33.	Biomerics	US	49	1945	Q
34.	Biometrika	UK	24	1901	3/yr.
35.	Biosciences	US	23	1951	M
36.	British Journal of Nutrition	UK	18	1947	3V/yr.
37.	Bulletin of Enviornmental Contamination and Toxicology.	US	33	1966	M
38.	Bulletin of Marine Science	US	104	1951	Q

1	2	3	4	5	6
39.	California Fish and Game	US	48	1914	Q
40.	Canadian Field Naturalist	CAN	12	1879	Q
41.	Canadian Journal of Biochemistry and Physiology.	CAN	20	1944	M
42.	Canadian Journal of Fisheries and Aquatic Science.	CAN	2119	1901	M
43.	Canadian Journal of Genetics and Cytology.	CAN	10	1959	Q
44.	Canadian Journal of Zoology	CAN	332	1921	Q
45.	Cancer Research	US	12	1941	M
46.	Cell and Tissue Research	US	59	1925	M
47.	Comparative Biochemistry and Physiology.	US	367	1961	M
48.	Copeia	US	225	1913	Q
49.	Coral Reefs	US	18	1982	Q
50.	Crustaceana	NE	42	1960	BI-M
51.	Cybium	FR	18	1977	Q
52.	Deep Sea Research	US	35	1953	M
53.	Developmental and Comparative Immunology.	US	25	1977	Q
54.	Development Biology	US	29	1959	M
55.	Diseases of Aquatic Organisams.	GER	56	1979	3/yr.
56.	Ecology	US	318	1920	BI-M
57.	Ecological Monographs	US	77	1931	Q
58.	Endocrinology	US	20	1917	M

1	2	3	4	5	6
59.	Environmental Biology of Fishes	NE	308	1976	M
60.	Environmental Pollution	UK	25	1970	M
61.	Environmental Science and Technology.	US	36	1967	M
62.	Environmental Toxicology and Chemistry	US	36	1982	M
63.	Estuaries	US	54	1978	Q
64.	Estaurine and Coastal Shelf Science	US	37	1973	M
65.	Evolution	US	92	1947	Q
66.	Experientia	SWT	20	1945	M
67.	Finnish Fisheries Research	FIN	11	1972	I
68.	Fisheries, Bulletin American Fisheries Society	US	21	1976	BI-M
69.	Fisheries Research	NE	42	1980	Q
70.	Fishery Bulletin	US	358	1981	Q
71.	Fish Pathology	JAP	37	1966	Q
72.	Fish Physiology and Biochemistry	NE	77	1986	8/yr.
73.	Fresh water Biology	UK	69	1971	BI-M
74.	Genetica	NE	10	1956	Q
75.	Genetics	US	68	1916	M
76.	General and Comparative Endocrinology.	US	234	1961	M
77.	Helgolander Meeresuntersuchungen	GER	17	1937	Q
78.	Heredity	UK	29	1947	BI-M

1	2	3	4	5	6
79.	Holarctic Ecology	DK	12	1978	Q
80.	Hydrobiologia	NE	129	1948	M
81.	ICES Journal of Marine Science	DK	152	1926	I
82.	Investigation pesquera	SP	18	1955	I
83.	Israel Journal of Aquaculture	IS	29	1949	Q
84.	Japanese Journal of Icthyology	JAP	42	1950	Q
85.	Journal of Acoustic Society of America.	US	18	1929	M
86.	Journal of Agricultural and Food Chemistry.	US	13	1953	BI-M
87.	Journal of American Statistical Association.	US	14	1888	Q
88.	Journal of Animal Ecology	UK	113	1932	3/yr.
89.	Journal of Animal Science	US	36	1942	M
90.	Journal of Applied Ichthyology	GER	21	1984	Q
91.	Journal of Aquatic Animal Health.	US	25	1989	BI-M
92.	Journal of Association of Official Analytical Chemists.	US	13	1915	BI-M
93.	Journal of Biological Chemistry	US	81	1905	BI-M
94.	Journal of Cell Biology	US	34	1955	M
95.	Journal of Chromatography	NE	16	1956	56/yr.
96.	Journal of Comparative Neurology.	US	11	1891	BI-M

1	2	3	4	5	6
97.	Journal of Comparative Physiology A & B.	US	95	1924	6v/yr.
98.	Journal of Crustacean Biology	US	55	1981	Q
99.	Journal of Ecology	UK	12	1913	Q
100.	Journal of Endocrinology	UK	34	1939	M
101.	Journal of Experimental Biology	UK	198	1923	M
102.	Journal of Epxeriemental Marine Biology and Ecology.	NE	281	1961	M
103.	Journal of Experiemental zoology.	US	159	1904	M
104.	Journal of Fish Biology	US	918	1969	M
105.	Journal of Fish Disease	UK	142	1978	BI-M
106.	Journal of Geophysical Research	US	21	1896	M
107.	Journal of Great Lakes Research	US	37	1975	Q
108.	Journal of Heredity	US	27	1910	BI-M
109.	Journal of Histochemistry and Cytochemistry.	CAN	10	1959	Q
110.	Journal of Ichthyology	US	27	1970	BI-M
111.	Journal of Invertebrate Pathology	US	11	1959	BI-M
112.	Journal of Lipid Research	US	17	1959	BI-M
113.	Journal of Marine Biological Association, UK	UK	165	1887	Q
114.	Journal of Marine Research	US	27	1937	Q

1	2	3	4	5	6
115.	Journal of Molecular Biology	UK	10	1959	36/yr.
116.	Journal of Molecular Evolution	US	20	1971	BI-M
117.	Journal of Morphology	US	48	1939	M
118.	Journal of Muscle Research and Cell Motility.	UK	12	1980	Q
119.	Journal of Natural History	UK	14	1979	BI-M
120.	Journal of Northwest Atlantic Fishery Science.	CAN	38	1964	S.A
121.	Journal of Nutrition	US	83	1928	M
122.	Journal of Parasitology	US	22	1914	BI-M
123.	Journal of Phycology	US	22	1914	BI-M
124.	Journal of Physiology	UK	15	1878	M
125.	Journal of Plankton Research	UK	46	1979	BI-M
126.	Journal of Science of Food and Agriculture	UK	11	1950	M
127.	Journal of Shellfish Research	US	45	1982	S.A
128.	Journal of Theoretical Biology	UK	25	1961	FN
129.	Journal of Ultrastructure Research	US	16	1957	M
130.	Journal of Wildlife Management	US	31	1937	Q
131.	Journal of world Aquaculture Society	US	116	1970	Q
132.	Journal of Zoology	UK	78	1830	M
133.	Limnology and Oceanography	US	170	1956	8/yr.

1	2	3	4	5	6
134.	Lipids	US	44	1966	M
135.	Malacologia	US	19	1962	S.A
136.	Marine Biology	US	549	1967	M
137.	Marine Ecology	GER	330	1978	M
138.	Marine Environmental Research	UK	21	1978	Q
139.	Marine Fisheries Review	US	25	1939	Q
140.	Marine Pollution Bulletin	US	17	1970	M
141.	Microbial Ecology	US	13	1974	Q
142.	Molecular Biology and Evolution	US	13	1983	BI-M
143.	Nature	UK	154	1809	W
144.	Nature Canada	CAN	11	1972	Q
145.	Netherlands Journal of Sea Research	NE	50	1961	Q
146.	Netherlands Journal of Zoology	NE	23	1947	Q
147.	Newzealand Journal of Marine and Fresh water Research	NZ	50	1967	Q
148.	New York Fish and Game Journal	US	11	1954	S.A
149.	Nippon Suisan Gakkaishi	JAP	343	1932	M
150.	North American Journal of Fisheries Management.	US	60	1981	Q
151.	Oecologia	US	104	1924	Q
152.	Oecologia (B)	GER	20	1968	M
153.	Oikos	DK	63	1948	BI-M

1	2	3	4	5	6
154.	Ophelia	DK	26	1964	S.A
155.	Pacific Science	US	24	1947	Q
156.	Parasitology	UK	13	1908	Q
157.	Philisophical Transactions Royal society of London.	UK	25	1665	I
158.	Physiological Review	US	11	1921	Q
159.	Physiological Zoology	US	42	1928	Q
160.	Polar Biology	US	21	1982	BI-M
161.	Poultry Science	UK	17	1908	BI-M
162.	Proceedings National Academy of Science	US	79	1950	M
163.	Proceedings Royal Society of London	UK	34	1832	I
164.	Proceedings Zoological society of London.	UK	16	1830	M
165.	Progress in Lipids Research	US	12	1952	Q
166.	Progress in Oceanography	US	11	1963	Q
167.	Progressive Fish Culturist	US	135	1938	Q
168.	Quarterly Review of Biology	US	10	1926	Q
169.	Reproduction, Nutrition, Development	FR	27	1961	BI-M
170.	Sarsia	GER	17	1961	I
171.	Science	US	163	1880	W
172.	South African Journal of Marine Science	S.AFR	28	1982	Q
173.	Systematic Zoology	US	18	1952	Q

1	2	3	4	5	6
174.	Theoretical and Applied Genetics	US	32	1929	BI-M
175.	Theoretical Population Biology	US	10	1970	BI-M
176.	Transactions American Fisheries Society.	US	588	1870	BI-M
177.	Verhandlungen der internationalen Vereinigung fur Theoretische and Angwandte Limnologie	FR	54	1922	I
178.	Veterinary Immunology and Immunopathology.	NE	15	1979	Q
179.	Vision Research	US	12	1961	M
180.	Water, Air and Soil Pollution	NE	53	1971	Q
181.	Water Research	US	48	1967	M
182.	World Aquaculture	US	14	1968	Q
183.	Xenobiotica	UK	11	1971	M
184.	Zoologica	GER	15	1888	S.A
185.	Zoological Journal of Linnean Society.	UK	16	1855	M

Key to Abbreviations:

W - Weekly, I - Irregular, M - Monthly, BIM - Bimonthly, Q - Quarterly, SA - Semi Annual, FN - Fortnightly, NZ - Newzealand, JAP - Japan, IS - Israel, DK - Denmark, SP - Spain, CAN - Canada, US - United States, UK - United Kingdom, NE - Netherlands, GER - Germany, CH - China, SWT - Switzerland, FR - French, AUS - Australia, CHK - Chekoslovakia, S.AFR - South Africa.

It is seen that periodicity of the journal has no influence on the number of citations. The journal with 32 issues per year is ranked second while first rank and third rank journals are monthly, fourth rank is bimonthly, fifth rank monthly and so on.

5.1.3 Ranking of most cited journals by year of origin

Most cited 185 journals are ranked by the increasing order of year of first publication. Number of journals originated in each decade is counted and the table showing decadewise distribution is prepared. Percentage of journals originated in each decade is calculated.

The oldest journal cited is the "Philosophical Transactions of the Royal Society of London" which started publishing from 1665. This is one of the first scientific journals which is being consulted by research workers worldwide. From 1800 to 1899 a total of 18 titles originated. Increase in titles is seen every decade from 1900 onwards and the maximum number is in 1961-70 with 35 titles. The reason for more number of journals during this period is that journals exclusively devoted to newly developed subjects like environmental science and aquaculture originated during this period. About 90% of the core periodicals publishing articles in Fishery science started in 20th century and this shows the rapid development of the subject during this period.

Table 5.1.3 RANKING OF MOST CITED JOURNALS BY YEAR OF ORIGIN

Sl. No.	Year	Title	Rank in Tables 5.1.1.
1	2	3	4
1.	1665	Philosophical Transactions Royal Society of London.	71
2.	1830	Proceedings Zoological Society of London	80
3.	1830	Journal of Zoology	38
4.	1832	Proceedings Royal Society of London	63
5.	1855	Zoological Journal of Linnean Society	80
6.	1867	American Naturalist	23
7.	1869	Nature	21
8.	1870	Transactions American Fisheries Society	4
9.	1878	Journal of Physiology	81
10.	1879	Canadian Field Naturalist	84
11.	1880	Science	19
12.	1881	Fishery Bulletin	7
13.	1887	Journal of Marine Biological Association UK	18
14.	1888	Journal of American Statistical Association	82
15.	1888	Zoologica	81
16.	1896	Journal of comparative Neurology	85
17.	1896	Journal of Geophysical Research	75
18.	1898	American Journal of Physiology	45
19.	1898	Biological Bulletin	28
20.	1901	American Journal of Anatomy	80

1	2	3	4
21.	1901	Biometrika	72
22.	1901	Canadian Journal of Fisheries and Aquatic Sciences	1
23.	1904	Journal of Experimental Zoology	20
24.	1905	Journal of Biological Chemistry	36
25.	1906	Archiv fur Hydrobiologie	58
26.	1908	Poultry Science	79
27.	1908	Parasitology	83
28.	1909	American Midland Naturalist	64
29.	1910	Journal of Heredity	69
30.	1911	Biochemical Journal	60
31.	1912	Biological Review	72
32.	1913	American Scientist	13
33.	1913	Copeia	15
34.	1913	Journal of Ecology	84
35.	1914	California Fish and Game	53
36.	1914	Journal of Parasitology	74
37.	1915	Journal of Association of Official Analytical Chemists	83
38.	1916	Genetics	41
39.	1917	Endocrinology	76
40.	1920	Ecology	11
41.	1921	Canadian Journal of Zoology	9
42.	1921	Physiological Review	85
43.	1922	Verhandlungen der International Vereinigung fur Theoretische and Angewandte Limnologie.	48

1	2	3	4
44.	1923	Journal of Experimental Biology	16
45.	1924	Journal of Comparative Physiology	32
46.	1924	Oecologia	31
47.	1925	Cell and Tissue Research	44
48.	1926	ICES Journal of Marine Science	22
49.	1926	Quarterly Review of Biology	86
50.	1928	Journal of Nutrition	35
51.	1928	Physiological Zoology	57
52.	1929	Analytical Chemistry	78
53.	1929	Journal of Acoustic Society of America	78
54.	1929	Theoretical and Applied Genetics	65
55.	1931	Ecological Monographs	39
56.	1931	Journal of Morphology	53
57.	1932	Journal of Animal Ecology	30
58.	1932	Nippon Suisan Gakkaishi	8
59.	1937	Helgolander Meeresuntersuchungen	79
60.	1937	Journal of Wildlife Management	66
61.	1937	Journal of Marine Research	69
62.	1938	Progressive Fish Culturist	26
63.	1939	Journal of Endocrinology	63
64.	1939	Marine Fisheries Review	71
65.	1941	Cancer Research	84
66.	1942	Australian Fisheries	84
67.	1942	Journal of Animal Science	61

1	2	3	4
68.	1944	Canadian Journal of Biochemistry and Physiology	76
69.	1945	Biometrics	52
70.	1945	Experientia	76
71.	1947	Behaviour	68
72.	1947	Biochimica et Biophysica Acta	71
73.	1947	British Journal of Nutrition	78
74.	1947	Evolution	33
75.	1947	Heredity	67
76.	1947	Netherlands Journal of Zoology	73
77.	1947	Pacific Science	72
78.	1948	Hydrobiologia	27
79.	1948	Oikos	42
80.	1949	Israel Journal of Aquaculture	67
81.	1950	Australian Journal of Marine and Freshwater Research.	25
82.	1950	Japanese Journal of Ichthyology	57
83.	1950	Journal of Science of Food and Agriculture	85
84.	1950	Proceedings National Academy of Science, USA	37
85.	1951	Bulletin of Marine Science	31
86.	1951	Biosciences	73
87.	1952	Progress in Lipid Research	84
88.	1952	Systematic Zoology	78
89.	1953	Animal Behaviour	34

1	2	3	4
90.	1953	Applied and Environmental Microbiology	72
91.	1953	Deep Sea Research	62
92.	1953	Journal of Agricultural and Food Chemistry	83
93.	1954	New York Fish and Game Journal	85
94.	1955	Investigation Pesquera	78
95.	1955	Journal of Cell Biology	63
96.	1956	Genetica	86
97.	1956	Limnology and Oceanography	17
98.	1956	Journal of Chromatography	80
99.	1957	Journal of Ultrastructure Research	80
100.	1959	Canadian Journal of Genetics and Cytology	86
101.	1959	Developmental Biology	29
102.	1959	Journal of Lipid Research	79
103.	1959	Journal of Invertebrate Pathology	85
104.	1959	Journal of Histochemistry and Cytochemistry	86
105.	1959	Journal of Moelcular Biology	86
106.	1960	Analytical Biochemistry	78
107.	1960	Crustaceana	57
108.	1961	American Zoologist	33
109.	1961	Behavioural Ecology and Sociobiology	69
110.	1961	Comparative Biochemistry and Physiology A & B	6
111.	1961	General and Comparative Endocrinology	14

1	2	3	4
112.	1961	Journal of Experimental Marine Biology and Ecology	13
113.	1961	Journal of Theoretical Biology	71
114.	1961	Netherlands Journal of sea Research	51
115.	1961	Reproduction, Nutrition, Development	69
116.	1961	Sarsia	79
117.	1961	Vision Research	84
118.	1962	Malacologia	77
119.	1963	Progress in Oceanography	85
120.	1964	Journal of North West Atlantic Fishery Science	59
121.	1964	Ophelia	70
122.	1965	Archives of Biochemistry and Biophysics	85
123.	1965	Journal of Phycology	75
124.	1966	Bulletin of Environmental Contamination Toxicology	64
125.	1966	Fish Pathology	60
126.	1966	Lipids	56
127.	1967	Biochemical Genetics	82
128.	1967	Environmental Science and Technology	36
129.	1967	Marine Biology	5
130.	1967	New Zealand Journal of Marine and Freshwater Research	51
131.	1967	Water Research	53
132.	1968	Biological Conservation	85
133.	1968	Oecologia (B)	76

1	2	3	4
134.	1968	World Aquaculture	82
135.	1969	Biological Journal of Linnean Society	74
136.	1969	Journal of Fish Biology	3
137.	1970	Aquaculture and Fisheries Management	50
138.	1970	Environmental Pollution	71
139.	1970	Journal of Ichthyology	69
140.	1970	Marine Pollution Bulletin	79
141.	1970	Theoretical Population Biology	86
142.	1970	Journal of World Aquaculture Society	29
143.	1971	Aquaculture	2
144.	1971	Freshwater Biology	40
145.	1971	Journal of Molecular Evolution	76
146.	1971	Journal of Natural History	82
147.	1971	Water, Air and Soil Pollution	49
148.	1971	Xenobiotica	85
149.	1972	Ambio	71
150.	1972	Archives of Environmental contamination Toxicology	76
151.	1972	Finnish Fisheries Research	85
152.	1972	Nature Canada	21
153.	1973	Estuarine and Coastal Shelf Science	60
154.	1974	Microbial Ecology	83
155.	1975	Acta Hydrobiologica sinica	79
156.	1975	Aquatic Botany	86
157.	1975	Journal of Great Lakes Research	60

1	2	3	4
158.	1976	Environmental Biology of Fishes	12
159.	1976	Fisheries	75
160.	1977	Cybium	78
161.	1977	Developmental and Comparative Immunology	71
162.	1978	Estauries	48
163.	1978	Holarctic Ecology	84
164.	1978	Journal of Fish Disease	24
165.	1978	Marine Ecology	10
166.	1978	Marine Envrionmental Research	75
167.	1979	Diseases of Aquatic Organisms	46
168.	1979	Journal of Plankton Research	54
169.	1979	Veterinary Immunology and Immunopathology	81
170.	1980	Fisheries Research	57
171.	1980	Journal of Muscle Research and Cell Motility	84
172.	1981	Aquatic Toxicology	52
173.	1981	Journal of Crustacean Biology	47
174.	1981	North American Journal of Fisheries Management	43
175.	1982	Aquacultural Engineering	73
176.	1982	Coral Reefs	78
177.	1982	Environmental Toxicology and Chemistry	61
178.	1982	Journal of Shellfish Research	55
179.	1982	Polar Biology	75
180.	1982	South African Journal of Marine Science	68

1	2	3	4
181.	1983	Molecular Biology and Evolution	83
182.	1984	Journal of Applied Ichthyology	75
183.	1986	Fish Physiology and Biochemistry	39
184.	1988	Aquatic Living Resources	81
185.	1989	Journal of Aquatic Animal Health	71

Table 5.1.3.1 DECADEWISE DISTRIBUTION OF JOURNALS

(By Year of Origin)

Decade	No. of Journals	% of Journals	Cum %
Below 1800	1	0.5	0.5
1800-1899	18	9.7	10.2
1890-1910	10	5.4	15.6
1911-1920	11	5.9	21.5
1921-1930	14	7.6	29.1
1931-1940	10	5.4	34.5
1941-1950	20	10.8	45.3
1951-1960	23	12.4	57.7
1961-1970	35	19.0	76.7
1971-1980	29	15.7	92.4
1981-1990	14	7.6	100.0
Total	185		

In 1981-90 the number of journals originated shows a decrease which may be due to the present study concentrated in the year 1993 which is close to this decade. Further, research findings are coming out in publications like bulletins, special publications and reports from various research institutions.

5.1.4 Subjectwise scatter of most cited journals

The most cited 185 journals are grouped by the major subject. This table gives the subject, number of titles, percentage of titles and cumulative percentage.

The subject scatter shows that most of the journals are on fisheries (16.2%) and biology (14.6%). Journals dealing with specialised areas like aquaculture, genetics and physiology are less. This may be because these are interdisciplinary topics and articles on these are published in journals dealing with broad coverage like biology, zoology, and science. Moreover articles on fisheries aspects of these subjects are published in fishery science journals. This is evident from the subject scatter study of the articles in 5 sample journals (Table 5.3.1). The subject scatter shows the importance of journals in allied subjects like biology, environmental science, biochemistry etc. in fishery science research.

Table 5.1.4 SUBJECTWISE SCATTER OF MOST CITED JOURNALS

Sl. No.	Subject	No. of Journals	% of Journals	Cum %
1.	Fisheries	30	16.2	16.2
2.	Biology	27	14.6	30.8
3.	Environmental Science	18	9.7	40.5
4.	Biochemistry	16	8.7	49.2
5.	Zoology	16	8.7	57.9
6.	Science (General)	15	8.1	66.0
7.	Oceangraphy	13	7.2	73.2
8.	Physiology	7	3.8	77.0
9.	Genetics	6	3.2	80.2
10.	Ecology	5	2.7	82.9
11.	Pathology	5	2.7	85.6
12.	Aquaculture	4	2.1	87.7
13.	Cytology	4	2.1	89.8
14.	Medical Science	4	2.1	91.9
15.	Agriculture	3	1.6	93.5
16.	Endorcrinology	3	1.6	95.1
17.	Microbiology	3	1.6	96.7
18.	Statistics	3	1.6	98.3
19.	Botany	2	1.1	99.4
20.	Physics	1	0.5	99.9

Table 5.1.4.1 DISTRIBUTION OF CITATION BY SUBJECT OF MOST CITED JOURNALS

Sl. No.	Subject	No. of Journals	No.of Citations	% of citation
1.	Fisheries	30	5797	36.7
2.	Biology	27	2038	13.3
3.	Environmental Science	18	515	3.3
4.	Biochemistry	16	736	4.7
5.	Zoology	16	1345	8.5
6.	Science	15	668	4.2
7.	Oceanography	13	765	4.8
8.	Physiology	7	291	1.8
9.	Genetics	6	258	1.6
10.	Pathology	5	151	0.9
11.	Ecology	5	850	5.4
12.	Cytology	4	113	0.7
13.	Medical Science	4	60	0.4
14.	Aquaculture	4	1669	10.5
15.	Agriculture	3	41	0.3
16.	Endocrinology	3	288	1.8
17.	Statistics	3	87	0.5
18.	Microbiology	3	57	0.4
19.	Botany	2	31	0.2
20.	Physics	1	18	0.1
	TOTAL :	185	15778	100.0

5.1.4.1 Distribution of citation by subject of most cited journals

The core journals sorted according to the subject are arranged by the number of citations and percentage of citation.

As in the number of journals, the number of citation is also more from fisheries (36.7%) and biology (13.3%) and the total of these two forms 50% of the citations in 185 core journals. For Aquaculture (4 journals with 1669 citations) and Zoology (16 journals with 1345 citations) eventhough the number of journals are less, citations are more compared to the other subjects with the same number of journals. This is because citations from these journals are on subjects closely allied to fishery science.

5.1.5 Distribution and yearwise scatter of self citation

Citations in each of the 5 sample journals are counted and tabulated giving number of self citation, total citation and percentage of self citation. Number of self citation in each journal according to cited year is tabulated to study yearwise scatter of self citation.

Study of self citation of journals shows that all the 5 sample journals have a high self citating rate. The journal Aquaculture has the highest self citing rate of 0.90 the percentage of which is 90.5%. This may be due to the number of journals dealing with aquaculture

Table 5.1.5 DISTRIBUTION OF SELF CITATION IN 5 JOURNALS

Sl. No.	Title	No. of Self citation	No. of Total citation	Self citing rate	Self citing %
1.	Aquaculture	1047	1156	0.90	90.5
2.	Canadian Journal of Fisheries and Awuatic Science	1027	2119	0.48	48.4
3.	Environmental Biology of Fishes	147	308	0.47	47.7
4.	Journal of Fish Biology	362	918	0.39	39.4
5.	Marine Biology	304	549	0.55	55.3

Table 5.1.5.1. YEARWISE SCATTER OF SELF CITATION IN 5 JOURNALS

Year	Can.J.Fish. Aquat.Sci.	Aquac.	Mar.Biol	J.Fish Biol.	Env.Biol Fish
1993	47	51	19	7	19
1992	69	72	21	27	9
1991	122	14	29	37	13
1990	94	91	31	45	19
1989	83	115	23	34	10
1988	104	84	16	27	8
1987	94	93	19	15	8
1986	60	74	19	14	16
1985	90	69	11	15	10
1984	59	94	20	12	5
1983	66	74	10	15	5
1982	48	35	21	10	7
1981	47	31	9	15	6
1980	46	27	7	16	2
1979	28	26	10	7	5
1978	22	30	10	15	4
1977	37	14	6	10	1
1976	34	26	7	8	-
1975	24	6	3	4	-
1974	17	12	4	5	-
1973	18	2	3	7	-
1972	23	6	3	5	-
1971	11	1	1	5	-
1970	20	-	2	2	-
1969	12	-	-	5	-
TOTAL	1027	1047	304	362	147

is scarce and the research workers depend on articles from this title for comparing their research work. This indicates the isolation of the field covered by the journal.

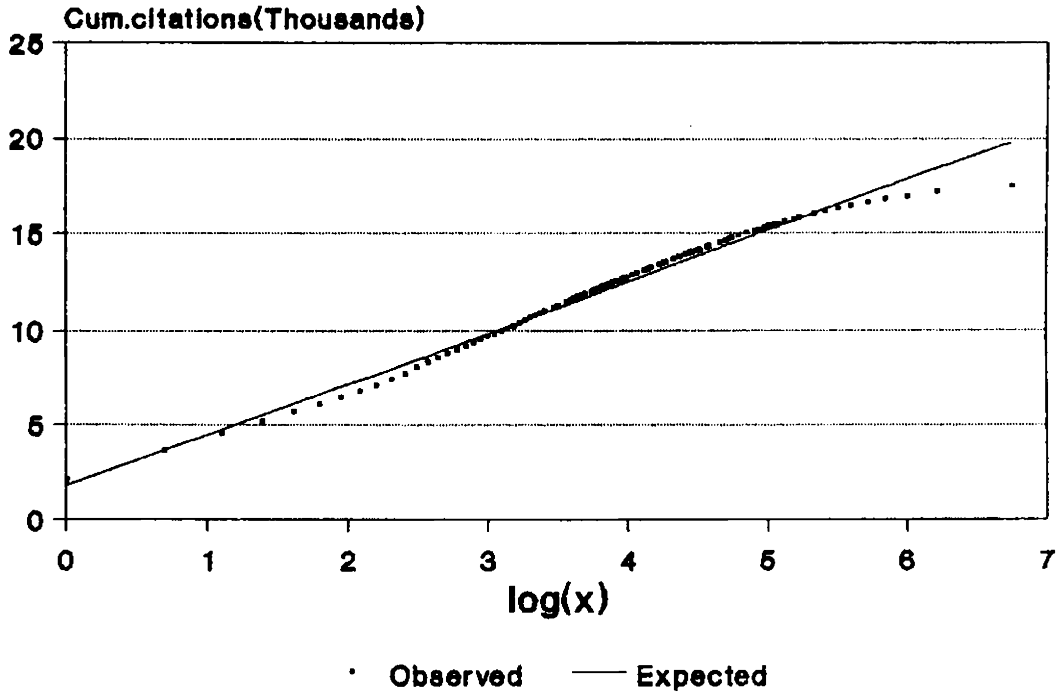
Yearwise distribution of self citation shows that most of these are from the 10 year period previous to the present period of study i.e. 1984 to 1993. This shows the present trend of the journals publishing articles of vital research interest.

5.1.1.3 **Fit of rank distribution (Bradford distribution)**

This graph is prepared by plotting log of cited journals (x) against cumulative citations (F(x)) from table 5.1.1.1 to test whether the data fits Bradford's distribution graphically. The data is also tested using various models like Bradford's, Bookstein's and Gompertz.

The graph is a straight line with a droop at the end known as 'groos droop'. This reveals that the data is from an interdisciplinary subject. When Bradford's model, $F(x)=a+b \log x$ is used the R^2 is found to be 98.4%. With Bookstein's generalised model, $f(x) = \frac{k}{x^{\alpha}}$, the R^2 is found 90.4%. When Gompertz model, $F(x)=k.a^{bx}$ is used, the R^2 is 95.2%. So it can be concluded that Bradford's model with 98.4% fits the data accurately than others.

Fig.5.1.1.3 Rank distribution
(Bradford Distribution)



5.1.1.4 <u>Frequency curve of distribution of citations</u>

Based on table 5.1.1.2, graph is plotted with number of citations (x) against number of journals (y). Number of journals receiving citations 1 (350 journals) to 104 (2 journals) are taken to prepare the graph, as above limit citations belong to single title only.

The graph obtained shows the frequency distribution curve shaped with long tail which is typical for empirical distribution in journal citation studies. The sample taken does not include the core journals with more than 100 citations. This indicates that the data belongs to a negative binomial population, and a curved graph is obtained only when the data is truncated at the point where the straight line begins in graph 5.1.1.3.

5.1.1.5 <u>Cumulative distribution of journal citations</u>

Cumulative number of journals (x) is plotted against cumulative citations (F(x)) from table 5.1.1.1 to prepare this graph. The data is also tested with Leimkuhler's model.

The graph is concave shaped which is typical of Leimkuhler distributions. By fitting the formula, $R(x) = a \log(1 + br)$ it is seen that R^2 is 98.1% which is less than that obtained for Bradford model. So it can be concluded that this model is not as accurate as Bradford's which is the best fitting among the tested models.

Fig.5.1.1.4 Frequency Distribution of Citations

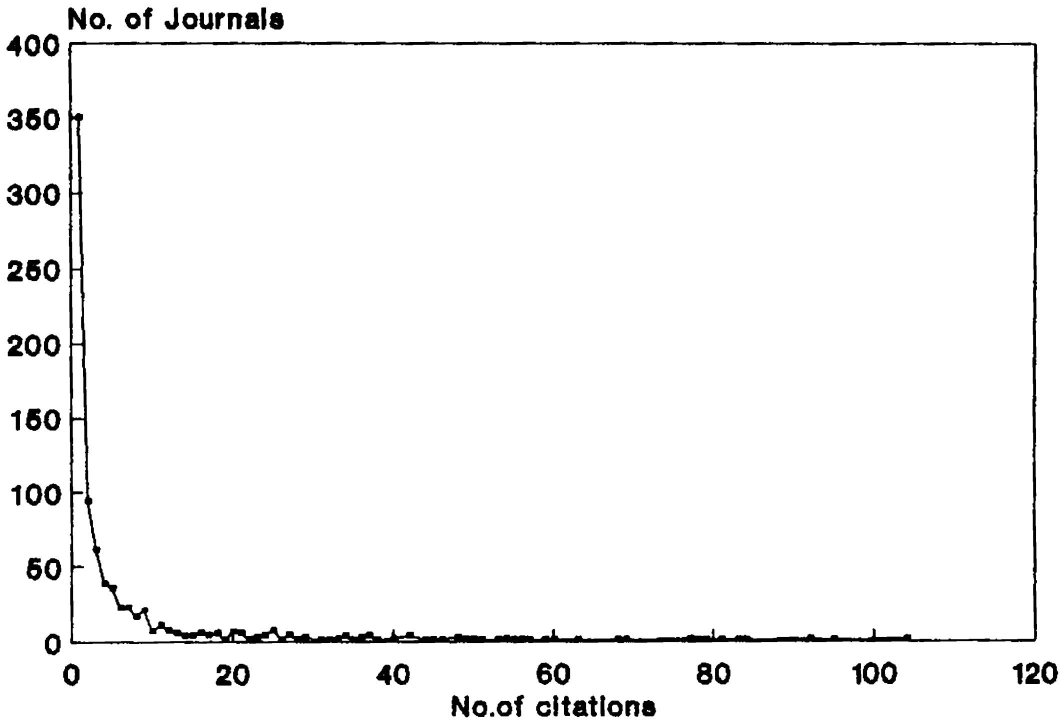


Fig.5.1.1.5.Cumulative Distribution (Leimkuhler's model)

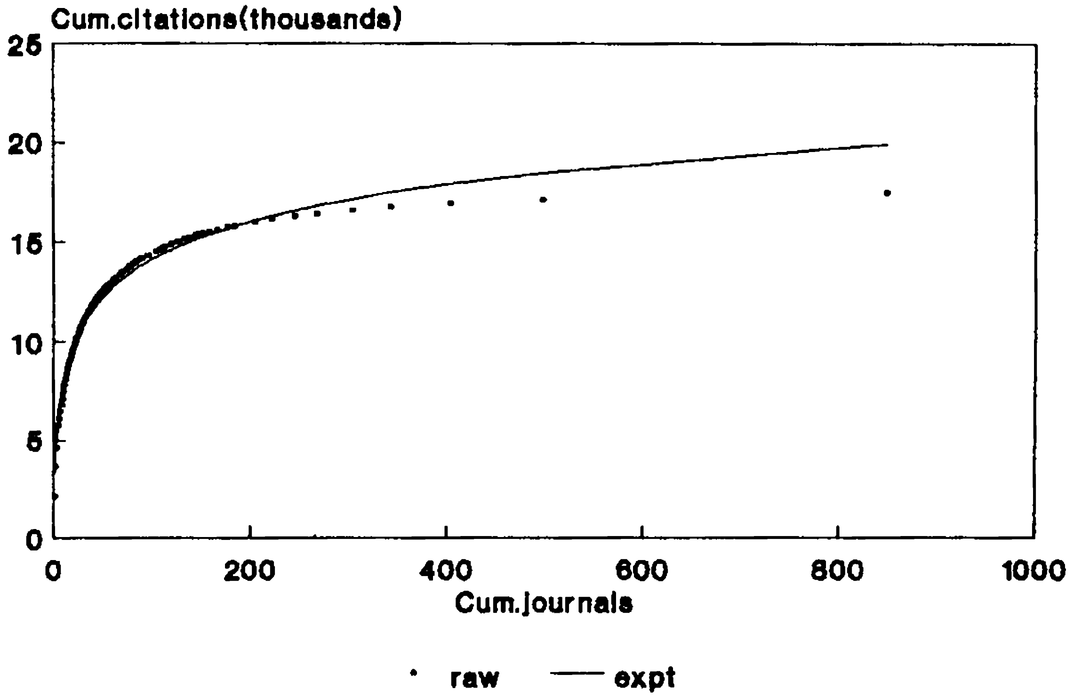


Table 5.2. DISTRIBUTION OF ARTICLES IN 5 JOURNALS DURING 10 YEAR

Year	Aquaculture	Can.J.Fish. Aquat.Sci.	Env.Biol. Fish	J.Fish. Biol	Mar.Biol.	Total
1984	270	130	78	135	59	672
1985	218	145	77	130	53	623
1986	280	194	87	151	59	771
1987	285	157	86	146	72	746
1988	202	167	67	216	97	749
1989	280	186	73	188	100	827
1990	267	160	71	198	105	901
1991	270	211	99	168	86	834
1992	286	202	113	198	101	900
1993	296	221	105	191	102	915
Total :	2654	1773	856	1721	834	7838

5.2 Distribution of articles

This table shows the yearwise distribution of articles in fishery science published in 5 sample journals over 10 year period previous to the year of present study 1993, i.e from 1984 to 1993.

The number of articles published shows an increasing trend every year. Total number of articles in the 5 titles in 1984 are 672 which increased to 915 in 1993. Maximum number of articles are from the journal 'Aquaculture' which has 33% of the total articles. The reason for the wide circulation of the particular journal deals in the fact that it deals with the culture of aquatic organisms and aquaculture as such is a rapidly growing research area in fishery science.

5.3 Distribution of authors

Number of papers published by authors during 1993 in 5 journals are counted to study distribution according to Lotka's law. A goodness-of-fit test using Kolmogorov-smirnov method is also done.

The study of authors shows that the distribution is not conforming to Lotka's law according to which 60% of total authors produce one article, $\frac{60}{2^2}$ (15%) produce 2 articles, $\frac{60}{3^2}$ (7%) produce 3 articles and so on.

It is observed that the percentage of authors with one

Table 5.3 DISTRIBUTION OF AUTHORS BASED ON LOTKA'S LAW

No. of Papers n	Observed No. of authors (a_n)	Observed % of authors $\frac{100 x a_n}{aN}$	Expected No. of authors (P)	Expected % of authors	$(a_n-P)^{2}/P$
1	1869	89.25	1869	100	0
2	157	7.50	467	25	205.7
3	45	2.14	207	11.11	126.7
4	13	0.62	116	6.25	91.4
5	8	0.48	74	4.00	58.8
6	1		51	2.76	49.0
7	0		38	2.04	38.0
8	1		29	1.56	27.0
TOTAL	2094	99.99	2851		594.6

K - S STATISTICAL TEST

No.of Papers	No.of Authors	Observed Freq.	Relative Cum.Freq.	Normal Probab.	Relative Normal	$D=F_o(x)-Sn(x)$
1	1869	0.8925	0.8925	0.6556	0.6556	0.2369
2	157	0.0750	0.9675	0.1638	0.8194	0.1481
3	45	0.0215	0.9890	0.0726	0.8920	0.0970
4	13	0.0062	0.9952	0.0407	0.9327	0.0625
5	8	0.0038	0.9990	0.0260	0.9587	0.0403
6	1	0.0005	0.9995	0.0179	0.9766	0.229
7	0	0.0000	0.0005	0.0133	0.9891	0.0096
8	1	0.0005	1.0000	0.0102	1.0000	0.0000

N=2094 D Max=0.2369

at 0.01 level of significance, K.S. Statistic

$D_x = 1.63/\sqrt{2094} = 1.63/45.76 = 0.0356$

$0.2369 > 0.0356$

$D_{Max} > D_{\alpha}$ ∴ Data do not fit Lotka's law.

contribution is 89%, 2 contributions is 7.55% and 3 contribution is 2.1% and so on. The difference is 29%, 7.5%, 5% and so on. Less number of highly productive authors in this subject may be that scholarly productivity is an "elitist phenomenon". Another reason which can be attributed to this is that most authors may not be active in the subject for a long time as this is an interdisciplinary actively developing subject. This phenomenon is called "transience in authorship". Collaborative research also leads to an increase in one paper contributor from fields allied to the subject.

Kolmogorov-smirnov test based on maximum difference between expected and cumulative distribution is conducted. The maximum difference between observed and expected frequency was found to be 0.2369 which is significantly high compared to the expected value of 0.0356 calculated at 0.01 level of significance. This also shows that the observed values do not conform to Lokta distribution.

5.3.1 Quantitative subjectwise scatter of articles

Articles are classified by the main subject dealt with and arranged quantitatively by the number of articles in each subject.

Majority of the articles are on fish physiology indicating research in this field is very active. It is also seen that research on applied topics are more than on fundamental topics such as biology and general fisheries. Study of cited journals indicate that journals devoted exclusively on physiology are only 7 in number (Table 5.1.4) This shows that though there are few journals on physiology, articles are published in other subject journals. It is also seen that research on physiology, ecology, and genetics are being given priority by researchers.

5.3.2 Distribution of source/cited articles

The number of source articles in each journal and the total citation received for the articles is given along with ratio of the two.

The proportion of citations per article is high in all the journals. Average number of citation is between 24 and 37 per article. It shows that research workers in this field refer to earlier papers heavily. This is typical in scientific research where existing methods are applied in formulating new findings.

5.4 Distribution of citations

Tables depicting number of total citation, journal citation, other citation and percentage of journal

Table 5.3.1 QUANTITATIVE SUBJECTWISE SCATTER OF ARTICLES IN 5 JOURNALS DURING 1993

SUBJECT	NO. OF ARTICLES
Fish Physiology	238
Fish Ecology	169
Fish Genetics	105
Fish Reproduction	98
Fish Pathology	68
Fish Culture	55
Fisheries	54
Fish Stock	47
Crustacea Physiology	42
Fish Biology	32
Fish Pollution	23
Fish Statistics	22.
Crustacea	18
Mollusca Physiology	18
Mollusca Culture	17
Crustacea Ecology	15
Mollusca	14
Aquaculture	13
Mollusca Genetics	12
Mollusca Ecology	9
Crustacea Reproduction	9
Crustacea Ecology	8
Crustacea Pathology	7
Crustacea Genetics	4
Mollusca Reproduction	4
Aquaculture Economics	3
Crustacea Stock	3
Fish Technology	3
Mollusca Pathology	1

Table 5.3.2 <u>DISTRIBUTION OF SOURCE/CITED ARTICLES</u>

Journal	Vol./Issue	No.of Source articles	No. of cited articles	Ratio
Aquaculture	109-108/40	296	7487	1:35
Can.J.Fish Aquat.Sci.	50/12	221	8747	1:25
Env.Biol. Fish.	36-38/12	105	3647	1:34
J.Fish.Biol.	42-43/12	191	4727	1:24
Mar.Biol.	115-117/12	102	3957	1:37

Table 5.4 <u>DISTRIBUTION OF CITATIONS IN 5 JOURNALS</u>

	Title	Total Cit.	Journal Cit.	Others	% Journal Cit.
1.	Aquaculture	7487	4616	2871	61.65
2.	Can.J Fish Aq. Sci	8747	5483	3264	62.68
3.	Env. Bio. Fish.	3647	2094	1553	57.42
4.	Journal Fish Biol.	4727	2828	1899	59.57
5.	Marine Biology	3957	2438	1474	62.74
	TOTAL	28565	17459	11106	61.25

citation are prepared. Other citation include books, theses reports, proceedings and miscellaneous publications.

Journal citation dominates the total citation with an average of 61.25% in all the 5 titles. This indicates the importance of journal literature in fishery science research. Moreover research results are published mainly in the form of journal articles which are the fastest means of information transfer.

5.5 Age of journals most cited

The most cited 32 journals, with more than 100 citations, are selected to study the age of journals. Distribution of number of citation for 10 years from 1984 to 1993) based on the year of cited journal is prepared. Total for each year and its cumulation are tabulated. A graph plotting year of citation against cumulative citation is drawn. From the graph the median citation age or the period during which half of the citation occurred is found. Most of the citations received by journals are from the 10 year period studied. Out of total 11,188 citations received by the journals, 6170 (55%) are from the 10 years showing moderate aging rate. Average age of journals is calculated as

$$\bar{x} = \frac{\sum xf(x)}{\sum f(x)} = \frac{29905}{6170} = 4.8 \text{ years.}$$

Table.5.5. AGE OF JOURNALS MOST CITED

Year	x	No.Ref. f(x)	x.f(x)	Cum.Freq f(x)
1993	0	243	243	243
1992	1	472	472	715
1991	2	705	1410	1420
1990	3	767	2301	2187
1989	4	740	2960	2927
1988	5	635	3175	3562
1987	6	733	4398	4295
1986	7	654	4578	4949
1985	8	621	4968	5570
1984	9	600	5400	6170

Fig.5.5.2. Age of journals cited

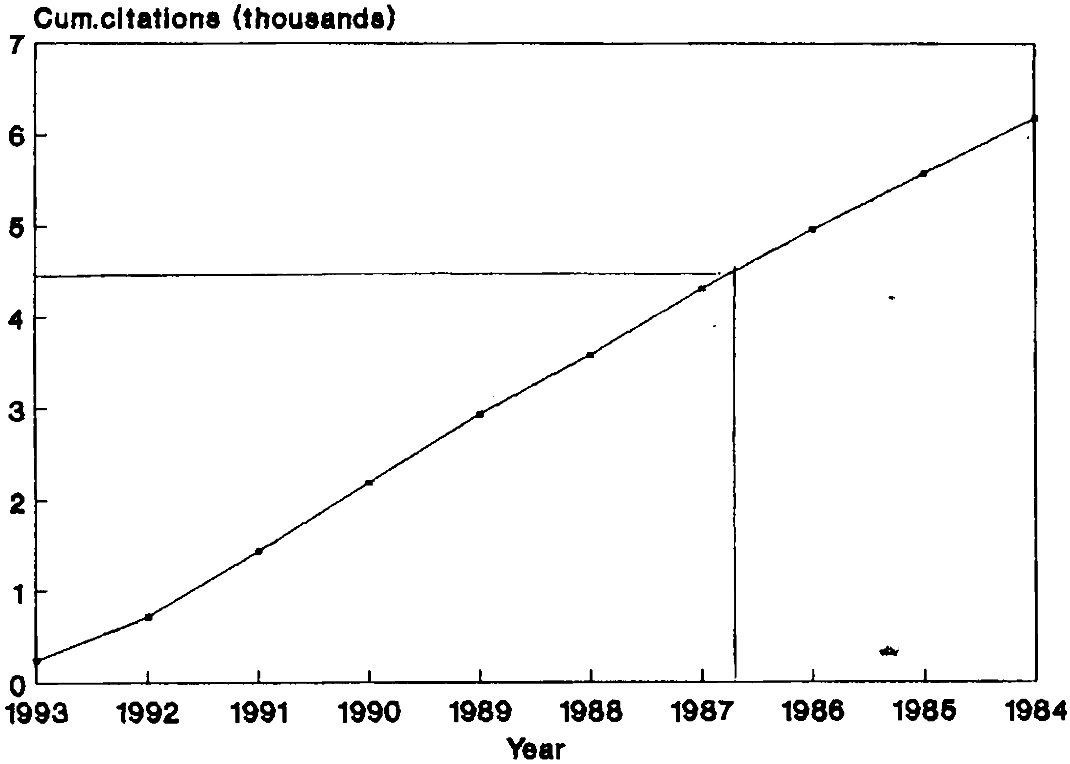


Table 5.5.1.DISTRIBUTION OF AGE OF JOURNALS MOST CITED

Name of Journal	Yearwise distribution of citation 1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Can.J.Fish.Aquat.Sci	86	124	91	126	149	121	125	165	82	50
Aquaculture	121	118	92	121	108	153	115	68	94	60
J.Fish.Biol.	46	37	43	59	72	86	85	88	52	14
Tr.Am.Fish.Soc.	41	28	49	38	21	20	41	23	8	2
Marine Biology	33	20	29	37	31	43	41	39	29	25
Comp.Biochem.Physiol	18	24	29	13	17	24	21	17	7	4
Fishery Bulletin	14	17	16	14	17	29	8	7	12	3
Nipp.Suisan Gak.	16	14	13	16	12	44	23	22	9	1
Can.J.Zool.	20	30	32	31	16	14	23	17	11	3
Marine Ecology	15	23	33	36	41	32	29	39	25	8
Ecology	18	23	19	21	18	19	24	9	9	2
Env.Biol.Fish.	12	20	31	17	16	18	40	31	19	22
J.Exp.Mar.Biol.Ecol.	25	12	25	32	19	26	10	17	15	4
Gen.Comp.Endocr.	15	14	21	23	19	19	21	21	8	1
Copeia	13	8	11	13	15	6	13	5	10	6
J.Exp.Biol.	10	6	6	4	10	9	16	6	9	1
Limnol.Oceanogr.	7	7	10	10	17	9	9	10	2	2
J.Mar.Biol.Assn.U.K.	4	9	11	6	2	8	11	5	2	3
Science	5	10	3	10	7	3	5	9	1	1
J.Exp.Zool.	2	6	6	18	6	24	11	11	13	1
Nature	4	9	5	7	12	3	4	7	4	3
ICES J.Mar.Sci.	5	6	1	7	4	8	11	15	4	3
Amer.Naturalist	15	3	6	3	9	1	7	9	4	1
J.Fish.Dis.	5	2	10	14	6	20	14	14	6	7
Austr.J.Mar.Fresh.Re	11	6	9	5	15	5	12	9	9	5
Prog.Fish.Cult.	4	7	19	5	5	4	3	5	3	1
Hydrobiologia	7	9	11	10	4	15	14	11	4	3
Biol.Bulletin	4	6	3	1	5	6	4	4	6	1
J.World Aquac.Soc.	4	12	1	10	9	15	7	5	7	3
Oecologia	12	8	6	11	13	4	4	9	1	1
J.Anim.Ecol.	1	1	3	3	4	8	7	2	3	1
Bull.Mar.Sci.	7	2	10	12	11	7	9	6	4	1
Total	600	621	654	733	635	740	767	705	472	243

Table 5.6 COUNTRYWISE DISTRIBUTION OF MOST CITED JOURNALS

Sl. No.	Country	No.of Journals	% of Journals
1	U.S.	98	52.9
2.	U.K.	32	17.2
3.	Netherlands	18	9.7
4.	Canada	8	4.3
5.	Germany	8	4.3
6.	Denmark	4	2.1
7.	France	4	2.1
8.	Japan	3	1.6
9.	Australia	2	1.0
10.	Chekoslovakia	1	0.6
11.	China	1	0.6
12.	Finland	1	0.6
13.	Israel	1	0.6
14.	New Zealand	1	0.6
15.	Spain	1	0.6
16.	Switzerland	1	0.6
17.	South Africa	1	0.6
	TOTAL	185	100.0

From the graph the median citation age is found to be 4.5 years. This low age shows that the contributors in this field depend on fresh data or new techniques. The results also enable us to make a proper stacking policy in the present context of shortage of space in libraries. The less used back volumes of journals can be stacked in store rooms thus facilitating more space for recent volumes which are used by research workers.

5.6 Distribution of most cited journals - countrywise

Countrywise analysis shows more than half of the journals cited are from U.S. (52.4%). It is seen that U.S., U.K. and Netherlands together publish 78.8% of the cited journals showing the largest concentration of fishery science journal publication. The sample journals taken were from Canada U.S and Netherlands. Increase in journals published from U.S. show the progress of research and education in the field in this country. It is also seen that no journal from India comes in the core journal list eventhough India has an important place in world fisheries production and research. The reason may be that journals dealing with fisheries in India are mostly published by government agencies and not by publishers who get international publicity.

CHAPTER - 6

FINDINGS AND CONCLUSIONS

The findings and conclusions discussed in this chapter are based on citations taken from 5 selected journals in Fishery Science. The study can be taken as an indirect use study as the units studied are the articles in the 5 journals and their citations and the citations represent the literature made use of by the researchers in their scientific work.

1. The rank list of 185 journals most cited, have an international coverage and are helpful for the following groups as given below.

   a) The librarian and policy makers of a research institution in the field of Fishery science can use the list for planning acquisition of journals to the best advantage of users. Due to the enormous increase in number of scientific journals and cost no library can afford to procure all the relevant journals needed for the clientele. Measures like ordering highly productive journals by airmail and others by surface mail would reduce financial burden to some extent. Another option is to subscribe highly productive journals only and get microfische copies of less productive and only photocopies of relevant papers in least productive journals. Binding, which also involves much cost can be planned giving priority for the more used journals.

b) Research workers and scientists in the field can be made aware of the important journals relevant to their studies from the rank list of journals. Researchers also can select journals in which to publish their results so that it would reach more users in the field.

c) Information Scientist: For planning information services, priority areas can be easily determined. For local database preparation also journals can be selected based on ranking. Local variation in acquisition and information services may be made depending on policy and areas of priority in research organizations and expert opinion.

d) Publishers of journals can assess the areas in which only a few journals are available and can concentrate on starting new journals in these areas. For example, fishery technology and Aquaculture are areas found in this study which have only a few journals eventhough these aspects have been given prime importance in fishery science. Publishers of secondary services also can select journals to be included in such services.

2. Application of informetric laws to the distribution of citation showed that theoretically it does not confirm to Bradford's pattern $(1:n:n^2)$. But the data fits Bradfords empirical model F(x) = a+b log x with 98.4% accuracy. Thus

the distribution is almost linear as suggested by Bradford's model.

Author productivity study shows that it does not conform to Lotka's law as the number of authors with one article is about 90%. This indicates the emergence of new authors who contribute only one article which is characteristic of newly developing interdisciplinary subjects.

3. Number of journal citations (61%) are more than other forms like books, reports, reviews etc. It can be concluded that researchers in the field of Fishery science depend mainly on journal literature for research work and they also publish their findings in the form of journal articles.

Self citation of the 5 sample journals shows that those publishing papers in these journals mostly consult these same titles for their work.

4. Age of journals cited is calculated as 4.8 years which shows the journals become obsolete after this period. This low age is due to increased research activity which replaces new findings in the place of old ones. Median citation age plotted in graph also shows the low age which shows that this is a growing subject. Rapid obsolescence indicates high popularity of the field.

5. Study of subject of articles indicates that fish physiology is the area where active research is going on.

The emergence of journals and publications on specific area of fish physiology during 1980 may be attributed because of the active research in this area. Subject of journals in rank list reveals that the majority of journals cited belong to fisheries and biology, the sum total of which is about 50% of the whole citations.

6. The oldest journal cited is 'Philosophical Transactions of Royal Society of London" which is one of the pioneers in the field of publishing of the Scientific Journals. The popularity of the journal shows it is an authentic research journal which publishes multidisciplinary articles. Starting of the majority of journals in 1961-'70 (35 titles) highlights the kind of progress made in research during this decade. It was also a period of new developments in fishery science and ushered a new era in the field of mechanisation in fishing.

7. Average number of citation per article is very high (24 to 37) which shows the researcher's increased dependence on earlier published journal articles for conducting new research.

8. U.S. is found to be the most productive country with 92 journals (52%) U.K. and Netherlands form second and third respectively. No journal from India is seen in rank list of journals. So it is seen that developed countries have all facilities for research, education and publication of

results while developing countries have to get the publications from others at a very high cost. It is seen that some international organizations extend gift and exchange facilities which can be availed by developing countries.

9. The distribution of journal citation doesnot conform to 80/20 rule which states that 80% of citations must be from 20% of journals. In this study it is observed that 90% of citations (15708) are from 20% of journals (178 Nos)

10. Some popular journals, like 'Science' and "nature' are top ranking and the results are quickly disseminated through these journals with shorter periodicity (weekly). It also indicates that research in Fishery science is of vital interest to those doing fundamental research in science. Any library or information centre can include these titles in their list for subscription or information service.

11. Number of articles published in 5 sample journals shows enhancement over 10 years (from 1984 to 1993). The increased productivity of articles indicates the increased output in research in the subject. The journal 'Aquaculture' is having maximum articles and it is the most productive area of research in the world at present. This can be taken as an area for allotment of more funds and encouragement of research.

Citation analysis is an effective tool which is useful to librarians, policy makers, information scientists, research scholars, scientists and publishers in different ways. Citation study is an indirect use study as citations are the papers which are used or consulted in preparation of source article. Earlier, citation studies were done in Social Science and hard science for determining scholarly eminence, major contributions to a discipline and content analysis of subject. Now the studies are used in assessing quality of research by individual, institution or a country, library collection building, information retrieval, science policy decision etc. This study is an attempt to evaluate Fishery science journals quantitatively based on citations from selected titles. Future studies of smilar type in other subjects can also be initiated using informetric methods as done in this study. The studies can be conducted keeping in mind the observation that 'the main purpose of quantitative measures is to provide information on which to base qualitative judgements not to replace them'.

ANNEXURE-I- LIST OF JOURNALS

Sl.No.	OCC.No.	Title
1	2	ACTA ADRIAT.
2	1	ACTA ANAT.SIN.
3	2	ACTA BIOL.HUNGARICA
4	1	ACTA CHEM.SCAND.
5	1	ACTA ECOL.SIN.
6	1	ACTA ENDOCRINOL.
7	2	ACTA GENETICA SINICA
8	1	ACTA HISTOCHEM.
9	1	ACTA HYDROBIOL.
10	17	ACTA HYDROBIOL.SIN.
11	1	ACTA ICHTHYOL.PISCATORIA
12	1	ACTA OCEANOL.SIN.
13	1	ACTA PARASITOL.POL.
14	1	ACTA PHARMACOL.TOXICOL.
15	1	ACTA PHYSIOL.SCANDINAVIA
16	1	ACTA PROTOZOOL.
17	1	ACTA VET.HUNG.
18	1	ACTA VET.SCAND.
19	6	ACTA ZOOL.
20	3	ACTA ZOOL.SIN.
21	3	AFR.J.TROP.HYDROBIOL.FISH.
22	16	AM.J.ANAT.
23	1	AM.J.BOT.
24	7	AM.J.CLIN.NUTR.
25	2	AM.J.CLIN.PATHOL.
26	3	AM.J.HUM.GENET.
27	3	AM.J.HYG.
28	1	AM.J.MED.
29	57	AM.J.PHYSIOL.
30	1	AM.J.SCI.
31	1	AM.J.TROP.MED.HYG.
32	2	AM.J.VET.RES.
33	1	AM.J.ZOOL.
34	33	AM.MIDL.NAT.
35	143	AM.NAT.
36	1	AM.STAT.
37	25	AMBIO
38	1	AMER.J.CARDIOVASC.PATHOL.
39	1	AMER.J.PATHOL.
40	4	AMER.MUS.NOVITATES
41	13	AMER.SCI.
42	92	AMER.ZOOL.
43	40	ANAL.BIOCHEM.
44	18	ANAL.CHEM.
45	2	ANAL.CHIM.ACTA
46	3	ANALYST
47	9	ANAT.EMBRYOL.

Sl.No.	OCC.No.	Title
48	8	ANAT.REC.
49	84	ANIM.BEHAV.
50	2	ANIM.BLOOD GROUPS BIOCHEM.GENE
51	1	ANIM.FEED SCI.TECH.
52	5	ANIM.GENET.
53	1	ANIM.PROD.
54	1	ANIMAL KINGDOM
55	16	ANN.BIOL.ANIM.BIOCHIM.BIOPHYS.
56	1	ANN.BOT.
57	1	ANN.INST.OCEAN.
58	1	ANN.INST.OCEANOGR.PARIS
59	6	ANN.MAG.NAT.HIST.
60	2	ANN.MATH.STAT.
61	2	ANN.N.Y.ACAD.SCI.
62	1	ANN.PARASITOL.HUM.COMP.
63	1	ANN.S.AFR.MUS.
64	1	ANN.STAT.
65	5	ANN.ZOOL.FENN.
66	1	ANNAL.MATHEMATICAL STAT.
67	1	ANNLS.INST.MAR.BIOL.
68	1	APPL.BIOCHEM.BIOTECHNOL.
69	24	APPL.ENV.MICROBIOL.
70	1	APPL.MICROBIOL.
71	7	APPL.STAT.
72	1	APPL.TOXICOL.
73	1	AQUA FENN.
74	1	AQUA.HUNGAR.
75	3	AQUABIOLOGY
76	23	AQUACULT.ENG.
77	51	AQUACULT.FISH.MANAGE.
78	5	AQUACULT.MAG.
79	1516	AQUACULTURE
80	1	AQUARIUM
81	10	AQUAT.BOT.
82	1	AQUAT.CONSERV.
83	15	AQUAT.LIVING RESOUR.
84	2	AQUAT.SCI.
85	49	AQUAT.TOXICOL.
86	1	ARCH.ANIM.NUTR.
87	10	ARCH.BIOCHEM.BIOPHYS.
88	20	ARCH.ENV.CONTAM.TOXICOL.
89	4	ARCH.FISH.WISS.
90	40	ARCH.HYDROBIOL.
91	2	ARCH.MICROBIOL.
92	2	ARCH.TOXICOL.
93	1	ARCH.VIROL.
94	1	ARCH.ZOOL.EXP.GEN.

Sl.No.	OCC.No.	Title
95	1	ARCHIV.BIOCHEM.BIOPHYS.
96	1	ASIAN AQUACULT.
97	7	ASIAN FISH.SCI.
98	1	ASIAN J.ENV.MANAG.
99	4	ASTARTE
100	4	ATMOSPHERE-OCEAN
101	2	ATOLL RES.BULL.
102	12	AUST.FISH.
103	1	AUST.J.BOT.
104	8	AUST.J.ECOL.
105	1	AUST.J.EXP.MED.SCI.
106	138	AUST.J.MAR.FRESHWATER RES.
107	1	AUST.J.PL.PHYSIOL.
108	5	AUST.J.ZOOL.
109	1	AUST.N.Z.J.MED.
110	1	AUST.ZOOL.
111	1	AUSTASIA AQUACULTURE
112	1	BACTERIAL REV.
113	29	BAMIDGEH
114	1	BANGLADESH J.FISH.
115	3	BEHAV.BIOL.
116	27	BEHAV.ECOL.SOCIOBIOL.
117	2	BEHAV.PROCESSES
118	28	BEHAVIOUR
119	7	BIOCHEM.BIOPHYS.ACTA
120	5	BIOCHEM.BIOPHYS.RES.COMMUN.
121	14	BIOCHEM.GENET.
122	37	BIOCHEM.J.
123	4	BIOCHEM.PHARMACOL.
124	1	BIOCHEM.SYST.ECOL.
125	7	BIOCHEMISTRY
126	25	BIOCHIM.BIOPHYS.ACTA
127	6	BIOGEOCHEMISTRY
128	117	BIOL.BULL.
129	11	BIOL.CONSERV.
130	22	BIOL.J.LINN.SOC.
131	1	BIOL.MONOGR.
132	2	BIOL.OCEANOGR.
133	3	BIOL.REPROD.
134	24	BIOL.REV.
135	1	BIOLOGIA
136	1	BIOLOGIST
137	49	BIOMETRICS
138	24	BIOMETRIKA
139	1	BIOPHYS.BIOCHEM.CYTOL.
140	23	BIOSCIENCE
141	1	BIOSYSTEMS

Sl.No.	OCC.No.	Title
142	3	BIOTECHNIQUES
143	1	BIOTECHNOL.BIOENG.
144	2	BIOTECHNOLOGY
145	1	BIOTROPICA
146	3	BOT.MAR.
147	18	BR.J.NUTR.
148	2	BR.J.PHARMACOL.
149	2	BR.PHYCOL.J.
150	2	BR.POULT.SCI.
151	5	BRAZIL J.GENET.
152	1	BREVIORA
153	1	BRITISH PHYCOL.J.
154	1	BULL.CHEM.SOC.JPN.
155	33	BULL.ENV.CONTAM.TOXICOL.
156	2	BULL.FAC.FISH.HOKKAIDO UNIV.
157	1	BULL.FAC.NAGASAKI UNIV.
158	1	BULL.INST.MAR.BIOL.OCEANOGR.
159	1	BULL.INST.OCEANOGR.(MONACO)
160	4	BULL.INST.ZOOL.ACAD.SINICA
161	1	BULL.JPN.SOC.FISH.OCEANOGR.
162	233	BULL.JPN.SOC.SCI.FISH.
163	104	BULL.MAR.SCI.
164	1	BULL.MATH.BIOPHY.
165	8	CAH.BIOL.MAR.
166	48	CALIF.FISH GAME
167	2	CAN.AQUACULT.
168	1	CAN.BIOL.FISH.
169	1	CAN.ENTOMOL.
170	12	CAN.FIELD NAT.
171	6	CAN.FISH CULT.
172	1	CAN.J.ANIM.SCI.
173	3	CAN.J.BIOCHEM.
174	20	CAN.J.BIOCHEM.PHYSIOL.
175	5	CAN.J.BOT.
176	1	CAN.J.EARTH SCI.
177	1452	CAN.J.FISH.AQUAT.SCI.
178	10	CAN.J.GENET.CYTOL.
179	5	CAN.J.MICROBIOL.
180	1	CAN.J.PLANT SCI.
181	1	CAN.J.STAT.
182	1	CAN.J.VET.RES.
183	332	CAN.J.ZOOL.
184	1	CAN.MINERAL
185	2	CAN.VET.J.
186	12	CANCER RES.
187	2	CARCINOGENESIS
188	1	CARIBBEAN J.SCI.

Sl.No.	OCC.No.	Title
189	5	CARYOLOGIA
190	5	CELL
191	2	CELL MOL.BIOL.
192	59	CELL TISSUE RES.
193	1	CELL.DIFFERENT.
194	1	CHEM.GEOL.
195	1	CHEM.SENSES
196	6	CHEMOSPHERE
197	14	CHESAPEAKE SCI.
198	1	CHIN.J.FISH
199	1	CHINESE J.OCEANOL.LIMNOL.
200	1	CHINESE J.ZOOL.
201	1	CHROMATOGRAPHIA
202	5	CHROMOSOMA
203	6	CLIN.CHEM.
204	1	CLIN.PHYSIOL.
205	1	COMML.FISH.REV.
206	200	COMP.BIOCHEM.PHYSIOL.
207	66	COMP.BIOCHEM.PHYSIOL.A
208	83	COMP.BIOCHEM.PHYSIOL.B
209	18	COMP.BIOCHEM.PHYSIOL.C
210	2	COMP.PHYSIOL.
211	1	COMPUT.J.
212	1	COMPUTERS & GEOSCIENCES
213	9	CONT.SHELF RES.
214	225	COPEIA
215	18	CORAL REEFS
216	42	CRUSTACEANA
217	7	CURR.SCI.
218	19	CYBIUM
219	1	CYTOBIOLOGIE
220	3	CYTOBIOS
221	6	CYTOGENET.CELL GENET.
222	1	CYTOGENETICS
223	5	CYTOLOGY
224	7	DANA
225	35	DEEP SEA RES.
226	29	DEV.BIOL.
227	1	DEV.COMP.BIOL.
228	25	DEV.COMP.IMMUNOL.
229	3	DEV.GROWTH DIFFER.
230	1	DEVELOPMENT
231	56	DIS.AQUAT.ORG.
232	1	DYN.ATMOS.OCEANS
233	1	EAST AFR.WILDL.J.
234	1	ECOL.APPL.
235	2	ECOL.BULL.

Sl.No.	OCC.No.	Title
236	9	ECOL.MODEL.
237	77	ECOL.MONOGR.
238	2	ECOL.RES.
239	318	ECOLOGY
240	9	ECOTOXICOL.ENVIRON.SAF.
241	1	EKOL.POL.
242	1	ELECTROPHORESIS
243	3	EMBO J.
244	1	EMBRYOLOGIA
245	1	ENDOCRINE RES.
246	1	ENDOCRINOL.REV.
247	20	ENDOCRINOLOGY
248	308	ENV.BIOL.FISH.
249	1	ENV.CONTAM.TOXICOL.
250	4	ENV.ECOL.
251	8	ENV.HEALTH PERSPECTIVES
252	2	ENV.MANAGE.
253	1	ENV.MONIT.ASSESS.
254	25	ENV.POLLUT.
255	6	ENV.RES.
256	36	ENV.SCI.TECHNOL.
257	3	ENV.SCI.TOXICOL.
258	1	ENV.STUD.
259	36	ENV.TOXICOL.CHEM.
260	1	ENVIRON.RES.
261	37	ESTUAR.COAST.SHELF SCI.
262	40	ESTUARIES
263	1	ETHNOS
264	1	ETHOL.ECOL.EVOL.
265	6	ETHOLOGY
266	7	EUR.J.BIOCHEM.
267	1	EUR.J.VET.PHARMACOL.
268	4	EUROP.J.CELL BIOL.
269	1	EVOL.ECOL.
270	92	EVOLUTION
271	5	EXP.BIOL.
272	9	EXP.CELL RES.
273	1	EXP.EYE RES.
274	1	EXP.PARASITOL.
275	20	EXPERIENTIA
276	1	FASEB J.
277	1	FEEDSTUFFS
278	11	FINN.FISH.RES.
279	2	FISH BULL.(DUBLIN)
280	1	FISH FARMER
281	37	FISH PATHOL.
282	59	FISH PHYSIOL.BIOCHEM.

Sl.No.	OCC.No.	Title
283	4	FISH SHELLFISH IMMUNOL.
284	358	FISH.BULL.
285	1	FISH.BULLETIN CALIF.FISH GAME
286	1	FISH.IND.RES.
287	5	FISH.MANAGE.
288	1	FISH.OCEANOGR.
289	2	FISH.PATHOL.
290	18	FISH.PHYSIOL.BIOCHEM.
291	42	FISH.RES.
292	1	FISH.RES.J.PHILIPP.
293	1	FISH.TECHNOL.
294	21	FISHERIES
295	1	FISHING CHIMES
296	1	FOLIA LIMNOL.SCAND.
297	2	FOLIA MORPHOL.
298	1	FOLIA PARASITOL.
299	9	FOLIA ZOOL.
300	1	FOOD PROC
301	3	FOOD TECHNOL.
302	69	FRESHWATER BIOL.
303	3	FRESHWATER CRAYFISH
304	1	FRESHWATER FISHERIES
305	6	FUNCT.ECOL.
306	3	GALAXEA
307	234	GEN.COMP.ENDOCRINOL.
308	7	GENET.RES.
309	4	GENET.SEL.EVOL.
310	10	GENETICA
311	1	GENETICAL REV.
312	68	GENETICS
313	3	GENETIKA
314	8	GENOME
315	9	GEOCHIM.COSMOCHIM.ACTA
316	1	GHANA J.SCI.
317	4	GROWTH
318	6	GULF RES.REP.
319	4	HALIOTIS
320	17	HELGOL.WISS.MEERESUNTERS
321	9	HEREDITAS
322	29	HEREDITY
323	1	HISTOCHEM.CYTOCHEM.
324	5	HISTOCHEMISTRY
325	12	HOLARCT.ECOL.
326	2	HYDROBIOL.J.
327	1	HYDROBIOL.STUD.
328	129	HYDROBIOLOGIA
329	3	HYDROBIOLOGY

Sl.No.	OCC.No.	Title
330	2	IBIS
331	16	ICES J.MAR.SCI.
332	2	ICHTHYOL.FENN.BOREALIS
333	1	ICHTHYOPHYSIOL.ACTA
334	1	IMMUNOCHEMISTRY
335	2	IMMUNOGENETICS
336	4	IMMUNOLOGY
337	1	INDIAN BIOL.
338	1	INDIAN J.ANIM.SCI.
339	2	INDIAN J.EXP.BIOL.
340	7	INDIAN J.FISH.
341	5	INDIAN J.MAR.SCI.
342	1	INDIAN J.PHYSIOL.PHARMACOL.
343	1	INDIAN J.ZOOTOMY
344	1	INDO-PACIF.MOLLUSCA
345	3	INFOFISH INTERN.
346	1	INSECT BIOCHEM.
347	2	INT.J.AIR WATER POLLUT.
348	2	INT.J.APPL.RADIAT.ISOTOPES
349	1	INT.J.AQ.FISH.TECHNOL.
350	5	INT.J.BIOCHEM.
351	1	INT.J.CANCER.
352	2	INT.J.DEV.BIOL.
353	8	INT.J.ENV.ANAL.CHEM.
354	1	INT.J.FOOD MICROBIOL.
355	1	INT.J.FORECASTING
356	1	INT.J.IMMUNOPHARMACOL.
357	5	INT.J.INV.REPROD.
358	1	INT.J.MASS SPECTROM. ION PHYS.
359	4	INT.J.PARASITOL.
360	1	INT.J.REMOTE SENS.
361	7	INT.J.SYST.BACTERIOL.
362	1	INT.J.TISSUE REACT.
363	5	INTER.REV.GES.HYDROBIOL.
364	1	INTERN.ARCH.IMMUN.APPL.IMMUNOL
365	1	INTERN.J. HYDROBIOL.
366	1	INTERN.J.ACAD.ICHTHYOL.
367	1	INTERN.J.PARASITOL.
368	1	INTERVIROLOGY
369	18	INV.PESQ.
370	1	ISRAEL J.CHEM.
371	1	ISRAEL J.TECHNOL.
372	5	ISRAEL J.ZOOL.
373	18	J.ACOUST.SOC,AM.
374	1	J.AGRIC.ECON.
375	13	J.AGRIC.FOOD CHEM.
376	2	J.AGRIC.RES.ICELAND

Sl.No.	OCC.No.	Title
377	4	J.AM.CHEM.SOC.
378	1	J.AM.MOSQ.CONTROL ASSOC.
379	5	J.AM.OIL CHEM.SOC.
380	15	J.AM.STAT.ASSOC.
381	2	J.AM.VET.MED.ASSOC.
382	1	J.AM.WATER WORKS ASSOC.
383	1	J.ANAL.ATOM.SPECTROM.
384	1	J.ANAL.CHEM.
385	1	J.ANAL.SPECTROM.
386	7	J.ANAT.
387	113	J.ANIM.ECOL.
388	1	J.ANIM.MORPHOL.PHYSIOL.
389	1	J.ANIM.PHYSIOL.ANIM.NUTR.
390	36	J.ANIM.SCI.
391	13	J.AOAC
392	2	J.APPL.AQUACULT.
393	8	J.APPL.BACTERIOL.
394	1	J.APPL.BACTERIOL.SYMP.
395	9	J.APPL.ECOL.
396	21	J.APPL.ICHTHYOL.
397	2	J.APPL.PHYCOL.
398	4	J.APPL.PHYSIOL.
399	2	J.APPL.TOXIC.
400	3	J.AQUACULT.TROP.
401	3	J.AQUARICULT.AQUAT.SCI.
402	25	J.AQUAT.ANIM.HEALTH
403	1	J.ARCHEOL.SCI.
404	1	J.ASIAT.SOC.BENGAL
405	2	J.ATMOS.SCI.
406	7	J.BACTERIOL.
407	1	J.BEIJING NORMAL UNIV.
408	7	J.BIOCHEM.
409	1	J.BIOCHEM.BIOPHYS.METHODS
410	1	J.BIOENG.BIOMEM.
411	4	J.BIOGEOGR.
412	9	J.BIOL.BD.CAN.
413	81	J.BIOL.CHEM.
414	1	J.BIOMATH.
415	8	J.BIOPHYS.BIOCHEM.CYTOL.
416	1	J.BOMBAY NAT.HIST.SOC.
417	1	J.BOT.
418	3	J.CELL BIOCHEM.
419	34	J.CELL BIOL.
420	2	J.CELL SCI.
421	5	J.CELL.COMP.PHYSIOL.
422	1	J.CELL.PHYSIOL.
423	2	J.CEPHALOPOD BIOL.

Sl.No.	OCC.No.	Title
424	4	J.CHEM.ECOL.
425	1	J.CHEM.SOC.
426	2	J.CHINESE AGRIC.CHEM.SOC.
427	16	J.CHROMATOGR.
428	3	J.CLIM.
429	1	J.CLIM.APPL.METEOROL.
430	2	J.CLIN.ENDOCRINOL.
431	3	J.CLIN.ENDOCRINOL.METABOL.
432	2	J.CLIN.INVEST.
433	8	J.CLIN.MICROBIOL.
434	1	J.CLIN.PATHOL.
435	1	J.COMP.BIOCHEM.PHYSIOL.
436	11	J.COMP.NEUROL.
437	96	J.COMP.PHYSIOL.
438	1	J.COMP.PHYSIOL.PSYCHOL.
439	2	J.COMP.PSYCHOL.
440	1	J.COMP.ZOOL.
441	4	J.CONCH.
442	55	J.CRUSTACEAN BIOL.
443	1	J.CRYSTAL GROWTH
444	4	J.DAIRY SCI.
445	1	J.DERMATOL.
446	136	J.DU CONS.
447	12	J.ECOL.
448	1	J.ECON.ENTOMOL.
449	1	J.ELECTRON MICROSC.
450	6	J.EMBRYOL.EXP.MORPHOL.
451	34	J.ENDOCRINOL.
452	1	J.ENG.ENV.
453	1	J.ENV.ECOL.MANAGE.
454	5	J.ENV.QUAL.
455	1	J.ENV.RADIOACT.
456	2	J.ETHOL.
457	198	J.EXP.BIOL.
458	1	J.EXP.BOT.
459	1	J.EXP.EMBRYOL.MORPHOL.
460	281	J.EXP.MAR.BIOL.ECOL.
461	5	J.EXP.MED.
462	159	J.EXP.ZOOL.
463	3	J.FAC.AGRIC.KYUSHU UNIV.
464	2	J.FAC.FISH.ANIM.HUSB.HIROSHIMA
465	1	J.FAC.FISH.HOKKAIDO UNIV.
466	1	J.FAC.MAR.SCI.
467	1	J.FAC.MAR.SCI.TECHNOL.TOKAI UN
468	5	J.FAC.SCI.HOKKAIDO UNIV.
469	918	J.FISH BIOL.
470	142	J.FISH DIS.

Sl.No.	OCC.No.	Title
471	1	J.FISH PHYSIOL.BIOCHEM.
472	8	J.FISH.CHINA
473	667	J.FISH.RES.BD.CAN.
474	3	J.FISH.SOC.TAIWAN
475	1	J.FLUID MECH.
476	1	J.FOOD HYG.SOC.JPN.
477	1	J.FOOD PROTECT.
478	7	J.FOOD SCI.
479	2	J.FOOD SCI.TECHNOL.
480	5	J.FOOD TECHNOL.
481	1	J.FORENSIC SCI.SOC.
482	3	J.FRESHWATER ECOL.
483	8	J.GEN.MICROBIOL.
484	9	J.GEN.PHYSIOL.
485	9	J.GEN.VIROL.
486	6	J.GENET.
487	1	J.GEOL.SOC.LOND.
488	21	J.GEOPHYS.RES.
489	1	J.GERONTOLOGY
490	37	J.GREAT LAKES RES.
491	1	J.HAEMATOLOGIA
492	4	J.HELMINTH.
493	27	J.HERED.
494	1	J.HERPETOL.
495	10	J.HISTOCHEM.CYTOCHEM.
496	1	J.HOKKAIDO INST.FISH.
497	1	J.HUM.GENET.
498	1	J.HYDROBIOL.
499	3	J.HYDROL.
500	27	J.ICHTHYOL.
501	3	J.IMMUNOL.
502	3	J.IMMUNOL.METHODS
503	2	J.INDIAN FISH.ASSOC.
504	1	J.INLAND FISH.SOC.INDIA
505	3	J.INSECT PHYSIOL.
506	2	J.INST.FISH.MANAGE.
507	11	J.INVERTEBR.PATHOL.
508	2	J.LAB.CLIN.MED.
509	1	J.LEUKOCYTE BIOL.
510	2	J.LIMNOL.SOC.S.AFRICA
511	2	J.LINN.SOC.LOND.(ZOOL.)
512	17	J.LIPID RES.
513	3	J.LIQUID CHROMATOGR.
514	3	J.MALACOL.SOC.AUST.
515	3	J.MAMMAL.
516	5	J.MAR.BIOL.ASSOC.INDIA
517	165	J.MAR.BIOL.ASSOC.U.K

Sl.No.	OCC.No.	Title
518	27	J.MAR.RES.
519	1	J.MAR.SCI.
520	4	J.MAR.SYST.
521	1	J.MATH.ANAL.APPL..
522	7	J.MEMBR.BIOL.
523	6	J.METEOR.SOC.JPN.
524	1	J.MICROENCAPSULATION
525	2	J.MICROSCOP.
526	1	J.MILKFOOD TECHNOL.
527	10	J.MOL.BIOL.
528	20	J.MOL.EVOL.
529	6	J.MOLLUSC.STUD.
530	48	J.MORPH.
531	1	J.MULTIVAR.ANAL.
532	12	J.MUSCLE RES.CELL MOTIL.
533	7	JN.AM.BENTHOL.SOC.
534	9	J.NAT.CANCER INST.
535	14	J.NAT.HIST.
536	2	J.NEUROCHEM.
537	1	J.NEUROPHYSIOL.
538	38	J.NORTHWEST ATL.FISH.SCI.
539	2	J.NUC.MED.
540	83	J.NUTR.
541	1	J.NUTR.SCI.VITAMINOLOGY,TOKYO
542	2	J.OCEANOGR.SOC.JAPAN
543	3	J.OPT.SOC.AM.
544	4	J.ORG.CHEM.
545	1	J.PA.ACAD.SCI.
546	5	J.PALEONTOL.
547	22	J.PARASITOL.
548	1	J.PEDIATR.
549	1	J.PENEL.PERIKANAN LAUT
550	3	J.PHARM.DYN.
551	2	J.PHARM.SCI.
552	2	J.PHARMACOK.BIOPHARM.
553	1	J.PHARMACOL.
554	1	J.PHARMACOL.EXP.THER.
555	21	J.PHYCOL.
556	8	J.PHYS.OCEANOGR.
557	15	J.PHYSIOL.
558	1	J.PLANAR CHROM.
559	46	J.PLANKTON RES.
560	3	J.PRIM.IND.
561	7	J.PROTOZOOL.
562	6	J.R.STAT.SOC.
563	2	J.RAD.RES.
564	6	J.REPROD.FERTIL.

Sl.No.	OCC.No.	Title
565	1	J.SCI.AGRI.SOC.FINLAND
566	11	J.SCI.FOOD AGRIC.
567	1	J.SCI.IND.RES.
568	3	J.SEDIMENT.PETROL.
569	45	J.SHELLFISH RES.
570	3	J.SHIMONOSEKI UNIV.FISH.
571	1	J.SMALL ANIM.PRACTICE
572	1	J.SOUTHWEST TEACHERS COLLEGE
573	1	J.SOUTHWEST TEACHERS UNIV.
574	1	J.STAT.COMPUT.SIMUL.
575	1	J.STEROID BIOCHEM.
576	4	J.SUBMICROSCOP.CYTOL.
577	3	J.SUBMICROSCOP.CYTOL.PATHOL.
578	1	J.SURG.RES.
579	1	J.TENN.ACAD.SCI.
580	25	J.THEOR.BIOL.
581	1	J.THERM.BIOL.
582	6	J.TOKYO UNIV.FISH.
583	3	J.TOXICOL.ENV.HEALTH
584	3	J.ULTRASTRUCT.MOL.STRUCT.RES.
585	16	J.ULTRASTRUCT.RES.
586	1	J.VERTEBR.PALEONTOL.
587	1	J.VET.DIAGN.INVEST.
588	5	J.VET.PHARMACOL.THERAP.
589	1	J.VET.SCI.
590	4	J.VIROL.
591	1	J.WASHINGTON ACAD.SCI.
592	8	J.WILDL.DIS.
593	31	J.WILDL.MANAGE.
594	55	J.WORLD AQUACULT.SOC.
595	36	J.WORLD MARICULT.SOC.
596	1	J.XIAMEN UNIV.(NAT.SCI.)
597	78	J.ZOOL.
598	1	J.ZOOL.SOC.INDIA
599	1	JAP.J.GENET.
600	42	JAP.J.ICHTHYOL.
601	1	JAP.J.PARASITOL.
602	1	JAP.J.PHARMACOL.
603	1	JASIS
604	7	JPN.J.ECOL.
605	5	JPN.J.LIMNOL.
606	1	JPN.J.MALACOL.
607	3	JPN.J.ZOOL.
608	2	KIELER MEERESFORSCHUNGEN
609	4	LA MER
610	170	LIMNOL.OCEANOGR.
611	3	LIMNOLOGICA

Sl.No.	OCC.No.	Title
612	44	LIPIDS
613	2	LIVESTOCK PROD.SCI.
614	2	MAHASAGAR
615	2	MALACOL.REV.
616	20	MALACOLOGIA
617	8	MAR.BEHAV.PHYSIOL.
618	549	MAR.BIOL.
619	1	MAR.BIOL.BIOTECHNOL.
620	5	MAR.CHEM.
621	330	MAR.ECOL.
622	21	MAR.ENV.RES.
623	1	MAR.FISH.RES.
624	25	MAR.FISH.REV.
625	1	MAR.FRESHWATER RES.
626	1	MAR.GEOL.
627	1	MAR.MICROB. FOOD WEBS
628	2	MAR.POLICY
629	17	MAR.POLLUT.BULL.
630	1	MAR.RES.
631	1	MAR.RES.ECON.
632	1	MAR.SCI.COMM.
633	1	MARINE AQUARIST
634	9	MARINE BIOL.LETT.
635	1	MATSYA
636	1	MEERESFORSCHUNG
637	1	MEM.FAC.FISH.KAGOSHIMA UNIV.
638	13	MICROB.ECOL.
639	1	MICROBIOL.REV.
640	1	MICROBIOLOGIA
641	3	MICRONESICA
642	1	MITT.INT.VER.LIMNOL.
643	1	MOL.BIOCHEM.
644	1	MOL.BIOL.
645	13	MOL.BIOL.EVOL.
646	4	MOL.CELL BIOL.
647	2	MOL.CELL.BIOCHEM.
648	1	MOL.GEN.GENET.
649	5	MOL.MAR.BIOL.BIOTECHNOL.
650	1	MOL.PHYSIOL.
651	1	MOL.REPROD.DEV.
652	2	MOLEC.CELL ENDOCRINOL.
653	3	MUTAT.RES.
654	60	N.AM.J.FISH.MANAGE.
655	1	N.ENG.J.MED.
656	11	N.Y.FISH GAME J.
657	1	N.Y.J.PALEOLIMNOL.
658	1	N.Z.J.AGRIC.RES.

Sl.No.	OCC.No.	Title
659	50	N.Z.J.MAR.FRESHWATER RES.
660	5	N.Z.J.SCI.
661	2	N.Z.J.SCI.TECHNOL.
662	11	NAT.CAN.
663	1	NAT.GEORG.
664	1	NATURA. RES.MODEL.
665	2	NATURALIST(HULL)
666	154	NATURE
667	6	NAUTILUS
668	1	NETH.J.MED.
669	1	NETH.J.PLANKTON RES.
670	50	NETH.J.SEA RES.
671	23	NETH.J.ZOOL.
672	1	NEUROPHYSIOL.
673	1	NEW SCIENT.
674	110	NIPPON SUISAN GAKKAISHI
675	5	NORDIC J.FRESHWATER RES.
676	2	NORTHWEST ENVIRON.J
677	4	NORWEGIAN J.ZOOL.
678	1	NOT.NAT.
679	6	NUCLEIC ACIDS RES.
680	2	OCEANIS
681	6	OCEANOL.ACTA
682	2	OCEANOL.LIMNOL.SIN.
683	2	OCEANUS
684	4	OEBALIA
685	104	OECOLOGIA
686	20	OECOLOGIA(B)
687	9	OHIO J.SCI.
688	63	OIKOS
689	1	ONCOLOGY
690	1	OPER.RES.
691	26	OPHELIA
692	1	PACIF.BIOL.CONSERV.
693	24	PACIF.SCI.
694	1	PAKISTAN J.SCI.IND.RES.
695	1	PAKISTAN J.ZOOL.
696	2	PALAEONTOLOGY
697	1	PALEOBIOLOGY
698	1	PAPUA NEW GUINEA AGRIC.J.
699	2	PARASITOL.RES.
700	1	PARASITOLOGIA
701	13	PARASITOLOGY
702	1	PATHOLOGY,RESEARCH PRACTICE
703	2	PEDIATRIC RES.
704	1	PELAGOS
705	1	PERTANIKA

Sl.No.	OCC.No.	Title
706	2	PESTIC.MONIT.J.
707	25	PHIL.TRAN.ROY.SOC.B
708	1	PHILIPP.J.BIOL.
709	1	PHILIPPINE J.ZOOL.
710	1	PHILL.J.SCI.
711	1	PHILLIP.J.FISH.
712	1	PHOTOCHEM.PHOTOBIOL.
713	3	PHYCOLOGIA
714	1	PHYSIOL.BEHAV.
715	11	PHYSIOL.REV.
716	42	PHYSIOL.ZOOL.
717	1	PHYSIOLOGIST
718	6	PHYTOCHEMISTRY
719	2	PL.CELL PHYSIOL.
720	1	PL.PHYSIOL.
721	1	PLANT SOIL
722	2	PLANTA
723	6	POL.ARCH.HYDROBIOL.
724	21	POLAR BIOL.
725	1	POLAR RES.
726	17	POULT.SCI.
727	1	PROC.ACAD.NAT.SCI.PHILAD.
728	1	PROC.ARKANSAS ACAD.SCI.
729	1	PROC.CALIF.ACAD.SCI.
730	1	PROC.GULF CARRIBEAN FISH INST.
731	2	PROC.INDIAN ACAD.SCI.(A)
732	7	PROC.INDIAN ACAD.SCI.B
733	2	PROC.INDIAN NAT.SCI.ACAD.
734	1	PROC.JPN.ACAD.
735	1	PROC.LINN.SOC.LOND.
736	2	PROC.LINN.SOC.N.S.W
737	5	PROC.MALACOL.SOC.LOND.
738	2	PROC.N.S.INST.SCI.
739	2	PROC.NAT.INST.SCI.INDIA.B
740	79	PROC.NATL.ACAD.SCI.USA
741	8	PROC.NATL.SHELLFISH ASSOC.
742	1	PROC.R.IR.ACAD.
743	9	PROC.R.SOC.EDINB.
744	1	PROC.ROY.IRISH ACAD.
745	34	PROC.ROY.SOC.LOND.B
746	25	PROC.WORLD MARICULT.SOC.
747	1	PROC.ZOOL.SOC.CALCUTTA
748	16	PROC.ZOOL.SOC.LOND.
749	135	PROG.FISH CULT.
750	12	PROG.LIPID RES.
751	11	PROG.OCEANOGR.
752	3	PROTISTOLOGICA

Sl.No.	OCC.No.	Title
753	2	PSYCHOMETRIKA
754	1	Q.J.EXP.PHYSIOL.
755	3	Q.J.FLORIDA ACAD.SCI.
756	3	Q.J.MICROSCOP.SCI.
757	12	Q.REV.BIOL.
758	1	QUAT.SCI.REV.
759	5	RAPP.P.V.REUN.CONS.INT.EXPLOR.
760	1	REC.AUST.MUS.
761	4	REC.IND.MUS.
762	11	REPROD.NUTR.DEV.
763	1	RES.IMMUNOL.
764	1	REVISTA BIOLOGICA
765	2	S.AFR.J.ANIM.SCI.
766	1	S.AFR.J.MAR.FRESHWATER RES.
767	28	S.AFR.J.MAR.SCI.
768	5	S.AFR.J.SCI.
769	9	S.AFR.J.ZOOL.
770	1	SANKHYA
771	16	SARSIA
772	2	SCAND.J.IMMUNOL.
773	1	SCAND.J.STAT.
774	1	SCANDIVIC J.CLIN.LAB.INVEST.
775	3	SCI.AMER.
776	1	SCI.CULT.
777	163	SCIENCE
778	1	SCIENCE TOTAL ENV.
779	2	SCIENTA MAR.
780	1	SEA FRONT.
781	2	SENKEN.BIOL.
782	4	SINGAPORE J.PRIM.IND.
783	1	SINGAPORE VET.J
784	2	SMITHSONIAN CONTRIB.ZOOL.
785	3	SOIL BIOL.BIOCHEM.
786	2	SOIL SCI.
787	3	SOIL SCI.SOC.AM.J.
788	1	SOV.J.MAR.BIOL.
789	2	STAIN TECHNOL.
790	4	STAT.SCI.
791	1	SYMBIOSIS
792	1	SYST.ECOL.
793	18	SYST.ZOOL.
794	3	TECHNOMETRICS
795	3	TETHYS
796	1	TEX.J.SCI.
797	1	THAI J.VET.MED.
798	3	THALASSIA JUGOSL.
799	32	THEOR.APPL.GENET.

Sl.No.	OCC.No.	Title
800	10	THEOR.POPUL.BIOL.
801	1	THERIOGENOLOGY
802	3	TISSUE CELL
803	7	TOHOKU J.AGRIC.RES.
804	8	TOXICOL.APPL.PHARMACOL.
805	2	TOXICOL.ENV.CHEM.
806	3	TOXICOLOGY
807	1	TOXICON
808	588	TRAN.AM.FISH.SOC.
809	1	TRAN.AM.GEOPHYS.UNION
810	3	TRAN.AM.MICROSCOP.SOC.
811	1	TRAN.AM.SOC.AGRIC.ENG.
812	1	TRAN.LIVERPOOL FISH.SOC.
813	1	TRAN.N.Y.ACAD.SCI.
814	1	TRAN.PATHOL.SOC.LOND.
815	1	TRAN.R.SOC.CAN.
816	7	TRAN.R.SOC.LOND.B
817	1	TRAN.R.SOC.N.Z
818	4	TRAN.R.SOC.S.AFR.
819	1	TRAN.R.SOC.SOUTH AUSTRALIA
820.	4	TRAN.ZOOL.SOC.LOND.
821	1	TRAN.ZOOL.SOC.S.AUSTRALIA
822	1	TRANSPLANTATION
823	4	TRENDS BIOTECHNOL.
824	2	TRENDS ECOL.EVOL.
825	1	TRENDS EVOL.
826	2	TRENDS GENET.
827	4	TROP.FISH HOBBYIST
828	4	TROPIC OCEANOL.
829	9	VELIGER
830	1	VENUS
831	54	VERH.INT.VER.LIMNOL.
832	15	VET.IMMUNOL.IMMUNOPATHOL.
833	1	VET.Q.
834	1	VET.REC.
835	1	VETER.PATHOL.
836	5	VIE MILIEU
837	3	VIROLOGY
838	1	VIRUS RES.
839	12	VISION RES.
840	1	VISSERIJ
841	1	VISUAL NEUROSCI.
842	1	WAT.RES.
843	53	WATER AIR SOIL POLLUT.
844	3	WATER POLLUT.RES.J.CAN.
845	48	WATER RES.
846	9	WATER RESOUR.RES.

Sl.No.	OCC.No.	Title
847	2	WATER SCI.TECHNOL.
848	14	WORLD AQUACULT.
849	11	XENOBIOTICA
850	1	Z.ZELLFORSCH.
851	2	ZOOL.ANZ.
852	14	ZOOL.J.LINN.SOC.
853	1	ZOOL.MAG.
854	9	ZOOL.SCI.
855	1	ZOOL.ZH.
856	15	ZOOLOGICA
857	7	ZOOMORPHOLOGY

ANNEXURE II

BIBLIOGRAPHY

Aaronson,S. 1975. Footnotes of science. Mosaic, 6 (2): 22-27 Reprinted in: Essays of an information Scientist, 2: 286-295.

Abdulla,S.B. and Lancaster,F.W. 1991. The contribution of scientists to popular literature, their role as expert witnesses and their influence on their peers: a case study in the field of Acid rain. Scientometrics, 20: 55-64.

Adewole,S. 1987. Selecting livestock periodicals through citation analysis technique. Information Processing and Management, 23 (6): 629-638.

Agarwal,S.C. 1990. Fishery Management. Ashish Publishing House, New Delhi 462 p.

Aiypeku,W.O. 1974. Towards a methodology of bibliometrics. Nigerian Librarian, 10 (2-3): 85-90.

Aiypeku,W.O 1976. The Productivity of geographical authors, a case study from Nigeria. Journal of Documentation, 32: 105-117.

Aiypeku,W.O. 1977. The Bradford distribution theory: The compounding of periodical literature in Geography. Journal of Documentation, 33 (3): 210-219.

Allsopp,W.H.L. 1985. Fishery development experiences. Fishing News Books Ltd., London, 160pp.

Anonymous. 1985. Fishes. Fishing and Marine Products. Encyclopaedia Britannica Vol.19. Macropaedia p. 190-202.

Aravinda,P. and Pulla Reddy,V. 1989. Literature of archaeological anthropology: a citation analysis. Annals of Library Science and Documentation, 36 (3): 85-90.

Arjun Lal, 1988. Citations in agricultural research. Journal of Library and Information Science, 13 (2): 175-183.

Arms,W.Y. and Arms,C.R. 1978. Cluster analysis used on Social science journal citations. Journal of Documentation, 34: 1-11.

Arora,J and Kaur,S.P. 1994. Bibliometric analysis of core journals in Immunology. Annals of Library Science and Doucmentation, 41: 81-94.

Arora,K and Sen,B.K. 1992. Use of impact factor as a valid measure for evaluating the performance of scientific papers. In Ravichandra Rao, I.K. Ed: Informetrics-91. Sarada Ranganathan Endowment for Library Science, Bangalore P. 36-50.

Arunachalam,S. 1988. The links between mainstream science and journals of periphery. Journal of Scientific and Industrial Research. 47: 307-314.

Arunachalam,S. 1993. Science in India: how much and how well do we do? Biobytes, 1 (3): 3-6.

Arunachalam,S and Manoharan,K. 1988. Status of scientific journals in India as seen through science citation Index, Journal of Scientific and Industrial Research, 47: 359-367.

Arunachalam,S and Manorama,K. 1989. Are citation based quantitative techniques adequate for measuring science on the periphery? Scientometrics, 15: 393-408.

Arunachalam,S and Markanday,S. 1981. Science in the middle level countries: a bibliometric analysis of scientific journals in Australia, Canada, India and Israel. Journal of Information Science, 3 (1): 13-26.

Arunachalam,S and Singh,N.U. 1992. Access to information and the scientific output of India. Journal of Scientific and Industrial Research, 51 (2): 99-119.

Arunlal, 1990. Ranking of periodicals in the fields of soil science. Annals of Library Science and Documentation, 37 (2): 67-73.

Asai,I 1981. A general formulation of Bradford's distribution: The graph oriented approach. Journal of American Society for Information Science, 32: 113-119.

Atkins,S.E. 1988. Subject trends in library and information science research 1975-1984. Library Trend, 36 (4): 633-658.

Aulakh,G.S. Jain, H.C. and Kochhar, V.B. 1983. Bibliometric study of Indian Phytochemical literature growth pattern and scatter. Journal of library and Information Science, 8 (1): 69-87.

Aversa,E.S. 1985. Citation patterns of highly cited papers and their relationship to literature aging: a study of the working literature. Scientometrics, 7: 383-389.

Avramescu,A 1979. Actuality and obsolescence of scientific literature. Journal of American Society for Information Science, 30: 296-303.

Avramescu,A. 1980. Theoretical foundations of Bradford's law. International Forum on Information and Documentation, 5: 15-22.

Aziagba,P.C. 1993. Scientific journal selection based on the study of a local journal. Information Processing and Management, 29: 83-93.

Balasubramanian,S and Bhaskar,P.A. 1984. Citation analysis in neurology from the point of view of Indian Scientists. IASLIC Bulletin, 29, (2): 63-67.

Bal,D.V. and Rao,K.V. 1990. Marine Fisheries of India. Tata MC-Graw Hill Publishing Company, New Delhi, 472p.

Baldauf,R.B. and Jernudd,B.H. 1983. Language use pattern in the fisheries periodical literature. Scientometrics, 5: 245-255.

Barker,D.L. 1966, Characteristics of research literature used by chemists. Ph.D. Dissertation, Universtiy of Illinois.

Barooah,P.K. 1993. Patterns of information use by Indian entomologists. Annals of Library Science and Documentation 40 (3): 104-114.

Basu, Aparna, 1992. On the theoretical foundation of Bradford's law: In: Ravichandra Rao, I.K. Ed: Informetrics - 91, Sarada Ranganathan Endowment for Library Science, Bangalore, p. 51-69.

Bayer,A.E. and Folger,J. 1966. Some correlates of a citation measure of productivity in science. Sociology of Education. 39 (4): 382-390.

Beckavac,A. Petrak,J and Buneta,Z. 1994. Citation behaviour and place of publication in the authors from the scientific periphery a matter of quality? Information Processing and Management 30: 33-42.

Bensman,S.J. 1982. Bibliometric laws and library usage as social phenomena. Library Research, 4: 279-312.

Bensman,S.J. 1985. Journal collection management as a cumulative advantage process. College and Research Libraries. 46: 13-29.

Bhattacharya,G. 1985. Project on study of subjects. Library Science, 12: 65-79 (Paper G)

Bonitz,M. 1985. Journal ranking by selective impact, New methods based on SDI results. Scientometrics, 7 (3-6): 471-485.

Bonitz,M. 1990. Journal ranking by different parameters Pt.1. Collectivity two ranking parameters reflecting the structure of a journal net work. Scientometrics, 18 (1-2): 57-73.

Bonitz,M. 1990. Journal ranking by different parameters Pt-II. Individual or collective: which parameters are best suited for journal ranking? Scientometrics, 18 (1-2): 75-93.

Bonzi,S. 1982. Characteristics of a literature as predictors of relatedness between cited and citing works. Journal of American Society for Information Science, 33 (4): 208-216.

Bookstein,A. 1976. The bibliometric distributions. Library Quarterly, 46: 416-423.

Bookstein,A. 1977. Patterns of scientific productivity and social change: A discussion of Lotka's law and bibliometric symmetry Journal of American Society for Information Science, 28: 206-210.

Bookstein,A. 1979. Explanations of the bibliometric laws. Collection Management, 3 (2-3): 151.

Bookstein,A. 1988. Applications of bibliometric distributions. In Egghe and Rousseau, Ed: Informetrics 87-88. Elsevier, Amsterdam p.5-13.

Bookstein,A. 1990. Informetric distributions. Pt. I. Unified overview. Journal of American Society for Information Science. 41 (5): 368-375.

Bookstein,A. 1990a. Informetric distributions Pt.II. Resilence to ambiguity. Journal of American Society for Information Science, 41 (5): 376-386.

Bookstein,A. 1992. Theoretical properties of the informetric distributions: Some open questions. In: Ravichandra Rao, I.K. Ed: Informetrics-91. Sarada Ranganathan Endowment in Library Science, Bangalore, p. 17-35.

Bookstein,A. 1994. Scientometrics - new opportunities. Scientometrics, 30: 455-460.

Bookstein,A. 1994a. Towards a multidisciplinary Bradford law. Scientometrics, 30: 353-361.

Borgstrom, Georg, 1961. Fish as food. Vol. I Academic Press, New York, p.41-75.

Bradford,S.C. 1934. Sources of information on specific subjects. Engineering, 137: 85-86. Reprinted in Collection Management, 1: 95-103 and Journal of Information Science, 10: 176-180, 1985.

Bradford,S.C. 1948. Documentation. Crosby Lockwood, London.

Braun,T., Glanzel,W. and Schubert,A. 1985 Scientometric indicators A 32-country comparative evaluation of publishing performance and citation impact. World scientific publishing company, Singapore.

Braun,T. etal 1990. Publication productivity, from frequency distribution to scientometric indicators, Journal of Information Science, 16: 37-44.

Broadus,R.N. 1977. The applications of citation analysis to library collection building. Advances in Librarionship 7: 300-335.

Broadus,R.N. 1987. Early approaches to bibliometrics. Journal of American Society for Information Science, 38: 127-129.

Broadus,R.N. 1987a. Towards a definition of bibliometrics. Scientometrics, 12: 373-379.

Brookes,B.C. 1968. The derivation and application of the Bradford-Zipf distribution. Journal of Documentation, 24 (4): 247-65.

Brookes,B.C. 1969, Bradford's law and the bibliography of science. Nature, 224: 953-956.

Brookes,B.C. 1970. Growth, utility and obsolescence of scientific periodical literature. Journal of Documentation, 26 (4): 283-294.

Brookes,B.C. 1973. Numerical methods of bibliographic analysis. Library Trends, 22: 18-43.

Brookes,B.C. 1977. Theory of the Bradford's law. In: Griffith, B.C. Ed: Key papers in Information Science, Knowledge Industry Publication, Whiteplains, New York, Reprinted from Journal of Documentation, 33: 180-209.

Brookes,B.C. 1981. A Critical commentary on Leimkuhler's exact formulation of the Bradford law. Journal of Documentation 37: 77-88.

Brookes,B.C. 1984. Towards informetrics. Haitun, Laplace, Zipf, Bradford and the Alvey programme. Journal of Documentation, 40 (2): 120-143.

Brookes,B.C. 1985. Development of bibliometrics. Journal of Information Science, 10: 91-92.

Brookes,B.C. 1988. Comments on the scope of bibliometrics. In: Egghe and Rousseau, Ed. Informetrics 87/88. Elsevier, Amsterdam, p. 29-41.

Brookes,B.C. 1990. Biblio ____, Sciento ____, Infor-metrics. what are we talking about? In: Egghe and Rousseau, Ed: Informetrics 89/90. Elsevier, Amsterdam, p.31-43.

Brooks,T.A. 1987. The bibliometrics tool box version 2.5. Software and documentation available from North City Bibliometrics, Seattle.

Brooks,T.A. 1989. The model of Science and scientific models in librarianship. Library Trends. 38 (2): 237-249.

Brooks,T.A. 1991. Literature core zones adjusted by impact factors. Journal of Information Science 16: 51-57.

Brown,C.H. 1956. Scientific serials characteristics and lists of most cited publications in Mathematics, Physics, Chemistry, Geology, Botany, Zoology and Entomology. ACRL, Chicago Monograph No. 16, p. 1-15.

Buckland,M.K. 1972. Are obsolescence and scattering related? Journal of Documentation 28 (3): 242.

Burrell,Q.L. 1985. The 80/20 rule: library lore or statistical law? Journal of Documentation, 41: 24-39.

Burrell,Q.L. 1988, Modelling the Bradford phenomenon. Journal of Documentation, 44 (1): 1-18.

Burrell,Q.L. 1988a. Predictive aspects of some bibliometric process. In: Egghe and Rousseau, Ed: Informetrics 87/88, Elsevier, Amsterdam, p. 43-63.

Burrell,Q.L. 1990. The non-equivalence of Bradford, Leimkuhler and Lotka's laws. Research Report 134/QLB, Statistical Laboratory, Department of Mathematics, University of Manchester, U.K.

Burrell,Q.L. 1991. The Bradford distribution and the Gini Index. Scientometrics, 21: (2) 181-194.

Burrell,Q.L. 1992. The dynamic nature of bibliometric processes; a case study. In: Ravichandra Rao, I.K. Ed: Infometrics-91 p.97-129.

Burrell,Q.L. 1993. A remark on the geometry of Egghe's dual IPP's. Information Processing and Management, 29 (2): 515-521.

Burton,H.D. 1988. Use of a virtual information system for bibliometric analysis. Information Processing and Management, 24 (1): 39-44.

Burton,R.E. and Kebler,R.W. 1960. The half-life of some scientific and technical literatures. American Documentation, 11: 18-22.

Campbell,M.B.M. 1974. A survey of the use of science periodicals in Wolverhampton polytechnic library. Research in Librarianship 5: 39-71.

Cano,V and Lind N.C. 1991. Citation life cycles of ten citation classics. Scientometrics, 22 (2): 297-312.

Carpenter,M.P. and Narin,F. 1973. Clustering of scientific journals. Journal of American Society for Information Science, 24: 425-436.

Cawkell,A.E. 1976. Understanding science by analysis of its literature. Information Scientist, 10: 3-10 Reprinted in: Essays of an Information Scientist, 2: 543-549.

Chandrasekhara Rao,B and Divakar,P. 1985. A bibliometric analysis of mathematical biology literature. Proceedings of 15th IASLIC Conference, Bangalore, p. 17-22.

Chen,C.C. 1972. The use pattern of physics journals in a large research library. Journal of American Society for Information Science, 23 (4): 254-270.

Chen,C.C. 1979. Scientific and technical libraries - use of scientific and technical literature. In: Encyclopaedia of Library and Information Science, Marcel Dekker, New York, 27: 11-13.

Chen,Y.S. 1989. Analysis of Lotka's law: the simon-yule approach Information Processing and Management, 25 (5) 527-544.

Chen,Y.S. and Leimkuhler, F.F. 1986. A relationship between Lotka's law, Bradford's law and Zipf's law. Journal of American Society for Information Science, 37: 307-314.

Chen,Y.S. and Leimkuhler,F.F. 1987. Bradford's law - an Index approach. Scientometrics, 11: 183-198.

Christavo,H.T. 1985. The aging of literature of biomedical sciences in developed and developing countries. Scientometrics, 7: 411-430.

Chubin,D.E. and Moitra,S.D. 1975. Content analysis of references: adjunct or alternative to citation counting. Social studies of Science, 5: 423-441.

Chudamani,K.S. and Shalini,P.R. 1983. Journal acquisitions - cost effectiveness models. Information Processing and Management, 19: 307-311.

Cline,G.S. 1981. Application of Bradford's law to citation data. College and Research Libraries,42 (1): 53-61.

Coile,R.C. 1976. Bibliometric studies of scientific productivity. Proceedings of American Society for Information Science, 13: 20.

Coile,R.C. 1977. Lotka's frequency distribution of scientific productivity. Journal of American Society for Information Science, 28 (6): 366.

Cole,E.J. and Eales,N.B. 1917. History of comparative anatomy Pt. I. Statistical analysis of literature. Science Progress. p. 578-596.

Cole,P.F. 1962. A new look at reference scattering. Journal of Documentation, 18(2): 58.

Connell,J.J. 1980. Advances in fish science and technology. Fishing News Books Ltd., London.

Cronin,B. 1981. The need for a theory of citing. Journal of documentation, 37: 16-24.

Crouch,D., Irvine,J. and Martin,B.R. 1986. Bibliometric analysis for science policy: an evaluation of the United Kingdom's research performance in ocean currents and protein crystallography. Scientometrics, 9 (5-6): 239-267.

Cushing,D.H. 1988. The provident sea. Cambridge University Press, Cambridge.

DeBruin,R.E., Braam,R.R. and Mode,H.F. 1991 Bibliometric lines in the sands. Nature, 349: 559-562.

Delendick,T.J. 1990. Citation analysis of the literature of systematic Botany - a preliminary survey. Journal of American Society for Information Science, 41: 535-543.

Delgado,H. and Russell,J.M. 1992. Bibliometrical analysis of medical articles published in the international literature during the eighties by research institutes in the Mexican Republic. In: Ravichandra Rao, I.K. Ed: Informetrics - 91, p. 130-149.

Deo,V.N. 1991. Citation study of the Marathwada University Journal: a case study of the patterns used by scholars. Annals of Library Science and Documentation, 38 (4): 131-147.

Deshmukh,G.R. and Ashok Kumar 1982. Ranking of periodicals in the field of soil observation. Annals of Library Science and Documentation, 29 (1): 26-28.

Dharmapurikar,R.G. 1992. Citation analysis: an important tool for knowledge organization. In: Cognitive paradigms in knowledge organization, Sarada Ranganathan Endowment for Library.

Dhawan,S.M., Phull,S.K. and Jain,S.P. 1980. Selection of scientific journals: a model. Journal of Documentation, 36 (1): 24-41.

Diamond,A.M. 1984. An economic model of the life cycle research productivity of scientists. Scientometrics, 6 (3): 189-196.

Dizon,L.B. and Sadorba,M.S.M. 1995. Pattern of publication by the staff of an international fisheries centre. Scientometrics, 32: 67-75.

Donhue,J. 1972. Understanding Scientific Literature: a bibliometric approach. MIT press, cambridge, Mass., 101p.

Doreian,P. 1987. A revised measure of standing of journals in stratified networks. Scientometrics, 11: 71-80.

Doreian,P. 1988. Measuring the relative standing of disciplinary journals. Information Processing and Management, 24: 45-56.

Doreian,P. 1989. On the ranking of psychological journals. Information Processing and Management, 25 (2): 205-214.

Drott,M.C. 1981. Bradford's law: theory, empiricism and the gaps between, Library Trends. 30: 41-52.

Drott, M.C. and Griffith,B.C. 1978. An empirical examination of Bradford's law and scattering of Scientific Literature. Journal of American Society for information Science, 29: 238-246.

Drott,M.C. Mancall,J.C. and Griffith,B.C. 1979. Bradford's law and libraries: present applications-potential promises. ASLIB Proceedings. 31: 296-304.

Earle,P and Vickery,B. 1969. Social Science Literature use in the U.K. as indicated by citations. Journal of Documentation. 25: 123-141.

Edge,D. 1977. Why I am not a co-citationist. Society for social studies of science News letter, 2: 13-19 Reprinted in: Essays of an Information Scientist, 3: 240-245.

Egghe,L. 1986. On the 80/20 rule. Scientometrics, 10: 55-68.

Egghe,L. 1987. Pratt's measure for some bibliometric distributions and its relation with 80/20 rule. Journal of American Society for Information Science, 38: 288-297.

Egghe,L. 1988. Mathematical relations between impact factors and average number of citations. Information Processing and Management, 24 (5): 567-576.

Egghe,L. 1988a. Methodological aspects of bibliometrics. Library Science, 25: 179-191.

Egghe,L. 1988b. On the classification of classical bibliometric laws. Journal of Documentation, 44 (1) 53-62.

Egghe,L. 1989. The duality of informetric systems with application to empirical laws. Doctoral dissertation, City University, London.

Egghe, L. 1990. A note on different Bradford multipliers. Journal of American Society for Information Science, 41: 204-209.

Egghe,L. 1990 a. Application of the theory of Bradford's law to the calculation of Leimkuhler's law and completion of bibliographies. Journal of American Society for Information Science, 41 (7) : 469-492.

Egghe,L. 1990b. New Bradfordian Laws, equivalent with old Lotka's laws evolving from a source item duality argument. In Egghe and Rousseau, Ed: Informetrics 89/90. Elsevier, Amsterdam, p. 97-137.

Egghe,L. 1990c. The duality of informetric systems. Journal of Information Science 16: 17-27.

Egghe,L. 1994. A theory of continuous rates and applications to the theory of growth and obsolescence rates. Information Processing and Management,30 (2): 279-292.

Egghe,L. 1994a. Bridging the gaps: conceptual discussions on informetrics. Scientometrics, 30: 35-47.

Egghe,L. 1994b. Little Science, big science and beyond. Scientometrics 30 (2-3): 389-392.

Egghe,L and Ravichandra Rao,I.K. 1992. Citation age data and the obsolescence function; fits and applications. Information Processing and Management, 28 (2): 201-217.

Egghe,L and Rousseau,R Ed. 1988. Informetrics 87/88. Select proceedings of the first International conference on bibliometrics and theoretical aspects of information retrieval, Belgium 25-28, August 1987. Elsevier, Amsterdam.

Eggheh,L and Rousseau,R 1990. Introduction to informetrics; quantitative methods in Library, documentation and information Science. Elsevier, Amsterdam 450 p.

Egghe,L and Rousseau,R, Ed. 1990 Informetrics 89/90. Selections of papers submitted for the second international conference on bibliometrics, scientometrics and informetrics, London, 5-7 July 1987. Elsevier, Amsterdam.

Egghe,L and Rousseau,R. 1993. Evolution of information production processes and its relation to the Lorenz dominance order. Information Processing and Management, 29 (4): 499-513.

Elisha Raju and Kavitha. 1985. Core journals in synthetic organic chemistry. Annals of Library Science and Documentation, 32 (3-4): 115-121.

Estabrook,L. 1983 Scoiology and Library research. Library Trends, 32 (4): 461-476.

Eto,H. 1984. Bradford's law in R & D expending of firms and R & D concentrations. Scientometrics, 6 (3): 183-188.

Eto,H. 1988. Rising tail in Bradford distribution: its interpretation and application. Scientometrics, 13 (5-6): 227-237.

Eto,H and Candelaria,P.M. 1987. Applicability of the Bradford distribution to international science and technology indicators. Scientometrics, 11 (1-2): 27-42.

Fairthorne,R.A. 1969. Empirical hyperbolic distributions. (Bradford - zipf - Mandelbrot) for bibliometric description and prediction. Journal of Documentation, 25: 319-343.

Fang,P.H. and Fang,J.M. 1995. A modification of Lotka's function for scientific productivity. Information Processing and Management, 31: 133-137.

Federovicz,J. 1982. A Zipfian model of an automatic bibliographic system: an application of Medline. Journal of American Society for Information Science, 33: 223-232.

Federovicz,J. 1982 a. The theoretical foundations of zipf's law and its application to the bibliographic database enviornment. Journal of American Society for Information Science, 33: 285-293.

Ferreiro,L and Ugena,S. 1992. Citation mechanics in journals covered by the Journal citation reports. Scientometrics, 24 (1): 149-162.

Folly,G. 1981. Some methodological problems in ranking scientists by citation analysis. Scientometrics. 3 (2): 135-147.

Fussler,H.H. 1949. Characterestic of the research literature used by physicists in the United States. Library Quarterly 19: pt I: 19-35 and pt II: 119-143.

Gapen,D.K. and Milner,S.P. 1981. Obsolescence. Library Trends, 30: 107-124.

Garfield,E. 1955. Citation indexes for science, a new dimension in documentation through association of ideas. Science 122: 108-111.

Garfield,E. 1963. Citation indexes in sociological and historical research. American Documentation, 14 (4): 289-291.

Garfield,E. 1970. Citation indexing for studying science. Nature 689-671. Reprinted in: Essays of an Information Scientists, 1: 133-138.

Garfield,E. 1970a. What is a significant journal? In: Essays of an Information Scientists, 1: 106-107.

Garfield,E. 1972. Citation analysis as a tool in journal evaluation. Science, 178: 571-579. Reprinted in: Essays of an Information Scientist, 1: 527-544.

Garfield,E. 1976. Significant journals of science. Nature: 264 609-615.

Garfield,E. 1977. Cost-benefit analysis and core journal collections in scientific libraries. In: Essays of an Information Scientist, 1: 247-248.

Garfield,E. 1977 a. Is citation frequency a valid criterion for selecting journals. In: Essays of an Information Scientist, 1: 289-290.

Garfield,E. 1977 b. The mystery of transposed journal lists - wherein, Bradford's law of scattering is generalised according to Garfield's law of concentration. In: Essays of Information Scientists, 1: 222-223.

Garfield,E. 1979. Citation Indexing, John Wiley, New York.

Garfield,E. 1980. Bradford's law and related statistical patterns. In: Essays of an Information Scientist, 4: 476-483.

Garfield,E. 1980 a. Restating fundamental assumptions of citation analysis. In: Essays of an Information Scientist, 3: 232-245.

Garfield,E. 1981. Bradford's law and related statistical patterns. In: Essays of an Information Scientist, 4: 476-483.

Garfield,E. 1981a. Essays of an Information Scientist, 4V. ISI Press, Philadephia, Pa.

Garfield,E. 1981b. Scientometrics comes of age. In: Essays of an Information Scientist, 4: 313-318.

Garfield,E. 1983. How to use citation analysis for faculty evaluations and when it is relevant. In: Essays of an Information Scientist, 6: 363-372.

Garfield,E. and Sher,I.H. 1963. New factors in the evaluation of scientific literature through citation indexing. American Documentation, 14 (3): 195-201.

Garfield,E., Sher,I.H. and Thorpie. 1964. The use of citation data in writing the history of science. Institute of Scientific Information, Philadelphia, 76 p.

Garg,K.C. and Dutt,B. 1992. Bibliometrics of Indian Science as reflected through Science Citation Index. Journal of Scientific and Industrial Research, 31 (4): 329.

Garg,K.C. and Karki,M.M.S. 1992. Bibliometrics of research communications of INSA fellows. Journal of Scientific and Industrial Research, 51 (12) : 929-935.

Garg,K.C. and Rao,M.K.D. 1988. Bibliometric analysis of scientific productivity: a case study of an Indian Physics laboratory. Scientometrics, 13: 262-289.

Garvey,W.D., Lin,N and Tomita,K. 1972. Research studies in Scientific communication by productive scientists. Information Storage & Retrieval, 8: 265-276.

Glanzel,W and Schoepflin,U. 1994. Little scientometrics, big scientometrics and beyond? Scientometrics, 30 (2-3): 375-384.

Gopinath,M.A. 1993. Across the frontiers: impact of foreign journals in library science in India: a citation analysis. Library Science, 30 (1): 17-24.

Gopinathan,M.A. 1993. Ranganathan: a profile in relation to librametry. Herald of Library Science, 32 (1-2): 7-11.

Goffman,W. 1971. A mathematical model for analyzing the growth of a scientific discipline. Journal of Association of Computer Mechanics, 18: 173-185.

Goffman,W and Morris,T.G. 1970. Bradford's law and library acquisitions. Nature, 226: 922-923.

Goffman,W and Newill,V.A. 1964. A generalisation of the theory of epidemics - an application to the transmission of ideas. Nature, 204: 225-228.

Gompertz,M.C. 1968. The law of constant citation for scientific literature. Journal of Documentation, 24: 113-117.

Gosnell,C.F. 1943. The rate of obsolescence in college library book collection. Ph.D. Dissertation, New York University.

Griffith,B.C. 1988. Exact fits to large ranked bibliometric distributions. Journal of American Society for Information Science, 39: 423-427.

Griffith,B.C. 1988a. Exact fits in bibliometrics. Some tools and results. In: Egghe and Rousseau, Ed: Informetrics 87/88, P. 85-95.

Griffith,B.C. Drott,M.C. and Small,H.G. 1977. On the use of citations in studying scientific achievements and communication. Society for social studies of science News letter. 2 9-13, Reprinted in: Essays of an Information Scientist, 3: 232-245.

Griffith,B.C. Servi,D.N. Anker,A.L. and Drott,M.C. 1979. The aging of scientific literature: a citation analysis. Journal of Documentation, 35 (3): 179-196.

Groos,O.V. 1969. Bradford's law and the Keenan - Atherton data. American Documentation, 18: 26.

Gross,P.L.K. and Gross,E.M. 1927. College libraries and Chemical Education. Science, 66: 385-389.

Gulland,J.A. Ed. 1971. Fish resources of the ocean. Fishing News Books Ltd., London. 255p.

Gupta,B.M. 1977. Citation analysis of solar energy research in USSR. Journal of Library and Information Science, 2: 202-219.

Gupta,B.M. and Nagpal,M.P.K. 1979. Citation analysis and its applications: a review. Herald of Library Science, 18 (1-2): 86-93.

Gupta,D.K. 1983. Citation analysis: a case study of most cited author and his most cited article in seafloor spreading. IASLIC Bulletin, 28 (1): 1-2.

Gupta,D.K. 1987. Lotka's law and the productivity patterns of entomological research in Nigeria for the period 1900-1973. Scientometrics, 12 (1-2): 33-46.

Gupta,D.K. 1988. Bibliometric study of the AIDs literature 1981-84. Annals of Library Science and Documentation, 35 (1): 34-44.

Gupta,D.K. 1989. Lotka's law and its application to author productivity distribution of psychological literature of Africa for the period 1966-1975. Pt.1. Development of Lotka's law. Herald of Library Science, 28 (1-4): 11-21. pt. II. Application of Lotka's law to psychological literature of Africa 1966-1975. Herald of Library Science, 28 (1-4): 318-326.

Gupta,D.K. 1989a. Scientometric study of biochemical literature of Nigeria 1970-1984: application of Lotka's law and the 80/20 rule. Scientometrics, 15 (3-4): 171-179.

Gupta,D.K. 1991. Application of Bradford's law to citation data of Ethiopian Medical Journal, Annals of Library Science and documentation, 38 (3): 85-98.

Gupta,D.K. 1993. Author productivity pattern: geoscientific literature of Nigeria for the period 1904-1974. Library Science, 30 (2): 76-89.

Gupta, Santosh, 1993. Research methodology and statistical techniques. Deep Deep Publications, New Delhi, 510 p.

Gupta, Usha. 1990. Obsolescence of physics literature: exponential decrease of the density of citations to physical Review articles with age. Journal of American Society for Information Science, 41: 282-287.

Hall,D.H. 1990. Growth and citation selection rates in rapidly growing sciences from date stacking and bibliographic databases. In: Egghe and Rousseau, Ed: Informetrics 89/90, p.163-192.

Hasso,M.H. 1984. A bibliometric study of two secondary services in civil engineering with special emphasis on Bradford-ZIpf application and validity. Journal of Library and Information Science, 9, (1):85-90.

Hayes,R.M. 1993. Measurement of Information. Information Processing and Management, 29 (1): 1-11.

He,C and Pao,M.L. 1986. A discipline specific journal selection algorithm. Information Processing and Management, 22: 405-416.

Hertzel, D orothy,H. 1987. Bibliometrics, history of development of ideas in. Encyclopaedia of Library and Information Science, 42: 144-219.

Hill,B.M. 1970. The rank frequency form of Zipf's law. Journal of American Statistical Association, 69 (348): 542.

Hirst,G. 1978. Disciplinary impact factors - a method for determining core journals. Journal of American Society for Information Science, 29: 171-172.

Hjerppe,R. 1978. An outline of bibliometrics and citation analysis. Report Stockholm papers in library and information science, The Royal Institute of Technology Library. Stockholm (TRITA-LIB-6014) 82p.

Hjerppe,R. 1980. A bibliography of bibliometrics, citation indexing and analysis. The Royal Institute of Technology Library, Stockholm (TRITA-2013).

Houston,W. 1983. The application of bibliometrics in veterinary science primary literature. Quarterly Bulletin of the International Association of Agricultural Librarians. 28 (1): 6-13.

Hubert,J.J. 1977. Bibliometric models for journal productivity. Social Indicators Research 4: 441-473.

Hubert,J.J. 1978. A relationship between two forms of Bradford's law. Journal of American Society for Information Science 29 (3): 159-161.

Hubert,J.J. 1981. A rank frequency model for scientific productivity. Scientometrics, 3(3): 191-202.

Hubert,J.J. 1981. General bibliometric models. Library Trends 30 (1): 65-81.

Hulme,E.W. 1923. Statistical bibliography in relation to the growth of modern civilization. Lectures, May 1922, Grafton, London.

Hurt,C.D. 1977. A correlation study of the journal article productivity of enviornmental scientists. Information Processing and Management, 13: 305-309.

Hurt,C.D. 1984. Important literature identification in science; a critical review of the literature. Advances in Librarianship; 13: 239-258.

Ijari,S.R. and Kannappanavar,B.U. 1989. Periodical literature of Geology - a citation analysis study to determine obsolescence factors and patterns. Indian Journal of Information Library and Society, 2 (1): 77-84.

Ijari,S.R. and Kannappanavar,B.U. 1990. Information use pattern of Indian clinical psychologists: a citation study. Journal of Library and Information Science, 15 (2): 179-189.

Ikpahindi,L. 1985. An overview of bibliometrics its measurements, laws and their applications. Libri, 35: 163-177.

Jarvelin,K and Vakkari,P. 1993. The evolution of Library and Information Science 1965-1985: a content analysis of journal articles. Information Processing and Managment, 29 (1): 129-144.

Jhingran,V.G. 1991. Fish and Fisheries of India. Ed.3. Hindustan Publishing Corporation (India) Delhi. 727p.

Kalyane,V. 1993. Informetrics on Neem Research in India. Library Science, 30: 139-145.

Kapoor,S.K. 1984. Citation analysis of earth science literature. Annals of library Science and Documentation. 31 (1-2): 56-62.

Karmeshu,N. Lind,N.C. and Cano,V. 1984. Rationales for Bradford's law. Scientometrics, 6(4): 233-241.

Kanasy,J.E. 1971. Citation Characteristic and bibliographic control of the literature of Microbiology. Ph.D. Dissertation, University of Pittsburg.

Kendall,M.G. 1960. The bibliography of operational research. Operational Research Quarterly, 11 (1-2): 31-36.

Kessler,M.M. 1963. Bibliographic coupling between scientific papers. American Documentation, 14 (1): 10-15.

Kessler,M.M. 1963a. An experimental study of bibliographic coupling between technical papers. IEEE Transactions in Information Theory, 49-51.

Kessler,M.M. 1965. Some statistical properties of citations in the literature of physics. In: Stevens, M.E. Ed: Statistical Association Methods in Mechanised Documentation, Proceedings. p. 193-198.

King,D.W. 1976. Statistical indicators of the Scientific and technical communication. V.2. King Research Inc., Rochwille.

King,J. 1987. A review of bibliometric and other science indicators and their role in research evaluation. Journal of Information Science, 13: 261-276.

Kochhar,V.B. and Verma,R.K. 1987. Indian Biotechnology literature: a bibliometric study. Annals of Library Science and Documentation 34 (2): 61-70.

Koening,M.E.D. 1992. The information enviornment and the productivity of research. In: Ravichandra Rao, I.K. Ed: Informetrics - 91, p. 261-288.

Kretschmer,H. 1990. Social stratifications of authors revealed from coauthorship network. In Egghe and Rousseau, Ed. Informetrics 89/90, p. 193-209.

Lalithakumari and Sengupta,I.N. 1988. Analysis of growth of lectin literature 1983-86. Journal of Scientific and Industrial Research, 47: 692-696.

Lalithkumari and Sengupta,I.N. 1989. Bibliometric evaluation of biochemical research in India - Part III. Library Heralad, 27 (3-4): 77-85.

Lancaster,F.W. 1977. The measurement and evaluation of library services. Information Resources Press, Washington D.C.

Lancaster,F.W. 1991. Bibliometric methods in assessing productivity and impact of research. Sarada Ranganathan Endowement for Library Science, Bangalore, 52p.

Lancaster,F.W. and Lee,J.L. 1985. Bibliometric techniques applied to issues management, a case study. Journal of American Society for Information Science, 36 (6): 389-397.

Lancaster,F.W. Susan,B. and Yuan,M.L. 1993. Kochen's influence examined bibliometrically. Library Trends, 41 (4): 549-566.

Lawani,S.M. 1972. Bradford's law and the bibliography of agriculture. International Library Review 5: 341-350.

Lawani,S.M. 1977. Citation analysis and quality of scientific productivity. Bioscience, 27 (1): 28-29.

Lawani,S.M. 1980. Quality, Collaboration and Citations in cancer research: a bibliometric study. Ph.D. Thesis, Florida State University, 395p.

Lawani,S.M. 1981. Bibliometrics its theoretical foundations, methods and applications. Libri, 31: 294-315.

Lawani,S.M. 1986. Some bibliometric correlates of quality in scientific research. Scientometrics, 9 (1-2): 13-25.

Lawson,J., Kostrewski,B. and Oppenheim,C. 1980. A bibliometric study of a new subject field: energy analysis. Scientometrics, 2 (3): 227-237.

Leimkuhler,F.F. 1967. The Bradford distribution. Journal of Documentation, 23 (3): 197-207.

Leimkuhler,F.F. 1980. An exact formulation of Bradford's law. Journal of Documentation, 36 (4): 285.

Leimkuhler,F.F. 1988. On bibliometric modelling. In: Egghe and Rousseau, Ed: Informetrics 87/88 p. 97-104.

Lifshin,A. 1993. Citation analysis of Geochimica et cosmochimica Acta. 1951-1960. Journal of American Society for Information Science, 44 (6): 322-326.

Lindsey,D. 1989. Using citation counts as a measure of quality in science - Measuring what is measurable rather than what is valid. Scientometrics, 15 (3-4): 189-203.

Line,M.B. 1970. The half-life of periodical literature - apparent and real obsolescence. Journal of Documentation, 26 (1): 46-54.

Line,M.B. 1978. Rank lists based on citations and library uses as indicators of journal usage in individual libraries. Collection Management, 2 (4): 313-315.

Line,M.B. 1979. The influence of type of source used on the result of citation analysis. Journal of Documentation, 35 (4): 265-284.

Line,M.B. 1987. Relation between productivity and obsolescence. Journal of American Society for Information Science, 38: 307-308.

Line,M.B. 1993. Changes in the use of literature with time. Obsolescence revisited. Library Trends, 41 (4): 665-688.

Line,M.B. and Sandison,A. 1974. 'Obsolescence' and changes in the use of literature with time. Journal of Documentation 30: 283-350.

Little,A.E. Harris,R.M. and Nicholls,P.T. 1990. Text to reference ratios in scientific journals. In: Egghe and Rousseau, Ed: Informetrics 89/90. p. 211-216.

Liu,M. 1993. A study of citing motivation of Chinese Scientists. Journal of Information Science, 19 (1): 13-23.

Logan,E.L. and Shaw,W.M. 1991. A bibliometric analysis of collaboration in a medical speciality. Scientometrics, 20 (3): 417-426.

Lotka,A.J. 1926. The frequency distribution of Scientific productivity. Journal of Washington Academy of Science, 16: 317-325.

Macrae,D. 1969. Growth and decay curves in scientific citations. American Sociology Review, 34 (5): 641-645.

MacRoberts,M.H. and MacRoberts,B.R. 1988. Problems of citation analysis: a critical review. Journal of American Society for Information Science, 40: 342-349.

Magyar,G. 1974. Bibliometric analysis of a new research subfield. Journal of Documentation, 30 (1): 32-40.

Mahapatra, Gayatri, 1992. Post-Ranganathan era a bibliometric analysis of Ranganathan's contributions. IASLIC Bulletin, 37(3): 177-182.

Mahapatra, Gayatri, 1994. Correlation between growth of publications and citations. Annals of Library Science and Documentation, 41: 8-12.

Mahapatra, Gayatri and Kaul, Rama 1994. Bibliometric analysis of citation classics in life sciences. Library Science, 31: 129-133.

Mahapatra,M. 1985. On the validity of the theory of exponential growth of scientific literature. Proceedings of the 15th IASLIC Conference, Bangalore, P. 61-70.

Maheswarappa,B.S. and Mathias,S.A. 1989. Multiple authorship and collaborative research in Biological Sciences in India: a bibliometric study. Library Herald, 27 (3-4): 86-94.

Maheswarappa,B.S. and Nagappa,B. 1987. Research collaboration in the field of phytopathology: a bibliometric study. Annals of Library Science and Documentation, 34 (4): 173-176.

Maheswarappa,B.S., Nagappa,B and Onkaramurty,B.N. 1986. Information use pattern of Indian Scientists: a citation study. Library Herald, 25 (2-3: 68-79.

Maheswarappa,B.S. Nagappa,B and Mathias,S.A. 1984. Collaborative research in Science and technology in India. Journal of Library and Information Science, 9 (2): 154-159.

Maheswarappa,B.S. and Surya Rao,K. 1982. Journal literature of food science and technology: a bibliometric study. Annals of Library Science and Documentation, 29 (3): 126-134.

Maheswarappa,B.S. and Surya Rao,K. 1989. Information use pattern of American, British and Indian food scientists as indicated by citations in journals: a comparative study. Library Herald, 28 (1-2):32-42.

Maheswarappa,B.S. and Sadavatti,S.G. 1990. Authorship pattern and collaborative research in plant breeding. IASLIC Bulletin, 35 (3): 119-123.

Maia,M.J.F. and Maia,M.D. 1984. On the unity of Bradford's law. Journal of Documentation, 40: 206-216.

Malwad,N.M. 1978. Oh to be quoted: Citation indexes and analysis. Science Today, 13 (4): 10-19.

Manorama,K and Anita Bhutiani 1988. Strengthening the coverage of Indian Scientific journal. Journal of Scientific and Industrial Research, 47: 23-27.

Margolis,J. 1967. Citation Indexing and evaluation of scientific papers. Science, 155: 1213-1219.

Maricic,S. 1983. A fourfold bibliometric evaluation of journals from less developed scientific communities - the pattern of references in medical journals from Yugoslavia. Annals of Library Science and Documentation, 30 (2): 45-62.

Martyn,J. 1975. Citation analysis. Journal of Documentation, 31 (4): 290-297.

Mc Cain,K.W. 1991. Core journal net works and citation maps: new bibliometric tools for serials research and management. Library Quarterly, 61 (3): 311-336.

McCain,K.W. 1991a. Mapping economics through the Journal literature: an experiemnt in journal citation analysis. Journal of American Society for Information Science, 42: 290-296.

McCain,K.W. and Bobick,J.E. 1981. Pattern of journal use in a departmental library: a citation analysis. Journal of American Society for Information Science, 32 (4): 257-267.

McCain,K.W. and Turner,K. 1989. Citation context analysis and aging patterns of journal articles in molecular genetics. Scientometrics, 17 (1-2): 127-163.

McMurtray,G and Ginksi,J.M. 1972. Citation pattern of cardiovascular serial literature. Journal of American Society for Information Science, 23: 172-175.

Meadows,A.J. 1967. The citation characteristics of astronomical research literature. Journal of Documentation. 23 (1): 28-33.

Mendez,A and Gomez,I 1986. The spanish scientific productivity through eight international data bases. Scientometrics, 10: 207-219.

Midorikawa,N. 1983. Citation analysis of physics journals, Comparison of subfield of physics. Scientometrics, 5 (6): 361-374.

Miguel,J.H. 1994. Little scientometrics, big scientometrics and beyond. Scientometrics, 30 (2-3): 420.

Moed,H.F. 1988. The use of on-line databases for bibliometric analysis. In: Egghe and Rousseau, Ed: Informetrics 87/88 p. 133-146.

Moed,H.F. 1989. Bibliometric measurement of Research performance and price's theory of differences among the sciences. Scientometrics, 15 (5-6): 473-483.

Moed,H.F. Burger,W.J.M., Frankfort,J.G., and Van Raan,A.F.J. 1985. A comparative study of bibliometric past performance analysis and peer judgement. Scientometrics, 8 (3-4): 149-159.

Moed,H.F., Burger,W.J.M., Frankfort,J.G. and Van Raan,A.F.J. 1985a. The application of bibliometric indicators; important field and time-dependent factors to be considered. Scientometrics, 8 (3-4): 177-203.

Mohammed Thaher, 1990. A bibliometric analysis of literature in the field of Islamic studies. Library Herald, 29 (1-2): 96-98.

Moll,J.K. 1978. Bibliometrics in library collection management. Collection Management, 2: 195.

Morales,M. 1985. Informetrics and its importance. International forum for Information and Documentation, 10 (2): 15-21.

Moravcsik,M.J. and Murugesan,P. 1979. Citation patterns in scientific revolutions. Scientometrics, 1 (2): 161-169.

Morse,P.M. 1981. Implications of the exact Bradford distribution. Journal of American Society for Information Science. 32 (1): 43-50.

Morse,P.M. 1981a. The underlying characteristic of the Bradford distribution. Scientometrics, 3 (6): 425-436.

Morse,P.M. and Leimkuhler,F.F. 1977. Exact solution for the Bradford distribution and its use in modelling information data. Report OR 068-77, MIT Operations Research Centre, Cambridge, Mass.

Mosher,P.H. 1984. Quality and library collections: new directions in research and practice in collection evaluation. Advances in Librarianship, 13: 211-238.

Molylev,V.M. 1989. The main problems of studying literature aging. Scientometrics, 15: 97-109.

Murphy,L.J. 1973. Lotka's law in the Humanities. Journal of American Society for Information Science. 24: 461-62.

Nagappa,B and Maheswarappa,B.S. 1981. Most frequently cited journals by Indian phytopathologists. Journal of Library and Information Science; 6 (1): 1-17.

Nagappa,B and Maheswarappa,B.S. 1982. Journals cited most frequently by Indian plant physiologists. Library Herald, 20 (2-4): 130-138.

Nakamoto,H. 1988. Synchronous and diachronous citation distributions. In: Egghe and Rousseau, Ed: Informetrics 87/88. Elsevier, Amsterdam, p. 153-165.

Naranan,S. 1970. Bradford's law of bibliography of science, an interpretation, Nature, 227: 631-632.

Naranan,S. 1971. Power law relations in science bibliography - a self consistent interpretation. Journal of Documentation, 27: 83-97.

Narendra Kumar, 1984. Citation study as a tool for evaluation of journal collection use: a case study. Journal of Library and Information Science, 9 (1): 48-64.

Narin,F. 1976. Evaluative bibliometrics, Computer Horizons, Cherry Hill, N.J.

Narin,F and Moll,J.K. 1977. Bibliometrics. Annual Review of Information Science and Technology, V 12. Knowledge Industry Publications Inc., Whiteplains, N.Y. p. 35-58.

Nazim Ali,S. 1993. Subject relationship between articles determined by co-occurrence of keywords in citing and cited titles. Journal of Information Science, 19 (3): 225-231.

Nicholas,D and Ritchie,M. 1978. Literature and Bibliometrics Clive Bingley, London 183p.

Nicholls,H.B. 1976. Citation statistics of publications in the Marine Sciences. Proceeedings Fourth Canadian Conference on Information Science, University of Western Ontaria, London p. 179-187.

Nicholls,P.T. 1986. Emprical validation of Lotka's law. Information Processing and Management, 22 (5): 417-419.

Nicholls,P.T. 1988. Bibliometric modelling processes and the empirical validity of Lotka's law. Journal of American Society for Information Science, 40: 379-385.

Nicholls,P.T. 1988a. Price's square root law; empirical validity and relation to Lotka's law. Information Processing and Management, 24 (4): 469-477.

Noma, Elliot. 1982. Untangling citation networks. Information Processing and Management, 18 (2): 43.

Nordstrom,L.O. 1990. Bradford's law and the relationship between ecology and biogeoraphy. Scientometrics, 18 (3-4): 193-203.

Norman,J.R. 1963. History of Fishes, Ed.2 Earnest Benn, London.

Nweke,K.M.C. 1989. Citation analysis study of authors of the literature used by research scholars in Zoology at Ibadan University, Nigeria. Annals of Library Science and Documentation, 36 (4): 139-147.

O'connor,D and Voos,H. 1981. Empirical laws, theory construction and bibliometrics, Library Trends, 30 (1): 9-20.

Oluic-Vukovic,V. 1989. Impact of porductivity increase on the distribution pattern of journals. Scientometrics, 17 (1-2): 97-109.

O'Neill,E.T. 1970. Journal usage patterns and their implications in planning of library systems. Ph.D. Dissertation, Purdue University.

O'Neill,E.T. 1973. Limitations of Bradford's distribution. Proceedings, American Society for Information Science, 11: 177-178.

Oppenheim,C and Renn,S.P. 1978. Highly cited old papers and the reasons why they continue to be cited. Journal of American Society for Information Science. 29 - 226.

Packer,C.V. 1989. Applying row column permutation to matric representations of large citation networks. Information Processing and Management, 25 (3): 307-314.

Pan, Elizabeth, 1978. Journal citation as a predictor of journal usage in libraries. Collection Management, 2 (1): 25-38.

Pangannaya,N.B. and Kumaraswamy,S. 1981. Leisure: subject scatter, journal dispersion and other characteristics - citation analysis. Journal of Library and Information Science, 6 (2): 28-72.

Pao,M.L. 1982. Lotka's test. Collection Management, 4 (12): 111-124.

Pao,M.L. 1985. Lotka's law: a testing procedure. Information Processing and Management: 21 (4) 305-320.

Pao,M.L. 1986. An empirical examination of Lotka's Law. Journal of American Society for Information Science, 37: 26-33.

Pao,M.L. and Mc Creery,L. 1986. Bibliometric applications of Markov Chains. Information Processing and Management, 22 (1): 7-17.

Parker,C.B, Paisely,W.J. and Garrett.R. 1967. Bibliographic citations as unobstructive measure of scientific communication. Institute for Communication Research, Stanford University, Stanford.

Parvathamma.N. Gunjal,S.R. and Nijagunappa,R. 1993 Growth pattern of literature and scientific productivity of authors in Indian Earth Science (1978-88): a bibliometric study. Library Science, 30 (2): 54-64.

Patel,D.R. 1991. Bibliometrics, citation study selective dissemination of Information (SDI) service using SCI CD-ROM. Journal of Information Science, 16 (2): 113-128.

Paul Mohan Roy, 1983. Towards a theory of citing in citation analysis studies. In: Sharma K.C. Ed: Developing Horizons in Library and Information Science. V: 2, Chap 14.p 223-235.

Paul Mohan Roy, 1985. Bibliometric analysis and evaluation of Indian Research writings in physics. Ph.D Thesis, Madurai, Kamuraj University.

Peritz,B.C. 1990. A Bradford distribution for bibliometrics. Scientometrics, 18 (5-6): 323-329.

Peritz,B.C. 1995. On the association between journal circulation and impact factor. Journal of information Science, 21 (1): 63-67.

Persson,O. 1985. On line bibliometrics, a research tool for everyman. Scientometrics, 10 (1-2): 69-75.

Pillai,T.V.R. 1976. Advances in Aquaculture. Fishing News Books Ltd., London.

Pinski,G. and Narin,F. 1976. Citation influence for journal aggregates of scientific publications. Information Processing and Management. 12: 297-312.

Pontigo,J and Lancaster,F.W. 1986. Qualitative aspects of the Bradford distribution. Scientometrics, 9 (1-2): 59-70.

Pope,A. 1975. Bradford's law and the periodical literature of information science. Journal of American Society for information Science, 26 (4): 207-213.

Porter,A.L. 1977. Citation analysis queries and caveats. Social studies of Science, 7: 257-267.

Porter,A.L. Chubin,D.E. and Jin,X.Y. 1988. Citations and Scientific progress comparing bibliometric measures with scientists judgement. Scientometrics, 13 (3-4): 103-214.

Potter,W.G. 1981. Lotka's law revisited, Library trends, 30 (1): 21-40.

Pratt,A.D. 1977. A measure of class concentration in bibliometrics. Journal of American Society for Information Science, 285-292.

Pravdic,N and Pekorari,R. 1985. The citing practices of the authors to the national journals in Mathematics, Physics, and Chemistry. Scientometrics, 8 (3-4): 233-246.

Price,D.J.S. 1961. Science since Babylon. Yale University Press, New Haven.

Price,D.J.S. 1963. Little Science, big science. Columbia University Press, New York, 118 p.

Price,D.J.S. 1963a. Network of scientific papers. Science, 149: 510-515.

Price,D.J.S. 1970. Citation measures of hard science, soft science, technology and nonscience. In Nelson, C and Pollock, D. Ed. Communication among scientists and engineers. Lexington, Ma. Heath. p. 3-22.

Price,D.J.S. 1971. Some remarks on elitism in information and the invisible college Phenomenon in science. Journal of American Society for Information Science, 27 (2): 348-349.

Price,D.J.S. 1976. A general theory of bibliometric and other cumulative advantage process. Journal of American Society for Information Science, 27: 292-307.

Price,D.J.S. 1981. The citation cycle. In: Essays of an Information Scientist. Vol. 4. p. 621-633.

Pritchard,A. 1969. "Statistical bibliography or bibliometrics"? Journal of Documentation, 25 (4): 358-358.

Pritchard,A. 1970. Computers, bibliometrics and abstracting services. Research in Librarianship, 15: 94-99.

Pritchard,A. 1972. Bibliometrics and information transfer. Research in Librarianship, 4: 37-46.

Pritchard,A and Witting,G.R. 1981. Bibliometrics a bibliography and index. ALLM Books, England.

Qiu,L. 1990. An empirical examination of the existing models for Bradford's law. Information Processing and Management, 26: 655-672.

Radhakrishnan,T and Kerdizan,R. 1979. Lotka's law and computer science literature. Journal of American Society for Informations Science, 29: 253-254.

Raghavan,K.S. 1978. Journal acquisitions and cost effectiveness in a special library: a case study. Annals of Library Science Documentation, 25: 98-100.

Raghavan,K.S. and Shalini,R. 1977. Economics of periodicals in special libraries: an application of Bradford's distribution to CFTRI Library periodicals holdings. Annals of library Science and Documentation, 24 (1) : 34-41.

Raisig,L.M. 1962. Statistical bibliography in Health Sciences. Bulletin Medical Library Association, 50: 450.

Rajan,T.N. and Sen,B.K. 1986. An essay on informetrics: a study on growth and development. Annals of Library Science and Documentation, 33 (1-2): 1-12.

Ranganathan,S.R. 1961. Librametry and its scope DRTC Seminar 7 Paper DA.

Ratan Chakraborty, 1983. Citation analysis of petrological literature. Lucknow Librarian, 15 (3): 99-104.

Ravichandra Rao,I.K. 1971. Obsolescence and utility factors of periodical publications. DRTC Seminar 9, Paper J. also Library Science, 10: 297-307, 1973.

Ravichandra Rao,I.K. 1980. Distribution of scientific productivity and social change. Journal of American Society for Information Science, 31 (2): 111-122.

Ravichandra Rao,I.K. 1981. Documents and user distribution in transaction records of Canadian University libraries. Ph.D. Thesis, Universtiy of Western Ontario, Canada.

Ravichandra Rao,I.K. 1983. Quantitative methods for library and Information Science, Wiley Easern Limited, New Delhi. 271 p.

Ravichandra Rao,I.K., 1985. Bibliometric models. An entropy approach and their applications. In: Sengupta, I.N. and Kapoor, S.K. Ed: Bibliometric studies and current information. Papers presented at the 15th IASLIC conference held at Bangalore, 26-29 December 1985. (IASLIC Special Publication No. 25) p. 1-133.

Ravichandra Rao,I.K. 1988. Probability distributions and inequality measures for analysis of circulation data. In: Egghe and Rousseau, Ed - Informetrics-87-88, Elsevier, Amsterdam p. 231-248.

Ravichandra Rao,I.K. Ed: 1990. Journal productivity in Economics In: Egghe and Rousseau, Ed Informetrics, 89/90 Elsevier, Amsterdam, p. 251-278.

Ravichandra Rao,I.K. Ed: 1992. Informetrics,91 Selected papers from the third International Conference on Informetrics 9-12 August 1991, Sarada Rangathan Endowment for Library Science, Bangalore 577 p.

Ravichandra Rao,I.K. 1993. Informetric models. Library Science 30 (3): Guest editorial. i-ii.

Ravichandra Rao,I.K. 1993a. Librametry to bibliometrics to informetrics. Library Science, 30 (2) Guest editorial. p. i-ii.

Ravichandra Rao, I.K. 1994. Little scientometrics, big scientometrics and beyond. Scientometrics, 30: 465-469.

Ravichandra Rao,I.K. and Meera,B.M. 1991. Growth and obsolescence of literature: an empirical study. In: Ravichandra Rao, I.K. Ed. Informetrics-91 p. 377-394.

Ravichandra Rao,I.K. and Neelameghan,A. 1992. From librametry to informetrics. An overview and Rangathan's contributions. Libri 42: 242-257.

Rees - Potter,L.K. 1989. Dynamic thesaural systems: a bibliometric study of terminological and conceptual change in sociology and economics with application to the design of dynamic thesaural systems. Information Processing and Management. 25 (6): 677-692.

Robinson,M.D. 1991. Applied bibliometrics: using citation analysis in journal submission process. Journal of American Society for Information Science, 42: 308-310.

Rothman,H. and Lester,G. 1985. The use of bibliometric indicators in the study of insecticide research. Scientometrics, 8 (3-4) 247-262.

Rothschild,B.J. Ed: 1983. Global Fisheries, Perspectives for the 1980's. Springer-Verlag, New York.

Rousseau,R. 1988. Citation distribution of pure Mathematics journals. In: Egghe and Rousseau, Ed: Informetrics,87/88 p. 249-261.

Rousseau,R. 1989. Constraint propagation applied to co-citation analysis: an example. Information Processing and Management. 25 (6): 721-725.

Rousseau,R. 1990. A bibliometric study of Nieuwenhuysen's bibliography of microcomputer software for online information and documentation work. Journal of Information Science, 16: 45-50.

Rousseau,R. 1990a. Relation between continuous versions of bibliometric laws. Journal of American Society for Information Science, 41: 68-75.

Rousseau,R. 1992. Concentration and diversity in informetric Research. Doctoral Dissertation, Antweep, U.I.A.

Rousseau,R. 1993. Determination of a core of a bibliography. IASLIC Bulletin, 38 (2): 49-57.

Rousseau,R. 1994. Bradford curve, Information Processing and Management, 30 (2): 267-277.

Rousseau,R. 1994a. Double exponential models for first citation process. Scientometrics, 30: 213-227

Rousseau,R. 1994b. Similarities between informetrics and econometrics. Scientometrics, 30: 385-387.

Rousseau,R. 1995. Suggestions for research topics in Citation and publication analysis. Library Science, 32 (1): 3-12

Rowley,J.E. and Turner,E.M.D. 1978. Dissemination of Information. Andre Deut sch (Grafton Books), London.

Royce,W.E. 1984. Introduction to Principles of fishery science. Academic Press, New York.

Russell,J.M. 1994. Back to the culture of informetrics. Scientometrics, 30(2-3) 407-410.

Salton,G. 1975. Dynamic Information and Library Processing. Ch.5.3 Empirical Distributions, Prentice Hall Inc., New Jersey p.169-214.

Sancho,R. 1992. Bibliometric approach to research performance in the field of refractory materials used in iron and steel making process. Scientometrics; 24(1): 115-136.

Sandison,A. 1971. The use of older literature and its obsolescence. Journal of Documentation, 27(3): 184-189.

Sandison,A. 1989. Thinking about citation analysis. Journal of Documentation, 45 (1): 59-64

Sangam,S.L. and Biradar,B.S. 1990. Pattern of information use by Indian surgical scientist - a citation study. Annals of Library Science and Documentation, 37 (4): 133 -142

Saracevic,T. and Perk,L.J. 1973. Ascertaining activities in a subject area through bibliometric analysis. Journal of American Society for Information Science, 24 (2): 120-134

Sardana,J.L. and Sehghl,R.L. 1982. Statistical methods for librarians. Ess Ess Publications, New Delhi.

Sarma,P and Garg,K.C. Bibliometrics of solar power research in India. IASLIC Bulletin, 38: 155-160

Scales,P.A. 1976. Citation analysis as indicators of the use of serials: a comparison of ranked title lists produced by citation counting and from use data. Journal of Documentation, 32(1): 17-25.

Schorr,A.E. 1974. Lotka's law and library science. Research Quarterly, 14: 32-33.

Schubert,P and Glanzel,W. 1983. Statistical reliability of comparisons based on the citation impact of scientific publications. Scientometrics, 5 (1): 59-74.

Sen,B.K. 1988. From Bibliometrics to Informetrics Workshop on Scientific Communications and bibliometrics, Calcutta 15-26 February 1988. p. 84-98.

Sen,B.K. and Kumar,K. 1990. Evaluation of recent scientific research output by bibliometric method. Paper presented at International Conference on Science Indicators for developing countries, UNESCO, Paris.

Sen,B.K., Karanjai,A and Munshi,U.M. 1989. A method for determining the impact factor of non-SCI Journal. Journal of Documentation, 45 (2): 139-141.

Sen,S.K. 1988. Defining information for informetric communication and bibliometrics. Proceedings 7th Annual Convention & Conference on Scientific Communication and Bibliometrics, Calcutta 18-20 January 1988. Society for Information Science, New Delhi.

Sen,S.K. and Kundra,R. 1986. Bibliometrics of English Language alcohol fuel literature - a new empirical equation of scatter. Scientometrics, 10: 43-54.

Sen,S.K. and Sunil Kumar Chatterjee. 1990. An introduction to researches in bibliometrics. Part I. Background and perspectives. IASLIC Bulletin, 35 (3): 105-117.

Sengupta,I.N. 1983. Bibliometric analysis of the impact of the growth of biochemical knowledge on other biological and medical sciences. Ph.D.Thesis, Karnataka University, Dharwad.

Sengupta,I.N. 1984. Weightage formula to rerank biochemical periodicals. International Library Review, 16: 447-458.

Sengupta,I.N. 1985. Bibliometrics, a birds eyeview. IASLIC Bulletin. 30: 167-174.

Sengupta,I.N. 1986. Three new parameters in bibliometric research and their application to rerank periodicals in the field of biochemistry, Scientometrics, 10: 235-242.

Sengupta,I.N. 1988. Bibliometric research Vol.I. Growth of bio-medical literature. SBA Publications, Calcutta, 366p.

Sengupta,I.N. 1988. Three new bibliometric parameters and physiology periodicals. Annals of Library Science and Documentation, 35 (3): 124-127.

Sengupta,I.N. 1988. Workshop on scientific communication and bibliometrics. Herald of Library Science. 27 (1-2): 91-92.

Sengupta,I.N. 1989. Three new bibliometric parameters to rerank microbiology periodicals. Annals of Library Science and Documentation. 36 (3): 69-74.

Sengupta,I.N. 1990. Bibliometrics and identification of core periodicals. Herald of Library Science, 29 (3-4): 226-247.

Sengupta,I.N. and Ghosh,B.N. 1980. The role of bibliometry in journal selection and library management. IASLIC Bulletin, 25 (2): 87-92.

Sengupta,I.N. and Lalitha Kumari,1991. Bibliometric analysis of AIDS literature. Scientometrics 20 (1): 297-315.

Shalaja,T.S. 1985. Characteristics of the literature used by the nutritionists, a citation study. Annals of Library Science and documentation 32 (3-4): 122-128.

Shalini,R. 1981. Journal Acquisition and cost effectiveness in speical libraries: a case study International Library Reveiw 13 (2): 189-194.

Shalini,R. 1993. Citation profile to improve relevance in two stage retrieval system, a proposal. Information Processing and Management, 29 (4): 463-47.

Sharada,B.A. 1993. Bibliometric studies in linguistics and bibliometric laws. Libary Science, 30 (2): 71-75.

Sichel,H.S. 1985. A bibliometric distribution which really works. Journal of American Society for Information Science, 36 (5): 314-321.

Simon,H.A. 1955. On a class of skew distribution functions. Biometrika, 42: 425.

Singleton,A. 1976. Journal ranking and selection a review in Physics. Journal of Documentation, 32 (4): 258-289.

Sinha,S.C. 1993. Citation profile of Dr. V.S. Ramachandran - a bibliometric analysis of his highly cited articles and books in the area of cement and concrete chemistry. Annals of Library Science and Documentation. 40 (1): 21-31.

Small,H. 1973. Co-citation in the scientific literature; a measure of the relationship between two documents. Journal of American Society for Informaion Science 24 (4) : 232-239. Reprinted in : Essays of an Information Scientist 2: 28-31.

Small,H. 1980. Co-citation context analysis and structure of paradigms. Journal of Documentation, 36 (3): 183-196.

Small,H. 1986. The synthesis of speciality narratives from Co-citation clusters. Journal of American Society for Information Science, 37: 97-110.

Smith,L.C. 1981. Citation analysis. Library Trends, 30 (1): 83-106.

Stefaniak,B. 1987. Use of bibliographic databases for scientific studies. Scientometrics, 12: 149-161.

Stewart,J.A. 1994. The poisson lognormal model for bibliometric scientometric distributions. Information Processing and Management, 30: 239 - 251.

Stinson,E.R. and Lancaster,F.W. 1937. Synchronous Vs diachronous mehods in the measurement of obsolescence in citation studies. Journal of Information Science, 13 (2): 65-74.

Subba Rao,C.V. 1993. Librametry - Case studies. ABC Publishing House, New Delhi.

Subramanyam,K. 1975. Scientific journals a review of current trends and future prospects. Unesco Bulletin of Libraries, 29 (4): 192-201.

Subramanyam,K. 1976. Core journals in computer science. IEEE Transactions in Professional Communication, 19 (2): 22-25.

Subramanyam,K. 1979. Scattering, laws of - Encyclopaedia of Library and Information Science, 26: 336-354.

Subramanyam,K. 1981. Lotka's law and library literature Library Research, 8: 167.

Sujatha Rao,E and Suresh,P. 1985. Citation pattern in leather science. Annals of Library Science and Documentation, 32 (3-4) 109-114.

Suku,J. 1989. Bibliometric analysis of Indian contributions to biological science literature : a case study of Indian journal of Experimental Biology MLI.Sc Dissertation, Kerala University.

Summers,E.G. 1984. A review and application of citation analysis methodology to reading research journal literature. Journal of American Society for Information Science, 35 (6): 332-343.

Swanson,D.R. 1988. Historical note : information retrieval and the future of an illusion. Journal of American Society for Inforamtion Science, 39: 92-98.

Swanson,D.R. 1993. Intervening in the life cycles of scientific knowledge. Library Trends, 41 (4): 606-631.

Sylvan,C. 1993. Canadian Research activity in Aquaculture : a bibliometric analysis. Scientometrics, 27 (3): 295-316.

Tagliacozzo,R. 1967. Citations and citation indexing - its theory and applications in science, technology and humanities. Wiley, New York.

Tague,J. 1981, Sucess breeds success phenomenon and bibliometric processes. Journal of American Society of Information Science, 32: 280-286.

Tague,J. 1988. What's the use of bibliometrics? In : Egghe and Rousseau, Ed: Informetrics 87/88, Elsevier, Amsterdam, p.271-278.

Tague,J. 1992. An introduction to informetrics. Information Processing and Management, 28: 1-3.

Tague,J. Beheshti,J and Rees - Potter,L. 1981. The law of exponential growth: evidence, implications and forecasts. Library Trends, 30 (1): 125-149.

Tague,J and Nicholls,P. 1987. The maximal value of a Zipf size variable: sampling properties and relationship to other parameters. Information Processing and Management, 23 (3): 155-170.

Tijssen,R.J.W. and Van Raan,A.F.J. 1990. Net citation balances a measure of influence between scientific journals. Journal of American Society for Information Science, 41: 298-304.

Tijssen,R.J.W. and Leeuw,J. De and Van Raan,A.F.J. 1988. A method for mapping bibliometric relations based on field classification and citations of articles. In Egghe and

Rousseau, Ed: Informetrics 87/88, Elsevier, Amsterdam. 279-292.

Todorov,R. 1994. Facts or imposed names on facts? Scientometrics, 30: 461-464.

Todorov,R. and Glanzel,W. 1988. Journal citation measures: a concise review. Journal of Information Science, 14: 47-56.

Tomer,C. 1986. A statistical assessment of two measures of citation : the impact factor and the immediacy index. Information Processing and Management, 22 (2): 251-258

Trueswell,R.W. 1969. Some behavioral patterns of library users: the 80/20 rule. Wilson Library Bulletin, 43: 458-461

Turner,W.A. 1994. What's in an R. Infometrics or Informetrics? Scientometrics, 30: 471-480.

Vaishnav,A.A. and Deo,V.N. 1993. Literature of computerised library and information service: a bibliometric study. Library Science, 30(2): 45-53.

Van Colt,H.P. and Zavala,A. 1967. Extracting the basic structure of scientific literature. American Institute for Research.

Van Heeringen,A and Dijkwel,P.A. 1987. The relationships between age, mobility and scientific productivity PtI Effect of mobility on productivity. Scientometrics 11(5-6): 267-280. Pt II: Effect of age on productivity. Scientometrics, 11 (5-6), 381-293.

Van Hooydonk,G. Gevart,R, Mills-Proost,G, Van de Sompel,H and Debackere, K. 1994, A bibliotheeconomic analysis of the impact factors of scientific disciplines. Scientometrics, 30: 65-81.

Van Raan, A.F.J. and Hartman, 1987. The comparative impact of scientific publications and journals, Methods of measurement and graphical display. Scientometrics, 11(5-6): 325-331.

Velho,L. 1986. The meaning of citation in the context of a scientifically peripheral country. Scientometrics, 9 (1-2): 71-89.

Vickery,B.C. 1948, Bradford's law of scattering. Journal of Documentation, 4: 198-203.

Vickery,B.C. 1969. Indicators of the use of periodicals. Journal of librarianship, 1 (3): 170-182.

Vinkler,P. 1986. Evaluation of some methods for the relative assessment of scientific publications. Scientometrics, 10 (3/4): 157-177.

Vinkler,P. 1990. Bibliometric analysis of publication activity of a scientific research Institute. In : Egghe and Rousseau,R Ed: Informetrics 89/90. Elsevier, Amsterdam. P. 308-334.

Virgo,J.A. 1977. A Statistical procedure for evaluating the importance of scientific papers. Library Quarterly, 47: 415-430.

Vlachy,J. 1978. Frequency distribution of scientific performance; a bibliography of Lotka's law and related phenomenon. Scientometrics, I: 109-130.

Voos,H. 1974. Lotka and information science. Journal of American Society for Information Science, 25: 270-272.

Wade,N. 1975. Citation analysis: a new tool. Science, 188: 430

Wallace,D.P. 1986. The relationship between journal productivity and obsolescence. Journal of American Society for Information Science, 37 (3): 136-145.

Wallace,D.P. 1987. A solution in search of a problem: bibliometrics and libraries. Library Journal, 112(8): 43-47

Weinberg,B.H., 1974. Bibliographic coupling : a review. Information storage and Retrieval, 10: 189-196.

Weinstock,M. 1971. Citation Indexes, In: Encyclopaedia of Library and information science, 5: 16-40.

Weisman,H.M. 1972. Information systems, services and centres. Wiley, New York p. 1-11.

Wersig,G. 1993. Information Science, the study of postmodern knowledge use. Information Processing and Management, 29 (2): 229-239.

White,H.D. and Mc Cain ,K.W. 1989. Bibliometrics. Annual Review of information Science and Technology. 24: 119-186.

Whitley,R.D. 1969. Communication nets in science. status and citation patterns in animal physiology. Sociological Review, 12 (2): 219-233.

Whitney,G. 1992. Asian authorship in major international bibliographic databases. In: Ravichandra Rao, I.K.Ed: Informetrics - 91, p. 501 - 526.

Wiberly,S.E. 1982. Journal rankings from citation studies: a comparison of national and local data from social work. Library Quarterly, 52 (4): 348-359.

Wilkinson,E.A. 1972. The ambiguity of Bradford's law. Journal of Documentation, 28(2): 122-130.

Windsor,D.A. 1976. De-aquisitioning journals using productivity/ cost rankings. Acquisitions Librarian, 1(1): 8-10.

Windsor,D.A. 1976a. Could bibliometric data be used to predict clinical success in drugs? Journal of Information Science, 19: 363-376.

Wissman,C. 1993. Techniques of data retrieval for scientometric research in ISI citation indexes. Journal of Information Science, 19: 363-376.

Wolfram,D., Chu,C.M. and Lu,X. 1990. Growth of knowledge: bibliometric analysis using online database. In: Egghe and Rousseau, Ed: Informetrics 89/90, Elsevier, Amsterdam, p. 355-372.

Goffman,W. 1971. A mathematical model for analyzing the growth of a scientific discipline. Journal of Association of Computer Mechanics, 18: 173-185.

Goffman,W and Morris,T.G. 1970. Bradford's law and library acquisitions. Nature, 226: 922-923.

Goffman,W and Newill,V.A. 1964. A generalisation of the theory of epidemics - an application to the transmission of ideas. Nature, 204: 225-228.

Gompertz,M.C. 1968. The law of constant citation for scientific literature. Journal of Documentation, 24: 113-117.

Gosnell,C.F. 1943. The rate of obsolescence in college library book collection. Ph.D. Dissertation, New York University.

Griffith,B.C. 1988. Exact fits to large ranked bibliometric distributions. Journal of American Society for Information Science, 39: 423-427.

Griffith,B.C. 1988a. Exact fits in bibliometrics. Some tools and results. In: Egghe and Rousseau, Ed: Informetrics 87/88, P. 85-95.

Griffith,B.C. Drott,M.C. and Small,H.G. 1977. On the use of citations in studying scientific achievements and communication. Society for social studies of science News letter. 2 9-13, Reprinted in: Essays of an Information Scientist, 3: 232-245.

Griffith,B.C. Servi,D.N. Anker,A.L. and Drott,M.C. 1979. The aging of scientific literature: a citation analysis. Journal of Documentation, 35 (3): 179-196.

Groos,O.V. 1969. Bradford's law and the Keenan - Atherton data. American Documentation, 18: 26.

Gross,P.L.K. and Gross,E.M. 1927. College libraries and Chemical Education. Science, 66: 385-389.

Gulland,J.A. Ed. 1971. Fish resources of the ocean. Fishing News Books Ltd., London. 255p.

Gupta,B.M. 1977. Citation analysis of solar energy research in USSR. Journal of Library and Information Science, 2: 202-219.

Gupta,B.M. and Nagpal,M.P.K. 1979. Citation analysis and its applications: a review. Herald of Library Science, 18 (1-2): 86-93.

Gupta,D.K. 1983. Citation analysis: a case study of most cited author and his most cited article in seafloor spreading. IASLIC Bulletin, 28 (1): 1-2.

Gupta,D.K. 1987. Lotka's law and the productivity patterns of entomological research in Nigeria for the period 1900-1973. Scientometrics, 12 (1-2): 33-46.

Gupta,D.K. 1988. Bibliometric study of the AIDs literature 1981-84. Annals of Library Science and Documentation, 35 (1): 34-44.

Gupta,D.K. 1989. Lotka's law and its application to author productivity distribution of psychological literature of Africa for the period 1966-1975. Pt.1. Development of Lotka's law. Herald of Library Science, 28 (1-4): 11-21. pt. II. Application of Lotka's law to psychological literature of Africa 1966-1975. Herald of Library Science, 28 (1-4): 318-326.

Gupta,D.K. 1989a. Scientometric study of biochemical literature of Nigeria 1970-1984: application of Lotka's law and the 80/20 rule. Scientometrics, 15 (3-4): 171-179.

Gupta,D.K. 1991. Application of Bradford's law to citation data of Ethiopian Medical Journal, Annals of Library Science and documentation, 38 (3): 85-98.

Gupta,D.K. 1993. Author productivity pattern: geoscientific literature of Nigeria for the period 1904-1974. Library Science, 30 (2): 76-89.

Gupta, Santosh, 1993. Research methodology and statistical techniques. Deep Deep Publications, New Delhi, 510 p.

Gupta, Usha. 1990. Obsolescence of physics literature: exponential decrease of the density of citations to physical Review articles with age. Journal of American Society for Information Science, 41: 282-287.

Hall,D.H. 1990. Growth and citation selection rates in rapidly growing sciences from date stacking and bibliographic databases. In: Egghe and Rousseau, Ed: Informetrics 89/90, p.163-192.

Hasso,M.H. 1984. A bibliometric study of two secondary services in civil engineering with special emphasis on Bradford-ZIpf application and validity. Journal of Library and Information Science, 9, (1):85-90.

Hayes,R.M. 1993. Measurement of Information. Information Processing and Management, 29 (1): 1-11.

He,C and Pao,M.L. 1986. A discipline specific journal selection algorithm. Information Processing and Management, 22: 405-416.

Hertzel, D orothy,H. 1987. Bibliometrics, history of development of ideas in. Encyclopaedia of Library and Information Science, 42: 144-219.

Hill,B.M. 1970. The rank frequency form of Zipf's law. Journal of American Statistical Association, 69 (348): 542.

Hirst,G. 1978. Disciplinary impact factors - a method for determining core journals. Journal of American Society for Information Science, 29: 171-172.

Hjerppe,R. 1978. An outline of bibliometrics and citation analysis. Report Stockholm papers in library and information science, The Royal Institute of Technology Library. Stockholm (TRITA-LIB-6014) 82p.

Hjerppe,R. 1980. A bibliography of bibliometrics, citation indexing and analysis. The Royal Institute of Technology Library, Stockholm (TRITA-2013).

Houston,W. 1983. The application of bibliometrics in veterinary science primary literature. Quarterly Bulletin of the International Association of Agricultural Librarians. 28 (1): 6-13.

Hubert,J.J. 1977. Bibliometric models for journal productivity. Social Indicators Research 4: 441-473.

Hubert,J.J. 1978. A relationship between two forms of Bradford's law. Journal of American Society for Information Science 29 (3): 159-161.

Hubert,J.J. 1981. A rank frequency model for scientific productivity. Scientometrics, 3(3): 191-202.

Hubert,J.J. 1981. General bibliometric models. Library Trends 30 (1): 65-81.

Hulme,E.W. 1923. Statistical bibliography in relation to the growth of modern civilization. Lectures, May 1922, Grafton, London.

Hurt,C.D. 1977. A correlation study of the journal article productivity of enviornmental scientists. Information Processing and Management, 13: 305-309.

Hurt,C.D. 1984. Important literature identification in science; a critical review of the literature. Advances in Librarianship; 13: 239-258.

Ijari,S.R. and Kannappanavar,B.U. 1989. Periodical literature of Geology - a citation analysis study to determine obsolescence factors and patterns. Indian Journal of Information Library and Society, 2 (1): 77-84.

Ijari,S.R. and Kannappanavar,B.U. 1990. Information use pattern of Indian clinical psychologists: a citation study. Journal of Library and Information Science, 15 (2): 179-189.

Ikpahindi,L. 1985. An overview of bibliometrics its measurements, laws and their applications. Libri, 35: 163-177.

Jarvelin,K and Vakkari,P. 1993. The evolution of Library and Information Science 1965-1985: a content analysis of journal articles. Information Processing and Managment, 29 (1): 129-144.

Jhingran,V.G. 1991. Fish and Fisheries of India. Ed.3. Hindustan Publishing Corporation (India) Delhi. 727p.

Kalyane,V. 1993. Informetrics on Neem Research in India. Library Science, 30: 139-145.

Kapoor,S.K. 1984. Citation analysis of earth science literature. Annals of library Science and Documentation. 31 (1-2): 56-62.

Karmeshu,N. Lind,N.C. and Cano,V. 1984. Rationales for Bradford's law. Scientometrics, 6(4): 233-241.

Kanasy,J.E. 1971. Citation Characteristic and bibliographic control of the literature of Microbiology. Ph.D. Dissertation, University of Pittsburg.

Kendall,M.G. 1960. The bibliography of operational research. Operational Research Quarterly, 11 (1-2): 31-36.

Kessler,M.M. 1963. Bibliographic coupling between scientific papers. American Documentation, 14 (1): 10-15.

Kessler,M.M. 1963a. An experimental study of bibliographic coupling between technical papers. IEEE Transactions in Information Theory, 49-51.

Kessler,M.M. 1965. Some statistical properties of citations in the literature of physics. In: Stevens, M.E. Ed: Statistical Association Methods in Mechanised Documentation, Proceedings. p. 193-198.

King,D.W. 1976. Statistical indicators of the Scientific and technical communication. V.2. King Research Inc., Rochwille.

King,J. 1987. A review of bibliometric and other science indicators and their role in research evaluation. Journal of Information Science, 13: 261-276.

Kochhar,V.B. and Verma,R.K. 1987. Indian Biotechnology literature: a bibliometric study. Annals of Library Science and Documentation 34 (2): 61-70.

Koening,M.E.D. 1992. The information enviornment and the productivity of research. In: Ravichandra Rao, I.K. Ed: Informetrics - 91, p. 261-288.

Kretschmer,H. 1990. Social stratifications of authors revealed from coauthorship network. In Egghe and Rousseau, Ed. Informetrics 89/90, p. 193-209.

Lalithakumari and Sengupta,I.N. 1988. Analysis of growth of lectin literature 1983-86. Journal of Scientific and Industrial Research, 47: 692-696.

Lalithkumari and Sengupta,I.N. 1989. Bibliometric evaluation of biochemical research in India - Part III. Library Heralad, 27 (3-4): 77-85.

Lancaster,F.W. 1977. The measurement and evaluation of library services. Information Resources Press, Washington D.C.

Lancaster,F.W. 1991. Bibliometric methods in assessing productivity and impact of research. Sarada Ranganathan Endowement for Library Science, Bangalore, 52p.

Lancaster,F.W. and Lee,J.L. 1985. Bibliometric techniques applied to issues management, a case study. Journal of American Society for Information Science, 36 (6): 389-397.

Lancaster,F.W. Susan,B. and Yuan,M.L. 1993. Kochen's influence examined bibliometrically. Library Trends, 41 (4): 549-566.

Lawani,S.M. 1972. Bradford's law and the bibliography of agriculture. International Library Review 5: 341-350.

Lawani,S.M. 1977. Citation analysis and quality of scientific productivity. Bioscience, 27 (1): 28-29.

Lawani,S.M. 1980. Quality, Collaboration and Citations in cancer research: a bibliometric study. Ph.D. Thesis, Florida State University, 395p.

Lawani,S.M. 1981. Bibliometrics its theoretical foundations, methods and applications. Libri, 31: 294-315.

Lawani,S.M. 1986. Some bibliometric correlates of quality in scientific research. Scientometrics, 9 (1-2): 13-25.

Lawson,J., Kostrewski,B. and Oppenheim,C. 1980. A bibliometric study of a new subject field: energy analysis. Scientometrics, 2 (3): 227-237.

Leimkuhler,F.F. 1967. The Bradford distribution. Journal of Documentation, 23 (3): 197-207.

Leimkuhler,F.F. 1980. An exact formulation of Bradford's law. Journal of Documentation, 36 (4): 285.

Leimkuhler,F.F. 1988. On bibliometric modelling. In: Egghe and Rousseau, Ed: Informetrics 87/88 p. 97-104.

Lifshin,A. 1993. Citation analysis of Geochimica et cosmochimica Acta. 1951-1960. Journal of American Society for Information Science, 44 (6): 322-326.

Lindsey,D. 1989. Using citation counts as a measure of quality in science - Measuring what is measurable rather than what is valid. Scientometrics, 15 (3-4): 189-203.

Line,M.B. 1970. The half-life of periodical literature - apparent and real obsolescence. Journal of Documentation, 26 (1): 46-54.

Line,M.B. 1978. Rank lists based on citations and library uses as indicators of journal usage in individual libraries. Collection Management, 2 (4): 313-315.

Line,M.B. 1979. The influence of type of source used on the result of citation analysis. Journal of Documentation, 35 (4): 265-284.

Line,M.B. 1987. Relation between productivity and obsolescence. Journal of American Society for Information Science, 38: 307-308.

Line,M.B. 1993. Changes in the use of literature with time. Obsolescence revisited. Library Trends, 41 (4): 665-688.

Line,M.B. and Sandison,A. 1974. 'Obsolescence' and changes in the use of literature with time. Journal of Documentation 30: 283-350.

Little,A.E. Harris,R.M. and Nicholls,P.T. 1990. Text to reference ratios in scientific journals. In: Egghe and Rousseau, Ed: Informetrics 89/90. p. 211-216.

Liu,M. 1993. A study of citing motivation of Chinese Scientists. Journal of Information Science, 19 (1): 13-23.

Logan,E.L. and Shaw,W.M. 1991. A bibliometric analysis of collaboration in a medical speciality. Scientometrics, 20 (3): 417-426.

Lotka,A.J. 1926. The frequency distribution of Scientific productivity. Journal of Washington Academy of Science, 16: 317-325.

Macrae,D. 1969. Growth and decay curves in scientific citations. American Sociology Review, 34 (5): 641-645.

MacRoberts,M.H. and MacRoberts,B.R. 1988. Problems of citation analysis: a critical review. Journal of American Society for Information Science, 40: 342-349.

Magyar,G. 1974. Bibliometric analysis of a new research subfield. Journal of Documentation, 30 (1): 32-40.

Mahapatra, Gayatri, 1992. Post-Ranganathan era a bibliometric analysis of Ranganathan's contributions. IASLIC Bulletin, 37(3): 177-182.

Mahapatra, Gayatri, 1994. Correlation between growth of publications and citations. Annals of Library Science and Documentation, 41: 8-12.

Mahapatra, Gayatri and Kaul, Rama 1994. Bibliometric analysis of citation classics in life sciences. Library Science, 31: 129-133.

Mahapatra,M. 1985. On the validity of the theory of exponential growth of scientific literature. Proceedings of the 15th IASLIC Conference, Bangalore, P. 61-70.

Maheswarappa,B.S. and Mathias,S.A. 1989. Multiple authorship and collaborative research in Biological Sciences in India: a bibliometric study. Library Herald, 27 (3-4): 86-94.

Maheswarappa,B.S. and Nagappa,B. 1987. Research collaboration in the field of phytopathology: a bibliometric study. Annals of Library Science and Documentation, 34 (4): 173-176.

Maheswarappa,B.S., Nagappa,B and Onkaramurty,B.N. 1986. Information use pattern of Indian Scientists: a citation study. Library Herald, 25 (2-3: 68-79.

Maheswarappa,B.S. Nagappa,B and Mathias,S.A. 1984. Collaborative research in Science and technology in India. Journal of Library and Information Science, 9 (2): 154-159.

Maheswarappa,B.S. and Surya Rao,K. 1982. Journal literature of food science and technology: a bibliometric study. Annals of Library Science and Documentation, 29 (3): 126-134.

Maheswarappa,B.S. and Surya Rao,K. 1989. Information use pattern of American, British and Indian food scientists as indicated by citations in journals: a comparative study. Library Herald, 28 (1-2):32-42.

Maheswarappa,B.S. and Sadavatti,S.G. 1990. Authorship pattern and collaborative research in plant breeding. IASLIC Bulletin, 35 (3): 119-123.

Maia,M.J.F. and Maia,M.D. 1984. On the unity of Bradford's law. Journal of Documentation, 40: 206-216.

Malwad,N.M. 1978. Oh to be quoted: Citation indexes and analysis. Science Today, 13 (4): 10-19.

Manorama,K and Anita Bhutiani 1988. Strengthening the coverage of Indian Scientific journal. Journal of Scientific and Industrial Research, 47: 23-27.

Margolis,J. 1967. Citation Indexing and evaluation of scientific papers. Science, 155: 1213-1219.

Maricic,S. 1983. A fourfold bibliometric evaluation of journals from less developed scientific communities - the pattern of references in medical journals from Yugoslavia. Annals of Library Science and Documentation, 30 (2): 45-62.

Martyn,J. 1975. Citation analysis. Journal of Documentation, 31 (4): 290-297.

Mc Cain,K.W. 1991. Core journal net works and citation maps: new bibliometric tools for serials research and management. Library Quarterly, 61 (3): 311-336.

McCain,K.W. 1991a. Mapping economics through the Journal literature: an experiemnt in journal citation analysis. Journal of American Society for Information Science, 42: 290-296.

McCain,K.W. and Bobick,J.E. 1981. Pattern of journal use in a departmental library: a citation analysis. Journal of American Society for Information Science, 32 (4): 257-267.

McCain,K.W. and Turner,K. 1989. Citation context analysis and aging patterns of journal articles in molecular genetics. Scientometrics, 17 (1-2): 127-163.

McMurtray,G and Ginksi,J.M. 1972. Citation pattern of cardiovascular serial literature. Journal of American Society for Information Science, 23: 172-175.

Meadows,A.J. 1967. The citation characteristics of astronomical research literature. Journal of Documentation. 23 (1): 28-33.

Mendez,A and Gomez,I 1986. The spanish scientific productivity through eight international data bases. Scientometrics, 10: 207-219.

Midorikawa,N. 1983. Citation analysis of physics journals, Comparison of subfield of physics. Scientometrics, 5 (6): 361-374.

Miguel,J.H. 1994. Little scientometrics, big scientometrics and beyond. Scientometrics, 30 (2-3): 420.

Moed,H.F. 1988. The use of on-line databases for bibliometric analysis. In: Egghe and Rousseau, Ed: Informetrics 87/88 p. 133-146.

Moed,H.F. 1989. Bibliometric measurement of Research performance and price's theory of differences among the sciences. Scientometrics, 15 (5-6): 473-483.

Moed,H.F. Burger,W.J.M., Frankfort,J.G., and Van Raan,A.F.J. 1985. A comparative study of bibliometric past performance analysis and peer judgement. Scientometrics, 8 (3-4): 149-159.

Moed,H.F., Burger,W.J.M., Frankfort,J.G. and Van Raan,A.F.J. 1985a. The application of bibliometric indicators; important field and time-dependent factors to be considered. Scientometrics, 8 (3-4): 177-203.

Mohammed Thaher, 1990. A bibliometric analysis of literature in the field of Islamic studies. Library Herald, 29 (1-2): 96-98.

Moll,J.K. 1978. Bibliometrics in library collection management. Collection Management, 2: 195.

Morales,M. 1985. Informetrics and its importance. International forum for Information and Documentation, 10 (2): 15-21.

Moravcsik,M.J. and Murugesan,P. 1979. Citation patterns in scientific revolutions. Scientometrics, 1 (2): 161-169.

Morse,P.M. 1981. Implications of the exact Bradford distribution. Journal of American Society for Information Science. 32 (1): 43-50.

Morse,P.M. 1981a. The underlying characteristic of the Bradford distribution. Scientometrics, 3 (6): 425-436.

Morse,P.M. and Leimkuhler,F.F. 1977. Exact solution for the Bradford distribution and its use in modelling information data. Report OR 068-77, MIT Operations Research Centre, Cambridge, Mass.

Mosher,P.H. 1984. Quality and library collections: new directions in research and practice in collection evaluation. Advances in Librarianship, 13: 211-238.

Molylev,V.M. 1989. The main problems of studying literature aging. Scientometrics, 15: 97-109.

Murphy,L.J. 1973. Lotka's law in the Humanities. Journal of American Society for Information Science. 24: 461-62.

Nagappa,B and Maheswarappa,B.S. 1981. Most frequently cited journals by Indian phytopathologists. Journal of Library and Information Science; 6 (1): 1-17.

Nagappa,B and Maheswarappa,B.S. 1982. Journals cited most frequently by Indian plant physiologists. Library Herald, 20 (2-4): 130-138.

Nakamoto,H. 1988. Synchronous and diachronous citation distributions. In: Egghe and Rousseau, Ed: Informetrics 87/88. Elsevier, Amsterdam, p. 153-165.

Naranan,S. 1970. Bradford's law of bibliography of science, an interpretation, Nature, 227: 631-632.

Naranan,S. 1971. Power law relations in science bibliography - a self consistent interpretation. Journal of Documentation, 27: 83-97.

Narendra Kumar, 1984. Citation study as a tool for evaluation of journal collection use: a case study. Journal of Library and Information Science, 9 (1): 48-64.

Narin,F. 1976. Evaluative bibliometrics, Computer Horizons, Cherry Hill, N.J.

Narin,F and Moll,J.K. 1977. Bibliometrics. Annual Review of Information Science and Téchnology, V 12. Knowledge Industry Publications Inc., Whiteplains, N.Y. p. 35-58.

Nazim Ali,S. 1993. Subject relationship between articles determined by co-occurrence of keywords in citing and cited titles. Journal of Information Science, 19 (3): 225-231.

Nicholas,D and Ritchie,M. 1978. Literature and Bibliometrics Clive Bingley, London 183p.

Nicholls,H.B. 1976. Citation statistics of publications in the Marine Sciences. Proceeedings Fourth Canadian Conference on Information Science, University of Western Ontaria, London p. 179-187.

Nicholls,P.T. 1986. Emprical validation of Lotka's law. Information Processing and Management, 22 (5): 417-419.

Nicholls,P.T. 1988. Bibliometric modelling processes and the empirical validity of Lotka's law. Journal of American Society for Information Science, 40: 379-385.

Nicholls,P.T. 1988a. Price's square root law; empirical validity and relation to Lotka's law. Information Processing and Management, 24 (4): 469-477.

Noma, Elliot. 1982. Untangling citation networks. Information Processing and Management, 18 (2): 43.

Nordstrom,L.O. 1990. Bradford's law and the relationship between ecology and biogeoraphy. Scientometrics, 18 (3-4): 193-203.

Norman,J.R. 1963. History of Fishes, Ed.2 Earnest Benn, London.

Nweke,K.M.C. 1989. Citation analysis study of authors of the literature used by research scholars in Zoology at Ibadan University, Nigeria. Annals of Library Science and Documentation, 36 (4): 139-147.

O'connor,D and Voos,H. 1981. Empirical laws, theory construction and bibliometrics, Library Trends, 30 (1): 9-20.

Oluic-Vukovic,V. 1989. Impact of porductivity increase on the distribution pattern of journals. Scientometrics, 17 (1-2): 97-109.

O'Neill,E.T. 1970. Journal usage patterns and their implications in planning of library systems. Ph.D. Dissertation, Purdue University.

O'Neill,E.T. 1973. Limitations of Bradford's distribution. Proceedings, American Society for Information Science, 11: 177-178.

Oppenheim,C and Renn,S.P. 1978. Highly cited old papers and the reasons why they continue to be cited. Journal of American Society for Information Science. 29 - 226.

Packer,C.V. 1989. Applying row column permutation to matric representations of large citation networks. Information Processing and Management, 25 (3): 307-314.

Pan, Elizabeth, 1978. Journal citation as a predictor of journal usage in libraries. Collection Management, 2 (1): 25-38.

Pangannaya,N.B. and Kumaraswamy,S. 1981. Leisure: subject scatter, journal dispersion and other characteristics - citation analysis. Journal of Library and Information Science, 6 (2): 28-72.

Pao,M.L. 1982. Lotka's test. Collection Management, 4 (12): 111-124.

Pao,M.L. 1985. Lotka's law: a testing procedure. Information Processing and Management: 21 (4) 305-320.

Pao,M.L. 1986. An empirical examination of Lotka's Law. Journal of American Society for Information Science, 37: 26-33.

Pao,M.L. and Mc Creery,L. 1986. Bibliometric applications of Markov Chains. Information Processing and Management, 22 (1): 7-17.

Parker,C.B, Paisely,W.J. and Garrett.R. 1967. Bibliographic citations as unobstructive measure of scientific communication. Institute for Communication Research, Stanford University, Stanford.

Parvathamma.N. Gunjal,S.R. and Nijagunappa,R. 1993 Growth pattern of literature and scientific productivity of authors in Indian Earth Science (1978-88): a bibliometric study. Library Science, 30 (2): 54-64.

Patel,D.R. 1991. Bibliometrics, citation study selective dissemination of Information (SDI) service using SCI CD-ROM. Journal of Information Science, 16 (2): 113-128.

Paul Mohan Roy, 1983. Towards a theory of citing in citation analysis studies. In: Sharma K.C. Ed: Developing Horizons in Library and Information Science. V: 2, Chap 14.p 223-235.

Paul Mohan Roy, 1985. Bibliometric analysis and evaluation of Indian Research writings in physics. Ph.D Thesis, Madurai, Kamuraj University.

Peritz,B.C. 1990. A Bradford distribution for bibliometrics. Scientometrics, 18 (5-6): 323-329.

Peritz,B.C. 1995. On the association between journal circulation and impact factor. Journal of information Science, 21 (1): 63-67.

Persson,O. 1985. On line bibliometrics, a research tool for everyman. Scientometrics, 10 (1-2): 69-75.

Pillai,T.V.R. 1976. Advances in Aquaculture. Fishing News Books Ltd., London.

Pinski,G. and Narin,F. 1976. Citation influence for journal aggregates of scientific publications. Information Processing and Management. 12: 297-312.

Pontigo,J and Lancaster,F.W. 1986. Qualitative aspects of the Bradford distribution. Scientometrics, 9 (1-2): 59-70.

Pope,A. 1975. Bradford's law and the periodical literature of information science. Journal of American Society for information Science, 26 (4): 207-213.

Porter,A.L. 1977. Citation analysis queries and caveats. Social studies of Science, 7: 257-267.

Porter,A.L. Chubin,D.E. and Jin,X.Y. 1988. Citations and Scientific progress comparing bibliometric measures with scientists judgement. Scientometrics, 13 (3-4): 103-214.

Potter,W.G. 1981. Lotka's law revisited, Library trends, 30 (1): 21-40.

Pratt,A.D. 1977. A measure of class concentration in bibliometrics. Journal of American Society for Information Science, 285-292.

Pravdic,N and Pekorari,R. 1985. The citing practices of the authors to the national journals in Mathematics, Physics, and Chemistry. Scientometrics, 8 (3-4): 233-246.

Price,D.J.S. 1961. Science since Babylon. Yale University Press, New Haven.

Price,D.J.S. 1963. Little Science, big science. Columbia University Press, New York, 118 p.

Price,D.J.S. 1963a. Network of scientific papers. Science, 149: 510-515.

Price,D.J.S. 1970. Citation measures of hard science, soft science, technology and nonscience. In Nelson, C and Pollock, D. Ed. Communication among scientists and engineers. Lexington, Ma. Heath. p. 3-22.

Price,D.J.S. 1971. Some remarks on elitism in information and the invisible college Phenomenon in science. Journal of American Society for Information Science, 27 (2): 348-349.

Price,D.J.S. 1976. A general theory of bibliometric and other cumulative advantage process. Journal of American Society for Information Science, 27: 292-307.

Price,D.J.S. 1981. The citation cycle. In: Essays of an Information Scientist. Vol. 4. p. 621-633.

Pritchard,A. 1969. "Statistical bibliography or bibliometrics"? Journal of Documentation, 25 (4): 358-358.

Pritchard,A. 1970. Computers, bibliometrics and abstracting services. Research in Librarianship, 15: 94-99.

Pritchard,A. 1972. Bibliometrics and information transfer. Research in Librarianship, 4: 37-46.

Pritchard,A and Witting,G.R. 1981. Bibliometrics a bibliography and index. ALLM Books, England.

Qiu,L. 1990. An empirical examination of the existing models for Bradford's law. Information Processing and Management, 26: 655-672.

Radhakrishnan,T and Kerdizan,R. 1979. Lotka's law and computer science literature. Journal of American Society for Informations Science, 29: 253-254.

Raghavan,K.S. 1978. Journal acquisitions and cost effectiveness in a special library: a case study. Annals of Library Science Documentation, 25: 98-100.

Raghavan,K.S. and Shalini,R. 1977. Economics of periodicals in special libraries: an application of Bradford's distribution to CFTRI Library periodicals holdings. Annals of library Science and Documentation, 24 (1) : 34-41.

Raisig,L.M. 1962. Statistical bibliography in Health Sciences. Bulletin Medical Library Association, 50: 450.

Rajan,T.N. and Sen,B.K. 1986. An essay on informetrics: a study on growth and development. Annals of Library Science and Documentation, 33 (1-2): 1-12.

Ranganathan,S.R. 1961. Librametry and its scope DRTC Seminar 7 Paper DA.

Ratan Chakraborty, 1983. Citation analysis of petrological literature. Lucknow Librarian, 15 (3): 99-104.

Ravichandra Rao,I.K. 1971. Obsolescence and utility factors of periodical publications. DRTC Seminar 9, Paper J. also Library Science, 10: 297-307, 1973.

Ravichandra Rao,I.K. 1980. Distribution of scientific productivity and social change. Journal of American Society for Information Science, 31 (2): 111-122.

Ravichandra Rao,I.K. 1981. Documents and user distribution in transaction records of Canadian University libraries. Ph.D. Thesis, Universtiy of Western Ontario, Canada.

Ravichandra Rao,I.K. 1983. Quantitative methods for library and Information Science, Wiley Easern Limited, New Delhi. 271 p.

Ravichandra Rao,I.K., 1985. Bibliometric models. An entropy approach and their applications. In: Sengupta, I.N. and Kapoor, S.K. Ed: Bibliometric studies and current information. Papers presented at the 15th IASLIC conference held at Bangalore, 26-29 December 1985. (IASLIC Special Publication No. 25) p. 1-133.

Ravichandra Rao,I.K. 1988. Probability distributions and inequality measures for analysis of circulation data. In: Egghe and Rousseau, Ed - Informetrics-87-88, Elsevier, Amsterdam p. 231-248.

Ravichandra Rao,I.K. Ed: 1990. Journal productivity in Economics In: Egghe and Rousseau, Ed Informetrics, 89/90 Elsevier, Amsterdam, p. 251-278.

Ravichandra Rao,I.K. Ed:.1992. Informetrics,91 Selected papers from the third International Conference on Informetrics 9-12 August 1991, Sarada Rangathan Endowment for Library Science, Bangalore 577 p.

Ravichandra Rao,I.K. 1993. Informetric models. Library Science 30 (3): Guest editorial. i-ii.

Ravichandra Rao,I.K. 1993a. Librametry to bibliometrics to informetrics. Library Science, 30 (2) Guest editorial. p. i-ii.

Ravichandra Rao, I.K. 1994. Little scientometrics, big scientometrics and beyond. Scientometrics, 30: 465-469.

Ravichandra Rao,I.K. and Meera,B.M. 1991. Growth and obsolescence of literature: an empirical study. In: Ravichandra Rao, I.K. Ed. Informetrics-91 p. 377-394.

Ravichandra Rao,I.K. and Neelameghan,A. 1992. From librametry to informetrics. An overview and Rangathan's contributions. Libri 42: 242-257.

Rees - Potter,L.K. 1989. Dynamic thesaural systems: a bibliometric study of terminological and conceptual change in sociology and economics with application to the design of dynamic thesaural systems. Information Processing and Management. 25 (6): 677-692.

Robinson,M.D. 1991. Applied bibliometrics: using citation analysis in journal submission process. Journal of American Society for Information Science, 42: 308-310.

Rothman,H. and Lester,G. 1985. The use of bibliometric indicators in the study of insecticide research. Scientometrics, 8 (3-4) 247-262.

Rothschild,B.J. Ed: 1983. Global Fisheries, Perspectives for the 1980's. Springer-Verlag, New York.

Rousseau,R. 1988. Citation distribution of pure Mathematics journals. In: Egghe and Rousseau, Ed: Informetrics,87/88 p. 249-261.

Rousseau,R. 1989. Constraint propagation applied to co-citation analysis: an example. Information Processing and Management. 25 (6): 721-725.

Rousseau,R. 1990. A bibliometric study of Nieuwenhuysen's bibliography of microcomputer software for online information and documentation work. Journal of Information Science, 16: 45-50.

Rousseau,R. 1990a. Relation between continuous versions of bibliometric laws. Journal of American Society for Information Science, 41: 68-75.

Rousseau,R. 1992. Concentration and diversity in informetric Research. Doctoral Dissertation, Antweep, U.I.A.

Rousseau,R. 1993. Determination of a core of a bibliography. IASLIC Bulletin, 38 (2): 49-57.

Rousseau,R. 1994. Bradford curve, Information Processing and Management, 30 (2): 267-277.

Rousseau,R. 1994a. Double exponential models for first citation process. Scientometrics, 30: 213-227

Rousseau,R. 1994b. Similarities between informetrics and econometrics. Scientometrics, 30: 385-387.

Rousseau,R. 1995. Suggestions for research topics in Citation and publication analysis. Library Science, 32 (1): 3-12

Rowley,J.E. and Turner,E.M.D. 1978. Dissemination of Information. Andre Deut sch (Grafton Books), London.

Royce,W.E. 1984. Introduction to Principles of fishery science. Academic Press, New York.

Russell,J.M. 1994. Back to the culture of informetrics. Scientometrics, 30(2-3) 407-410.

Salton,G. 1975. Dynamic Information and Library Processing. Ch.5.3 Empirical Distributions, Prentice Hall Inc., New Jersey p.169-214.

Sancho,R. 1992. Bibliometric approach to research performance in the field of refractory materials used in iron and steel making process. Scientometrics; 24(1): 115-136.

Sandison,A. 1971. The use of older literature and its obsolescence. Journal of Documentation, 27(3): 184-189.

Sandison,A. 1989. Thinking about citation analysis. Journal of Documentation, 45 (1): 59-64

Sangam,S.L. and Biradar,B.S. 1990. Pattern of information use by Indian surgical scientist - a citation study. Annals of Library Science and Documentation, 37 (4): 133 -142

Saracevic,T. and Perk,L.J. 1973. Ascertaining activities in a subject area through bibliometric analysis. Journal of American Society for Information Science, 24 (2): 120-134

Sardana,J.L. and Sehghl,R.L. 1982. Statistical methods for librarians. Ess Ess Publications, New Delhi.

Sarma,P and Garg,K.C. Bibliometrics of solar power research in India. IASLIC Bulletin, 38: 155-160

Scales,P.A. 1976. Citation analysis as indicators of the use of serials: a comparison of ranked title lists produced by citation counting and from use data. Journal of Documentation, 32(1): 17-25.

Schorr,A.E. 1974. Lotka's law and library science. Research Quarterly, 14: 32-33.

Schubert,P and Glanzel,W. 1983. Statistical reliability of comparisons based on the citation impact of scientific publications. Scientometrics, 5 (1): 59-74.

Sen,B.K. 1988. From Bibliometrics to Informetrics Workshop on Scientific Communications and bibliometrics, Calcutta 15-26 February 1988. p. 84-98.

Sen,B.K. and Kumar,K. 1990. Evaluation of recent scientific research output by bibliometric method. Paper presented at International Conference on Science Indicators for developing countries, UNESCO, Paris.

Sen,B.K., Karanjai,A and Munshi,U.M. 1989. A method for determining the impact factor of non-SCI Journal. Journal of Documentation, 45 (2): 139-141.

Sen,S.K. 1988. Defining information for informetric communication and bibliometrics. Proceedings 7th Annual Convention & Conference on Scientific Communication and Bibliometrics, Calcutta 18-20 January 1988. Society for Information Science, New Delhi.

Sen,S.K. and Kundra,R. 1986. Bibliometrics of English Language alcohol fuel literature - a new empirical equation of scatter. Scientometrics, 10: 43-54.

Sen,S.K. and Sunil Kumar Chatterjee. 1990. An introduction to researches in bibliometrics. Part I. Background and perspectives. IASLIC Bulletin, 35 (3): 105-117.

Sengupta,I.N. 1983. Bibliometric analysis of the impact of the growth of biochemical knowledge on other biological and medical sciences. Ph.D.Thesis, Karnataka University, Dharwad.

Sengupta,I.N. 1984. Weightage formula to rerank biochemical periodicals. International Library Review, 16: 447-458.

Sengupta, I.N. 1985. Bibliometrics, a birds eyeview. IASLIC Bulletin. 30: 167-174.

Sengupta, I.N. 1986. Three new parameters in bibliometric research and their application to rerank periodicals in the field of biochemistry, Scientometrics, 10: 235-242.

Sengupta, I.N. 1988. Bibliometric research Vol.I. Growth of bio-medical literature. SBA Publications, Calcutta, 366p.

Sengupta, I.N. 1988. Three new bibliometric parameters and physiology periodicals. Annals of Library Science and Documentation, 35 (3): 124-127.

Sengupta, I.N. 1988. Workshop on scientific communication and bibliometrics. Herald of Library Science. 27 (1-2): 91-92.

Sengupta, I.N. 1989. Three new bibliometric parameters to rerank microbiology periodicals. Annals of Library Science and Documentation. 36 (3): 69-74.

Sengupta, I.N. 1990. Bibliometrics and identification of core periodicals. Herald of Library Science, 29 (3-4): 226-247.

Sengupta, I.N. and Ghosh, B.N. 1980. The role of bibliometry in journal selection and library management. IASLIC Bulletin, 25 (2): 87-92.

Sengupta, I.N. and Lalitha Kumari, 1991. Bibliometric analysis of AIDS literature. Scientometrics 20 (1): 297-315.

Shalaja,T.S. 1985. Characteristics of the literature used by the nutritionists, a citation study. Annals of Library Science and documentation 32 (3-4): 122-128.

Shalini,R. 1981. Journal Acquisition and cost effectiveness in speical libraries: a case study International Library Reveiw 13 (2): 189-194.

Shalini,R. 1993. Citation profile to improve relevance in two stage retrieval system, a proposal. Information Processing and Management, 29 (4): 463-47.

Sharada,B.A. 1993. Bibliometric studies in linguistics and bibliometric laws. Libary Science, 30 (2): 71-75.

Sichel,H.S. 1985. A bibliometric distribution which really works. Journal of American Society for Information Science, 36 (5): 314-321.

Simon,H.A. 1955. On a class of skew distribution functions. Biometrika, 42: 425.

Singleton,A. 1976. Journal ranking and selection a review in Physics. Journal of Documentation, 32 (4): 258-289.

Sinha,S.C. 1993. Citation profile of Dr. V.S. Ramachandran - a bibliometric analysis of his highly cited articles and books in the area of cement and concrete chemistry. Annals of Library Science and Documentation. 40 (1): 21-31.

Small,H. 1973. Co-citation in the scientific literature; a measure of the relationship between two documents. Journal of American Society for Informaion Science 24 (4) : 232-239. Reprinted in : Essays of an Information Scientist 2: 28-31.

Small,H. 1980. Co-citation context analysis and structure of paradigms. Journal of Documentation, 36 (3): 183-196.

Small,H. 1986. The synthesis of speciality narratives from Co-citation clusters. Journal of American Society for Information Science, 37: 97-110.

Smith,L.C. 1981. Citation analysis. Library Trends, 30 (1): 83-106.

Stefaniak,B. 1987. Use of bibliographic databases for scientific studies. Scientometrics, 12: 149-161.

Stewart,J.A. 1994. The poisson lognormal model for bibliometric scientometric distributions. Information Processing and Management, 30: 239 - 251.

Stinson,E.R. and Lancaster,F.W. 1937. Synchronous Vs diachronous mehods in the measurement of obsolescence in citation studies. Journal of Information Science, 13 (2): 65-74.

Subba Rao,C.V. 1993. Librametry - Case studies. ABC Publishing House, New Delhi.

Subramanyam,K. 1975. Scientific journals a review of current trends and future prospects. Unesco Bulletin of Libraries, 29 (4): 192-201.

Subramanyam,K. 1976. Core journals in computer science. IEEE Transactions in Professional Communication, 19 (2): 22-25.

Subramanyam,K. 1979. Scattering, laws of - Encyclopaedia of Library and Information Science, 26: 336-354.

Subramanyam,K. 1981. Lotka's law and library literature Library Research, 8: 167.

Sujatha Rao,E and Suresh,P. 1985. Citation pattern in leather science. Annals of Library Science and Documentation, 32 (3-4) 109-114.

Suku,J. 1989. Bibliometric analysis of Indian contributions to biological science literature : a case study of Indian journal of Experimental Biology MLI.Sc Dissertation, Kerala University.

Summers,E.G. 1984. A review and application of citation analysis methodology to reading research journal literature. Journal of American Society for Information Science, 35 (6): 332-343.

Swanson,D.R. 1988. Historical note : information retrieval and the future of an illusion. Journal of American Society for Inforamtion Science, 39: 92-98.

Swanson,D.R. 1993. Intervening in the life cycles of scientific knowledge. Library Trends, 41 (4): 606-631.

Sylvan,C. 1993. Canadian Research activity in Aquaculture : a bibliometric analysis. Scientometrics, 27 (3): 295-316.

Tagliacozzo,R. 1967. Citations and citation indexing - its theory and applications in science, technology and humanities. Wiley, New York.

Tague,J. 1981, Sucess breeds success phenomenon and bibliometric processes. Journal of American Society of Information Science, 32: 280-286.

Tague,J. 1988. What's the use of bibliometrics? In : Egghe and Rousseau, Ed: Informetrics 87/88, Elsevier, Amsterdam, p.271-278.

Tague,J. 1992. An introduction to informetrics. Information Processing and Management, 28: 1-3.

Tague,J. Beheshti,J and Rees - Potter,L. 1981. The law of exponential growth: evidence, implications and forecasts. Library Trends, 30 (1): 125-149.

Tague,J and Nicholls,P. 1987. The maximal value of a Zipf size variable: sampling properties and relationship to other parameters. Information Processing and Management, 23 (3): 155-170.

Tijssen,R.J.W. and Van Raan,A.F.J. 1990. Net citation balances a measure of influence between scientific journals. Journal of American Society for Information Science, 41: 298-304.

Tijssen,R.J.W. and Leeuw,J. De and Van Raan,A.F.J. 1988. A method for mapping bibliometric relations based on field classification and citations of articles. In Egghe and

Rousseau, Ed: Informetrics 87/88, Elsevier, Amsterdam. 279-292.

Todorov,R. 1994. Facts or imposed names on facts? Scientometrics, 30: 461-464.

Todorov,R. and Glanzel,W. 1988. Journal citation measures: a concise review. Journal of Information Science, 14: 47-56.

Tomer,C. 1986. A statistical assessment of two measures of citation : the impact factor and the immediacy index. Information Processing and Management, 22 (2): 251-258

Trueswell,R.W. 1969. Some behavioral patterns of library users: the 80/20 rule. Wilson Library Bulletin, 43: 458-461

Turner,W.A. 1994. What's in an R. Infometrics or Informetrics? Scientometrics, 30: 471-480.

Vaishnav,A.A. and Deo,V.N. 1993. Literature of computerised library and information service: a bibliometric study. Library Science, 30(2): 45-53.

Van Colt,H.P. and Zavala,A. 1967. Extracting the basic structure of scientific literature. American Institute for Research.

Van Heeringen,A and Dijkwel,P.A. 1987. The relationships between age, mobility and scientific productivity PtI Effect of mobility on productivity. Scientometrics 11(5-6): 267-280. Pt II: Effect of age on productivity. Scientometrics, 11 (5-6), 381-293.

Van Hooydonk,G. Gevart,R, Mills-Proost,G, Van de Sompel,H and Debackere, K. 1994, A bibliotheeconomic analysis of the impact factors of scientific disciplines. Scientometrics, 30: 65-81.

Van Raan, A.F.J. and Hartman, 1987. The comparative impact of scientific publications and journals, Methods of measurement and graphical display. Scientometrics, 11(5-6): 325-331.

Velho,L. 1986. The meaning of citation in the context of a scientifically peripheral country. Scientometrics, 9 (1-2): 71-89.

Vickery,B.C. 1948, Bradford's law of scattering. Journal of Documentation, 4: 198-203.

Vickery,B.C. 1969. Indicators of the use of periodicals. Journal of librarianship, 1 (3): 170-182.

Vinkler,P. 1986. Evaluation of some methods for the relative assessment of scientific publications. Scientometrics, 10 (3/4): 157-177.

Vinkler,P. 1990. Bibliometric analysis of publication activity of a scientific research Institute. In : Egghe and Rousseau,R Ed: Informetrics 89/90. Elsevier, Amsterdam. P. 308-334.

Virgo,J.A. 1977. A Statistical procedure for evaluating the importance of scientific papers. Library Quarterly, 47: 415-430.

Vlachy,J. 1978. Frequency distribution of scientific performance; a bibliography of Lotka's law and related phenomenon. Scientometrics, I: 109-130.

Voos,H. 1974. Lotka and information science. Journal of American Society for Information Science, 25: 270-272.

Wade,N. 1975. Citation analysis: a new tool. Science, 188: 430

Wallace,D.P. 1986. The relationship between journal productivity and obsolescence. Journal of American Society for Information Science, 37 (3): 136-145.

Wallace,D.P. 1987. A solution in search of a problem: bibliometrics and libraries. Library Journal, 112(8): 43-47

Weinberg,B.H., 1974. Bibliographic coupling : a review. Information storage and Retrieval, 10: 189-196.

Weinstock,M. 1971. Citation Indexes, In: Encyclopaedia of Library and information science, 5: 16-40.

Weisman,H.M. 1972. Information systems, services and centres. Wiley, New York p. 1-11.

Wersig,G. 1993. Information Science, the study of postmodern knowledge use. Information Processing and Management, 29 (2): 229-239.

White,H.D. and Mc Cain ,K.W. 1989. Bibliometrics. Annual Review of information Science and Technology. 24: 119-186.

Whitley,R.D. 1969. Communication nets in science. status and citation patterns in animal physiology. Sociological Review, 12 (2): 219-233.

Whitney,G. 1992. Asian authorship in major international bibliographic databases. In: Ravichandra Rao, I.K.Ed: Informetrics - 91, p. 501 - 526.

Wiberly,S.E. 1982. Journal rankings from citation studies: a comparison of national and local data from social work. Library Quarterly, 52 (4): 348-359.

Wilkinson,E.A. 1972. The ambiguity of Bradford's law. Journal of Documentation, 28(2): 122-130.

Windsor,D.A. 1976. De-aquisitioning journals using productivity/ cost rankings. Acquisitions Librarian, 1(1): 8-10.

Windsor,D.A. 1976a. Could bibliometric data be used to predict clinical success in drugs? Journal of Information Science, 19: 363-376.

Wissman,C. 1993. Techniques of data retrieval for scientometric research in ISI citation indexes. Journal of Information Science, 19: 363-376.

Wolfram,D., Chu,C.M. and Lu,X. 1990. Growth of knowledge: bibliometric analysis using online database. In: Egghe and Rousseau, Ed: Informetrics 89/90, Elsevier, Amsterdam, p. 355-372.

Wood,J.B. 1988. The growth of scholarship; an online bibliometric comparison of dissertations in science and humanities. Scientometrics, 13(1-2): 53-62.

Worthen,D.B. 1973. Epidemic process and the contagion model. Journal of American Society for Information Science, 24: 343-346.

Worthen,D.B. 1975. Application of Bradford's law to monographs. Journal of Documentation, 31 (1): 19-25.

Wyllys,R.E. 1975. Measuring scientific prose with rank-frequency (Zipf) curves: a new use for an old phenomenon. Information Revolution, 12: 30-31.

Wylly,R.E. 1981. Empirical and theoretical basis of Zipf's law. Library Trends, 30: 53.

Xhingnesse,L.V. and Osgood,C.E. 1967. Bibliographical citation characteristics of the psychological journal network in 1950 and in 1960. American psychologist, 22: 778-791.

Yanovsky,V.L. 1981. Citation analysis: significance of scientific journals. Scientometrics, 3(3): 223-233.

Yitzhaki,M and Ben-Tamar,D. 1991. Number of references in biochemistry and other fields; a case study of the journals of biological chemistry throughout 1910-1985. Scientometrics, 21: 3-22.

Yuthavong.Y. 1986. Bibliometric indicators of scientific activity in Thailand. Scientometrics, 9 (3-4): 139-143.

Zang,Q. 1986 Obsolescence and Bradford Distribution of Rice Literature. M.Sc. Thesis, The city University, U.K.

Zipf,G.K. 1935. The Psycho-biology of language: an introduction to dynamic philology. Cambridge, MIT Press, Mass.

Zipf,G.K. 1949. Human behaviour and the principle of least effort. Addison Wesley, Cambridge.

Zunde,F. 1984. Empirical laws and theories of information and software sciences. Information Processing and Management, 20: 5-18.