TOXICOLOGY LITERATURE :
AN INFORMETRIC ANALYSIS

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Research Guide

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DECLARATION

I, **B. MINI DEVI** *do hereby declare that the thesis entitled* **"TOXICOLOGY LITERATURE : AN INFORMETRIC ANALYSIS"** *is a bonafide record of research work done by me under the supervision of Dr. C.V. Rajan Pillai and that no part of it has not previously formed the basis for the award of any degree, diploma, associateship, fellowship or other similar titles or recognition of any other University or Institution.*

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CERTIFICATE

This is to certify that the thesis entitled **"TOXICOLOGY LITERATURE : AN INFORMETRIC ANALYSIS"** *is a bonafide record of work carried out by* **Smt. B. MINI DEVI,** *under my guidance and supervision for Ph.D. degree and no part of this has hither to been submitted for the award of any other degree in any university.*

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Research Guide

CONTENTS

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LIST OF TABLES

LIST OF FIGURES

ACRONYMS USED

AGRICOLA	-	Agricultural On-Line Access
AIDSLINE	-	Aids information on Line
AIDSTRIALS	-	Aids clinical Trials
ASLIB	-	Association of Special Libraries and Information Bureau
AVLINE	-	Audio-Visuals on Line
BIOETHICSLINE	-	Bioethics on line
BIOSIS	-	Bio-sciences Information Services
BRS	-	Bibliographic Retrieval Service
CA	-	Chemical Abstracts
CABS	-	Current Awareness in Biological Sciences
CANCERLIT	-	Cancer-related Literature
CAS	-	Chemical Abstracts Service
CATLINE	-	Catalog on Line
CBAC	-	Chemical Biological Activities
CCRIS	-	Chemical Carcinogenesis Research Information System
CHEMID	-	Chemical Identification
CRC	-	Cyclic Redundancy Checksum
CRISP	-	Computer Retrieval of Information on Scientific Projects
CSIN	-	Chemical Substance Information Networks
DART	-	Developmental and Reproductive Toxicology
DIANE	-	Direct Information Access Network for Europe
DIRLINE	-	Directory of Information Resources on Line
DNA	-	Deoxy-ribo Nucleic Acid

DOCUSER	-	Document Delivery User
ECDIN	-	Environmental Chemicals Data and Information Network
EMIC BACK	-	Environmental Mutagen Information Centre Back file
EPA	-	Environmental Protection Agency
ETIC	-	Environmental Teratology Information Centre
ETIC BACK	-	Environmental Teratology Information Centre Back file
EURONET	-	European Network Incorporated (USA)
GENE-TOX	-	Genetic Toxicology
HEALTHSTAR	-	Health Services, Technology, Administration and Research
Histline	-	History of Medicine on Line
HMTC	-	Hazardous Materials Technical Centre
HSDB	-	Hazardous Substances Data Bank Projects
HSRPROJ	-	Health Services Research Projects in Progress
ICRDB	-	International Cancer Research Data Bank
ICTs	-	Information & Communication Technologies
IGM	-	Internet Grateful Med
IPA	-	International Pharmaceutical Abstracts
IRIS	-	Integrated Risk Information System
JAMA	-	Journal of American Medical Association
JICST	-	Japan Information Centre of Science and Technology
LADB	-	Laboratory Animal Data Bank
MEDLARS	-	Medical Literature Analysis and Retrieval Systems
MeSH	-	Medical Subject Headings

NIH	-	National Institute of Health
NLM	-	National Library of Medicine
NTIS	-	National Technical Information Service
POPLINE	-	Population Information on Line
QSAR	-	Quantitative Structure Activity Relationship
RTECS	-	Registry of Toxic Effects of Chemical Substances
RTECS	-	Registry of Toxic Effects of Chemical Substances
SANSS	-	Structure and Nomenclature Search System
SDC	-	Systems Development Corporation
SDILINE	-	Selective Dissemination of Information on LINE
SERLINE	-	Serials on Line
TD 3	-	Toxicology Document and Data Depository
TDB	-	Toxicology Data Bank
TMIC	-	Toxic Materials Information Centre
TOXLINE	-	Toxicology Information on Line
TOXNET	-	Toxicology Data Net works
TRI	-	Toxic Chemical Release Inventory
TSCA	-	Toxic Substances Contract Act
TYHNET	-	Network Operated by Timeshare

CHAPTER - I

INTRODUCTION

CHAPTER - I

INTRODUCTION

1 Introduction

Knowledge is the most important asset and greatest competitive advantage of individuals as well as organizations. To Davenport , Thomas and Prusak, Lawrence [1], "Knowledge is fluid mix of framed experience, values, contextual information, expert insight and grounded intuition that provides an environment of framework for evaluating and incorporating new experiences and information". Knowledge originates and is applied in the minds of the knower. Knowledge is the information stored or captured along with its context. This allows for making predictions, casual associations or predictive decisions about what to do, unlike information, which simply gives us the facts. Knowledge is intuitivè, hard to communicate and difficult to express in words and chunk of it is not stored in database but in the minds of people. However 'information' and 'knowledge' are often used as if they are interchangeable or synonyms. When information has been utilised to achieve a specific purpose by an individual or organisation then it becomes knowledge. Information is considered as a fourth resource, which facilitates effective utilization of other essential resources. The conceptualisation of the fourth resource for effective management of the other resources can be considered as knowledge. Knowledge is a very difficult concept to be defined because knowledge is formulated in the minds of individuals. Information can be the basis for expertise knowledge for one individual, but for another person it may not have any value. Knowledge has inherent value, which is formulated on the basis of the individual's conceptualisation and his/her ability to extract facts.

Before the invention of printing, the knowledge was in the form of personal knowledge and disseminated through talking. By the invention of printing 'documents' became the channel for communication of knowledge. Hence the universe of knowledge is expanding with the addition of documents. With the accumulation of documents of different types, the phenomenon of 'knowledge explosion' or 'knowledge fragmentation' occurred. Then steps towards organising the knowledge took place so that the various sources can be utilized in times of need. With 17^{th} century onwards collaborative research starts and scientists began to communicate their research results to one another and the world at large. This put ways to the building up of the modern journals. The first journals published were 'Journal des Scavans' and 'The Philosophical Transactions', started in 1665 [2]. By the end of 17^{th} century, about thirty scientific and medical journals were published. The specialised journals were become common in the next century. The proliferation of literature from traditional subjects to its narrower fields and research papers with the characteristic system of citation took shape in the 19^{th} century.

Research is a diligent enquiry and careful search for knowledge through systematic, scientific and analytic approach in any branch of knowledge. With the emergence of global collaboration of research, scientists speak to the world through international conferences, symposia, seminar etc. The number of international conferences and participation of scientists in these programmes are increasing. Hence Science is advanced from "little science to big science" by "standing on the shoulders of giants" pointed out by Price [3]. Increase in the rate of collaborative research resulted in the exponential growth of scientific journals. The professional societies which publish journals have to compete with professional publishers.

The exponential growth of Science and Technology literature during 20^{th} century led to the phenomenon of 'information explosion' or 'information pollution'. In the field of Toxicology, the interdisciplinary research resulted in 'information fragmentation' of the basic subject to environmental, medical and economic toxicology. The interest in collaborative research resulted in the transdisciplinary growth of Toxicology which ultimately resulted in the scatter of literature. In scientific fields the research results published in journals are peripheral to the subject. Therefore there is a need for selection of literature by applying scientific methods. The rapid growth of scientific information has begun to pose serious problems for both scientists and librarians.

As well as offering greater functionality within journals, the Web offers possibilities for interactivity between journals. In medical field High Wire Press, run by Stanford University Libraries, Science Direct by Elsevier Science, Open Archives Initiative, Pub Med Central by US National Institute of Health, Cross Ref by Wiley and Academic Press, SPARC (Scholarly Publishing and Academic Resources Coalition) by the Association of Research Libraries are such journal communities.

The Internet offers rapid publication; 'live' cross-reference links; and greater interaction between journals and their readers. Most journals presently replicate some or all of their content into Web pages and add a search engine; others are using the Internet to improve traditional publishing practice, devising new ways of delivering content with additional features. The peer-review process is revolutionized by unlimited publication space; greater interactivity between editors, authors, and reviewers making peer review an ongoing process of comment and revision and the possibility of an openness that offers greater accountability and higher standards of ethical behaviour.

Easy and efficient access to the Toxicology journal literature is vital to the process of providing evidence-based health care. Advantages of retrieving information via the Web include its simple interface; currency of content; breadth of online resources; cost-effectiveness; and malleability of content to individual requirements. Many medically focused indexes and search engines have been developed. Manual indexes employ people to select and catalogue Web sites producing directories, whereas automated search engines use computer programs to generate searchable indexes. Manual directories are generally better at locating whole Web site relating to a particular topic, whereas computer-generated indices are generally better at locating individual Web pages or more specific information.

Open access, online peer review, e-prints, and online-only journals are changing the way we process and communicate Toxicology information. The Internet enables us to access databases of information that were previously either inaccessible or available solely in libraries. This enables these databases to evolve from a source of references and abstracts to a fully searchable and comprehensive set of online full-text articles, all at the click of a mouse.

Researchers can utilize the anonymity of the Internet to conduct qualitative research in Toxicology using techniques of passive observation, active participation, or interviews and surveys. The surveys are conducting via the Internet require an awareness of various methodological issues, selection bias, and technical issues. The Internet can help researches find information about laboratory or clinical protocols, or about statistical methods and instruments. The electronic 'pre-publication' of preliminary research results and conclusions facilitate an ongoing process of peer review and online collaboration. The automated current awareness services alert researchers to the ultimate publication of new work.

During the closing years of the twentieth century the Internet had become virtually ubiquitous, insinuating its way into almost all facets of life.

The transdisciplinary research resulted in the growth and scatter of Toxicology literature. Hence measuring of information becomes an essential need of toxicologists and as well as librarians working in the field. Information analysis is an efficient and accurate technique, can be applied to measure the information. This enables proper selection of literature for researchers and information managers.

1.1 Relevance of the study

Informetric research is undertaken by scholars from many disciplines including Library and Information Science, history of Science, Computer Science, Communications, Sociology and Linguistics. Studies examining the most popular search topics on Internet, search services or usage pattern of books within libraries are of interest to library managers are examples of research topics within scope of Informetrics.

According to Tague - Sutcliffe [4] Informetrics is "the study of the quantitative aspects of information in any form, not just records or bibliographic, 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 the measurement of information that lie outside the boundaries of both 'Bibliometrics' and 'Scientometrics' "and she continues to say that, "Although in practice the scope of 'Informetrics' is very broad, two phenomena that have not, in the past, been seen as part of 'Bibiliometrics and 'Scientometrics', but fit within the scope of 'Informetrics' are

- definition and measurement of information and
- types of characteristics of retrieval performance measures".

Retrieval performance measures have been studied by information retrieval theorists to `Information and Computer Sciences', for both its theoretical and practical aspects. Thus, it can be said that the scope of

'Informetrics' is both practical and theoretical. However, the primary emphasis has been on the development of mathematical models, and a secondary emphasis on the derivation of measures for the diverse phenomena studies. The value of a model lies in its ability to summarize, in terms of a few parameters, the characteristics of many data sets; the overall shape, concentration, scatter, and the way the data sets change over time. Such models provide a basis for practical decision-making.

Brookes [5] is of opinion that "this new term is being used to cover both sciento - and bibliometrics impartially. It has produced no distinctively new ideas of its own but as it implicitly covers both documentary and electronic forms of communication, it may have a future".

While tracing the origin of informetrics from 1979 by Otto Nacke of West Germany [6] to the 21st century it is evident that informetrics includes the application of informetric laws has led to two different types of studies; quantitative and qualitative. According to B.C. Brookes [7] quantitative studies have five general objectives :

i) "Design of more economic information systems and networks;

ii) Improvement of efficiency rates of information handling process;

iii) Identification and measurement of deficiencies in bibliographical services;

iv) Prediction of publishing trends; and

v) Discovery and elucidation of empirical laws that can provide a basis for developing a theory of Information Science".

Whereas the qualitative studies direct to the following findings which can be intelligently used in library administration are [8]:

i) "Identification of core literature.

ii) Ranking of publications in zones of diminishing importance.

iii) Establishing a transition point between zones of higher and lower utility.

iv) Tracing the spread of ideas as a study of edidemics; and

v) Classifying segments of literature through interconnection of citations".

To Susan Artandi [9] the application of informetric laws helps in the

i) determination of the impact value of a given document;

ii) location of criticisms, of published results of research and experiments.

Burton [10] is of the opinion that the product of bibliometric analysis or informetric analysis is meta information or information about information. This meta information can be used as :

i) a means to better understand the environment in which service and support are offered;

ii) a means to measure and evaluate productivity of his or her own staff and how it compares to other comparable units; and

iii) a new research project or compare his or her own progress to that of a broader spectrum such as other institutions, related disciplines, or other nationalities.

As citation analysis also comes under the perview of informetrics, it can be used to derive the following benefits in any subject field :

i) To study the use pattern of different types of documents

Based on the frequency of citations the relative use and the types of documents cited i.e. books, journals articles, reports, conference proceedings, Web sources etc can be determined.

ii) To study the use of literature

The country of origin can be identified in all types of documents like books, journal articles, reports etc. from the citations.

iii) For preparing subject bibliographies

Compilation of bibliographies is a difficult task in today's information flood. The citations gathered for analysis in different subjects can be used for the compilation of bibliographies.

iv) To study the use of different languages

Although English language dominates in all subject fields, the influence of other languages can be ascertain from analysing the citations.

v) To do further research in the subject

By analysing the citations in a given subject the reader get a sound subject background which lead him to further studies in the subject.

vi) To ascertain the subject scattering

Through citation analysis the dispersion of subject to different fields i.e. related or unrelated can be found out.

vii) To study the obsolescence rate of documents

Analysis of citations by age of documents show their 'half-life'. The time scales thus obtained are useful in planning of library holdings in future.

viii) To determine the interdependence and lineage of subjects

The interdependence of traditional and applied fields can be studied from citation analysis. By studying the lineage of subject, the mapping of the subject can be done. These two factors can be of use in the acquisition policy of libraries and information centre.

ix) To prepare ranked list of journals

By actual citation counting and by counting the number of entries in indexing and abstracting periodicals, the ranked list of periodicals can be prepared. These ranked lists are efficient and effective guidelines in the acquisition of periodicals in the library.

x) To study the rate of collaborative research

From the number of authors in papers, collaborative research can be measured. These studies reveal authorship pattern at the global, national and regional level in different subjects.

xi) To study the characteristics of scientific journals

The Institute for Scientific Information (ISI) [11] had developed five citation measures in the citation study of scientific periodicals :

i) Impact factor

Impact factor is the ratio between the citation rate of the journal and its citation potential

$$I\,F = \frac{\textit{the number of times a journal was cited}}{\textit{the number of citable items of the journal published}}$$

ii) Citation rate of a journal

The citation rate of a journal is the number of times a journal has been cited.

iii) Self-citing rate

Self-citing rate is a measurement of frequency with which journals cite themselves. It shows what percentage of a journal's reference cite articles it published.

iv) Self-cited rate

Self-cited rate shows what percentage of citations received by a journal originated in articles published by the journal. These self-citation rates serve as induces to the newness, size and isolation of the intellectual universe in which a journal operates.

v. Immediacy Index

Immediacy Index is a method of showing how rapidly the materials published by a journal are selected and used. Immediacy index is calculated by counting the number of citations received by articles in a journal during the year in which they were published.

In short the relevance of informetric study, according to Bjorneborn, E and Ingwersen, P [12] " the field of informetrics embracing the overlapping fields of bibliometrics and scientometrics following the widely adopted definitions by Brookes [13], Egghe and Rosseau [14] and Tague - Sutcliffe" [15] . Cybermetric studies of still fit in the generic field of informetrics as the study of the quantitative aspects of information "in any form" and "in any social group" as stated by Tague - Sutcliffe [16]. The ideas rooted in bibliometrics, scientometrics and informetrics contributed to the emergence of webometrics.

Today's digital and global age due to information overload users are in a confusion to retrieve the relevant information they need. Although the traditional role of librarian as a bookkeeper has changed to service provider and then to information manager, he has a vital role to play in directing the researchers to select suitable literature for their research.

Due to escalating price and constrained library budget the subscription of hard copy of journals become a difficult matter to deal with. The Internet and emergence of e-journals dominate today's journal literature. Therefore librarian must know about evaluative methods that can be applied to assess the particular needs of researchers in their organisation.

The acquisition of books and journals in many libraries are without following a definite pre-planned acquisition policy. As a result the amount spent on research and libraries become a real waste. Hence the acquisition and services are to be planned to meet the information requirements of the researchers to the maximum. Here comes the importance of informetric studies of the literature. The results obtained through informetric studies can be of great importance to librarians, researchers, faculty members and information scientists. The modified 'citation weights', 'impact factor' and 'immediacy index' put forward by Science Citation Index are of special mention here. The present study focuses on Toxicology literature.

1.2 Toxicology

People are exposed to a great variety of natural and man-made substances. Under certain conditions such exposures cause adverse health effects. These effects range from death to subtle biologic changes. Society's ever - increasing desire to identify and prevent these effects has prompted the dramatic evolution of Toxicology as a study of poisons to the present day complex science.

The assessment of health hazards of industrial chemicals, environmental pollutants, and other substances represents an important element in the protection of the health of the workers and members of communities. In-depth studies of the nature and mechanism of the effects of toxicants are invaluable in the invention of specific antidotes and other ameliorative measures. Thus Toxicology is the study of the nature and mechanism of toxic effects of substances on living organisms and other biologic systems. Toxicology also deals with quantitative assessment of the severity and frequency of these effects in relation to the exposure of the organisms. The US Society of Toxiocology has defined "Toxicology is both a scientific discipline and, like Medicine, an art that is practised. While toxicologists can differ on the exact definition of Toxicology, the central focus of Toxicology is a concern with the adverse effects of chemicals on living organisms and a commitment to assess the like hood that such adverse effects will occur. Along with other sciences, Toxicology contributes to the development of safer chemicals used as drugs, food additives, and pesticides.

1.3 Scope of Toxicology

Toxicology has a broad scope. It deals with toxicity studies of chemicals used :

i) In medicine for diagnostic, preventive and therapeutic purposes.

ii) In food industry as direct and indirect additives.

iii) In agriculture as pesticides, growth regulators, artificial pollinators and animal feed additives.

iv) In chemical industry as solvents, components, and intermediates of plastics and many other types of chemicals.

v) In the health effects of metals, petroleum products, paper and pulp, toxic plants, and animal toxins.

The Bhopal MIC gas tragedy of December 3, 1994, Chernobyl nuclear reactor accident of April 25, 1986 and Gulf War 1990 are some of the man-made catastrophes that remind us to take stringent measures to control environmental pollution to save humanity from being put into jeopardy. Meuse Valley Incident, Belgium of December 1, 1930, Donora Smog Incident, Pennsylvania of October 26, 1948, Tokyo-Yokohana

Asthma developed in 1946, London Smog of December 5, 1952, Los Angeles Smog of 1953, Chlorine Accident of Chembur, Bombay in August 1985, Oleum Leakage in Delhi on December 4, 1985 are notable air pollution episodes. The decaying of marbles of Taj Mahal, leaning tower of Pisa, Italy among the wonders of the world is due to air pollution. In Kerala, people's march against Coco-Cola Company, Plachimada, Palakkad, spraying of endosulphan in the cashew nut estates of Kasargod cause pollution due to toxins. As the population increase, human impacts on environmental systems and technological hazards are not simply a matter of subject curiosity but threaten both the stability of industrialised and developing countries.

In the face of a growing population, modern society demands improvements of the health and living conditions. To meet this goal, a great variety of chemicals must be manufactured and used. It has been estimated that tens of thousands of different chemicals are in commercial production in industrialized countries. In one way or another, these chemicals come in contact with various segments of population; people are engaged in their manufacture, handling, use, consumption or misuse. Furthermore, people may be exposed to the more persistent chemicals through various environmental media. The depletion of ozone layer, disposal of hazardous wastes, burning of plastic materials are of special mention here.

The expansion of the various facets of Toxicology has been outcome of the need of an affluent society to protect itself from harmful chemicals, physical agents, and various industrial and consumer products. The need for Toxicology information on unlimited number of chemicals has had a profound effect upon the development of the Science and profession of Toxicology. Research in Toxicology is carried out in universities, in government and private research laboratories and in certain industrial laboratories. Today Toxicology research is increasingly being focussed on medical, environmental and industrial division as people all around the world are more alert and aware about how widespread the toxins and more particularly over the last century. Many of the themes that are attracting widespread attention and interest are desertification, acid deposition, stratospheric ozone depletion, climatic changes, industrial wastes, drugs are of vital importance to the future of the planet and its people. As the scale of interest of Toxicology research has broadened i.e. from local and regional problems towards global problems, approaches have also progressed from subject-specific disciplinary emphasis towards increasingly multidisciplinary and interdisciplinary research programmes. Increase in research activities results increase in literature. To select relevant literature, the application of scientific techniques is essential. Informetric studies are the widely accepted methods, which enables meticulous selection of literature.

Lack of informetric studies in the field of Toxicology is a major disadvantage pointed out by researchers. Toxicology is a transdisciplinary field which is not only related to traditional subjects like Medicine, Chemistry, Biology, Pharmacology but also to newly emerging subjects like Biotechnology, Environmental Sciences, Food Sciences etc. Being a transdisciplinary subject the results based on Toxicology research may be coming out in a wide variety of documents. Therefore an informetric study of Toxicology literature is an effective tool that can be successfully and wisely used in any library attached to an organization specializing in Toxicology research.

1.4 Title of the study

The title of the study is "Toxicology Literature : An Informetric Analysis".

1.5 Keyword definition

The keywords in the title are defined as follows for the purpose of study.

Toxicology

According to 'Funk & Wagnalls New Encyclopaedia' [17], "Toxicology is the science of poisons, embracing the physical and chemical history of all the known poisonous substances, as well as the methods of testing for them, their action on the living body, and the post mortem results they occur."

To the 'New Encyclopaedia Britannica' [18], "Toxicology is the study of poisons and their effects, particularly on living systems, because many substance are known to be poisonous to life, Toxicology is a broad field, overlapping Biochemistry, Histology, Pharmacology, Pathology and many other disciplines."

According to 'Van Nostrand's Scientific Encyclopaedia' [19], "Toxicology is the technology of poisonous substances, their detection and counteractions. Basic to this branch of science is the realization that chemical compounds vary in their danger to humans and their environment. Sources of information pertaining to toxic substances include local and national health organisations in many countries. Several treaties on the subject have been prepared including the broad spectrum 'Dangerous properties of Industrial materials."

For the purpose of present study Toxicology is defined as the physical and chemical aspects of all poisons affecting environmental, economical and medical aspects of human life.

Literature

Literature is the body of writings produced in a particular country or period or in the world general or the body of books and writings that treat of a particular subject. In simple terms it means published materials on a specific topic.

Literature is also defined as "a literary productions as a whole" by the Oxford English Dictionary [20].

According to Reader's Digest Oxford Complete Word Finder [21], literature is defined as " the written works, those whose value lies in beauty of language or in emotional effect."

To Chambers 21st Century Dictionary [22], literature is defined as " written material, such as novels, poems and plays, that is valued for its language and content i.e. the whole body of written works of a particular country or period in time."

Toxicology Literature

The whole body of written materials, i.e. books, journal articles, information from Web etc, produced and available for use in the discipline Toxicology is known as Toxicology literature.

Informetrics

The 'International Encyclopaedia of Information and Library Science' [23] defines informetrics as "an emerging sub field in Information Science based on the combination of quantitative studies of information flows, advanced information retrieval and text, and data mining. It has a broader scope than bibliometrics, because it also covers non-scholarly communities in which information is produced, communicated and used."

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." It covers the mathematical and statistical applications on information and includes the quantitative and qualitative study of information. To certain extent it means a measure of information.

Informetrics is also defined as " the extensive use of quantitative and qualitative techniques used for studying the structure of literature or discipline. These techniques have been helpful in enabling the mapping of disciplines as also a study of any transition in the structure and composition of a discipline" [24].

Analysis

Analysis is the tracing of things to their source and the resolution of knowledge into its original principles, the discovery of general principles underlying concrete phenomena.

According to the 'Oxford English Dictionary' [25], "analysis is the investigation of any production of intellect, as a poem, tale argument, philosophical system; so as to exhibit its component elements in simple form."

To 'Reader's Digest Oxford Complete Word Finder' [26], "analysis is the detailed examination of the elements or structure of a substance i.e. investigation, examination, study, scrutiny, enquiry, inquiry, dissection, assessment, interpretation, review etc."

According to 'Chambers 21st Century Dictionary' [27], "analysis is the detailed examination of the structure and content of something" [27].

Informetric Analysis

The quantitative and qualitative techniques used for enquiring the elements or structure of information is known as informetric analysis.

1.6 Objectives of the study

The major objectives of the study are :

i) To assess the growth and development of toxicology literature.

ii) To analyse the literature scatter employing standard variables in informetrics.

iii) To identify prominent areas of research in Toxicology.

iv) To study the authorship pattern.

v) To analyse the type of language and documents cited.

vi) To examine how far the literature scatter satisfy the existing laws of informetrics.

vii) To examine the literature scatter in Toxicology in the light of laws of informetrics and suggests deviations if any.

1.7 Other Dimensions

The study focuses on the Toxicology literature produced during 1998 January to December 2003. Because of tremendous research output, the number of journals in Toxicology is increasing. Therefore from the core journal list, the first nine journals were selected and journal study was based on the above nine journals. The present study fled light on the main fields of Toxicology research as well as the important primary journals through which the results are being published. The authorship pattern, subject-wise scatter, country-wise, language-wise and growth pattern, self-citation, bibliographic coupling of the journals were studied. The study will be of great use in formulating the acquisition policy of documents in a library. The present study is useful in identifying obsolate journals so that they can be discarded from the collection.

From the Toxicology literature during 1998 to 2003, author collaboration, subject dispersion, language and types of documents, core books, core authors and their scientific productivity were analysed.

1.8 Hypothesis

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

i) The toxicology literature will not satisfy the existing laws of informetrics.

ii) Obsolescence or aging of journals is quick in the field of Toxicology.

iii) 80/20 rule conform in the subject in which the percentage of articles receiving more citations.

iv) Input of the literature in Toxicology is mostly from developed countries.

1.9 Methodology

In order to get an idea about similar studies done in informetrics, an exhaustive search was carried out. For this many primary periodicals, secondary periodicals like LISA (Library and Information Science Abstract) and its CD-version LISA plus, bibliographies, UGC Infonet E - Journal Consortium, Internet etc were consulted. Details about the studies made in the area of Informetrics were reviewed in Chapter 2 of this thesis. Since the study is about Toxicology Literature it is necessary to have background information about the subject. For this general and subject dictionaries, encyclopaedias, monographs, primary periodicals, secondary periodicals and online databases in the field of Toxicology were consulted. After collecting the background information, the data from TOXLINE was collected. Collecting, organizing and analysing of data were done on the basis of established informetric methods. The down loaded data was transformed to CDS/ISIS programme. The data was sorted to prepare tables and figures and informetrically analysed using SPSS, a statistical software programme. Wherever found suitable, the dependence of different variables were tested statistically using formulae in order to prove the validity of hypotheses based on objectives. The Lotka's and Bradford's informetric distributions were used for analysing the data.

1.10 Organization of the study

After completing the analyses and formulating the results of the study, the format of the thesis was determined. The study is organised under six chapters as follows :

Chapter - I - Introduction

In this chapter a brief introduction of the whole study is provided. It introduces subject under the captions: the relevance of the topic, keyword definitions of the title, objectives of the study, hypothesis, methods of data collection and organization of the study.

Chapter - 2 - Review of Literature

The literature review covers almost all the important aspects of the topic from its origin to the period of this study i.e. from 1928 to 2004. The literature is collected for the purpose of the study was scrutinised under the following divisions such as definition of bibliometrics, scientometrics, informetrics, webometrics, genesis and development, literature reviews, informetric laws i.e. Lotka's law, Bradford's law, Zipf's law, informetric distribution, Lotka - Bradford - Zipf relation, citation analysis i.e. aging or obsolescence, citation half - life, ranking and evaluation, impact factor, bibliographic coupling and clustering, co-citation, current trends, advanced studies and conclusion. Total number of documents reviewed include 285 journal articles, 46 books, 29 conference proceedings, 11 dissertations, 2 unpublished articles, 1 pre-print, 1 monograph and 2 articles from the Web.

Chapter - 3 - Toxicology : Its structure and development

This chapter starts with the genesis and development of Toxicology, outline of the subject, definition, terminological development, classification systems, Toxicology literature, other sources, popular works and online databases. The major divisions of Toxicology such as environmental toxicology, economic toxicology and medical toxicology were examined in detail.

Chapter - 4 - Methodology & Data Collection

A detailed description of the methodology i.e. choosing the sample, sampling technique, variables for analysis are given in this chapter. For the collection of data TOXILINE, TOXLINE Core, TOXLINE Special, its accessibility and retrieval of information were described. The computer programmes used for analysis such as CDS/ISIS, SPSS, the standard format and finally the organization of data were given.

Chapter - 5 - Analysis of data

The description, statistical analysis and the results of the study are provided in this chapter. Authorship pattern, subject dispersion, language and types of documents cited, core books, core authors and scientific productivity, productivity of authors, application and extension of Lotka's law, core journals, rank distribution of cited journals, application and extension of Bradford's law, growth study, bibliographic coupling and self-citation were studied and the interpretation of the data were presented along with tables and figures.

Chapter - 6 - Findings, Areas for research and Conclusion

The findings and conclusions derived from the analysis of collected data are given in this chapter. Suggestions for further study and areas of application of the study are also included.

The dissertation ends with a general bibliography listing books and articles consulted by the researcher for the preparation of this work.

References

1. Davenport, T.H. and Prusak, L. : Information ecology : Hastering the information and knowledge environment. New York : Oxford University Press, 1997.p.28.

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

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

4. Tague - Sutcliffe, J. : An introduction to informetrics. Information Processing and Management, 28 (1) : 1992. p.1.

5. Brookes, B.C. : Numeric methods of bibliometric analysis. Library Trends, 22 (1) : 1973. p.18.

6. Potter, W.G. : Introduction to bibliometrics. Library Trends, 30 : 1981.p.5.

7. Ibid.,p.5.

8. White, Emele C. : Bibliometrics from curtiosity to convention. Special Libraries, Winter : 1985. p. 35.

9. Ferrants, Barbara Kopelock. : Bibliometrics : Access in the library literature. Collection Management, 2(3) :1978.p.39.

10. Burton, Hilary. D. : Use of vital information system for bibliometric analysis. Information Processing and Management, 24 (1) : 1998 p. 39.

11. Garfield, Eugene. : Citation indexing : Its theory and application in science, technology and humanities. New York : John Wiley, 1979.

12. Bjorneborn, L. and Ingwersen, P. :Toward a basic framework for Webometrics. Journal of the American Society for Information Science and Technology, 55 (14) : 2004.p.1217.

13. Brookes, B.C. : Biblio - Sciento-inform-metrics??? What are we talking about?. In. L. Egghe and R. Rousseau, Eds. Informetrics 89/90: Selection of papers submitted for the Second International Conference on Bibliometrics, Scientometrics and Informetrics. London, Ontario. Canada, July 5-7, 1989. Amsterdan: Elsevier, 1990.p.31.

14. Egghe, L and Rosseau, R. : Introduction to Informetrics : Quantitative methods in library, documentation and information science. Amsterdam: Elsevier, 1990.

15. Tague - Sutcliffe, J. An intorudction to informetrics. Information Processing and Management, 28 (1) : 1992. p.1.

16. Ibid., p.1.

17. Funk & Wagnalls New Encyclopaedia . :Vol.23. New York : Funk & Wagnalls Inc.,1971.p.208.

18. New Encyclopaedia Britannica. : Vol.3. Chicago : Encyclopaedia Britannica Inc.,1911.p.878.

19. Van Nostrand's Scientific Encyclopaedia. : New York : Van Nostrand's Reinhold,1976.p.220.

20. Oxford English Dictionary. Vol.1. Oxford Clarendon Press,1989.p.1029.

21. Reader's Digest Oxford Complete Word Finder. : Oxford : Clarendon Press, 1989.p.892.

22. Chambers 21st Century Dictionary. New Delhi : Allied Chambers (India) Limited, 1999.p.798.

23. International Encyclopaedia of Information and Library Science . : Feather, John and Sturges, Paul. Eds. London : Routledge, 2003.pp.319-320.

24. Kumar, P.S.G. : Research methods and statistical techniques. Delhi : B.R. Publishing Corporation, 2004.p.483.

25. The Oxford English Dictionary. Op.Cit.,p.434.

26. Reader's Digest Oxford Complete Word Finder. Op. Cit., p.49.

27. Chambers 21st Century Dictionary. Op. Cit., p.43.

CHAPTER - 2

REVIEW OF LITERATURE

CHAPTER - 2

REVIEW OF LITERATURE

2 Introduction

The review of literature is intended to give a background as well as a broad review of research methods and procedures used by earlier workers in the field of study and points out briefly the findings of related studies. In this chapter, an attempt is made to present a review of related literature published in the area of informetrics, which will help to give an overview of the researches conducted in the area earlier. In this review of literature, journal articles, thesis, seminar papers etc published in India and abroad are included. Internet is also used for retrieving articles. This will give a clear picture of the subject under investigation.

For the purpose of review of literature on informetrics, the following sources were consulted.

1. LISA CD-version (1958 -2004)

   (Library and Information Science Abstract)

2. ILISA (1943-2004)

   (Indian Library and Information Science Abstract)

The literature collected for the purpose of the present study are conveniently grouped and reviewed under the following headings:

- Definition of Bibliometrics/Scientometrics/Informetrics /Webometrics
- Literature review
- Informetric laws
- Citation analysis
- Current trends
- Advanced studies.

To achieve clarity the start is made with a systematic analysis of the genesis, development, definition of various concepts in informetrics.

2.2 Definition of Bibliometrics, Scientometrics and Informetrics

To Hulme [1] the purpose of statistical bibliography is to "shed light on the process of written communication and of the nature and course of development of a discipline (in so far as this is displayed through written communication), by means of counting and analysis its various facts of written communication". Raising [2] in 1962 defined statistical bibliography as "the assembling and interpretation of statistics relating to books and periodicals. . . to demonstrate historical movements, to determine national and universal research, use of book and journals and to ascertain in many local situation the general use of books and journals". The term bibliometrics was accepted widely instead of statistical bibliography after the publication of Pritchard's paper in 1970 [3]. The term bibliometrics was originated from two words - 'biblio' meaning 'book' and 'metrics' meaning 'science of meter' i.e. 'measurement'. Pritchard [4] defines bibliometrics as "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". According to Fairthorne [5], bibliometrics is the "quantitative treatment of properties of recorded discourse and behaviour appertaining to it". Pritchard [6] used bibliometrics as "the application of mathematical methods to books and other media of communication". To the British Standard Glossary of Documentation of Terms [7], bibliometrics is "the use of documents and patterns of publication in which mathematical and statistical methods have been applied". Hawkins [8] interpreted bibliometrics as "the quantitative analysis of the bibliographic features of a body of literature", in his on-line bibliometric study. Nicholas and Ritchie [9] in their book, 'Literature on Bibliometrics', stated that bibliometrics provide information about the structure of knowledge and how it is communicated.

They accepted the definition of bibliometrics as the statistical or quantitative description of literature i.e. those describing characteristics or features of a literature (descriptive studies) and those examining the relationship formed between the components of a literature (behavioural studies). Potter [10] defined bibliometrics as "the study and measurement of the publication patterns of all forms of written communication and their authorship". To Schrader [11] bibliometrics is "the scientific study of recorded discourse". A historical overview of various definitions of bibliometrics was put forward by Broadus [12], bibliometrics is "the quantitative study of physical published units of bibliographic units or of surrogates of either". According to Hertzel [13], "Bibliometrics is 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 reqularity of communication phenomenon". Egghe [14] explained bibliometrics as the development and applications of mathematical models and technique to all aspects of communication. More recently Sengupta [15] defines bibliometrics as the "organisation, classification and quantitative evaluation of publication patterns of all macro and micro communications along with their authorships by mathematical and statistical calculus".

The term 'Scientometrics' originated in Russia to mean "the application of quantitative methods to the history of science" [16]. Merton and Garfield [17] defined it as the field of enquiry given over to the quantitative analysis of science and scientific field . . . come to be known as Scientometrics or Bibliometrics. To Beck [18] ,'Scientometrics' which is sometimes also used for bibliometric like phenomena is defined as "quantitative evaluation and intercomparison of scientific activity, productivity and progress". Brusilovsky [19] defined scientometrics as "the study of the measure of scientific and technological progress".

"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" [20].

To Sen [21], bibliometrics deals with documents and its components while metric studies pertaining to information is informetrics. Morales [22] uses the term 'informetrics' to cover almost all the aspects of bibliometrics and librametrics. According to Lancaster [23], "informetrics covers all quantitative analyses of information transfer, whether or not they involve the published literature". 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" [24].To Almind and Ingwersen [25], Bjorneborn and Ingwersen [26] , Webometrics is the application of informetric and other quantitative techniques to the study of the Web.

From the definition of bibliometrics, scientometrics , informetrics and webometrics, it is clear that the scope of bibliometrics is limited to documents, that of scientometrics to the studies of science, the informetric studies cross the above boundaries and spread over all the fields of information, whereas webometrics is the informetric study of the Web. In today's information age the relevance of informetrics is realized all over the world and a series of international conferences are organised in this topic. According to Lancaster, the subject has grown form simple data analysis to well defined subject having applications in statistics, simulation, modelling, cluster analysis, network studies etc.

2.2.1 Genesis and Development

In 1917 Cole and Eales [27] presented 'The History of Comparitive Anatomy Part - I : A statistical Analysis' is recorded to be the first bibliometric study, in Science Progress. This project analyses publications in comparative anatomy from 1543-1860 by simply counting the number of titles, both books, and journal articles. They mainly studied the fluctuations of interest and distribution of literature among countries and hence named as "statistical analysis of the literature". Hulme [28] introduced the term "Statistical bibliography", in 1923 and later it was used by many others, where Hulme analysed the journal articles in "English International Catalogue of Scientific Literature" and derived the ranking of countries by their productivity. From the two terms statistics and bibliography, originated the term 'statistical bibliography'. 'Statistics' is derived from the world 'status' meaning state, position, standing. According to Webster's Dictionary, statistics "is facts or data of a numerical kind, assembled, classified and tabulated so as to present information about a subjects" [29]. From 'biblion' derived the terms bibliography meaning 'book' and 'graphos' which inturn means 'to write'. According to Webster's Dictionary bibliography "is a list of authors writings or the literature dealing with a certain subject or author" [30]. To Hulme bibliography is the "science of organization of knowledge" [31]. From the amalgamation of statistics and bibliography originated the term statistical bibliography, which indicates the quantitative methods in Library Science. Instead of statistical bibliography to denote the "application of mathematical and statistical methods to books and other media of communication". Gross and Gross's [32] study is considered to be the third study in the field based on citation data. After Hulme, the term statistical bibliography was used by Henkle [33], 1938 in his article "The Periodical Literature of Biochemistry" and Gosnell [34] in 1943, Introduced the term in his thesis to "emphasise on the quantitative aspect than qualitative" and later in his article [35] of 1984. Later Fusseler [36] [37] in 1948 and 1949, Raising [38] in 1962, Barker [39] in 1966 and Pritchard [40] [41] in 1968 argued that there was a potential utility of statistical bibliography as a method of analysing information needs. Witting [42] has been traced the historical development of the term 'Statistical Bibliography'. As the term was considered "very clumsy, not very descriptive, and can be confused with statistics itself or bibliographies on statistics" [43], Pritchard [44] introduced the word "Bibliometrics" in 1969. In the meanwhile, S.R. Ranganathan introduced the term "Librametry" in 1948. Ranganathan [45] described the term to be used to study the various library operations by applying statistics. S.R. Ranganathan also introduced the application of statistical and mathematical techniques in Indian libraries to improve their functions and services.

In the beginning of 1970's Russian concept "Scientometrics" aimed at getting structural (or qualitative) picture of the state of science is gaining popularity. The term was introduced and came into prominence with the founding of the journal named "Scientometrics" by T. Braunin in 1977, originally published in Hungary and currently from Amsterdam. According to Brookes [46] the fourth term 'Informetrics' was first proposed by Otto Nacke of West Germany in 1979. An FID Committee with very broadly defined objectives in the provision of research and technical data was subsequently given this name. The term was not widely adopted until 1987 when B.C. Brookes at the First Conference on Bibliometrics & Theoretical Aspects of Information Retrieval held at Diepenbeek, Belgium, suggested that the term 'Informetrics' be included in the name of the Second International Conference on the subject. Egghe and Rousseau [47] state that "the term `Informetrics' was favoured rather than the terms 'Bibliometrics' and 'Scientometrics'". In promoting the new name, it was decided to use the name 'Informetrics' together with the name 'Bibliometrics' in the title of the following conferences and in the title of the published Conference Proceedings also [48]. The second meeting was thus named as "International Conference on Bibliometrics, Informetrics and Scientometrics" and the term 'Informetrics' continues to be used in this series of biennial conference. The proceedings of earlier conferences [49] is sufficient to express the wide scope of the field of informetrics. There are attempts to measure extent of concentration [50], methods to represent various aspects of co-operative effort and disciplinary structure [51]. The field has acquired its own development, elaboration and applied definitions of measures of output, using various counts and modes of citation analysis [52]. The methodologies used range form empirical counting to axiomatics [53]. Brookes states that "this new term is being used to cover both sciento - and biblio - metrics impartially. It has produced no distinctively new ideas of its own but as it implicity covers both documentary and electronic forms of communication, it may have a future". Kopelock [54] points out that during the period of 1969 - 1977, there are a total of 52 different terms have been used to describe bibliometrics. Thus from the study it is evident that informetrics evolved from earlier terms like statistical bibliography, librametry, bibliometrics and scientometrics.

2.3 Literature Review

The first paper based on significant statistical data was F.J. Cole and Nellie Eales [55] in 1917 in Science Progress. This project analyses publications on Comparitive Anatomy from 1543 - 1860 by simply counting the number of titles, both books and journal articles. They mainly studied the fluctuations of interest and distribution of literature among countries. This kind of study was named as "statistical analysis of literature". In this paper, publication counts and graphic illustrations were used for the statistical analysis of Comparative Anatomy. Even though the paper came out before the subject bibliometrics was formed as a separate discipline, it is placed as a source article in the field of bibliometrics. In 1923 E. Hulme conducted the first analytical account on the growth of literature. In this paper Hulme critically evaluated the productivity of scientific literature for a period of time and concluded that the fall and rise of scientific literature are influenced by population change, political and economic issues. The utmost importance of the paper was that for the first time the term "statistical bibliography" was used in scientific literature. Hulme analysed journal articles in "English International Catalogue of Scientific Literature". In 1926, scientific productivity formula was published [56]. This law was known later as Lotka's Law. Gross and Gross [57] wrote a paper based on the studies of references in "Journal of American Chemical Society". This study was recognized as a model for other studies and is the first recorded study of citation analysis.

In 1934, Bradford published an article on scattering which was later known as Bradford's Law of Scattering. This is the first important law in the field of informetrics [58]. While studying on 300 abstracting and indexing journals, Bradford realized that "out of 750, 000 articles, only 250,000 are dealt with and the remaining 500,000 are missed". Then he continued the study using a bibliography on applied Geophysics (1928 - 1931) and Lubrication (1931-1932) compiled by Lancaster Jones. From the study 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" [59]. In the book 'Documentation', Bradford's law is discussed in detail which was published in 1948. G.K. Zipf [60] made a remarkable contribution to bibliometrics by publishing his book in 1935 in which he put forward the relation between rank and frequency of word usage. This concept was later came to be known as Zipf's Law of Word Frequency. Zipf studied the rank and frequency of word usage by using M.L. Hanley's " Index of words for James Joyce's Ulysses".

Fussler [61] put forward a classic paper in 2 parts and discussed "the importance of literature of various subject fields to research in Chemistry and Physics, 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". The concept about 'impact factor' was introduced by Garfield [62] in 1955. The impact factor is the ratio of the number of citations a journal receives to the number of papers published over a period of time. According to Garfield, the impact factor is useful in evaluating the significance of absolute citation frequencies. To Garfield [63] "impact is a measure of relationship between citations and articles published". Another method to measure journals or articles cited is by ‘immediacy index’ which is a measure of how quickly the average cited articles in a particular journal is cited. The values of immediacy index are published in Journal Citation Reports. Narin [64] calculated the influence of a journal by measuring the citation ratio between two journals.

Kessler [65] introduced the concept of bibliographic coupling as a method for grouping technical and scientific papers. Two documents are bibliographically coupled if their reference lists share one or more of the same cited documents. Weinberg [66] in 1974 referred to Kessler's paper as "classic paper in bibliographic coupling".

Goffman and Newill [67] in 1964 published a paper on epidemic theory, a technique explaining the transmission of ideas by means of literature. Here an ‘infectious disease epidemic’ is compared to an ‘intellectual epidemic’. This comparison helps to describe the publication activity within a given discipline to determine the necessity for an information retrieval system. There are three groups exists in this model i.e. infective, susceptible 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 neither infective nor susceptibles. This model can be applied to cluster of papers, an original paper being infective and papers which cite original are susceptibles.

In 1965 Pritchard [68] first coined the term ‘bibliometrics’ instead of ‘statistical bibliography’. Small [69] put forward the concept of co-citations and compared the ‘co-citation analysis’ with that of ‘bibliographic coupling’.

From 1971 onwards the papers published on bibliometrics showed a difference in the methods and applications. The papers published before 1971 were basically on theoretical and empirical aspects. Theoretical papers accepted mathematical formula rather than empirical data to study various distributions. Several attempts have been made to bring out the interrelationship among these three laws. Vickery [70] analysed Bradford's Law and came to the conclusion that there is difference in verbal and graphical expressions of the law . Kendall [71] suggested that there exists a relationship between Bradford and Zipf distribution. Yablonsky says "one can assume at any rate that the 'frequency' law of Lotka and the 'rank' law of Zipf describe most accurately two different 'boundary regions' of the scientific productivity and scientists . . . is characterized more precisely by the frequency approach (the Lotka's Law). The distribution of highly productive scientists when the productivity of different scientists differs at least by one so that they can be ranked in the order of diminishing productivity and each scientist can be ascribed an extra rank is described more accurately by the rank approach (the Zipf's Law)". Leimkuhler [72] analysed Bradford's law and suggested that the 'Law of Scattering' indicates the number of references for a given portion of journals while the 'distribution' gives the number journals required to obtain a given portion of reference. Brookes [73] strongly criticised Bradford's law and found that the theoretical basis of the law is agreeable but its practical application is difficult. Yablonsky [74] analysed the bibliometric and scientometric core - scatter distributions and found that there is a close similarity between them. To Hatium [75] Zipf's distribution is the fundamental to all other distributions. Bookstein [76] considers that the three informetric distributions as unified models. Egghe [77] traces the similarities and differences between the classical bibliometric laws. Rousseau [78] studied the relation between informetric laws and how they differ in certain vital aspects. Some of the important empirical studies based on prediction and evaluation of informetric laws are by Pratt [79], Drott [80], Lawani [81], Goffman and Morris [82], Brookes [83] and Egghe [84].

Much of the later informetric studies were made either to substantiate, modify, link, extend or challenge the basic informetric laws. These studies pave way to the emergence of some more empirical laws and many theoretical models. Some of them are Brooke's Logarithmic model [85], Price's Cumulative Advantage Distribution model where he derives a negative Betafunction [86], Bookstein's model linking Bradford, Lotka and Zipf's laws [87], Coile's model [88] recommending the K - S (Kolmogrov - Smirnov) statistical test to verify the applicability of Lotka's Law on Scientific Productivity, Hubert's model for Journal Productivity [89], Sengupta's model providing an Offsetting Weightage Formula for post - war scientific periodicals [90], Naranan's Power Law model [91], O'Neill's model pointing to limitations of Bradford distribution [92], Schorr [93], Voos [94] and Subramanayam [95] on Lotka's Law, Wilkinson's model pointing out ambiguity of Bradford's model pointing out ambiguity of Bradford's law [96], Mandelbort's model structure of language expending and restating Zipf's law [97], Fairthorne's model linking Lotka's law with the distribution of Bradford, Zipf and Mandelbort [98], Vickery's model extending Bradford's distribution [99], graphical model of Kendall [100], Cole [101] and Gross [102]; model of Leimkuhler [103], Goffman and Warren [104], Worthen's contagion Model [105], Vlachy's work on Lotka's law [106].Steven's [107] model on psychology ; Yule's [108] and Willi's [109] models in biology ; model of Zipf [110] in population growth ; Paerto's [111] model in income distribution ; Simon's [112] statistical model equation which was proposed by Price twenty years later ; Carroll's [113] log normal model ; Poisson's statistical model was first used in bibliometric research by More [114] and Buckland [115]. Some outstanding contributors are Narin [116] Shockley [117], Hubert [118], Rogge [119], Line [120], Sandison [121], Moravcsik [122], Ravichandra Rao [123], Tague's [124] and Hill's [125] negative binomial model. The models developed by Bradford, Lotka and Zipf have not applied any Goodness - fit tests to check the validity of the data. The above studies applied Chi - Square, Kolmogrov - Smirnov and regression tests to the data. Good I.J. and Tague [126] developed an explicativity method to test models to data. Recently the models put forward by Brookes, Bookstein, Ravichandra Rao and Tague have gained wider acceptance in the field of informetrics. The origin of the journal 'Scientometrics' edited by Tibor Braun in 1977 led to a new dawn of articles in informetrics. Among them the articles of Broadus

[127], Bensman [128], Lawani [129], Rao [130], Ikpaahindi [131], Zunde [132], White and Mc Cain [133]. Pritchard and Wittig [134] Hjerppe [135], Schubert [136] and Sellen [137] compiled bibliographies on informetrics.

With the development of Internet, World Wide Web, online databases, informetric studies were conducted using data from the above sources. Pioneer among this category are Oppenheim [138], Persson [139], Hibbs [140], Lancaster and Lee [141], Stefaniak [142], Zitt [143] Todorov [144] Grivel, Polanco, Kaplan [145], Katz and Hicks [146]. Later Larson [147] examined the explosive growth of bibliometrics of the World Wide Web based on both analysis of over 30 giga bytes of www pages collected by the Inktomi Web Crawler and on the use of the DEC Altavista search engine for co-citation analysis as a set of Earth Science related www sites. Nelson and Downie [148] conducted non-textual informetric analysis of music n-grams using different representations of note intervals as characters. Wornell [149] applied informetric methods to databases like Scisearch and Social Scisearch on DIALOG.

2.4 Informetric Laws

In every subject we find some similarities while counting and tabulating readings is known as models, measures or laws. Informetrics deals with the study of library and information dissemination processes by using quantitative treatment of the properties and behaviour of knowledge. From these studies valid laws and theoretical formulations are discovered. The three fundamental classic laws which laid the foundations of informetrics are :

(a) Lotka's Inverse Square Law of Scientific Productivity (based on Author Productivity in terms of papers published);

(b) Bradford's Law of Scattering of Scientific Papers (based on the distribution of articles over various journals); and

(c) Zipf's Law of Word Occurrence (based on ranking of word frequency in a text). These laws are discussed below.

2.4.1 Lotka's Law

In 1926, Alfred J. Lotka proposed his Inverse Square Law correlating contribution of scientific papers to their number of contributions. His law provided fundamental theoretical base for bibliometric studies involving authorships. He was interested in determining "the part which men of different calibre contribute to the progress of Science" [150]. This became known as the Inverse Square Law of Scientific Productivity. For this, he used the decennial index of 'Chemical Abstracts' 1907 - 1916 and counted the number of names against which appeared 1, 2, 3 etc. Then tabulated the data for 6,8901 names, beginning with letter 'A' and 'B'. In the same way data about 1325 physicists are taken from the Auerbach's Geschietftafeln der physih. Lotka then plotted the graph on a logarithmic scale of authors against the number of contributions made by each author and he found that in each case the points were closely scattered about a straight line, having a slope of approximately two to one. From these data, Lotka deduced a general equation, for the relation between the frequency distribution 'y' of persons making 'x' contributions as

X^n y = constant and for the special case n = 2, the constant is 0.6079. Lotka [151] explained the phenomenon as follows :-

"In the case examined it is found that the number of persons making two contributions is about one-fourth of those making one contribution, the number making 'n' contributions is about $1/n^2$ of those making one and the proportion of all contributions is about 60 percent".

The law was termed Lotka's law in 1949 and attracted the attention of researchers but its applicability to other disciplines was tested only in 1973. Murphy [152] applied this law in Humanities and found it was fit to this field. Voos [153] in 1974 applied the law in the field of Information

Science and found that "the relationship in this field is $\frac{1}{n^{3.5}}$ instead of Lotka's $\frac{1}{n^2}$ ". In the same year 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 [154] found that Schorr's calculation was wrong as the law did not fit to map librarianship .

Pao [155] states that several studies have assumed the inverse square relation as the basis for testing, and derived the value of constant 'c' form the percentage of single paper contributors which can not 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".

Many analytical approaches different from Lotka's law for scientific productivity was found. Narin [156] found that "Scientific talent is highly concentrated in a limited number of individuals". Dennis found a close correlation between quantity of scientific publication and achievement of eminence. According to Price, the number of elite in science is small compared to total number of scientists and an elite mean is an eminent scientist producing scholarly writing. Bookstein [157] suggested a theoretical model which is a generalised version of Lotka's law, f (x) = $\frac{k}{x^{\infty}}$ where 'k' and α are constants. According to this, the number of authors with 'x' papers is proportional to $\frac{1}{x^{\alpha}}$.

Pao, Nichollas and Griffith used the version of Lotka's Law by Bookstein, and estimated that the values of 'n' rather than using n = 2. They counted authors and suggested a goodness - of - fit test for the model. Nichollas [158] found that the generalised version is "surprisingly well fitting and stable" whereas Pao suggested "overwhelming conformity" to this model.

Price [159] [160] found that "Half of the scientific papers are contributed by the square root of the total number of scientific authors". This empirical law is later known as Price's Square Root Law of Scientific Productivity. In other words, $N^{½}$ sources yield a fraction ½ of the items and is associated with invisible colleges. This law is sometimes called 'Rousseau's law' since Jean Jacques Rousseau has mentioned the same thing quite clearly in his "Social Contract" about the size of the elite. This law was proved to be invalid both theoretically and empirically by Nicholls [161], Egghe and Rousseau [162]. This can also be treated as an extension of the success - breeds - success principle originally developed by Simon in 1955.

The problem of crediting authorship to multi-authored paper occurs while applying Lotka's Law. Lotka counted only first author in multi-authored paper. Bookstein [163] discusses 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".

In author productivity studies it is found that the number of single paper producers are more. It is also found that authors who are more productive are having more collaborative studies than single paper producers. Because of the multidisciplinary nature of research topics, there is more scope for multi-authored paper than a single authored paper. Lawani [164] has shown that "citation rate and quality of paper both correlate positively with the number of authors per paper". In addition to collaboration, individual productivity is affected by working environment, motivation, record system etc.

Lotka's proposition led to a whole gamut of studies on scientific productivity. Such studies conducted during post-second world war period has cultniated in the rise of a new discipline called 'Scientometrics'. Scientometrics is defined as the study of the measurement of Scientific and Technological progress.

Three decades back Yuasa [165], in a statistical study of scientific achievement in various countries showed that there is a shifting of the world scientific dominance from one country to another. He found out that his dominance shifted from Italy to Britain, then to France, from France to Germany and finally to USA in the 20^{th} century.

Price, who had traced the development of Science since Babylon and plotted the growth of big science from little science had observed that Lotka's law applied equally well to the productivity of scientists in the 17^{th} as well as in the 20^{th} century i.e. the majority of publications emanated from a handful of people. Narin [166] showed that scientific talent was highly concentrated in a limited number of individuals.

Newby [167] applies Lotka's law to metadata on open source software development. Lotka's law predicts the proportion of authors at different levels of productivity. Authoring patterns found are comparable to prior studies of Lotka's law for scientific and scholarly publishing, Lotka's law was found to be effective in understanding software development productivity patterns, and offer promise in predicting aggregate behaviour of open source deveoplers. Pao [168] presents an evaluative framework for comparison of authorship data with Lotka's Law's predictions. Pao suggests the Kolomgrov -Smirnov (K-S), one - sample goodness of fit test for evaluate the statistical significance of results.

2.4.2 Bradford's Law

This is most prominent informetric law as it is applied to the control of literature. Samuel Clement Bradford [169] should be considered for his classic paper 'Sources of Information on Specific Subjects', which is the first paper published an observation on scattering. Bradford discovered the scattering phenomenon while studying the extent to which literature in a discipline is scattered over a range of journals. 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 prepared in the Science Library (Britain) on Applied Geophysics (1928-31) and Lubrication (1931 - 32). 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. The whole range of periodicals was thus seen as "a family of successive generations of diminishing kinship, each generation being greater in number than the preceeding, and each constituent of generation producing inversely according to its degree of remoteness" [170]. 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 "[171]. This graph is sometimes called as Bradford Bibliograph. Based on this observation, another graph was drawn to develop an algebraic relation for the straight portion of curve. From this the law was originated which he states as "if scientific periodicals are arranged in the order of decreasing productivity of articles on a given subject that may be divided into a nucleus of periodicals more particularly devoted to the subject and several groups or zones containing the same number of articles as the nucleus when the number of periodicals in the nucleus and succeeding zones will be as $1 : n : n^{2}$" [172].

Bradford's Law attracted the attention of many researchers after the publication of his book in 1948 in which the law is discussed in detail. The law is mathematically 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.

While preparing bibliographies we are faced with the problems of coverage, the journals that are to be scanned etc. Bradford's distribution can be effectively used to estimate the total size of a bibliography. During the analysis of 1600 periodical references, Vickery found that Bradford Law was not in total agreement with his algebraic expression. Vickery [173] concluded that the relation which Bradford discovered only "fits the upper portion of the observed curve". Cole [174] took a different approach at the 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".

Brookes [175] gave a simplified form of this formulation as this required much tedious computation for practical use. The modified form is $B(r) = a + K \log r$, where ' B (r)' represent total number of articles published in journals up to rank 'r', 'a' and 'K' are constants. This became the widely used formulation of Bradford's law. Brookes is of the view that if the total expenditure on periodical provision is limited to the fraction ' f ' of the sum needed to cover the subject completely, the buying of periodicals may be supplemented by the buying of photocopies of the relatively few relevant papers published in the peripheral periodicals.

A theoretical expression to the scatter of journals was given by Leimkuhler, which was found to be the inverse fraction of the Bradford distribution. Leimkuhler's [176] Bradford distribution is given as

$$F\ (x) = \frac{In\ (I + \beta x)}{In(I - \beta x)}$$ where ' x ' denotes the fraction of the 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.

But in 1972 Wilkinson suggested that the formula provided by Brookes and Leimkuhler did not describe the same phenomenon. Because of Bradford's graphical representation of Applied Geophysics data and the verbal expression of the law the error arise. Wilkinson [177] found that Leimhuhler derived his distribution from Bradford's verbal representation and Brookes from the graphical representation. Brookes formulation conformed more closely to empirical data in comparative tests.

Naranan [178] 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.

But later studies found that this assumption was invalid 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. While studying the Agriculture literature, Lawani found the distribution conformed to Bradford's Law. The curve obtained in this was linear with a Groos droop [179] for journals of lowest rank. This was an important point of controversy. Brookes is of opinion that this was due to the incomplete bibliography. But O'Neill [180] found that the Groos droop is not due to the incomplete bibliography but is a part of Bradford distribution.

Goffman and Morris [181] applied Bradford's Law to a study on acquisition of journals in the Allen Memorial Library. They found that "Bradford's law should apply to the use of periodicals in a library as well as to the dispersion of articles among journals". Their study proved that the distribution of both circulating periodicals and their users obey the law. The smallest core of journals which must belong to the library's collection can be defined. This smallest core should consists of a minimal nuclei of periodicals circulating in the library plus the minimal nuclei 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 considered. Thus the library collection can be maintained in an orderly fashion and viable state thus providing its users with the most potentially useable materials for the funds at disposal.

Fasler [182] is of opinion that the above method 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". In 1975 Pope [183] found that "the area in which Bradford's distribution has the greatest potential is in collection development".

Brookes [184] did a complete re-evaluation of the law in 1977 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 these numbers of items each source accounts for in that time. Thus Bradford Law is concerned with :

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

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

iii) items of some homogenous kind which are discrete and countable.

Statistical distribution 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's distributions are samples of some ongoing activity but all too often, the sample data have been regarded as constituting a total population. Brookes [185] states that a new statistical theory based on both Bradford and Zipf's Law together "provide the most convenient analytical instrument for the exploration of social science data". Asai [186] gives a general formulation of the law 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. Leimkuhler and Chen [187] found 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 found two parameters that affect the shape of Bradford curve is least productive and most productive zones. Drott and Griffith [188] have shown that the linear slope of Bradford curve is related to the number of articles plotted and intercepts are related to the number of journals.

Based on random subdivision of papers over the field of journals and on individual scientific productivity, Karmeshu et al. [189] derives a rationale for Bradford's Law. Price [190] explained Bradford's law and other statistical laws as 'Cumulative Advantage Distribution' of the success - breeds - success type. Price found that $F(n) = (m + 1)\,\beta\,(m + 2)$, where 'n' is number of successes, 'm' is a constant and 'β' a Beta function. Examples are;

i. a journal which has been used is more likely to be used again ;

ii. an article in a journal cited many times is more likely to be cited again ;

iii. an author of many papers is more likely to publish again than one who is less prolific.

Ravichandra Rao [191] also supports this but his analysis of circulation data collected from six Canadian University Libraries shows that the negative binominal distribution describes this phenomenon better than cumulative advantage distribution. Here the rank distribution of transactions follow a Bradford distribution. In statistics this is generally described by a hyperbolic distribution function known as 'Yule distribution' and depends on sample size. Yule characteristic ' k ' = $\frac{1+(Sample\ \text{variance} - mean/mean)^2}{Number\ of\ classes}$. Garfield [192] point out the number of journals involved in publishing the literature of a single field. The findings make it possible to move from Bradford's law of dispersion to Garfield's Law of Concentration. The law states that "a basic concentration of journals is the common core or nucleus of all fields". This is due to the explosion of literature and number of journals.

Sengupta's [193] law of Bibliometrics is basically an extension of the Bradford's Law, states that "during phases of rapid growth of knowledge in scientific discipline, articles of interest to that discipline appear in increasing number of periodicals distant form that field". Sengupta's law can be mathematically expressed as

$$F(x + y) = a + b \log (x + y)$$

Where 'F (x + y)' is the cumulative number of references as contained in the first '(x + y)' most productive journals, 'x' indicates number of journals in the same discipline and 'y' stands for number of journals of unrelated disciplines '(y > x)' and 'a' and 'b' are two constants.

Maia and Maia [194] found that there is no ambiguity in Bradford's theory of distribution. In the Bradford's experiment the verbal and graphical expressions are in agreement showing that there is no ambiguity. Wilkinson also studied the ambiguity of Bradford's Law and found that a documentation researcher has no means to decide which formulation should be used.

Drott [195] studied the theoretical and empirical development of Bradford's law. O' Connoor and Voos [196] examined the relation between theory and empirical laws. Bookstein [197] discussed the various informetric laws as the different various of a single regularity and explored the consequences of demanding that informetric laws are resilent to ambiguity.

Burrell [198] studied the Bradford phenomenon and opines a stochastic process termed 'waring process' which conforms to the general features of Bradford's Law. He also examines 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 [199]. Aparna Basu [200] attempted to find a theoretical foundation for Bradford's law and suggests a modified log linear two-parameter model to explain journal productivity.

Not only the scattering of publications but also in other fields also this law can be applied. Garg and Lalitha Sharma [201] conducted a study of R & D indicators in Indian industry. The R & D expenditure of 452 in - house R & D units in different sectors of the Indian industry, they found that 19 in - house R & D houses as the core, 60 as the medium and the rest as small. As compared to medium and small - level in - house R & D units, there is a heavy concentration of manpower deployed, papers published, patents fields processes/products developed in the core in - house R & D units. A goodness - of - fit test has been developed for the Gini Index [202]. Aulakh and Jain [203] studied the growth of phytopathology literature emanating form Indian laboratories for the period 1976 - 1980 and concludes that growth pattern observes the Bradford's Law. Hasso, Maysoon [204] reports a partial conformity to Bradford - Zipf and discusses the validity of the law concerning coverage, suggests a procedure in studying the coverage. Maheswarappa, and Prakash [205] studied the self-citation pattern, obsolescence and Bradford's law application to botanical literature. Peritz [206] investigates the fit of Bradford's law to bibliometrics and no 'falling away' from Bradford's distribution towards the right - hand end of the bibliography was observed.

The law is based originally on an investigation by John Lancaster in 1933, was confirmed in 1948 by Bernal [207]. The law gained wide attention after the publication of Bradford's book in 1948 [208]. There after the law has been verified for a large number of disciplines by Lawani [209], Aiyepeku [210], Bulick [211] and Kendall [212].

A theoretical foundation of the law was proposed by Price [213] based on a model of "cumulative advantage processes". Zipf has formulated his "principle of least effort in human endeavour" [214]. Kansay [215] is of opinion in Kent's Encyclopedia of Library and Information Science that "until an acceptable theoretical proof of its empirical stability is found, the Law of Scattering is not likely to be accepted as a fundamental law, but will continue to be regarded as a statistical curiosity". In 1979, Brookes [216] ". . . we may . . . be mistaken in continuing to search for that single formulation embracing all Bradford phenomena which has eluded capture for more than forty years".

The less frequently observed rising tail of the distribution has been discovered by Eto [217]. In a series of paper Burrell [218] [219] [220] has argued that time is not only essential for the appropriate modelling of these situations, but also allows genuine practical applications of bibliometric techniques which are not possible using the classical laws.

The stochastic models of Bradford law is mixtures of simple counting processes Burrell [221], Sichel [222], birth - and - death processes of Schubert and Gianzel [223]. Cane [224] has shown that under fairly general conditions, mixtures of Poisson processes have equivalent descriptions as birth - and - death processes, and vice versa.

2.4.3 Zipf's Law

Zipf, developed and extended an empirical law, as observed by Estoup, based on the frequency of occurrence 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 respectively

$\frac{1}{2^2}\ \frac{1}{3^2}\ \frac{1}{4^2}\ \ldots\ldots\ldots\ldots\ \frac{1}{n^2}$ of 'x'. From this Zipf developed a formula $ab^2 = k$ where 'a' is the number of words occurring 'b' times.

Zipf [225] explained the law as a consequence of a general "principle of least effort" in his book published in 1949. Zipf applied his principle to study Hanley's Index of words for James Joyce's Ulysses and found a clear-out correlation between rank (r) and frequency (f) of word,

i.e. r f = c, when the law is applied correctly, a hyperbola is obtained while plotting the frequencies against rank.

Several studies were conducted on Zipf's Law. Wyllys [226] quoted it as "one of the most puzzling phenomenon in bibliometrics". Simon [227] observed the fitness of the Yule distribution to a number of empirical data including word frequency. Mandelbrot published several observations about Zipf's law. At the 38th Annual Meeting of ASIS, in 1975 Wyllys [228] presented a paper, which points out that "inclined towards mysticism, Zipf not only leaped to the conclusion that the true slope of rank frequency course was - 1, but also claimed that this regular slope resulted from some fundamental force of nature".

Several studies aimed at finding out the pattern of frequency distribution of descriptors of a thesaurus and the distribution of indexing terms are available. Fedorowicz [229], [230] applied the distribution of indexing terms in inverted files of bibliographic databases using Zipf and other models. Hubert, reviewed the law and its development in later work. Tague and Nicholls [231] tries in relating the law to file design the general bibliometrics is done. The sample 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' is dispersion of token over types. Zunde and Slamecka [232] developed a function for optimum distribution of indexing terms by the number of posting. Emile C White [233] is of opinion that the super-imposition of the Bradford distribution over the linear Zipf distribution when applied to circulation data, these formulations can support such policies as shortened loan periods for heavily used books and the identification of a core collection.

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 seen that Pareto's law in economics which relates the income and number of people are a variant of Zipf's law. Zipf's law is also used for identifying words more frequently used in different foreign languages.

2.4.4 Informetric distributions Lotka - Bradford - Zipf relation

Several studies have been made regarding the theoretical and practical implications of the informetric laws. These studies led to the study of relationship between the three laws. Kendall explained the earlier relation between Bradford and Zipf's law that the two are almost equivalent. He agreed the idea that Bradford distribution is really Zipfian and provided a more refined statistical explanation for the straight line observed by Bradford. Leimkuhler also supported Kendall's theory that the two laws were essentially two different angles of looking at the same thing.

Brookes [234] indicates the Bradford - Zipf distribution can be expected to arise when selection is made of items, characterized by some common element, which are all equally open to selection for an equal period and subject to the "success - breeds - success" mechanism, but when the selection of a most popular group is also, but to a weaker extent, subject to restriction.

Brookes [235] also says that "the near identifity of Zipf's and Bradford's Law are not immediately obvious because, in practice, the most marked deviation of empirical data form the mathematical expectations of Bradford's law are likely to occur among most productive journals of the nucleus. Journals also lack statistical unity as they are not issued at regular intervals and number of articles per issues also vary.

Garfield [236] found that "while each 'law' applies to a different specific phenomenon, they all tend to demonstrate one thing that a few i.e. journals, scientists etc. account for the many i.e. articles, citations". Here he found a relationship with the Pratt's index which measures the degree of concentration of papers in a subject to Bradford's Law. Garfield put forward 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. Goffman and Morris [237] have demonstrated the applicability of these three laws, as well as to the distribution, by diseases, of patients in a medical clinic. Price [238] suggested 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. In the case of use of documents Ravichandra Rao also supports this phenomenon.

All the informetric distributions are claimed to be essentially are by authors like Yablonsky [239], Bookstein [240] [241] [242]. Brookes [243], is of opinion that a new statistical theory based on Zipfian distribution is needed for applications to Social Sciences. Hatium [244] considered Zipf's as fundamental distribution. Brooks proposes the use of

Bradford and Zipf's law together for analytical exploration of Social Science data. He is also in view that both Bradford's and Zipf's are rank-frequency distributions and 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.

Egghe [245] gives an inventory of bibliometric laws and develops the "criteria by which they are the same or different". According to Bookstein [246] the informetric distributions are described as 'variants of a single distribution'. These provide rich and diverse issues and approaches for research in the field.

Chen and Leimhuhler [247] based on the data from Kendall's study of bibliography of operational research derived a common functional relationship between the three laws. A more useful formulation for the three laws is also given.

Researches 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 articles 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 lies in their simplicity and familiarity. But their use will depend on how well they assist in making decisions.

Kunz [248], Tague [249] and others noted that there are problems with interpreting ranks when there are tied scores. If we plot each source on a graph we get a 'fuzzy tail.' "The head of one distribution forms the tail of the other one".

2.5 Citation Analysis

Informetric studies depend mainly on document units or written records of communications i.e. books, journals, articles, reports, theses, etc. which form the objects of studies. The 'document representations' are considered for informetric studies as the physical documents are difficult to handle. Now-a-days bibliographies, databases, online sources, Internet or data from users are also used in the studies. These are the secondary sources of data 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 [250] "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".

To Martyn [251], the primary function of citation is to provide "a connection between two documents, one which cites and other which is cited". Weinstock [252], Liptez [253], Moravcsik and Murugesan [254], Hodges [255], Oppenheim and Renn [256], Finney [257], Frost [258] and Thorne [259] have attempted to explore the reasons for giving citations. The first recorded citation analysis was a study by Gross and Groose [260] published in 1927 in order to determine the journals to be subscribed to and the back volumes to be acquired for the Library of Pomona College. They studied the citation frequency in the references given in the Journal of the American Chemical Society.

Citation analysis the most common technique which is the most 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. Hence this method is useful in many studies including citation counts, impact factor, bibliographic coupling, co-citation and obsolescence. Citation studies are valid for determining the quality of research produced by individuals. It also correlates to the use of libraries by researchers.

To Ravinchandra Rao [261] "Citation analysis means the analysis of the citations or references which form part of the articles in journals". According to Garfield [262], citation analysis "provides a number of interesting and useful insight into the network of journals that function as primary, formal communication medium of science". Citations in journals indicate the connection between two documents, one which cites and the other which is cited. 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.

Numerous studies have been done to find out reasons for citations to papers by the authors. One of such studies was carried out by Oppenheim and Renn [263] give the following reasons :

I. Historical background

II. Description of other relevant work

III. Supplying information or date for comparison

IV. Use of theoretical equation

V. Use of methodology

VI. Theory or method not applicable or not the best one.

Many scientists have put forward arguments against the validity of citations like negative citation, self 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. But the honesty and integrity of the majority of the scientists who may not involve in such practices is to be given weight. In nutshell citations are the major tool for evaluating the quality of research journals.

Barker [264] found out 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. In the first one the source may be major abstracting or indexing journals, review journals, databases or bibliographies. In the second one the source may be the literature used by an author. Applications of bibliographies or abstracts can not be considered as true citation studies as they are compiled for the purpose of use and do not represent actual use made by users whereas true citation analysis deals with works cited as having actually been used.

Selection of source for citation analysis is usually done by sampling as the collection of documents is usually too large. In this field Science Citation Index (SCI) published by the Institute of Scientific Information (ISI), Philadelphia from 1963 onwards can be selected as one main source of data for citation studies. These citation indexes give a list of documents that have been given as source journals covered by the index. The cited documents are arranged alphabetically by the author. Thus citation index is a structured list of all citations in a given collection of documents. Journals Citation Reports (JCR) was started from 1973 by ISI, which are also useful in citation studies. This gives three lists :

(a) a list of most frequently cited journals for the period covered by JCR;

(b) a list of journals in which they are cited (source journal listing);

(c) shows the list of citing journals to the frequently cited journals (reference journal listing). There are several merits and demerits for the use of SCI in citation studies e.g. multiple authorship, homonym, self-citation etc.

For citation studies the collection characteristics such as form (monograph, journal etc), type (articles, notes, news etc.), subject (specific subject), institutions, set of authors etc are taken into account. Then the objects of the study such as references, citations etc. are to be selected. Other factors 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. Some of the earlier work are those of Garfield [265], Tagliacozzo [266] and Hjerppe [267].

The first recorded citation analysis was a study by Gross and Groose [268] in 1927 in order to determine the journals to be subscribed to and the back volumes to be acquired for the Library of the Pomona College. They studied the citation frequency in the references given in the Journal of the American Chemical Society. Following this, a number of papers defining the importance and dispersion of the various segments of scientific literature came out. Bradford published a paper analysing the importance of a small number of core journals for a specific subject became the basis for research afterwards. Price made use of a number of literature counts to devise his outline of scientific enterprise. As a means of structuring scientific literature, citation counting began to attract more attention. Some important works of this type are by Garfield [269], Mc Cain and Bobick [270] and Brown [271]. Scales [272] in a study of the most used journals in the National Lending Library compared it with highly cited journals listed in JCR. She found that there is no relation between actual use and citations. Brown found 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 citations in a primary journal. This method has its own limitations as the objective of the abstracting journal may be comprehensive to the subject coverage. Sengupta suggested modifications like weightage formula [273], bibliometric parameters [274] and using the annual review to collect source data [275] to eliminate the limitations in the use of raw citations. Citation counts are often taken as a measure of the use of journals though the validity of this assumption is often criticised. Now-a-days informetric studies based on data form on-line data bases are attempted [276], [277]. The scope of citation analysis include:

i. aging or obsolescence

ii. clustering

iii. bibliographic coupling

iv. ranking and evaluation

v. growth and decay

vi. trend analysis.

Lal, Arjun [278] attempted to identify the most important source of citation, its geographical and chronological distribution in the field of agronomic research in agriculture in Bihar and found that among the cited journal India occupied first rank as a country of publication followed by USA and UK. The chronological distribution of citation to journals suggests that the researchers in agriculture cite from current journals and seldom refer to back number. Mujoo-Munshi, Usha and Vashishth [279] found that among Indian agricultural scientists the general trend is to quote reference from the last decade (1980s) and earlier period and they have less exposure to the latest developments in their fields and have limited access to current awareness tools/services.

Musib [280] studied the citations received by the eight journals in the field of Philosophy and showed that the journal literature decays faster than book literature; period wise analysis also showed the same result. Nagappa, and Maheswarappa [281] pointed out that the result of citation analysis will be used for librarians in the selection and acquisition of periodicals and compares the present ranking list with that of Eugene Garfield. Narendra Kumar [282] found that 61% of the Biological periodicals in library have been cited which are originated from USA (48.43%), UK (15.65%) and India (12.50%) and the ranking of journals based on the study is correlated with another study of Temple University of Philadelphia (Mc Cain and Bobick, 1981). Pangannaya and

Kumaraswamy [283] studied the pattern of distribution of citation in the concept of Leisure; provides citation productivity of sources journals, geographical dispersion, subject dispersion and use of citations.

Alfiatayo and Jasilin [284] studied the literature of Health Economics revealed that journals are the most prominent media of communication and dissemination of knowledge and information in subject field. Gupta [285] attempted to study the various parameters of citation analysis having implications on both a library and information policy and growth and development of subjects, on the basis of analysis of citation of Soviet articles in the area of solar energy appearing in the journal "Geliotekhnika" during the period 1965-75. Hasso, and Oppenheim, [286] found that archaeologists cite journal material less than non-journal material and the implications of this for secondary services are discussed. Ijari and Kannappanavar [287] studied the citations appended to 155 articles published in three volumes of Indian Journal of Clinical Psychology; core journals, types of documents used and their quantitative data, geographical distribution of cited journals, chronological scattering of citation in tabular form are presented. Kangugo and Neena Talwar [288], [289] introduced citation counts study by analysing the source article and their authors, gives year wise, subject wise break-up, makes a rank list of the different types of sources cited by the Indian historians, draws a profile of Indian historians based on the citing patterns. Rangarajan and Verma [290] showed through citation analysis that 5 journals account for the major portion of the papers published and the vast majority of other journals individually account for a negligible portion of papers published. Singh, Jha, and Mohinder Singh [291] presented a quantitative study of various aspects of literature published in the field of Aerospace Science and Technology; text format-wise distribution of citation indicates that researchers mainly depend upon journal articles, books/monographs and technical reports for their scholarly communication, journals published by the American Institute of Aeronautics and Astronautics are the backbone of any library/information centre. Peritz [292] used the technique of meta-analyses for citation studies and proposed to make use of these data in order to study the associations between citations and various characteristics of these studies, with the ultimate purpose of evaluating citation frequencies as measures of a paper's worth.

2.5.1 Aging or Obsolescence

According to Lancaster [293] "the term 'obsolescence' as applied to library materials, refers to the decline in the use of these materials as they get older; the words 'aging' and 'decay' have been used as synonyms". 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. Numerous studies on aging are conducted in special libraries in the aspect of collection management or in journal references as the indicator of previously published work. Rapidly expanding scientific techniques and extension of scientific knowledge are reasons attributed for the aging of journals. Rate of aging varies with discipline and is a characteristic factor of scientific and technical literature. Obsolescence studies are of two types:

(a) 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' ;

(b) diachronous studies which use citation history of a document or subject from the beginning to the end of a period are studied and here 'half life' is calculated. Both types give different results [294].

Brookes [295] found that the rate of obsolescence is related to the rate of growth of scientific literature and the number of contributions in the field. If these measures are constant, then the rate of obsolescence remains constant. Ravichandra Rao and Meera [296], studied the relation between growth and obsolescence and stated that "faster the growth of literature then quicker the obsolescence as well as the half-life". Wallace stated 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 [297], "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."

The librarian's interest in obsolescence is practical rather than theoretical. If use declines with age, one should be able to discard items on the basis of age or at least move older items to less accessible and less costly storage. Thus obsolescence has been the concern of librarians for quite sometime because of the overabundance of materials, lack of housing facility. 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 reference published in a journal in a particular year. Price [298] found out 'Price's Index' which is the percentage of references to works published in the most recent five year period. He attributed the citation of recent papers to 'immediacy effect' due to the citation of ephemeral papers at the research front. Citation counts have also been stretched even to measure the productivity in other areas. As Broadus [299] points out, "over the last two decades, tabulation of citations have been used to measure the importance of academic departments, but especially of individual scholars and the contributions they have made to their respective fields".

Maurice Line and Alexander Sandison [300] studied aging using citation data or use data. They found that the growth of literature must be allowed for by calculating the density of the use for each title considered. Line [301] calculated the use per metre of shelf and found the evidence of increasing density of use with increase of age. 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. Ole Groos [302] showed that how limited space for storage of periodicals could be optimised by considering alternative strategies in which the number of titles and the number of years held are varied. Taylor developed a "consultation factor" to account for use of shelf space.

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 journals showed high median citation age.

Christavao [303] in a study found out that articles from developed countries aged the literature faster than articles from developing countries. This may be due to the international and local relevance of research topic. Aversa [304] conducted a diachronous study using Journal Citation Reports data form 1972 to 1980 and found 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. Two types of aging pattern are 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 help in information generation, collection management in libraries, study of growth of literature etc.

Gupta, Usha [305] found that rate and pattern at which usage drops has been shown to vary by discipline i.e. documents in the physical sciences receive most of their use early in their 'lives' and then drop off rather steeply, whereas documents in the Humanities tend to be used on a more consistent basis and have a less steep drop off curve.

Markwell [306] and Brooks reported that a study of Web links in a corpus of online Biology courses have a half-life of 55 months. Burrell [307] develops the theory for a stochastic model for the citation process in the presence of obsolescence to predict the future citation pattern of individual papers in a collection. The above study investigates the conditional distribution and its mean of the number of citations to a paper after time 't', given the number of citations it has received up to time 't'. In an important parametric case it is shown that the expected number of future citations is a linear function of the current number, this being interpretable as an example of a success - breeds success phenomenon.

Marton [308] observed that "the decrease in the frequency of reference is faster in the early years (5 - 10 years) than later". Studies of growth of literature was conducted by Tague and others [309], Wolfram and Xin, Lu [310] suggested a power model. Egghe and Ravichandra Rao [311] while observing quite different calculations from that of Wolfram's result, found out the power model, fits best for modelling the growth of Science and Technology databases and on the other hand, they observed that Gompertz function is best for modelling the growth of Social Sciences and Humanities.

2.5.2 Citation Half - life

From the field of Nuclear Physics, the concept of half-life has been borrowed to illustrate the journal obsolescence. The citation half-life indicates a quantitative measure of the rate at which scientific papers become obsolete. The citation half-life is the period of time during which one half of the currently cited literature was published. There is a high probability of use of journal literature in the immediate years after their publication but thereafter their use decreases rapidly as these journals become old. According to Narayana [312] ,"half - life of the literature is the time by which one half of the currently published literature become obsolescent".

Gross and Gross [313] studied on the references of a single volume of Journal of American Chemical Society and reported a halving of the number of references for every fifteen years of increased age. To

Burton and Kebler [314] the half-life of the literature of different subject varies much, i.e. the value of half-life in Chemical Engineering - 4.8 years, Mechanical Engineering - 5.2, Metallurgical Engineering - 3.9, Mathematics - 10.5, Physics - 4.6, Chemistry - 8.1, Geology - 11.8, Physiology - 7.2., and in Botany 10.2 years.

Brookes [315] put forwarded the concept of "utility in relation to journal aging", for discarding the back volume of individual journals on the basis of half-life calculations. Line [316] studied a problem of accurately predicting the decline of journal use with age i.e. if the number of journals published in a single subject field in 1970 is double the number published in 1960, assuming that the number of papers in each journal remains constant, then the random probability of citation within that field is doubled.

Singh, Jha, Ajeet and Mohinder Singh [317] found that half-life of literature published in the field of Aerospace Science and Technology is 7 years i.e. literature is doubling after every 7 years. Over 80% citations cited by authors are published after 1980. The growth-rate of aerospace literature to be calculated by arranging the data in chronological order.

2.5.3 Ranking & Evaluation

One of the most important applications of citation analysis is to prepare ranked list of journals and evaluate journals in specific subjects. In many of the libraries journals are purchased on the judgement by a selection committee. This is usually depended on the utility in a local library. But in the case of a special library, utility alone may yield misleading data as the users are of biased interests and the existing titles may be used repeatedly. Within the limited fund and information explosion, 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 analysis combined with 'impact factor' study are very useful in the case of subscription of periodicals.

Citation studies help to identify core periodicals in a particular subject area and formulate a need based acquisition policy in a specialised scientific library. It is very useful in assessing the quality of research journals. As the journals are geographically and linguistically separated evaluative studies have their own limitations. Bradford's law and other models derived from this are usually applied for journal ranking studies. Within the constrained budget and escalating price of journals this method is economical and more practical.

Journals are strongly connected through the references in the articles they contain. Thus the core titles may be the highly connected journals. As journals are a major communication channel for research in Science and Technology field, journal citations are the basis for many informetric studies. Garfield conducted a number of journal citation studies on different disciplines [318]. Ranked list of periodicals can be prepared by two methods:

i. by actual citation counting, and

ii. by counting the number of entries in indexing and abstracting periodicals.

Citation analysis enables to determine author productivity or scientific productivity, institutional productivity, national productivity, the number of citations received by an author and major areas of a subject where active research is going on etc. Measuring the output of Science by this method is useful in determining the science policy of developed as well as developing countries. Lotka's law is applied on author productivity studies, which are based on the assumption that frequency of authors producing papers is constant. Pao [319], Nicholls [320] and Gupta [321] applied Lotka's law to determine scientific productivity. Chi-square test, K-S statistical tests were used to test the applicability of the law. Bookstein [322] found out that Lotka's law is invariant under the impact of society on the pattern of scientific productivity. According to Price's theory of cumulative advantage distribution if an individual becomes successful at the first attempt, the possibility of success at subsequent attempts increases. With the help of 80/20 rule, Price's success - breeds - success phenomenon can be explained. This rule states that 80% of items i.e. articles, number of publications, number of citations etc. are accounted for by 20% of sources i.e. authors, journals etc, i.e. 20% of journals receive 80% of citations or 20% authors contribute to 80% of literature. Egghe [323] found that the 80/20 rule is much stronger if the underlying distribution is Lotka type. Author productivity is most typically measured by the number of papers written by an author. The data counting the occurrence of events has the nature that almost all statistical measures systematically change according to changes in the sample size [324], [325], [326]. Yoshikane and Kageura [327] propose a method for the comparitive analysis of concentration in author productivity distributions. They define the notion of concentration on the basis of two- view points i.e. absolute and relative concentration and select Gini's index and ' v ' (number of authors) as suitable measures. The statistical peculiarity of author productivity data is that most of the statistical measures change systematically according to changes in the sample size.

Ranking of journals based on informetric method are found mostly to agree with the expert opinion. Some researchers are introducing new methods combined with citation studies to formulate list of journals more specific to different subjects. In the field of Biochemistry, Sengupta has adopted three parameters to re-rank periodicals. The parameters were

i. scientific interest of papers published;

ii. compactness of the information content in a scientific periodical;

iii. the scientific value of paper in relation to compactness of presentation.

2.5.4 Impact Factor (I F)

Impact Factor (I F) is the average citation rate of a journal's articles. 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. In this view the most cited journal may be the most productive journal also. Taking the relation between size and citation frequency, the size can be taken to assess the citation frequency. Thus impact factor is basically a ratio between the citation rate of the journal and its citation potential. Thus the method of calculating 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 Reports (JCR), i.e. the 1986 impact factor of journal 'x' would be calculated by dividing the number of all the Science Citation Index, Social Science Citation Index and Arts of Humanities Citation Index Source Journals' 1986 citations of articles journals 'x' published in 1984 and 1985 by the number of items it published in 1984 and 1985 .

Impact Factor can be 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.

$$\text{i.e. Impact Factor (IF)} = \frac{\textit{the number of citations received in year}}{\textit{the number of articles published in years } 1 \,\&\, 2}$$

Journal impact factor denotes the average citation rate per published article. It shows the quality and merit of the journals . Ranking of journals based on impact factor tend to be different from ranking based on absolute citation. Higher the impact factor, greater is its quality. Based on impact factor, journal ranking can be done and can be used for journal selection in a library. There are certain limitations in calculating impact factor by the above method i.e. fixing impact of journals not covered by Science Citation Index. A new formula was introduced by INSDOC, Indian National Scientific & Documentation Centre, Bangalore, to overcome this and is used by B.K. Sen et al [328] in a short communication. 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. Hirst [329] introduced a new method of finding 'Discipline Impact Factor' (DIF) 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

$$Dis_A = \frac{No.of\ items\ J_1\ cited\ Journal\ A}{Total\ No.of\ times\ J_1\ cited\ all\ Journals}$$ where 'Dis_A' is the discipline influence score of journal 'A' in the candidate journal set, 'J_1' is the number of discipline journal set and 'n' is total number of journals in discipline journal set.

He and Pao [330] found that discipline specific journal selection and compared the results with that of expert evaluation, impact factor and total citation ranking. User's preference was reflected more close to discipline influence score than the other two methods.

The output of scientists, scientific organizations, industries, nations or scientific agency can be analysed using impact factor. Individual impact is a measure of impact of an individual's published out put [331]. Institutional impact help to evaluate the output of research organisations in a country [332], various nations or of a specific agency [333]. There are several opinions regarding the evaluation of impact factor. According to some, it is a misleading indicator of true impact [334]. Some are of opinion that the ranking and impact are relevant only in specific disciplines. In certain subject, impact factor of journal varies from country to country

[335]. To overcome the differences Sen and Kumar [336] introduced the use of a Normalised Impact Factor (NIF). 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. The importance of this method is that it is useful to study NIF at institutional or individual level.

Narin [337] developed another method to measure impact of a journal is the influence which involves complicated calculations which can be done by a computer. This involves finding citation ratio between two journals. From this the influence weight can be calculated. The influence weight depends on the citation relationship of a journal 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. As this calculation accounts interrelationship of journal citations, it is considered more refined than impact factor.

'Immediacy index' is also a measure used in journal citation studies. Immediacy index is a measure of how quickly the papers in journals are cited. It is calculated as follows :-

$$\mathrm{Im}\,mediacy\ index = \frac{Number\ of\ citations\ received\ in\ year \times by\ items\ published\ in\ year\ 'x'}{Number\ of\ items\ published\ in\ year\ 'x'}$$

According to Garfield [338] the newly published journals in a subject show high impact. Tomer [339] showed that the journals with high impact have high immediacy index.

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 of citations a journal receives in its most recent complete year of publication to the number of source items published during the same interval.

Daniel Janzen [340] studied that for estimating the real impact of publications

i. the impact of a paper is expressed by citations and the citation impact is positively correlated with the quality and or relevance of the paper;

ii. most cited and citing journals are considered i.e. easily possible if Bradford's law of scattering applies to a field, as most cited papers are published in a few core journals;

iii. a paper gets most of its citations in the first few years after publication. As the number of taxonomists is declining, it does not follow the 'exponential curve' of most Sciences. The old literature is not overwhelmed by an avalanche of new papers.

"The impact factor of a journal is indicative of its rank and to a certain extent its quality in the world. The higher the impact factor, the higher is its prestige. The quality of research papers published in such journals is ensured since the journals having high impact factor are in most cases rigorously referred journals and getting a paper published in there journals is not an easy task" [341]. The output of a scientist, a scientific organisation or even a scientific agency could be subjected to bibliometric analysis. CSIR research output of 1986 was analysed taking into account impact factor of journals for 1985 from SCI database [342]. In 1987, 1988 and 1989 works of similar nature was carried out [343], [344], [345]. A paper presented in the International Conference on Science Indicators for Developing Countries held in Paris in October 1990 [346] described this method in detail. Arora, Kamlesh and Sen, B. K. [347] tested the validity of using impact factor in place of citation for the purpose of evaluation.

2.5.5 Bibliographic coupling and clustering

In 1962 Kessler [348] put forward a concept named bibliographic coupling between scientific papers. He found that 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.

When one item of paper is referenced by a number of journals clustering occurs. All these journals form a cluster. In the field of Physics, Chemistry and Molecular Biology, Carpenter and Narin [349] studied clustering of journals. Thus related journals can be classified 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. Earlier cluster studies were done by using bibliographic coupling but now this is replaced by co-citation.

2.5.6 Co-citation

When one paper cited two other papers together it is clear that the two papers are related. If the papers are cited together by more authors, their relation is clearly indicated. Thus co-citation studies help in the mapping of literature. Small [350] found that there are links between documents which are obtained by co-citation counts. Such documents are arranged in a cluster with the highly co-cited document in the centre of cluster. When new papers are published over time, the co-citation links also change. Co-citation analysis can be done by using data collected from databases, Internet. Thus they form clusters of documents, authors etc. Co-citation context analysis is another type of study which helps to produce research reviews. Swanson [351] done such studies in the field of Information Science.

Between the clusters of cited documents there exists a co-citation strength. The strength of relationship is proportional to the number of items the papers are cited together. Citation indexing in ISI database uses this technique.

2.5.6.1 Author co-citation analysis

Author co-citation analysis, a special type of co-citation analysis was introduced by White and Griffith [352]. This technique has mostly been used to analyse the intellectual structure of a given scientific field. In 1990, Mc Cain [353] published a technical review of author co-citation analysis which has been adopted as a standard worldwide, a testified by publication in journals such as JASIST, Scientometrics and the Proceedings of the ISSI Conferences. It is also used in PubSearch, a Web citation based retrieval system, developed at the Nanyang Technological University in Singapore [354].

Mc Cain states that there are four main steps in an author co-citation analysis;

i. the raw data matrix (author co-citations) is compiled;
ii. a conversion of this matrix to a proximity, association, or similarity matrix is performed;
iii. a multivariate analysis of the relations between the authors represented in the matrixs is to be done;
iv. cluster analysis, multidimensional scaling, factor analysis and correspondence analysis have been used [355], [356], [357], [358], [359], [360].

Finally the study ends with the interpretation and validation of the results .Mc Cain [361] notes that Pearson's Correlation Coefficient, denoted as 'r' is often used as a similarity measure. But Ahlgren & Jarneving [362] proved that the Pearson's 'r' does not satisfy some natural requirements for such a proximity or similarity measure. Pearson's 'r' is probably not an optional choice of a similarity measure in author co-citation analysis. Still, further empirical research is needed to show to what extent, the use of similarity measure in author co-citation analysis that fulfil these requirements would lead to objectively better results in full-scale studies.

White [363] introduces a newer technique, Pathfinder Networks (PFNETs) has considerable advantages for author co-citation analysis. In PFNETs, nodes represent authors, and explicit links represent weighted paths between nodes, the weights in this case being co-citation counts. The links can be drawn to exclude all but the single highest counts for author pairs, which reduces a network of authors to only the most salient relationships. When these are mapped, dominant authors can be defined as those with relatively many links to other authors. Links between authors and dominant authors define specialities, and links between dominant authors connect specialities into a discipline. Maps are made with one rather than several computer routines and in one rather than many computer passes. PFNETs can be generated from matrices of raw counts rather than Pearson correlations, which removes a computational step associated with the traditional author co-citation analysis. Because PFNETs are fast to compute, they are used in 'Author Link', a new Web based system that creates live interfaces for co-cited author retrieval on the fly.

Egghe [364] introduces Type/Token-Taken informetrics, a new part of informetrics that studies the use of items rather than the items itself. Here items are the objects that are produced by the sources i.e. journal producing articles, authors producing papers etc. In linguistics a sources is called a type and an item a token. The relative use of these occurrence will be higher than their relative occurrence itself; hence the Type/Token - Taken informetrics.

Huber [365] introduces Mann - Whitney test to compare two informetric or scientometric samples and calculate the probability that they come from different distributions. This can be used to test the productivity of journals and authors. The main limitation is a lack of power on small samples that have small differences.

2.6 Current Trends

To identify the trends in a subject, discipline, and research, informetric techniques are used. Informetrics is accepted as a research area that gives additional understanding of the form and structure of scientific communication. Some of the uses of the informetric study are :

i) to study the growth of subject and its literature ;

ii) to assess the productivity of an individual scientist ;

iii) to evaluate quality of research of an individual, an organisation or a country;

iv) to study history of science and science policy ;

v) to study the obsolescence or aging of scientific literature;

vi) to evaluate individual journals or a group of journals especially for acquisition purposes ;

vii) to identify core areas in different subjects;

viii) to measure usefulness of SDI services;

ix) to assess authorship trend of scientific literature.

Bradford's law is most used in informetric distributions. 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 the following fields:

i) computerised bibliographic search systems (Medlars);

ii) discarding of 'aged' periodicals;

iii) planning special library systems;

iv) subject bibliography compilation.

The universality and stability are the two characteristic that make Bradford's law more acceptable. 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.

Now a days research on informetric techniques applied to various disciplines have been done. This has led to an increase in the number of papers on informetric study. Most of the studies were conducted to evaluate the specific publications, scientists, research organisations etc. Citations are observed to be valid measure 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.

To enable proper utilization of available resources informetric measures of research productivity and quality are supported by decision makers. Quantitative methods in Science and Technology help in determining funding priorities for research in the present context of economic crisis. In Europe quantitative studies using informetric methods are taken as Science policy indicators. Such studies are reported in journals like 'Scientometrics', Research Policy' etc. These studies can be considered as one of the many sources of information for Science policy indicators. Rousseau [366] introduced fitted mathematical models to Web data.

2.7. Advanced Studies

Jarvelin and Ingwersen [367] found that how informetric calculations can easily and declaratively be specified through advanced data management techniques. The data modelling and query interface enable endusers to perform basic informetric adhoc calculations, such as bibliographic coupling, author co-citation analysis, generalized impact factors, international visibility and international impact, productivity calculations in a given area etc., easily and often with much less effort than in contemporary online retrieval systems.

In the age of information explosion and Internet the application of informetric methods is very significant. By the development of computer databases most of the studies are done by data from online. Stefaniak [368] refer to works done in U.S. and Europe. Brooks [369] developed "The Bibliometrics Toolbox" in which a variety of measures for downloading data are available. The results of informetric analysis have been used for periodical and book acquisition, user studies, weeding of obsolete materials etc. To evaluate the structure of literature in different disciplines, informetric methods are used. Thus the quantitative methods which were termed 'Bibliometrics' to denote 'written communication' have progressed to Information Science which give birth to the term 'informetrics'. Informetrics has become an effective tool in research for quantitative and qualitative measurement.

Recently a new growth area in bibliometrics has been developed in the emerging fields of webometrics, or cybermetrics as it is often called. Webometrics can be defined as using of bibliometric techniques in order to study the relationship of different sites on the World Wide Web. Such techniques may also be used to map out areas of the Web that appear to be most useful or influential, based on the number of times they are hyperlinked to other websites. Ingwersen [370] then introduced a new metric that could be used to assess the impact of Web spaces such as University Web sites and Web Impact Factor had many variants but the most successful was the ratio of the number of links pointing to the space in question from outside of that space (in links) divided by the total number of pages in the space. Wilkinson et al., [371] conducted a study of random collection of 414 links between U K University Web sites found that although over 90% were related in some way to research, less than 1% targeted Web pages that were equivalent to refereed journal articles. While some of the studies have focused on the evaluation of online impact metrics, others have used hyperlinks to investigate the patterns of communication between large areas of the Web or individual scientists. Thelwall, Tang and Price [372] studied international links and have been counted between the Universities in the whole countries both in Europe and in the Asia - Pacific region. These studies showed that the approach was feasible and the meaningful information could be extracted, but that care had to be taken when comparing the results for countries with significantly different scales of Web use. Bjorneborn [373] investigated possibilities for information discovery through serendipity on the Web in a pilot study of online bookmark pages of a selection of researchers. Cronin, Snyder, Rosenbaum, Martinson, and Callahan [374] developed a typology of reasons for the online invocation of scholars, finding a diverse set. Goodrum, Mc Cain, Lawrence, and Giles [375] compared a Web-based citation analysis of online PDF and postscript documents with a traditional approach Landes and Posner [376], Cronin and Shaw [377] used counts of mentions of scholars in Web pages as partial indicators of public intellectual status, although this does not relate to the Web content produced by them.

2.8 Conclusion

The articles reviewed in the chapter are published between the years 1917 to 2004. Total number of documents reviewed include 46 books, 285 journals articles, 11 dissertations, 29 conference proceedings, 2 unpublished articles, 1 pre print, 1 monograph and 2 references from the Web. The review of literature helps to trace the genesis and development of informetrics. Most of the studies reviewed in this chapter are carried out abroad. It helped to understand the classic laws and later studies done by earlier researchers.

References

1. Hulme, E. Wyndham. : Statistical bibliography in relation to the growth of modern civilization. London : Butler and Tanner Grafton, 1923.p.9.

2. Raising, L . M. : Statistical bibliography in health sciences. Bulletin of the Medical Library Association,50:1962.p.450.

3. Pritchard, Alan. : Statistical bibliography or bibliometrics. Journal of Documentation, 25(4) :1989.p.348. H.H. : Periodical literature of biochemistry, Bulletin of the Medical Library Association, 27 : 1938.pp. 139-147.

4. Pritchard, Alan. : Statistical bibliography or bibliometrics. Journal of Documentation, 25(4) :1989.p.348.

5. Fairthorne, R.A. : Empirical hyperbolic distributions (Bradford, Zipf-Mandelbort) for bibliometric description and prediction. Journal of Documentation, 25 : 1969.p.319.

6. Pritchard, Alan. Op.Cit.,p.349.

7. British Standards Institution. : British Standards of Documentation Terms. London : BSI, 1976. p.7.

8. Hawkins, D.T. : Unconventional use of on-line information retrieval systems : On-line bibliometric studies. Journal of American Society for Information Science, 28 (1) : 1977.p.13.

9. Nicholas, D. and Ritchie, M. : Literature on bibliometrics. London : Bingley, 1978.pp.9-10.

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

11. Schrader, Alvin.M. : Teaching of bibliometrics. Library Trends, 30 : 1981.p.151.

12. Broadus, R.N. : Definition of bibliometrics. Scientometrics, 12 : 1987. p.377.

13. Hertzel, Dorothy, H. : Bibliometrics : History of the development of ideas in. In : Encyclopaedia of Library and Information Science, 42 : 1987.p.144.

14. Egghe, L. : Methodological aspects of bibliometrics. Library Science, 25 : 1988. p.179.

15. Sengupta, I.N. : Bibliometrics and its applications. In : Information Science and Libraries. Ed. by Pushpa Dhyani. New Delhi : Atlantic, 1990.p.256.

16. Dobrov, G.H. and Korennoi, A. A. : The informational basis of scientometrics : On theoretical problems of informetrics. FID.435 : 1969.p.165.

17. Merton, R.K. and Garfield, E. : Forward to little science, big science - and beyond by D J de Solla Price. New York : Columbia University Press, 1963.

18. Beck, M.T. : Editorial statement. Scientometrics, 1 : 1978.pp.3-4.

19. Brusilovsky, B.Y.A. : Partial and system forecast in scientometrics. Technology Forecast Soc. Change, 12 : 1978.pp.193-200. Quoted by Egghe, L. (1988).

20. Tague, J. : An introduction to informetrics. Information Processing and Management, 28 (1) : 1992.p.1.

21. Sen, S. : From bibliometric to informetrics : Workshop on Scientific Communication and Bibliometrics held at ICCB and INSDOC, Calcutta, Feb. 15-28, 1988.p.84. (preprint).

22. Morales, M. : Informetrics and its importance. International Forum for Information and Documentation, 10 (2) : 1985.p.15.

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

24. Ravichandra Rao, I.K. and Neelameghan, A. : From librametry to informetrics : An overview and Ranganathan's contributions. Libri, 42 : 1992.p.242.

25. Almind, T.C. and Ingwersen, P. :Informetric analyses on the World Wide Web : Methodological approaches to "Webometrics". Journal of Documentation, 53(4) :1997.p.406.

26. Bjorneborn, L. and Ingwersen, P. : Perspectives of Webometrics. Sccientometrics,50(1) :2001.p.65.

27. Cole, F.J. and Eales, N.B. : The History of Comparitive Anatomy Pt.I. A statistical analysis of literature. Science Progress, 11 (4) : 1917.pp.578-596.

28. Hulme, E. Wyndham. Op. Cit., p.21.

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

30. Ibid., p.144.

31. Hulme, E. Wyndham. Op. Cit., p.9.

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

33. Henkle, H.H. : Periodical literature of Biochemistry. Bulletin of the Medical Library Association, 27 : 1938.pp.139-147.

34. Gosnell, Chas,F. : Rate of obsolescence in college library book collections a determined by the analysis of three select list of book for college libraries. Dissertation. New York University, 1943.

35. Gosnell, Chas,F. : Obsolescence of books in college libraries. College and Research Libraries, 5 : 1944.pp. 115-125.

36. Fusseler, Herman H. : Characteristics of the research literature used by chemists and physicists in the United States. Dissertation. University of Chicago, 1948.

37. Fusseler, Herman H. : Characteristics of the research literature used by chemists and physicists in the United States. Library Quarterly, 19 : 1949.pp.19-35.

38. Raising, L Milks. Op. Cit.,pp.450-461.

39. Barker, Dale Lockard. : Characteristics of the scientific literature cited by chemists of the Soviet Union. Dissertation. University of Illinois, 1966.

40. Pritchard, Alan . :Computers, statistical bibliography and abstracting services, 1968. (unpublished).

41. Prltchard, Alan. : Statistical bibliography : An interim bibliography. London : New Western Polytechnic School of Librarianship, 1969.

42. Witting, Glenn.R. : Statistical bibliography : A historical footnote. Journal of Documentation, 34 : 1978.pp.240-241.

43. Pritchard, Alan. Op.Cit,.p.348.

44. Ibid.,p.348.

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

46. Potter, W.G. Op. Cit.,pp.5-7.

47. Egghe, L. and Rousseau, R.: Informetrics 87/88. Select proceedings of International Conference on Bibliometrics and theoretical aspects of information retrieval. Diepenbeck, Belgium, 1987. Amsterdam : Elsevier, 1988.p.3.

48. Egghe, L. and Rousseau, R. : Informetrics 89/90. Selection of papers submitted for IInd International Conference on Bibliometrics, Scientometrics and Informetrics. Ontario, Canada, 1989. Amsterdam : Elsevier, 1990.

49. Egghe, L. and Rousseau, R.Op. Cit.,p.3.

50. Ibid.,p.3.

51. Ibid.,p.3.

52. Ibid.,p.3.

53. Ibid.,p.3.

54. Kopelock, B. : Bibliometrics : Access in the library literature. Collection Management, 2 (3) : 1978. pp.199-204.

55. Cole, F.J. and Eales, N.B. Op. Cit.,pp.578-596.

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

57. Gross, P.L.K. and Gross, E.M. Op.Cit.,pp.385-389.

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

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

60. Zipf, G.K. : The Psycho-biology of language : An introduction to dynamic philology. Cambridge : MIT Press, Mass, 1935.

61. Fussler, H.H. Op. Cit.,pp.19-35.

62. Garfield, E. : Significant journals of Science. Nature, 264 : 1976.pp. 609-615.

63. Garfield, E. : Citation indexes for Science. Science, 122 : 1955.pp.108-111.

64. Narin, F. : Evaluative bibliometrics. New Jersey : Computer Horizons. Inc., Cherry Hill, 1976.pp.41-44.

65. Kessler, M.M. : An experimental study of bibliographic coupling between technical papers. IEEE Transactions : 1963.P.49.

66. Weinberg, B.H. : Bibliographic coupling : A review. Information Storage and Retrieval, 10 : 1974.p.190.

67. Goffman, W. and Newill, V.A. : A generalization of the theory of epidemics : An application to the transmission of ideas. Nature, 204 : 1964.pp.225-268.

68. Pritchard, A. Op. Cit.,p.349.

69. Small, H. : Co-citation in the scientific literature : A new measure of the relationship between two documents. Journal of American Society for Information Science, 24 : 1973.pp.256-259.

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

71. Kendall, M.G. The bibliography of operational research. Operational Research Quarterly, 11(1-2) : 1960.pp.31-36.

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

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

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

75. Hatium, S.D. : Stationery scientometric distributions. Pt. I-III, Scientometrics, 4 : 1982.pp.89-104, pp.181-194.

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

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

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

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

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

81. Lawani, S.M. : Bradford's law and the literature of Agriculture. International Library Review, 5 : 1973.pp.341-350.

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

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

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

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

86. Price, D.J.S. : A general theory of bibliometrics and other cumulative advantage process. Journal of American Society for Information Science, 27 (5/6) : 1976.pp.292-306.

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

88. Colie, R.C. : Lotka's frequency distribution of scientific productivity. Journal of American Society for Information Science, 28 1977.p.366.

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

90. Sengupta, I.N. Weightage formula to re-rank biochemical periodicals. International Library Review, 16 : 1984.pp.447-458.

91. Naranan,S. : Power law relations in science bibliography : A self consistant interpretation. Journal of Documentation, 27 : 1971. pp.83-97.

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

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

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

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

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

97. Mandelbort. : An information theory of statistical structure of language. In : Proceedings of Symposium on Application of Communication Theory. London : Butterworths, 1953.pp.486-500.

98. Fairthrone, R.A. : Empirical hyperbolic distributions for bibliometric description and prediction. Journal of Documentation, 25 : 1969. pp.319-343.

99. Vickery, B.C. Op.Cit.,pp.198-203.

100. Kendall, M.G. Op.Cit.,pp.31-36.

101. Cole, P.F. : A new look at reference scattering. Journal of Documentation, 18 : 1962.pp.58-64.

102. Gross, C.V. : Bradford law and the Keeman - Autherton data. American Documentation, 18 : 1975.p.46.

103. Leimkuhler, F.F. : Bradford distribution. Journal of Documentation, 23 (3) : 1967.pp.197-207.

104. Goffman, W. and Warren, K.S. : Distribution of papers among journals based on mathematical analysis of two diverse medical literature. Nature, 221 : 1969. pp.1205-1207.

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

106. Vlachy, J. : Frequency distribution of scientific performance : Bibliography of Lotka's law and related phenomena. Scientometrics, I : 1978.pp.109-130.

107. Stevens, S.S. : On the psychological law. Psychology Review, 64 : 1957.pp.153-181.

108. Yule, G.U. : A mathematical theory of evolution based on the conclusions of Dr. J. C. Willis, F.R.S. Philosophical Transactions Research Society Series B, 213 : 1924.pp.21-87.

109. Willi, J. : Age and area : A study in geographical distribution and origin of species. England : University Press, 1922.

110. Zipf, G.K. : Human behaviour and the principle of least effort : An introduction to human ecology . Cambridge, Mass : Addison - Wesley, 1949.

111. Paerto, V. : Cours d' Economic Polique. Lausanne, F. Rouge & Cie, Vol.2, Sec.3, 1896.

112. Simon, H.A. : On a class of skew distribution functions. Biometrica, 42 : 1955.pp.425-440.

113. Carroll, J.B. : On sampling from a long normal model of word-frequency distributions. In : Computational analysis of present - day American English, Ed. by Henry Kueera and W. Nelson Francis .U.S.A : Brown University Press,1967.pp.406-424.

114. More, P.M. : Library effectiveness : A system approach .Cambridge : MIT press,1968.

115. Buckland, M.K. : Analytical study of library book duplication and availability. Information Storage and Retrieval, 5 : 1969.pp.64-79.

116. Narin, F. : Evaluative bibliometrics : The use of publication and citation analysis in the evaluation of scientific activity. New Jersey : Computer Horizons Inc., Cherry Hill, 1976.pp.41-44.

117. Shockley, W. : On the statistics of individual variations of productivity in research laboratories. Proceedings International for Radio Engineers, 45 : 1957. pp.279-290.

118. Hubert, J.J. : Analysis of data in rank frequency. Ph.D. dissertation .U.S.A : State University of New York, 1974.

119. Rogge, A.E.: A look to academic anthropology. American Anthropology, 78 : 1976.p.855.

120. Line, M.B.: The half-life of periodical literature : Apparent and real obsolescence. Journal of Documentation, 26 : 1970.pp.46-52.

121. Sandison, A.: Patterns of citation densities by date of publication in Physical Review. Journal of the American Society for Information Science, 26 : 1975.pp.349-351.

122. Moravcsik, M.J. : How to grow science. New York : Universe Books, 1980.

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

124. Tague, J. : Success breeds success phenomena and bibliometric processes. Journal of American Society for Information Science, 32 : 1981.pp.280-286.

125. Hill, B.M. : Ziff's law and prior distribution for the composition of a population. Journal of American Statistical Association, 65 : 1970.pp.1220-1232.

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

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

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

129. Lawani, S.M. : Bibliometrics : Its theoretical foundations, methods and applications. Libri, 3 : 1981.pp.294-315.

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

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

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

133. White, H.D. and Mc Cain K.W. : Bibliometrics. Annual Review of Information Science & Technology, 24 : 1989.pp.119-186.

134. Pritchard, A. and Wittig, G.R. : Bibliometrics : A biography and index. Vol. I : 1874-1959 : 1981.

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

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

137. Sellen, Mary, K. : Bibliometrics : An annotated bibliography 1970-1990. New York : G.K. Hall, 1983.p.169.

138. Oppenheim, C. : Use of online databases in bibliometrics studies. In : Proceedings 9th International Online Information Meeting. Oxford : Learned Information Ltd., 1985.pp.355-404.

139. Persson, O. : Online bibliometrics : A research tool for everyman. Scientometrics, 10 : 1986. pp.69-75.

140. Hibbs, J.E., Bobner, R.R., Newman, I., Dye, C.M. and Benx, C.R. : How to use online databases to perform trend analysis in research. On line, 8 : 1984.pp.59-64.

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

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

143. Zitt, M. : A simple method of dynamic scientometrics using lexical analysis. Scientometrics, 22 (1) : 1991.pp.229-252.

144. Todorov, R. : Computer bibliometrics for journal classification. Information Processing and Management, 26 (5) : 1990.pp.673-680.

145. Grievel, L., Polanco, X. and Kaplan, A. : A computer system for big scientometrics at the age of the World Wide Web. Scientometrics, 40 (3) : 1997.pp.493-506.

146. Katz, J.S. and Hicks, D. : Desktop scientometrics. Scientometrics, 38 (1) : 1997.pp.141-153.

147. Larson, R.R. : Bibliometrics of the World Wide Web : An exploratory analysis of the intellectual structure of cyberspace, Proceedings of the 59th annual meeting of the American Society for Information Science, Baltimore, Heryland, 21-24 Oct. 1996.

148. Nelson, M. and Downie, J.S. : Informetric analysis of a music database : Distribution intervals. In : Davis, M. and Wilson, C.S. Ed. Proceedings of the 8th International Conference on Scientometrics and Informetrics. Sydney : Bibliometric & Informetric Research Group, University of New South Wales, 2001.

149. Wornell, I. : Informetrics : Exploring databases as analytical tools. Databases, 21 (5) : 1998.pp.25-30.

150. Lotka, A.J. : The frequency distribution of scientific productivity. Journal of Washington Academy of Sciences, 16 : 1926.pp.317-325.

151. Ibid.,p.319.

152. Murphy, Larry, J. : Lotka's law in the humanities. Journal of American Society for Information Science, 24 : 1973 p.461-462.

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

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

155. Pao, H.L. : Lotka's test. Collection Management, 4 : 1982.p.112.

156. Narin, F. : Op.Cit.,pp.41-44.

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

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

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

160. Price, D.J.S. : Some remarks on elitism in information and the invisible college phenomenon in science. Journal of American society for Information Science, 22 : 1971.pp.74-75.

161. Nicholls, P.T. : Price's square root law : Empirical validity and relation to Lotka's law. Information Processing and Management, 24 : 1988.pp.469-477.

162. Egghe, L. and Rousseau, R. : Introduction to informetrics. Amsterdam: Elsevier , 1990.p.377.

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

164. Lawani. S.M. : Quality, collaboration and citation in cancer research. Ph.D. thesis. Florida : State University Press,1980.

165. Yuasa, M. : Centre of scientific activity, its shift from the 16th to 20th century. Japanese Studies in the History of Science, 1 1962.p.527.

166. Narin, F. : Evaluative bibliometrics : The use of publication and citation analysis in the evaluation of scientific activity .New Jersey : Cherry Hill, 1976.

167. Newby, Gregory B. : Open source software development and Lotka's law : Bibliometric patterns in programming. Journal of the American Society for Information Science and Technology, 54 (2) : 2003.pp.169-178.

168. Pao, M.L. : Lotka's Law : A testing procedure. Information Processing and Management, 21 (4) : 1985.pp.305-320.

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

170. Ibid.,p.86.

171. Ibid.,p.86.

172. Ibid.,p.86.

173. Vickery, B.C. Op. Cit., pp.128-203.

174. Cole, P.F. Op. Cit., p.58.

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

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

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

178. Naranan,S. : Bradford's law of bibliography of science: An interpretation. Nature, 227 : 1970.p.1377.

179. Groos, V. Op. Cit.,p.46.

180. O'Neill, E.T. : Journal usage patterns and their implications in the planning of library systems. Ph.D. Thesis : Prudue University, 1970.

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

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

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

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

185. Brookes, B.C. Op. Cit., pp.120-143.

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

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

188. Drott, M.C. and Griffith, B.C. : An empirical examination of Bradford's Law and the scattering scientific literature. Journal of American Society for Information Science, 29 : 1978.pp.238-246.

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

190. Price, D.J.S. : A general theory of bibliometrics and other cumulative advantage process. Journal of American Society for Information Science, 27 : 1976.pp.292-306.

191. Ravinchandra Rao, I.K. : Documents and user distribution in transaction records of canadian university libraries. Ph.D. Thesis. Canada : University of Western Ontaria,1981. (Quoted in Ravichandra Rao, I.K. Quantitative methods in Library & Information Science. New Delhi : Wiley ,1983.)

192. Garfield, E. : The mystery of transposed journal lists. Current Contents, 14 (31) : 1971.pp.5-6.

193. Sengupta, I.N. : Growth of biochemical literature. Nature, 224 : 1973.pp.75-76.

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

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

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

197. Bookstein, A. Op. Cit.,pp.376-386.

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

199. Burrell, Q.L. : The dynamic nature of bibliometric processes : Case study, In : Ravichandra Rao, I.K., Ed : Informetrics-91. Amsterdam :Elsevier, 1992.pp.97-129.

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

201. Garg, K.C. and Lalitha Sharma. : A study of R & D indicators in Indian industry using Bradford's law. Journal of Scientific and Industrial Research, 53 (2) : 1994. pp. 81-87.

202. Rousseau, R. : Bradford's curves, cumulative rank - frequency distributions and a goodness - of - fit - test. Journal of Information, Communication, and Library Science, 6 : 2000.pp.1-10.

203. Aulakh, G.S. and Jain, H.C. : Bibliometric study of Indian Phytopathology literature : Growth pattern and scatter. Journal of Library and Information Science, 8 (1) : 1983. pp.69-87.

204. Hasso, Maysoon H. : 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) : 1984.pp.85-90.

205. Maheswarappa, B.S. and Prakash, B.P. : Literature use pattern by the researchers in the field of Botany : A citation study of Doctoral Theses. Journal of Library and Information Science, 7 (1) : 1982.pp.15-32.

206. Peritz, Bluma C. : A Bradford distribution of bibliometrics. Scientometrics, 18 (5-6) : 1990.pp.323-329.

207. Bernal, J.D. : Royal Society Scientific Information Conference. London. Paper No.46 : 1948.

208. Bradford, S.C. Op.Cit.,p.85.

209. Lawani, S.M. : Bradford's law and the literature of agriculture. International Library Review., 5 (3) : 1973.pp.341-350.

210. Aiyepeku, W.O. : Bradford distribution theory : Compounding of Bradford periodical literature in Geography. Journal of Documentation, 33 : 1973.pp.210-250.

211. Bulick, S. : Book use as a Bradford - Zipf Phenomenon. College and Research Libraries, 39 : 1978.pp.215-219.

212. Kendall, M.G. Op. Cit.,pp.31-36.

213. Price, D.J.S. : A general theory of bibliometrics and other cumulative advantage processes. Journal of American Society for Information Science, 27 : 1976.pp.292-306.

214. Zipf, G.K. : Human behaviour and the principle of heart effort. NewYork : Hafner, 1972.p.578.

215. Kansay, J.E. : Law of scattering. In: Encyclopaedia of Information Library Sciences. Ed. by A. Kent, 1971.

216. Brookes, B.C. :The Bradford law : A new calculus for the Social Science ? Journal of America Society for Information Science, 30 : pp.233-234.

217. Eto, H. : Rising tail in Bradford distribution : Its interpretation and application. Scientometrics, 13 : 1988.pp. 271-287.

218. Burrell, Q.L. : A third note on ageing in a library circulation model : Applications to future use and relegation. Journal of Documentation, 43 : 1987.pp.24-45.

219. Burrell, Q.L. : Predictive aspects of some bibliometric processes. In : Egghe, L. and Rousseau, R., Ed. :Informetrics 87/88. Amsterdan : Elsevier, 1988.pp.43-63.

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

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

222. Sichel, H.S. : A bibliometric distribution which really works. Journal of the American Society for Information Science, 36 : 1985.pp.314-321.

223. Schubert, A. and Glanzel, W. : A dynamic look at a class of skew distribution functions : A model with scientometric applications. Scientometrics, 6 : 1984.pp.149-167.

224. Cane, V.R. : A Class of non-identifiable stochastic models. Journal of Applied Probability, 14 : 1977. pp.475-482.

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

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

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

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

229. Fedorowicz, J. : A Zipfian model of an automatic bibliographic system : An application of Medline. Journal of American Society for Information Science, 33 : 1982.pp.223-232.

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

 G8942

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

232. Zunde, Pranas and Slamecka, V. : Distribution of indexing terms for maximum efficiency of information transmission. American Documentation, 18 (2) : 1967.pp.104-108.

233. White, Emilie C. : Bibliometrics, from curiosity to convention. Special Libraries : Winter 1985 . pp.35-42.

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

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

236. Garfield, E. : Bradford's law and related statistical patterns. Current Contents, 12 (5). Reprinted In : Essays of an Information Scientist, 4 : 1980.pp.476-483.

237. Goffman, W. and Morris, T.G. : Bradford's law and library acquisitions. Nature, 226 : 1970, pp.922-923.

238. Price, D.J.S. : A general theory of bibliometrics and other cumulative advantage process. Journal of American Society for Information Science, 27 : 1976.pp.292-306.

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

242. Bookstein, A : Theoretical properties of informetic distributions. In : Ravichandra Rao, I.K., Ed. : Informetrics - 91 .Amsterdam: Elsevier, 1991 .pp.17-35.

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

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

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

246. Bookstein, A. Op. Cit., pp.365-375.

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

248. Kunz, M. : Lotka and Zipf : Paper dragons with fuzzy tails. Scientometrics, 13 (5-6) : 1988.pp.289-297.

249. Tague, Jean. : Ranks and sizes : Some complementarities and contrasts. Journal of Information Science, 16 : 1990.pp.29-35.

250. Weinstock, M. : Citation Indexes. In : Encyclopedia of Library and Information Science. Vol.5. New York : Marcel Deckker, 1971. pp.15-40.

251. Martyn, J. : Citation analysis. Journal of Documentation, 31 (4) : 1975.pp.290-297.

252. Weinstock, M. Op. Cit.,pp.15-40.

253. Lipetz, B.A. : Improvement of the selectivity of citation indexes to science literature through inclusion of citation relationship indicators. American Documentation, 16 (2) : 1965 : pp.81-90.

254. Moravcsik, M.J. and Murugesan, P. : Some results on the function and quality of citations. Social Studies of Science, 5 : 1975.pp.86-92.

255. Hodges, T. : Citation Indexing, its potential for bibliographic control. Ph. D. Thesis. Barkeley : University of California , 1978.

256. Oppenheim, C. and Renn, S.P. : Highly cited old papers and the reasons why they continue to be cited. Journal of American Society for Information Science, 29 (5) : 1978. pp.225-231.

257. Finney, B. : The reference characteristics of scientific texts. M.Sc. Dissertation. London Centre for Information Science, City University ,1979.

258. Frost, C. : The use of citations in literary research : Preliminary classification of citation functions. Library Quarterly, 49 (4) : 1979.pp. 399-414.

259. Thorne, F.C. : The citation index : Another cause of spurious validity. Journal of Clinical Psychology, 33 : 1971.pp.1157-1161.

260. Gross, P.L.K. and Groose, E.M. : College libraries and chemical education. Science, 66 : 1927 : pp.1229-1234.

261. Ravichandra Rao, I.K. Op. Cit., p.271.

262. Garfield, E. : Citation Indexing :Its theory and applications in science, technology and humanities . New York : Wiley,1979.p.274.

263. Oppenheim, C and Renn, Susan P. Op. Cit.,p.226.

264. Barker, D.L. : Characteristics of research literature used by chemists. Ph.D. Thesis. Illinois : University of Illinois,1966.

265. Garfield, E. : Citation analysis as a tool in journal evaluation. Science, 178 : 1972.pp.471-479. Reprinted In : Essays of an Information scientist, I:pp.527-544.

266. Tagliacozzo, R.: Citations and citation indexes : A review . Methods Information Science, 6 : 1967.pp.136-142.

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

268. Gross, P.L.K. and Groose, E.M. Op. Cit.,1229-1234.

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

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

271. Brown, C.H. : Scientific serials characteristics 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 : 1956.pp.1-15.

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

273. Sengupta, I.N. : Weightage formula to re-rank biochemical periodicals. International Library Review, 16:1984.pp.447-458.

274. Sengupta, I.N. :Three new parameters in bibliometrics research and their applications to re-rank periodicals in Biochemistry. Scientometrics, 10 : 1986.pp.235-242.

275. Sengupta, I.N. : Bibiolmetrics and identification of core periodicals. Herald of Library Science, 29 : 1990.pp.226-247.

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

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

278. Lal, Arjun. : Citations in Agricultural research. Journal of Library and Information Science, 13 (2) : 1988.pp.175-83.

279. Mujoo - Munshi, Usha., and Vashishth, C.P. : Recency of citations. Journal of Library and Information Science, 18 (1) : 1993.pp.25-31.

280. Musib, S.K. : Age of literature studies in Philosophy. Journal of Library and Information Science, 12 (1) : 1987.pp.46-52.

281. Nagappa, B., and Maheswarappa, B.S. : Most frequently cited Journals by Indian Phytopathologists. Journal of Library and Information Science, 6 (1) : 1981.pp.1-17.

282. Nareendra Kumar. : Citation study as a tools for evaluation of Journal collection use : A case study. Journal of Library and Information Science, 9 (1) : 1984.pp.48-64.

283. Pangannaya, N.B., and Kumarawamy, S. : Leisure : Subject scatter, Journal dispension and other characteristics : A citation analysis. Journal of Library and Information Science, 6 (2) : 1981.pp.28-72.

284. Alfiatayo, Benjamin O., and Kadiri, Jasilin.A. : Periodical literature of Health Economics. Journal of Library and Information Science, 15 (1) : 1990.pp.74-86.

285. Gupta, B.M. : Citation analysis of solar energy research in USSR. Journal of Library and Information Science, 2 (2) : 1977.pp.202-19.

286. Hasso, Maysoon, H. and Oppenhein, Charles. : Secondary services in Archaeology : An evaluation. Journal of Library and Information Science, 12 (1) : 1987.pp.1-18.

287. Ijari, S.R. and Kannappanavar, B.U. : Information use pattern of Indian clinical psychologists : A citation study. Journal of Library and Information Science, 15 (2) : 1990.pp.179-89.

288. Kanungo, Neena Talwar. : Citing pattern of Indian political scientists : A case study of the Indian Journal of Political Science. Journal of Library and Information Science, 20 (1-2) : 1995.pp.56-65.

289. Kanungo, Neena Talwar. : Citing pattern of Indian historians : A case study of the Indian Historical Review. Journal of Library and Information Science, 21 (1) : 1996.pp.81-92.

290. Rangarajan, K.S. and Verma, B.K. : Indian Physics journals : Analysis of their impact on service to Physics research workers. Journal of Library and Information Science, 7 (1) : 1982.pp.1-14.

291. Singh, J.P., Jha, Ajeet K. and Mohinder Singh. : Citation analysis of literature in the field of Aerospace Science and Technology. Journal of Library and Information Science, 26 (1) : 2001.pp.1-17.

292. Peritz, Bluma C : The use of meta analysis for citation studies : An illustrative example. In : Ravichandra Rao, I.K. Ed. : Informetrics - 91. Amsterdam : Elsevier, 1992. pp.358-376.

293. Lancaster, F.W. : If you want to evaluate your library. London : Library Association,1993.p109.

294. Ibid., pp.109-120.

295. Brookes, B.C. : The growth, utility and obsolescence of scientific periodical literature : Journal of Documentation, 26 : 1970.pp.283-294.

296. Ravichandra Rao, I.K. and Meera, B.H. : Growth and obsolescence of literature an empirical study. In : Ravichandra Rao, I.K., Ed. : Informetrics-91 .Bangalore : Sarada Ranganathan Endowment for Library Science, 1992.pp.377-394.

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

298. Price, D.J.S. : Citation measures of hard science, soft science, technology and non science. In : Nelson, C. & Porlock, D., Ed : Communication among Scientists and Engineers. Lexington, MA : Health , 1970.pp.3-22.

299. Broadus, Robert N.: The application of citation analysis to collection building. In : Advances in Librarianship. Vol.7. New York : Academic Press , 1977.

300. Line, M.B. and Sandison, A. : 'Obsolescence' and changes in the use of literature with time. Journal of Documentation, 30 : 1974.pp.283-250.

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

302. Groos, Ole. : Citation characteristics of astronomical literature. Journal of Documentation, 25 : 1969.pp.344-347.

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

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

305. Gupta, Usha : Obsolescence of physics literature exponential decrease of the density of citations to Physical Review with age. 41 (H) : 1990.pp.282-287.

306. http : //www-class.unl.edu/biochem/url/ broken links.html. Accessed on 18 January 2000.

307. Burrell, Quentin L. : Predicting future citation behaviour. Journal of the American Society for Information Science and Technology, 54 (5) : 2003.pp.372-378.

308. Marton, J. Obsolescence or immediacy? Evidence supporting Price's hypothesis. Scientometrics, 7 (3-6) : 1985.pp.145-153.

309. Tague, J., Beheshti, J. and Rees - Potter, L. : The Law of exponential growth : Evidence, implications and forecasts. Library Trend, 30 (1) : 1981.pp. 125-149.

310. Wolfram, Chu.C.M. and Lu, Xin. : Growth of knowledge : Bibliometric analysis using on-line database data. In : Proceedings of the 2nd International Conference on Bibliometrics, Scientimetrics and Informetrics. London. Egghe, L. and Rousseau, R., Ed. : Amsterdam : Elsevier, 1989.

311. Egghe, L. and Ravichandra Rao, I.K. : Classification of growth models based on growth rates and its applications : 1990 (to be published).

312. Narayana, G.J. : Library and information management. New Delhi : Prentice - Hall of India. Ltd, 1991.pp.128-130.

313. Gross, P.L.K. and Gross, E.M. : College libraries and chemical education. Science, 16 : 1927.pp.384-389.

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

315. Brookes, B.C. : Numerical methods of bibliographic analysis. Library Trends, 22 (1) : 1973.pp.18-43.

316. Line, Maurice. : The half-life of periodical literature. Journal of Documentation, 26 (1) : 1970.pp.46-54.

317. Singh, J.P., Jha, Ajeet K. and Mohinder Singh. Op.Cit.,pp.1-17.

318. Garfield, E. : Essays of an information scientist. Vol. 4. Philadelphia : ISI Press, Philadelphia,1977.

319. Pao, M.L.: Lotka's law : A testing procedure. Information Processing & Management, 21 : 1985.pp.305-320.

320. Nicholls, P.T. : Price's square root law : Emperical validity and relation to Lotka's law. Information Processing and Management, 24 : 1988.pp.469-477.

321. Gupta, D.K. : Lotka's law and its application to author productivity distribution in psychological literature of Africa 1966 - 1975. Pt. 11. Herald of Library Science, 28 : 1989. pp.318-326.

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

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

324. Good, I.J. : The population frequencies of species and the estimation and population parameters. Biometricka, 40 (3-4) : 1953.pp.237-264.

325. Good, I.J. and Toulmin, G.H. : The number of new species, and the increase in population coverage, when a sample is increased. Biometrika, 43 (1) : 1956.pp.45-63.

326. Baayen, R.H. : Word frequency distribution. Dordrecht : Kulwer Academic Publisher,2001.pp.18-19.

327. Yoshikane, F. and Kageura, K. : A method for the comparative analysis of concentration of author productivity, giving consideration to the effect of sample size dependency of statistical measures. Journal of the American Society for Information Science and Technology, 54 (6) : 2003.pp.521-528.

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

329. Hirst, G. : Disciplinary impact factors a method for determining core journals lists. Journal of American Society for information Science, 29 : 1978.pp.171-172.

330. He, C. and Pao, M.L.: Discipline specific journal selection algorithim. Information Processing and Management, 22 1986.pp.405-416.

331. Abdulla, S.B. and Lancaster F.W. : 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 : 1991.pp.55-64.

332. Vinkler, P. : Bibliometric analysis of publication activity of a scientific research institute. In : Egghe & Rousseau, Ed : Informetrics, 89/90 .Amsterdam : Elsevier, 1990.pp.309-33.

333. Arora, K. and Sen, B.K. : Use of impact factor as a valid measure for evaluating the performance of scientific papers. In : Ravichandra Rao, I.K. Ed. : Informetrics 91. Bangalore : Sarada Ranganathan Endowment for Library Science, 1991.pp.36-50.

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

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

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

337. Narin, F. : Evaluative bibliometrics. New Jersey, Cherry Hill : Computer Horizons. Inc.,1976.pp.41-44.

338. Garfield, E.: Citation indexes for science. Science, 122 : 1976.pp.609-615.

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

340. Janzen, Daniel. : Fwd : Taxonomy has no citation classics. Nature, 2 : 2002.pp.

341. Arora, Kamlesh. and Sen, B.K. : Use of impact factor as a valid measure for evaluating the performance of scientific papers. In : Ravichandra Rao, I.K., Ed : Informetrics - 91 : 1992.pp. 36-50.

342. CSIR research output 1986 : Analysis (Part I and Part II). New Delhi : CSIR, 1988.

343. Rsearch output 1987 : A Bibliometrics analysis of research papers. New Delhi : CSIR, 1988.

344. CSIR research Output 1988 : A bibliometric analysis. New Delhi : CSIR, 1989.

345. CSIR Research output 1989 : A bibliometric analysis. New Delhi : CSIR, 1990.

346. Sen, B.K. and Shailendra Kumar. : Evaluation of recent scientific research output by bibliometric method : paper presented at the International Conference on Science Indicators for Developing Countries, Paris, 1990.

347. Arora, Kamlesh and Sen, B.K. Op.Cit., pp.36-50.

348. Kessler, M.M. Op. Cit.pp.10-25.

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

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

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

352. White, H.D. and Griffith, B. : Author co-citation : A literature measure of intellectual structure. Journal of the American Society for Information Science, 32 : 1998.pp.163-171.

353. Mc Cain, K.W. : Mapping authors in intellectual space : A technical overview. Journal of the American Society for Information Science 41 : 1990.pp.433-443.

354. Davis, M. and Wilson, C.S. : Proceedings of the 8th International Conference on Scientometrics & Informetrics. Sydney : BIRG (UNSW), 2001.

355. He, Y. and Hui, S.C. : Pub Search : A Web citation based retrieval system. Library Hi Tech, 19 : 2001.pp.274-285.

356. Eom, S.B. and Farris, R.S. : The contribution of organizational science to the development of decision support systems research sub-specialities. Journal of the American Society for Information Science, 47 : 1996.pp.941-952.

357. Braam, R.R., Moed, H.F. and Van Raan, A.F.J. : Mapping of science by combined co-citation and word analysis. 1 : Structural aspects, Journal of the American Society for Information Science, 42 : 1991a. pp.233-251.

358. Braam, R.R., Moed, H.F. and Van Raan, A.F.J. : Mapping of Science by combined co-citation and word analysis. II : Dynamical aspects, Journal of the American Society for Information Science, 42 : 1991 b. pp.252-266.

359. Bayer, A.E., Smart, J.C. and Mc Laughlin, G.W. : Mapping intellectual structure of a scientific sub field through author co-

citations. Journal of the American Society for Information Science, 41 : 1990.pp.444-452.

360. Lin, Y. and Kaid, L.L. : Fragmentation of the intellectual structure of political communication study : Some empirical evidence. Scientometrics, 47 : 2000, pp.143-164.

361. Mc Cain, K.W. : Mapping economics through the journal literature : An experiment in journal co-citation analysis . Journal of the American Society for Information Science, 42 : 1991.pp.290-296.

362. Ahlgren, P. and Jarnevig, B. O. : Requirements for a co-citation similarity measure, with special reference to Pearson's correlation coefficient. Journal of the American Society for Information Science and Technology, 54 (6) : 2003.pp.550-560.

363. White, Howard D. : Pathfinder networks and author co-citation analysis : A re-mapping of paradigmatic information scientists. Journal of the American Society for Information Science and Technology, 54 (5) : 2003.pp.423-434.

364. Egghe, L. : Type/Token-Taken informetrics. Journal of the American Society for Informetric Science and Technology, 54 (7) : 2003.pp. 603-610.

365. Huber, John C. and Wagner-Doubler, R. : Using the Mann - Whitney Test on informetric data. Journal of the American Society for Information Science and Technology, 54 (8) : 2003.pp.798-801.

366. Rousseau, R. : Situations An exploratory Cybermetrics 1 (1) : 1997. Retrieved July 30, 2002, From http://www.csic.es/cybermetrics/articles/v2illp2.html.

367. Jarvelin, K., Ingwersen, P. and Niemi,T. : Informetrics through advanced data management : Complex object restructuring , data aggregation and transitive computation .Tampere, Finland

:University of Tampere, Department of Information Studies, Report,1999.pp.1-44.

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

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

370. Ingwersen, P. : The calculation of Web Impact Factors. Journal of Documentation, 54 (2) : 1998.pp.236-243.

371. Wilkinson, D., Harries, G., Thelwall, M. and Price.E. : Motivations for academic Web site inter-linking : Evidence for the Web as a novel source of information on informal scholarly communication Journal of Information Science, 29 (1) : 2003.pp. 59-66.

372. Thelwall, H., Tang, R. and Price, E. : Linguistic patterns of academic Web in Western Europe. Scientometrics, 56 (3): 2003.pp.417-432.

373. Bjorneborn, L. : Small-word linkage and co-linkage. In : K.M. Anderson, S., Moulthrop J. Blustein, & B.M. Irwin. Eds. Proceedings of the 12th ACM Conference on Hypertext and Hypermedia . New York : ACM Press, 2001.pp.133-134.

374. Cronin, B., Synder, H.W., Rosenbaun, H., Martinson, A., and Callahan, E. : Invoked on the Web. Journal of the American Scoiety for Information Science, 49 (14) : 1998. pp.1319-1328.

375. Goodrum, A.A., Mc Cain, K.W. Lawrence, S. and Giles, C.L. : Scholarly publishing in the Internet age : A citation analysis of Computer literature. Information Processing and Management, 37 (5) : 2001.pp.661-676.

376. Landes, W.M., and Posner, R.A. : Citations, age, fame and the Web. Journal of Legal studies, 29 (319) : 2000.pp.329-341.

377. Cronin, B., and Shaw, D. : Banking (on) different forms of symbolic capital. Journal of the American Society for Information Science and Technology, 53 (14) : 2002 . pp.1267 - 1270.

CHAPTER - 3

TOXICOLOGY :
ITS STRUCTURE AND DEVELOPMENT

CHAPTER - 3

TOXICOLOGY : ITS STRUCTURE & DEVELOPMENT

3.1 Introduction

Science is essentially 'knowledge'. Science is concerned with human understanding of the real world around i.e. the inherent properties of space, matter, energy and their interaction. It is the concomitant of the inquiring mind. Technology is the systematic knowledge and action. The term 'technology' covers the practice, description and terminology of any or all of the Applied Sciences that have practical value or industrial use. Science and Technology have always been part of the development process that is inherent to civilization. In the modern world, Science and Technology have become indispensable. Science generates 'information', changes in attitudes and new value; Technology is a major instrument of social and economic change. The role of Science and Technology in the development of a country is at times so obvious that one tends to ignore it. There is no doubt that Science and Technology have shaped and reshaped India over the years.

Education and research in Science and Technology is essential for the progress, welfare and economic growth of the nation. Scientific research constitutes a fundamental activity of the nation, value to its progress, intellectual attainments, moral and well - being [1]. The scientific discipline is growing at a faster rate, with its doubling period as 7-10 years. The number of scientists is also doubling every 10 years. As a result of this extensive research huge mass of literature is producing every year. The production of literature in quantity and its varied formats during different periods is a reflection of scientific and technological development of a country. If the literature in Science is examined, it can be seen that about 100 years ago, there were only 1000 journals and now their number is around 100000. This shows the rapid growth of research in Science and technology field. The ever-changing world needs ever-changing methods to deal with its ever-changing problems. Toxicology is not an exception to this rule. The 20th century has witnessed a remarkable progress in the field of Toxicology. Although many epoch-making discoveries have been made in the past, their application for practical purposes and the rapid development of associated sciences has become a phenomenon of the 20th century, more than that of any other period.

The practice of Toxicology can be traced to ancient times, when humans were well aware of the toxic effects of animal venoms and poisonous plants. The literature on Toxicology includes not only scientific journals and text books but also books on mythology and legendary, the archeological literature and history books. Thus there has been a metamorphosis in the structure and contents of Toxicology in the past about hundred years of its existence. The problems of exponential proliferation of literature, both at the macro and micro levels in the ever expanding and continuously turbulent field of knowledge has necessitated the sharpening of the skills and the development of tools and techniques so as to cope with the information explosion and information management. The Documentation Research and Training Centre (DRTC), Bangalore has developed a methodology to study the structure and development of a subject. Following this method, the subject 'Toxicology' is analysed in this chapter.

3.2 Genesis & Development

3.2.1 History

Early in the days of the development of civilization, man in his quest for food must have attempted to eat a variety of materials both botanical and animal origin. Through this experience, it is likely that he found that certain substances, principally of plant origin, if taken into the body produced varying degrees of illness or caused death. Other materials served as a desirable form of food. Therefore, it would seen reasonable to believe that man soon recognized that there were harmful as well as beneficial consequences associated with taking materials into his body. All materials could be placed in two classes, one of which was safe and the other harmful.

3.2.2 Antiquity

Earliest man was well aware of the toxic effects of animal venoms and poisonous plants. His knowledge was used for hunting, for waging more effective warfare, and probably to remove undesirables from the small groups of primitive society. The Ebers papyrus, perhaps our earliest medical record (circa 1500 B.C.) contains information extending back many centuries [2]. Of the more than 800 recipes given, many contain recognized poisons. For example, one finds 'hemlock', which later became the poison of the Greeks; 'aconite', an arrow poison of the ancient Chinese; 'opium', used as both poison and antidote; and such metals as lead, copper and antimony. There is also an indication that plants containing substances akin to digitalis and belladonna alkaloids were known. Hippocrates, while introducing rational medicine about 400 B.C., added a number of poisons. He further wrote instructions that might be considered as primitive principles of Toxicology, in the form of attempts to control absorption of the toxic materials in therapy and over dosage.

In the mythology and literature of classic Greece, one finds many references to poisons and their use, and it was during this period that the first professional treatment of the subject began to appear. For example, Theophrastus (370-286 B.C.), a student of Aristotle, included numerous references to poisonous plants in De Historia Plantarum. Dioscorides, Greek physician in the court of Emperor Nero, made the first attempt at a classification of poisons, which was accompanied by descriptions and drawings. Dioscorides also dabbled in therapy, recognizing the use of emetics in poisoning and the use of caustic agents or cupping glasses in snakebite.

Poisoning with plant and animal toxin was quite common. Perhaps the best known recipient of a poison used as a state of method of execution was Socrates (470-399 B.C.). Although he was in distinguished company, expeditious suicide on a voluntary basis also made use of toxicology knowledge. Demosthenes (385-322 B.C.), who took poison hidden in his pen, was only one of many examples. The mode of suicide calling for one to fall on his sword, although manly and noble, carried little appeal and less significance for ladies of the day. Cleopatra's (69-30 BC) knowledge of natural, primitive Toxicology permitted her the more gentled method of falling on her asp instead.

The Romans too made considerable use, often political, of poisons. Much legend and myth have grown out of the skill of poisoner's and the occupational hazards of political life. To Guthrie [3] one such legend tells of the kind Mithridates VI of Pontus whose numerous experiments on unfortunate criminals led to his eventual claim that he had discovered "an antidote for every venomous reptile and every poisonous substance". He himself was so fearful of poisons that he regularly ingested a mixture of 36 ingredients (Galen reports 54) as protection against assassination.

In Rome, poisoning seemed to take an epidemic characteristics, which are described by Livy as being especially distressing to the public in the fourth century B.C. It was during this period that a conspiracy of women to remove those from whose death they might profit was uncovered, and similar large scale poisoning continued form time to time until 82 B.C., when Sulla issued the Lex Cornelia. This appears to be the first law against poisoning, and it later became a regulatory statute directed at careless dispensers of drugs.

The history of poisons and their use is the basis of entertaining retrospective diagnosis, as described by Meek in his essay, 'The Gentle Art of Poisoning' [4] and in a book by Thompson entitled 'Poisons and Poisoners' [5].

3.2.3 Middle Ages

Prior to the Renaissance and extending well into that period, the Italians, with characteristic pragmatism, brought the art of poisoning to its zenith. Maimonides (A.D. 1135-1205), a prolific writer, his volume entitled 'Poisons and their Antidotes' (1198) is a first-aid guide to the treatment of accidental or international poisonings and insect, snake or mad dog bites. The significant figure in the history of Science and Medicine in the late middle ages was the renaissance man, Phillipus Aureolus Theophrastus Bonbastus von Hohenheim - Paracelsus (1493 - 1541). Between the time of Aristotle and the age of Paracelsus there was little substantial change in the Biomedical Sciences. Paracelsus formulated many then revolutionary views that remain an integral part of the present structure of Toxicology. He promoted a focus on the "toxicon", the toxic agent, as a chemical entity. Another noteworthy contribution was his volume entitled Bergsucht (1583 - 1534), the first treatise in the medical literature to provide a comprehensive description of the occupational disease of miners. This book contains numerous clinical observations of chronic, arsenic and mercury poisoning and describes in detail the asthmatic attacks and gastrointestinal symptoms of Miner's disease [6].

3.2.4 Modern toxicology

Often cited as the founder of Toxicology is Matlieu Joseph Bonaventura Orfila (1787-1853), a Spanish Physician who held a position of respect as attending physician to Louis XVIII of France and occupied a chair at the University of Paris. Orfila wrote an important treatise (1814-1885) describing a systematic correlation between the chemical and biologic information of the then poisons [7].

Among other contributions, Orfila singled out Toxicology as a discipline from others and defined Toxicology as the study of poisons. Orfila turned attention to problems combining Chemistry and Jurisprudence. Francois Magendie (1783-1855) spent a significant part of his time in the study of the mechanism of action of emetine and strychinine [8]. Claude Bernard (1813 - 1878) conducted study of arrow poisons and reported a classic experiment identifying the site of action of curare, confirming an earlier report of Kolliker at Wiirtzburg [9]. Louis Lewin (1854-1929) was a prodigious figure in Toxicology. Among his publications was 'A Toxicologist's View of World History', and 'A Text Book of Toxicology' [10] are worth mention. Robert Christison (1797-1882) produced a major work on poisons [11]. Rudolf Kobert (1854-1918) produced a textbook on Toxicology in 1983.

Developments in Toxicology occurred rapidly in twentieth century. The 1920's saw many events that began to mould the fledgling field of Toxicology. The discovery of arsenicals for treatment of diseases such as syphilis got attention. The late 1930s saw the publication of the first journal especially dedicated to Toxicology, 'Archiv fur Toxicologie', in Europe.

3.3 Outline of the subject

Toxicology is the youngest science of poison. The discipline is one of the oldest field in Medicine. The ancient Greeks and Romans utilized toxic chemicals as arsenic and mercurials for therapeutic purposes. (The developments of Industrial Revolution stimulated the rise of occupational diseases). Toxicology, a borrowing science, developed in fits and starts. Toxicology calls on almost all of the basic sciences to test its hypothesis.

Modern Toxicology can be viewed as a continuation of the development of the biological and physical sciences in the late nineteenth and twentieth centuries. Toxicology borrows freely from the principles of Chemistry, Biochemistry. Toxicology depends upon a knowledge and understanding of Physiology, Pathology, Pharmacology, Forensic

Medicine, Veterinary Science are closely related to Toxicology. Now Toxicology is recognized as a multidisciplinary subject. The multidisciplinary nature of Toxicology can be well explained in the figure given below.

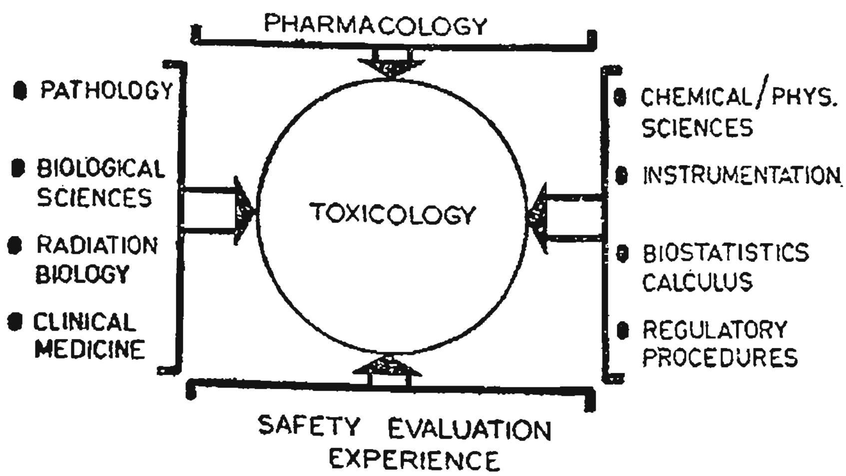

Fig. 3.1. Toxicology a multi-disciplinary approach

The expansion of the various facets of Toxicology has been the outcome of the need of an affluent society to protect itself form injuries resulting from introduction of new chemicals, physical agents and various industrial and consumer products. Today Toxicology has become an important field of research all around the world. Many governmental, non-governmental professional organisations and institutions are giving prime importance to Toxicology because entire world is facing environmental pollution and industrial pollution.

3.3.1 Major Areas in Toxicology

The multidisciplinary nature of Toxicology is one of its greatest strengths, because it brings the capabilities and techniques of experts in other Sciences into the field of Toxicology. Toxicology borrows freely from the principles of Chemistry, and more particularly Biochemistry. It depends upon a knowledge and understanding of Physiology. Familiarity with statistics and public health is fundamental to the study of Toxicology. Pathology is a major part of Toxicology, for harmful effect from a chemical on a cell, tissue or organism. The field most closely related to Toxicology is Pharmacology, as the pharmacologist must understand not only the beneficial effects of chemicals, but also the harmful effects of those chemicals that may be put to therapeutic use. The major areas in Toxicology are :

3.3.1.1 Environmental Toxicology

The industrial revolution together with increasing population creates a complicated array of patterns by which chemicals are transferred from their sources into and within the environment. Exposure to chemicals in the environment and the public health consequences are continuing source of concern in Toxicology. One can subdivide environmental toxicology into pollution with toxicological consequences for man, pollution that changes the biosphere and therefore disturbs the biological equilibrium, and pollution that affects the aesthetics of the environment. The pollution of the environment with persistent, chemically and biochemically inert waste products such as plastic packaging materials and radioactive waste.

This field is concerned primarily with the harmful effects of chemicals that are encountered by man either directly or indirectly because they are in the atmosphere, or by contact during occupational or recreational activities or by ingestion as food additives or as food residues. One can subdivide environmental toxicology into pollution with toxicological consequences for man, pollution that changes the biosphere and therefore disturbs the biological equilibrium, and pollution that affects the aesthetics of the environment. One can also distinguish between chemical pollution, where the environment is affected by chemical action of pollutants.

The pollution of air, water, and soil results from intense industrial activities, large urban concentrations of the population, and quantities of waste materials. Such waste materials include exhaust fumes of motor vehicles, smoke and gases from fire, the massive quantity of excreta detergents and household chemicals released via sewage systems, and enormous quantities of rubbish of which non-reusable forms of packaging materials and throw away articles are important components.

The massive use, often measure, of drugs on or with out prescription, cigarette smoking, and alcohol consumption, the extensive use of cosmetics, ever increasing use of household chemicals in aerosol such as deodorants, air refreshers, and cleaners are the important aspects of chemical pollution of the environment. This aspect of pollution appears to have received very little recognition in the past but recently the people have become more concerned about these hazards.

3.3.1.2 Economic Toxicology

Economic Toxicology is concerned with harmful or unwanted effects of drugs or combinations that are intentionally administered to biological system for the purpose of achieving a specific effect. This also relates to the risks involved when using food additives, including all substances used to treat foodstuffs such as preservatives, binding agents, colorants and flavourants. The use of such substance results from a desire to transport foodstuffs over long distances and to store them for long periods. Additionally, the need for massive quantities of food requires massive amounts of pesticides and fertilizers. The risks involved in the use of pesticides in the agrarian sector as well as the dangers of small quantities of pesticides in the food products that reach the consumer, fall under this heading.

Academic expends considerable effort in determining the mechanisms of chemical - biological interactions. History has shown that an understanding of the mechanism of action of some highly toxic compounds can suggest concepts for the development of new drugs and newer, safe industrial chemicals. Although most Toxicology data are obtained considerable progress has been made in recent years in the development of in vitro Toxicology protocols. The industries involved in production of chemicals, the agencies involved in the regulation and control of distribution of chemical products, and the laboratories involved in studying chemical-biological interactions all contribute to the acquisition of knowledge about the harmful effects of chemicals.

3.3.1.3 Medical Toxicology

Medical Toxicology involves those disciplines that are concerned principally with the chemical identification, clinical effects, diagnosis and treatment of chemical intoxication in human populations. In addition, medical toxicology involves the acquisition of information and the estimation of human risk associated with exposures of individuals as well as populations to chemical entities.

These include accidental and intentional abuse of chemical substances, including therapeutic agents; undesirable excessive and non-therapeutic drug effects; injurious interactions of exogenous substances; accidental exposure to toxic substances in home and in industry; intentional and in advertent food additives and environmental pollutants, and naturally occurring toxic hazards. Closely related to this branch is the forensic toxicology, which deals with the medical and legal aspects of the harmful effects of chemicals on humans. Often in post mortem material where there is a suspicion of murder or attempted murder by poisoning Determination of alcohol concentration in expired air blood and identification of suspicious substances in connection with trade in narcotics, as well as investigations on doping in sports, fall under this category. The exposure of all forms of living tissue to chemicals that are foreign to the tissue is unavoidable, and the fact that the numbers and variety of chemicals continuously increasing indicate the vast scope of the study of Toxicology.

3.3.2 Scope of Toxicology

As a multidisciplinary subject, the students of Toxicology continue to study the subject in a fragmented fashion from a variety of sources. For medical students, teaching of Toxicology is usually allocated to the Pharmacology division. In clinics, the diagnosis and treatment of chemical intoxication is taught, whereas the clinical chemical methodology is taught in the departments of laboratory medicine. To study the harmful effects of chemicals on livestock and pets, veterinary schools have excellent facilities. Similarly Fisheries and Oceanography departments study and instruct in the effects of chemicals on marine forms of biologic tissue.

The modern toxicologists are a cross section of scientists from different branches of Science who have a common interest in the harmful effects of chemicals. There are the veterinarians who are interested with the effects of chemicals, food additives on livestock and pets. There are marine biologists who are concerned with the harmful effects of foreign chemicals on marine life. There are chemists who are interested in the detection and quantification of chemicals on biologic tissue. There are pharmacologists who are concerned with the harmful effects of chemicals that are used as drugs. There are industrial health physicians who are concerned with the control of pollution and the effects of pollutants on the environment. There are pathologists whose studies are related to the gross and microscopic effects of foreign chemicals. There are engineers and geologists who study the distribution of chemicals in the air, water and soil [12].

Thus the multidisciplinary nature of Toxicology brings out clearly its significance in the 21st century. Today Toxicology has a broad scope. The three major subdivisions of Toxicology are Environmental, Economic, and Medical.

3.4 Definitions

According to the 'Encyclopaedia Americana' [13], "Toxicology deals with the harmful effects of chemicals on living organisms. Every person comes in contract with a large variety of chemicals, many of which may be harmful if not properly used ".

To the 'Macmillan Encyclopaedia' [14], "Toxicology is the study of poisons, which deals with their chemical nature and origin, the pathological changes they induce, their recognition in a poisoned patient, and the determination of specific antidotes".

According to 'Collins Co-build English Language Dictionary' [15], "Toxicology is the study of poisons that are produced by bacteria and is harmful to plants, people or other living creatures".

To 'Mc Graw Hill Encyclopaedia of Science and Technology' [16], "Toxicology is the study of adverse effects of chemical and physical agent on living organisms. Toxicology has also been referred to as the science of poisons".

To the 'Encyclopaedia of Scientific Terms' [17], edited by E.C. Graham, "Toxicology, science of poisons, embracing the physical and chemical history of all the known poisonous substances, as well as the methods of testing them, their action on the living body, and the post mortem results they occasion".

According to the 'Oxford English Dictionary' [18], "Toxicology is the science of poisons; that department of pathology or medicine which deals with the nature and effects of poisons. Toxicity is toxic or poisonous quality, especially in relation to its degree or strength."

'Webster's 3rd New International Dictionary of English Language'[19], defines "Toxicology as a science that deals with poisons and their effect on living organisms, with substances otherwise harmless that prove toxic under particular conditions, and with the clinical, industrial, legal or other problems involved."

'Webster's Comprehensive Dictionary'[20], defines "Toxicology as the science that treats of the origin, nature, properties, and effects of poisons, of their detection in the organs or tissues, of their antidotes, and of the treatment of diseases due to poisoning."

'Encarta World English Dictionary' [21], defines "Toxicology as the scientific study of poisons, especially their effects on the body and their antidotes."

From the aforesaid definitions "Toxicology is the area of Science which deals with origin, properties of poisons and their reactions on cells and tissues".

3.5 Terminological Development

The word 'toxic' (adj) means pertaining to poison or involving STH poisoning relating to. In the mid 17th century, from the medieval Latin word 'toxicus' meaning 'poisoned form' (from Latin. toxicum), and ultimately from Greek word 'toxikos' meaning 'of the bow' (Greek toxikon pharmakon meant 'poisoning for smearing arrows') derived the word 'toxic' [22] . When used as a noun 'Toxicology', i.e. the scientific study of poisons, especially their effects on the body and their antidotes, is compounded of 'toxico' and 'toxikos' and the Greek word 'logic' which means word or account i.e. one who speaks (in a certain manner) ; one who deals (with a certain topic) [23].

3.6 Classification systems

The tremendous growth of Toxicology during 21st century clearly showed its multidisciplinary nature and potential relevance of the subject. All the major classification schemes gave an important consideration for this subject. An analysis of the subject 'Toxicology' in various classification schemes is given below.

3.6.1 Document general classification

Generally studies on Toxicology are given under Medicine, Environmental Sciences. Chemistry.

3.6.1.1 Colon classification, 7th Ed.

L Medicine

4 Disease

4 poison

L : 44 Toxicology [24] .

3.6.1.2 Dewey Decimal Classification, 22nd Ed.

600	-	Technology (Applied Science)
610	-	Medicine and Health
611	-	Human Anatomy, Cytology, Histology
612	-	Human Physiology
613	-	Personal Health and Safety
614	-	Forensic Medicine
615	-	Pharmacology and Therapeutics
615.9	-	Toxicology /
		class here poisons and poisoning

615.91 - Gaseous poisons

615.92 - Inorganic poisons

615.94 - Animal poisons

615.95 - Organic poisons [25].

3.6.1.3 Universal Decimal classification

615 - Medicine

615.9 - Toxicology [26].

3.6.2 Thesauri & Subject Headings

3.6.2.1 Sears List of subject Headings

Toxic Substances

Use Hazardous substances

Poisons and Poisoning

Toxcic wastes

Use Poisons and Poisoning

Toxicology

Use Poisons and Poisoning

Under

Poisons and Poisoning 363.17, 615.9

UF Poisonous substances

Toxico substances

Toxicology

SA Individual poisons, to be added as needed; and, for the influences of particular substances on humans and animals, names of poisonous substances with the subdivision Toxicology [27].

3.6.2.2 Me SH (Medical Subject Headings)

Biological Sciences [G01]

Pharmacology [G01.703]

Ethnopharmacology [G01.703.015]

Neuropharmacology [G01.703.030]

Pharmacoepidemiology [G01.703.045]

Pharmacogenetics [G01.703.052] +

Pharmacognosy [G01.703.060]

Pharmacology, Clinical [G01.703.152]

Psychopharmacology [G01.703.546]

Toxicology [G01.703.795] [28].

3.6.2.3 SPINES THEAURUS

7171 TOXEMIA

7172 TOXIC PLANTS

FR PLANTES TOXIQUES

SP PLANTAS TOXICAS

PT PLATAS TOXICAS

UF PESTICIDE PLANTS

bt 1 PLANTS (Botany)

rt TOXICOLOGY

7173 TOXICOLOGY

FR TOXICOLOGIE

SP TOXICOLOGIA

PT TOXICOLOGIA

bt 1	Pharmacology
nt 1	Drug Toxicology
nt 2	Drug induced abnormalities
nt 1	Lethal dosage
nt 1	Permissible dosage
rt	Chemical properties
rt	Poisoning
rt	poison
rt	pollution
rt	pollutants
rt	toxins
rt	vaccines [29] .

3.7 Toxicology Literature

The multidisciplinary nature of Toxicology has resulted in an increase in the number of research organizations all over the world. This has led to the publication of research papers in the form of reports, patents, bulletins etc. in addition to journals, book and reviews. The past 30 years have seen an explosion in the volume of Toxicology literature and it appears to continue to expand. The resources available to the professional seeking literature about Toxicology are many and varied. The sources of information in Toxicology can be divided into documentary, non-documentary sources and other sources.

3.7.1 Documentary sources

Documentary sources are divided into primary, secondary and tertiary. Primary sources include periodicals, proceedings, research bulletins, patents, official publications, theses and dissertations.

3.7.1.1 Periodicals

Periodicals are publications issued at intervals not necessarily, but generally, regular, each issue being numbered consecutively and usually dated with no pre-determined and to the sequence of publication. Periodicals are primarily a source of new information, whether it be the results of research, news items, statistical data, announcements, correspondence, advertisements about products and services, or what ever. Each type of periodical is important to at least one group of people, relating to their work or leisure activities; some have an ephemeral existence; others may be useful for many years, even indefinitely [30].

Among the earliest periodicals in Toxicology were 'Sammlung von Vergiftungs faellen' (Germany, begun in 1930), 'Farmakilogiia i Toksikologiia' (Russia, begun in 1938) and 'Acta Pharmacologica et Toxicologica' (Denmark, begun in 1945). One can detect, in these early titles, a close link between Pharmacology and Toxicology, which is partially with us even today. In the U.S., the 'Journal Toxicology' and 'Applied Pharmacology', begun in 1946, was to become the official organ of the Society of Toxicology, founded in 1961.

Readers can observe the rapid growth of Toxicology by the number of journals beginning in the 1970s and the 1980s. There is also a greater trend towards specialization in toxicological journals. Ross [31] has recently indicated that primary publications relevant to Toxicology include over 100 journals. The 100 most frequently cited journals have been listed by Kissman [32]. Some outstanding general scientific journals that regularly publish Toxicology articles are the 'British Medical Journal', 'JAMA', 'Lancet', Nature and 'Science'. For information about the periodicals, following sources are consulted:

i. Ulrich's International Periodicals Directory : Bowker, New York ;

ii. Irregular Serials and Annuals : An International Directory : Bowker, New York ;

iii. The National Library of Medicine's SERLINE database.

Some important primary periodicals in the field Toxicology are the following :

1. Ambio

Elmsford, New York. : Pergramon Press, 1972 -

A bimonthly international journal published by the Royal Swedish Academy of Sciences and dedicated to recent work in the interrelated fields of Environmental Toxicology, Technology etc.

2. American Industrial Hygiene Association Journal

Akron, Ohio : American Industrial Hygiene Association, 1940 -

This journal deals primarily with monitoring and control of exposure and analytical techniques and equipment. Also includes articles on health effects, especially related to inhalation, heat, noise and radiation toxicology, book reviews, and lists meeting, conferences and courses.

3. American Journal of Industrial Medicine

New York.: Alan R. Liss, 1980 -

A fine series of wide - ranging papers on worker exposure.

4. Aquatic toxicology

Amsterdam : Elsevier /North-Holland, 1981 -

This journal is devoted to the mechanisms and assessment of toxicity in the aquatic environments, at all levels from the community to the cellular. Topics such as uptake, metabolism and excretion are included.

5. **Archives of Environmental Contamination and Toxicology**

New York. : Springer - Verlag, 1972 -

This official publication of the society for Occupational and Environmental Health Publishes scientific articles on contaminants in the environment, the introduction of toxic substances into the environment, and waste.

6. **Archives of Environmental Health**

Washington, D.C. : Heldref Publications, 1960 -

Articles on human health effects of environmental agents, covering clinical, experimental and epidemiological studies. Relevant animal studies are also included. The journal publishes announcements of courses and meetings.

7. **Archives of Toxicology**

Berlin : Springer - Verlag, 1930 -

Official journal of the European Society of Toxicology. '... accepts papers which advance the science of Toxicology from any relevant discipline. These studies include mechanisms of Toxicology, defined effects in man and new methods of treatment, new methods of analysis and experimental studies of chemicals'. The journal publishes review articles, original investigations, short communications and letters to the editor. The annual supplement usually consists of the Proceedings of the European Society of Toxicology.

8. **Bulletin of Environmental Contamination and Toxicology**

New York : Springer - Verlag, 1966 -

Rapid communications in the fields of environmental and food contamination and pollution. On going research is presented as brief reports.

9. **Carcinogenesis**

Oxford : IRL Press, 1980 -

Publishes papers and short communications on carcinogenesis; mutagenesis; factors modifying these processes such as DNA repair, genetics and nutrition.

10. **Cell Biology and Toxicology**

Princeton, N.J : Princeton Scientific, 1984 -

"Dedicated to the publication of Scientific reports dealing with the basic Biology and with the physiological, pharmacological and toxic responses of cellular systems . . . studies of toxic effects many include, but are not limited to, cytotoxicity, genotoxicity etc.

11. **Chemico - Biological Interactions**

Shannon, Ireland : Elsevier Scientific, 1969 -

Research reports, rapid communications, review articles, and commentaries that examine molecular aspects of cytoxicity, carcinogenesis, mutagenesis and teratogenesis and molecular mechanisms by which therapeutic or toxic effects are exerted.

12. **Chemosphere : Chemistry, Biology and Toxicology as related to environmental problems.**

Oxford : Pergamon Press, 1972 -

A multidisciplinary journal, reporting investigations related to health and safety of life. Topics covered are the natural environment, meteorology and climate, environmental chemicals and analysis, air and water pollution, waste treatment, environmental fate of chemicals, pharmacodynamics - bio-accumulation - metabolism, effects on humans, occupational hazards and exposure and ecotoxicology.

13. Clinical Toxicology Consultant

Memphis, Tenn. : Clinical Toxicology Consultant, 1979 -

Provides "the practicing clinician and other health care providers with up-to-date information regarding current trends and promising new developments in the prevention, detection, diagnosis and treatment of acute and chronic toxicities from drugs and environmental chemicals". Each issue includes a list of forth coming articles.

14. CRC Critical Reviews in Toxicology

Boca Raton, Fla. : CRC Press, 1971 -

Lengthy critical evaluations with several hundred references per review.

15. Drug and Chemical Toxicology

New York : Marcel Dekker, 1977/78-

". . . . full-length research papers, review articles, and short notes broadly pertaining to animal toxicology, teratology, mutagenesis and carcinogenesis".

15. Drug - Nutrient Interactions : A journal of Research in Nutritional Pharmacology and Toxicology

New York : Alan R Liss, 1981 -.

Articles discuss the often complex interaction between drugs and nutrients.

16. Ectoxicology and Enviromental Safety

New York : Academic Press, 1977 -

This official journal of the International Society of Ecotoxicology and Environmental Safety deals with "studies of the biologic and toxic effects caused by natural on synthetic chemical pollutants to ecosystems, whether animal, plant or microbial . . . entry and fate of chemicals in the biosphere and reports of quantitative and qualitative studies of the toxic effects of chemical pollutants and their impact on humans".

17. Environmental Mutagenesis

New York : Alan R. Liss, 1979 -.

Official journal of the Environmental Mutagen Society. Research papers, book and article reviews, meeting reports, lits of papers accepted for publication in future issues. This journal stresses environmental mutagenesis, genetics and public health.

18. Environmental Research

New York : Academic Press, 1967 -

Broadly concerned with Environmental Biology and Medicine. The journal contains original research, reviews and selected book reviews.

19. Environmental Toxicology and Chemistry

New York : Pergamon Press, 1982 -

A publication of the Society of Environmental Toxicology and Chemistry. "An international peer - reviewed journal open to papers of merit dealing with all phases of environmental toxicology, environmental chemistry, and hazard assessment." Strong in aquatic toxicology.

20. Food and Chemical Toxicology

Oxford : Pergamon Press, 1963 -

Published for the British Industrial Biological Research Association (BIBRA); formerly entitled Food and Cosmetics Toxicology. An international journal publishing original papers and reviews in a wide - ranging field covering all aspects of Toxicology, but with particular reference to food. This journal aims to be informative to all who generate or make use of toxicological data. The main part of each issue consists of original research papers, but book reviews and interpretive articles of toxicological interest prepared by BIBRA also appear in most issues. A software survey section intended to encourage the exchange of information on software programs relevant to Toxicology is also included.

21. Food, Drug, Cosmetic Law Journal

New York : Academic Press, 1946 -

Articles on legal concern relating to food, drugs, cosmetic, medical devices and Biologics and a forum for discussion of general issues in these areas.

22. Fundamental and Applied Toxicology

New York.: Academic Press, 1981 -

"An official publication of the Society of Toxicology, publishes scientific articles and reports relating to those broad aspects of Toxicology which are relevant to assessing the risks or effects of toxic agents and chemicals, including drugs and natural products of forms of energy, on human and other animal health . . . Also included are articles on methods and equipment, regulatory issues or policy articles relevant to the practice of Toxicology, scientific reviews on topics and articles form symposia."

23. Hazardous Waste and Hazardous Materials

New York. : Many Ann Liebert, 1984 -,

"Serves as the central source for the dissemination of information which will advance technology and, ultimately provide economical and ecological methodology for the regulation and management of hazardous waste". Official journal of the Hazardous Materials Control Research Institute.

24. Human Toxicology

Basingstoke, United Kingdom : Macmillan, 1981 -.

This journal includes original articles, editorial, short communications, and book reviews. Recent issues have contained papers on nitrates and genetic cancer. A good source for clinical Toxicology studies, particularly British ones.

25. International Journal of Clinical Pharmacology, Therapy, and Toxicology.

Munich : Dusti - Verlag, Dr. Karl Feistle, 1967 -.

Official Publication of the International Society of Chemotherapy. Worldwide contributions in areas such as pharmacology, biometrics, metabolism and clinical toxicology.

26. Journal of the American College of Toxicology.

New York. : Many Ann Libert, 1982 -.

This official journal of the American College of Toxicology Publishes fully referred papers in such areas as "risk assessment, general toxicology, carcinogenicity, safety evaluation, reproductive and genetic toxicology, epidemology and clinical toxicology, mechanisms of toxicity, new approaches to toxicological testing. Reviews and major symposia in the field are included".

27. Journal of Analytical Toxicology

Niles, Ill : Preston Publications, 1977-

Research papers, reviews, short communications, book reviews on analytical methods relating to toxic substances and their metabolites, new literature and meetings/short course.

28. Journal of Applied Toxicology

Philadelphia : Heyden, 1981 -

An official publication of the Genetic Toxicology Association, the journal emphasizes the direct clinical, industrial and environmental applications of Toxicology and encompasses such fields as mutagenesis, carcinogenesis, health, environment and biological mechanisms. Sections on communications and letters, and "a Toxicology update" of review and original research articles.

29. Journal of Environmental Pathology, Toxicology, and Oncology.

Park Forest, Ill : Chem - Orbital, 1978 -

Official organ of the International Society for Environmental Toxicology and Cancer, with articles grouped into the following sections : Aquatic Toxicology, Toxicology and environmental health, Genetic. Toxicology etc.

30 Journal of Toxicological Science

Sapporo, Japan : Dolu Say kekyukai, 1976 -

Official journal of the Japanese Society of Toxicological Sciences.

31. Journal of Toxicology, Clinical Toxicology

New York : Marcel Dekker, 1979 -

Most useful for the practioner involved in the diagnosis on treatment of human poisoning.

32. Journal of Toxicology. Cutaneous and Ocular Toxicology.

New York : Marcel Dekker, 1982 -

Explores "the phenomena of cutaneous and ocular irritation, sensitisation, phototoxicity and photoallergenicity of cosmetics, drugs, soaps and other detergents, fragrances, textiles, preservatives, adhesives, environmental exposures and occupational exposures.

33. Journal of Toxicology, Toxin Reviews

New York : Marcel Dekker, 1982 -

"An international journal designed to provide a readily identifiable source of critical and sometimes speculative reviews bringing together information on toxins from the full range of clinical and scientific disciplines on which toxins impinge"

34. Journal of Toxicology and Environmental Health

Washington, D.C.: Hemisphere, 1975 -

"Places emphasis on the toxicological effect of natural and anthropogenic environmental pollutants and their actions on intact organisms as well as in vitro systems. Fields of special interest are carcinogenesis, mutagenesis, teratology, neurotoxicity, environmental factors affecting health and other toxicological phenomena . . . epidemiological studies on select groups of workers or exposed populations are also of particular interest.

35. Medical Toxicology

Newton, Pa.: ADIS Press, 1986 -

Original clinical toxicology, adverse drug experience studies, comprehensive review articles, and case reports of acute poisoning. The emphasis is on the practical aspects of intoxications or adverse reactions in patients.

36. Molecular Toxicology

Washington, D.C. : Hemisphere, 1987 -.

In vitro research on genetic, regulatory, on adaptive responses to chemical on physical agents at molecular, cellular and tissue levels. Topics covered include detoxification mechanisms and metabolic activation, DNA adduct formation and repair process, transcriptional translational control of molecular responses to alkylation, oxidation or other chemical damage and heat, shock or radiation injuries.

37. Neurotoxicology

Little Rock, Ark. : Intox Press, 1979 -

Papers deal with the effects of poisonous substances on the nervous systems of humans or animals. Environmental chemicals are emphasized but drugs and other natural compounds are also in scope. Announcements, book reviews and abstracts of meetings are periodically published.

38. Regulatory Toxicology and Pharmacology

New York : Academic Press, 1981 -

The official journal of the International Society of Regulatory Toxicology and Pharmacology takes a worldwide look at issues concerning Toxicology and Pharmacology related to legal, regulatory and social matters, including risk management.

39. Toxicity Assessment

New York : John Wiley & Sons, 1986 -

The journal is devoted to the field of toxicity testing using microbial systems, providing articles on the design and development of microbial methods for the assessment of chemical toxicity, the genetic and mutagenic effects toxicants on the environment, current exposure assessment assays which use micro organisms for risk estimation, the interactions between toxicants and micro organisms.

40. Toxicology

Amsterdam : Elsevier, 1973 -

The broad scope of the journal is evident in its subtitle, "an international journal concerned with the effects of chemicals on living systems'. Articles deal with biological effect on tissues arising from the administration of chemical compounds, principally to animals, but also to humans.

41. Toxicology Letters

Amsterdam : Elsevier, 1977-

This periodical, international in scope, provides for rapid publication of short papers on all areas of toxicological research. Many primary periodicals are published by learned societies, research associations and other official or semi-official bodies with only a small proportion produced by commercial publishers.

3.7.1.2 Books

Books are without question the largest part of the library collection. Book opens the way to reading as a deliberately creative activity. According to well-known librarian, Lionel Mc Colvin "Books are not action, though they may be dynamic, nor thought, feeling, or experience. They are the record of man's reaction to his environment in all its phases. They are not life, but the representation of life, and he who would regard books and reading as good in themselves starts with a fundamental misapprehension of their function. . . Their value lives in enabling men to do, think, feel, and understand better than they could if they depended entirely on their individual experience and that of those with whom they were in immediate contact"[33]. In the process of reading books, the reader may gain awareness, increase perception and exercise imagination i.e. he may get knowledge and experience, an understanding of relationships existing in life and the ability to project himself into the life of others.

Textbooks are generally intended for group use. Today, there is a trend towards making the text book a supplementary aid to the course of study and using a host of media in conjunction with it, e.g. other books, films, filmstrips, programmed instruction, etc. But this trend does not be little the value of the textbook because a good textbook still eliminates the need to use parts of several books to acquire information on a particular topic [34].

3.7.1.2.1 Earlier works in the field of Toxicology

The first resource of those who seek information on the general subject of Toxicology is books. A characteristic of such a literature is a lag between the original presentation of a work and its formal publication. Obviously, access to information is greatly facilitated by publication. Since Toxicology began as an area in the discipline of Pharmacology, most textbooks of Pharmacology or books on screening of drugs or dealing with pharmacological actions of drugs, frequently contain sections on Toxicology. The books published in 1980s are still widely used, well regarded, and that merit special attention, all of which are highly subjective criteria. The older toxicological literature and data may still be quite relevant and valid today. Although discussions of new techniques in instrumentation or recently elucidated mechanisms of action may supplement former methods of theories, older well-documented quality controlled data may still be of considerable value to research today.

Toxicologists are being increasingly courted by book publishers, and it becomes more difficult each year to keep with the increasing mass of publications. Among book publishers paying special attention to Toxicology are CRC, Academic, Elsevier, Raven, Plenum, Hemisphere and Wiley. Carcinogeneus, mutagensis and textogenesis have remained favourite book topics with many other subjects now right on their heels. There has been an increase both in more general text books and in specialized topics such as individual chemicals. As the number of test methods available to toxicologists has grown, so has the number of books which outline such methods.

There is an ever greater tendency in all the sciences to publish proceedings, and with the number of meetings growing every year, books based upon papers presented at meetings are beginning so far outnumber texts created de novo. This is not bad in itself and may be some indicator of the substantial work involved in starting a book from scratch. The quality of published conference proceedings is largely based upon the quality of the presented papers, and the organization of such a book is usually a measure of the organization of the meeting.

Information contained in such sources may be adequate for a casual knowledge. For example, Goldstein et al. [35] gave an excellent general awareness on the subject. Those who require more detailed information are usually faced with some particular problem because a general reference book tends to vary with the nature of the problem to be solved.

Until recent years, toxicologists confined their studies to estimates of lethal doses and these are summarised by Spector [36]. Spector was the original editor of the 'Hand book of Toxicology', which contained data on lethal doses for several thousand compounds assembled form the literature by a committee of the National Academy of Sciences and the National Research Council of the United States of America. There are several good reference books on 'Forensic Toxicology' of which Steward and Stlman [37] and Sunshine [38] are most useful and worth mentioning.

Another important title describing the nature of toxic responses is that of Loomis [39]. Most of the books are devoted to descriptive Toxicology. Boyd [40] has covered in detail the methods employed in the evaluation of new drugs for use in man usually. Some books have some sections on Toxicology. Such reviews are those of Herrick and Cattell [41], and Zaimis and Elis [42]. For information on mechanism of drug toxicity, the review by Whipple et al. [43] and particularly that by Goldstein [44] are good sources.

The best general book on the toxic effects of commercially available products is that of Gleason et al. [45], which has already undergone five revisions, and is now stored on computer files for periodic updating. More detailed information on individual groups of drugs and chemical agents are available in several books. Chemicals used in crop protection are reviewed by Spencer [46] and in animal fields by Smith [47]. Albert [48] discusses the selective toxicity of ant infectives, pesticides, and herbicides and O'Brien [49] narrates the action and metabolism of insecticides. The toxicity of metals is reviewed by Browning [50] and the industrial toxicology by Patty [51], Fairhall [52], Trainter [53], and Irving [54]. Methods in Toxicology has been reviewed by Paget [55]. Ariens et al. cover the general topics of Toxicology, and Redeleff [56] has described information on Veterinary Toxicology. The behavioural toxicology has been reviewed by Weiss and Laties [57], Toxicology of eye by Grant [58], Toxicology of Drug/Chemicals by Deichman and Gararde [59] and Casarett and Doull [60] and poison by Moeschlin [61], and Brookes [62].

3.7.1.3 Reference Books

Reference books are designed for reference purpose so that specific information can be quickly extracted. Most important reference books in the field of Toxicology are :

3.7.1.3.1 Subject Dictionary

Subject dictionary explains terms used in a particular subject, trade and professions. Few important titles are noted below:

- Dictionary of Toxicology. Hodgron, E., Mailman. R,B., Chamber, J.E. : London : Macmillan, 1987.

3.7.1.3.2 Handbook

Handbooks generally cover a particular subject area and contain most frequently required data and subject information i.e. formulae, numerical data etc.

- Handbook of Toxicology. Haley T.J., Berndt, W.O, eds. Washington, D.C. : Hemisphere, 1986.

- Handbook of Analytical Toxicology. Cleveland : Chemical Rubber Company, 1969.

3.7.1.3.3 Theasuri

Theasuri is used to control indexing term vocabulary especially in a computerised information storage and retrieval system. The National Library of Medicine produces MeSH, Medical Subject Headings, a thesaurus [63], and in the sense that it provides a strict heirarchical structure and it is subject-oriented. MeSH has a subdivision list from which terms are taken to be used with the terms and phrases found in the list proper.

MeSH is used for providing subject access points on every bibliographic record created at the NLM. In print form MeSH has three volumes : a heirarchical listing; an alphabetical arrangement that includes scope notes; and a permuted alphabetical listing, in which every word of a phrase heading is brought into the lead position and arranged alphabetically. It is updated annually and is available from the National Technical Information Service [64]. In machine - readable form MeSH is provided free on the Web [65].

3.7.1.4 Indexing services

Indexes are keys to the contents of the back volumes of journals without which they are likely to remain closed books only.

Through indexes one can reach to the material of lasting value. Indexes thus have been among "the most important bibliographical tools for controlling the periodical literature " In an indexing service, the citation has to provide sufficient bibliographical information about each item to enable it to be identified and traced. William Katz [66] states that "an index represents an analysis, usually by name and by subject, of a document".

3.7.1.5 Abstracting services

Abstracts are considered are archetypal secondary information sources. These comprise not only the citations with bibliographical details but also provide summaries of the contents of publications or articles thus they 'organise the primary literature in most convenient form'.

According to Lancaster [67]," an abstract is a brief accurate representation of the contents of a document". Abstracts are widely used as an aid to the reader in assessing the contents of a document and their potential relevance. Abstracts are found in both primary and secondary publications. Abstracts in primary publications are generally found accompanying reports of research and other developments in both published and unpublished report literature, in journal articles, reports of professional, scientific and technical meetings and conferences, theses, books and patent applications and specifications. They are also the corner stone of secondary publications. Together with indexes, abstracts have for sometime constituted a major component of published abstracting services, literature reviews and bibliographies. The primary objective of an abstract is to save the user's time in information gathering and selection. In an age of information explosion, abstracts provide an alertness to work in related fields and avoids duplication of work. Abstracts may also make a contribution to overcoming the language barrier and aid in the compilation and provision of other tools such as indexes, bibliographies. Abstract were more effective than other parts of a record, such as titles and index terms, in judging the relevance of an item. Abstract can substitute for the full text in indexing activities but this may not always be a desirable practice. Abstracts now -a- days play an important role in computer based retrieval systems, by facilitating the identification of pertinent items and by providing access to stored items.

Materials cited has traditionally been journal articles although, increasingly space is being devoted to monographs, technical reports, and other forms and formats of documentation. Whether in hard copy or as a computer file, these are the sources used by the Toxicology researcher in performing a literature search.

Current awareness tools, generally published more frequently than abstracts and indexes, and computer databases somewhat alleviate this problem. Although there are not an extensive number of abstracts and indexes in Toxicology, the standard literature is reasonably well covered, especially when one takes computer files into account.

3.7.1.5.1 Abstracts, Indexes and Current Awareness Services in Toxicology

1. Abstracts on Health Effects of Environmental pollutants (HEEP)

Philadelphia : Biosciences Information Service (BIOSIS)

Reports worldwide research in environmental toxicology, particularly with regard to human health; also includes reviews, meetings and selected patents; encompasses studies on industrial medicine, occupational health, analytical methods, and vertebrates and invertebrates as indicators of substances toxic to humans or as disease vectors in the food chain; contains entries from Biological Abstracts and Biological Abstracts/RRM. Five indexes : author, bio-systematic, generic, subject and CAS Registry Number.

2. Aquatic Sciences Fisheries Abstracts

Bethesda, Md : Cambridge Scientific Abstracts

"An international information journal for the science, technology and management of marine and fresh water environments". Particularly relevant sections on pollution of the aquatic environment, and environmental changes, conservation, public health.

3. Biological Abstracts and Biological Abracts/RRM

Philadelphia : Biosciences Information Services (BIOSIS)

A broad - based biological abstracting service with author, bio-systematic, generic and subject indexes. A section on Toxicology divides the field into antidotes and preventative toxicology, foods, food residues, additives and preservatives, general pharmacological toxicology and veterinary toxicology. Includes many other related subjects as well. Whereas Biological Abstracts focuses upon journal articles, Biological Abstracts/RRH is for reports, reviews and meetings.

4. Biological and Agricultural Index

Bronx, New York.: H.W. Wilson

"A cumulative subject index to English Language periodicals in the field of agricultural chemicals, agricultural economics, agricultural engineering, environmental science, food science, genetics and cytology, horticulture, veterinary medicine".

5. CA selects

Columbus, Ohio : American Chemical Society

A Series of bulletins on 164 chemical topics, containing abstracts of recent journal articles, patents, and conference reports. Issued every two weeks, each topic includes CA abstracts and bibliographic information from the CA database. Topics that may be especially useful to toxicologists are acid rain and acid air, carcinogens, mutagens and teratogens, chemical hazards, health and safety, drug and cosmetic toxicology, environmental pollution, food toxicity, fungicides, herbicides etc.

6. Chemical Abstracts

Columbus, Ohio : American Chemical Society

A premier abstracting publication for all types of chemical literature and patents. Eighty subject sections are divided into the following broad area: Biochemistry, Organic Chemistry, Chemical Engineering. Abstract sections of particular interest to Toxicology are: Pharmacology, Toxicology, Air Pollution and Industrial Hygiene. Numerous indexes by keyboard, patent, author etc provide efficient access to the references.

8. CIS Abstracts

Geneva : International Labour Organisation

Prepared by the International Safety and Health Information Centre ; contains abstracts to recent literature on industry hygiene and occupational health in three Section : (i) Hazards, Pathology and Control Measures (ii) Industries and Occupations, and (iii) General Problems.

9. Clin - Alert

Louis ville, Ky. : Science Editors

A current awareness news letter providing published case study summaries of adverse reactions.

10. Current Advances in Pharmacology and Toxicology

Oxford : Pergamon Press.

A current awareness service produced from the Current Awareness in Biological Sciences (CABS) database. Within Toxicology, the database covers the areas of xenobiotic metabolism, toxins and venoms, neurotoxins, foods, metals, industrial pollutants, carcinogens, mutagens, methods etc.

11. Current Contents

Philadelphia : Institute for Scientific Information (ISI)

Provides access to the tables of contents of current journals. Each issue also contains current book contents, title word index, author index and address directory and publisher's address directory. The sections of greatest potential interest to toxicologists are life sciences, physical and chemical and earth science, agriculture, biology and environmental sciences and clinical practice.

12. Environment Abstracts

New York : EIC/Intelligence

Documents abstracted fall into 21 environmental areas; among these are air pollution, chemical and biological contamination, food, drugs and water pollution.

13. Environment Index

New York.: EIC/Intelligence

A review section offers articles on national and international environmental activities of the past year. There is a directory of federal and state contacts, a list of periodicals monitored by EIC, a conference list, a list of environmental films and one of significant books. Finally, the bulk of the book is devoted to a compilation of environmental of environmental article references, arranged by subject with indexes by author, source, geographic area and SIC code.

14. EPA Publications Bibliography : Quarterly Abstract Bulletin.

Washington D.C. : U.S. Environmental Protection Agency.

It is available from National Technical Information Service. An excellent source for keeping up with the prolific literature of EPA - sponsored reports. Indexes by title, keyword, sponsoring EPA office, corporate author, personal author, contract/grant number and NTIS order/report number.

15. Exerpta Medica

Amsterdam : Elsevier

Series of 44 abstract journals. Among those with particular relevance to toxicology are cancer, developmental biology and teratology, environmental health, industrial medicine, population control and toxicology. Also includes two literature indexes.

16. Food Science and Technology Abstract.

Farnham Royal; Bucks, England:International Food Information Service.

A good source for locating international literature on food hygiene and Toxicology.

17. ICRDB Cancergrams

Spring field, Va.: National Technical Information Service

A service of the International Cancer Research Data Bank (ICRDB) program of the U.S. National Cancer Institute. Every few weeks, an updated Cancergram containing abstracts of selected cancer-related articles recently published in more than 3000 journals. Some cancergrams of particular interest to toxicologists fall within the Chemical, Environmental and Radiation Carcinogenesis Series.

18. Index Medicus

Bethesda, Md. : National Library of Medicine

This monthly publication cumulates each year into an annual called Cumulated Index Medicus. Dating back to 1879, this publication has a long and distinguished tradition as an outstanding source of reference to the world's biomedical literature. Each issue includes a bibliography of medical reviews, subject and author sections. Through the controlled vocabulary, Medical Subject Heading (MeSH), Toxicology literature is well represented. Among the subheadings particularly useful in Toxicology searching are toxicity, adverse effects, poisoning, drug effects and chemically induced. Index Medicus, augumented by additional material, is available online as the MEDLINE database.

19. Oncology Overviews

Spring field, Va : National Technical Information Service.

A service of the International Cancer Research Data Bank Program of the National Cancer Institute. These are retrospective bibliographies containing 100-500 selected abstracts of recent cancer research publications on narrowly focused topics. Over 2000 journals as well as books, theses and meeting abstracts are used to compile this publication. Abstracts in Oncology Overviews are also available online via NLM's CANCERLIT database.

20. Pollution Abstracts

Bethesda, Md. : Cambridge Scientific Abstracts.

Indexes the world wide technical literature on environmental pollution. "Covers air pollution, marine and fresh water pollution, toxicology and health, radiation, land pollution, noise pollution etc. An online version of this publication is also available.

21. Science Citation Index

Philadelphia, Institute for Scientific Information (ISI)

"An international interdisciplinary index to the literature of Science, Medicine, Agriculture, Toxicology and Behavioural Sciences". In three parts the Citation Index is an alphabetical listing of cited items found in journal articles; the Source Index is essentially an author index providing bibliographic descriptions of indexed items; the Subject Index is generated from title works of source items. An excellent source for locating Toxicology literature.

22. TOX/TIPs

Spring field, Va.: National Technical Information Service

Sponsored by the Toxicology Information Sub Committee of the DHHS Committee to coordinate Environmental Health and Related Programmes. A cooperative effort to prevent the duplication of toxicity testing programme and epidemiology studies to determine toxic risk of chemical substances and other agents. TOX-TIPs contains research projects of industrial, governmental and academic groups. Indexes by supporting and performing organizations and principal investigators are also included. References to completed studies are included. TOX-TIPs also carries selected references to articles from the recent literature on work related to the reported project.

23. Toxicology Abstracts

Bethesda, Md. : Cambridge Scientific Abstracts.

Compiled by monitoring some 5000 primary journals and other source references. Each monthly issue contain approximately 650 abstracts, coverage includes reviews, books and proceedings. Author and subject indexes are provided.

3.7.1.6 Monographs

The scope of monograph is narrower than that of a treatise. Monographs are separately published reports on original research and it embodies the results of seminal research. Some of the monographs in the field of Toxicology are

i. Advances in Modern toxicology

Washington, D.C.: Hemisphere publishing, 1976

ii. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Lyon : International Agency for Research on Cancer, 1972.

3.7.1.7 Treatises

Treatises are of encyclopaedic in coverage, presents in a systematic and consolidated manner the results of work and research with bibliographic details.

- Paracelsus, Philippus Aureolus. Theophrastus Bombastus Von Hohenheim (1567)

On the Miners' Sickness and other Diseases of Miners. In Four Treatises of Theophrostus Bombastus von Hohenheim called Paracelsus.

Baltimore : Johns Hopkins Press, 1981

3.7.1.8 Bibliography

Bibliography is a list of any kind of literature in a given subject or wide range of subjects and generally arranged in some kind of order.

i. Bibliography of Agriculture. Phoenix, Ariz.: Oryx Press.

ii. EPA publications Bibliography : Quarterly Abstract Bulletin.

3.7.1.9 Review of progress

Review of progress is a critical summary by a specialist of developments in a particular field of endeavour over a given period. There are several serial reviews in which data on toxicity is periodically updated. Some of the series include Side effects of drugs [68], Essays on Toxicology [69], Drug induced diseases [70], Progress in Chemical Toxicology [71], Modern trends in Toxicology [72] and Advances in Modern Toxicology [73]. Currently several reviews have been published by CRC, U.S.A. which deal in great depth individual chemicals as well as general topics on a particular aspect [74] [75].

3.7.2 Non-Documentary sources

Non- Documentary sources include

- People as a source
- Organizations as a source
- Institution as a source

3.7.2.1 People as source

Earlier, information in the form of expert opinion formed source of information. Some organizations and institutes provide consultancy services in the field of Toxicology, who's who or directories give more details about such persons and firms.

3.7.2.2 Organization as a source

There are so many governmental, non-governmental organizations i.e. professional groups, independent associations. Independent associations, deal with toxicological issues on a regular basis.

3.7.2.3 Institution as a source

Both national and international institutions are doing research in Toxicology area. Institutions organize seminars, workshops, conferences, symposia on selected topics. Then these are published as proceedings.

3.8 Other sources

These include audiovisual materials, newsletters, popular works and online databases.

3.8.1 Audiovisual Materials

Primary, secondary and tertiary sources may also come in audio-visual format such as films, tapes, videotapes, gramophone records, electronic media. A common characteristic of this alternate format is its reliance upon equipment for access. Radio, television, records, tapes, slides, movies, microforms etc. are now -a-days available both at home as well as in library and information centres. They capture important events and moments of life. These materials not only educate people but also entertain them. As copying of these documents is easier, their use is widening.

Audiovisuals, in addition to taking the form of taped lectures, are especially useful as instructional tools in demonstrating methods and procedures. In Toxicology audiovisuals are short in supply. There is certainly much more that can be done in producing educational media in such areas as in vitro and in vivo testing, good laboratory procedures and toxicologic pathology. Personal computers and high capacity storage and retrieval media such as optical discs are opening up the potential for wide array of educational products beyond traditional audiovisuals. This medium deserves further exploration by interested and enterprising firms.

The importance of the purpose of the medium is emphasized by division into the following broad categories:

- Still-projection materials.
- Motion - projection materials.

3.8.1.1 Still - projection materials

Filmstrips, microforms, slides, transparencies, projected opaque materials come under this category. Those visuals which are projected with out motion are referred to as still projection materials. Their attention focussing value for group viewing has long been accepted.

3.8.1.1.1 Slides

Slide tape and multi-image programmes are more useful in education and motivation. As they make materials widely available, more users are using them. User can grasp concepts more rapidly because the sequential order of slides, enables him to visualize the developmental process. As a rapidly developing branch of Science, in Toxicology field slides are produced on subjects of public interest as well as on traditional topics. Many slides and films are distributed through National Audiovisual Centres. Some among them are:

1. Accidental poisoning in children.

   Ann Arbor, Mich.: University of Michigan Medical Center Media Library, 1973.

2. Acute poisoning and drug overdose.

New York. : Medcom, 1980.

3 Agricultural Respiratory problems.

Oakdale, Iowa: Institute of Agricultural Medicine and Environmental Health, Department of Preventive Medicine and Environmental Health, University of Iowa, 1978.

4 Biochemistry, Pharmacology, and Toxicology of alcohols.

Timonium, Md.: Milner - Fenwick, 1981.

5 Biological effects of X-rays.

Rock ville, Md.: Bureau of Radiological Health, 1981.

6. Caging systems, Bedding materials and environmental considerations for laboratory rodents.

Scattle.: University of Washington, North West Committee for Educational Resources, 1985.

7 The causes of cancer.

Berkeley, Calif : Biology Media, 1979.

8 Chemical hazard control.

Berkeley, Calif : Biology Media, 1978.

9 Common anaesthetic problems.

Ann Arbor, Mich : University of Michigan, Department of Anesthesiology, Biomedical Media Production Unit, University of Michigan Medical Center, 1982.

10 Cosmetics.

Evanston, 111. : American Academy of Dermatology, 1975.

11 Drug reactions caused by systematic and topic agents.

Evanston, 111. : American Academy of Dermatology, Committee on Audiovisual Education, 1981.

12 Drugs during pregnancy.

Ann Anbor, Mich. : Michigan Perinatal Education Project, Biomedical Media Production Unit, University of Michigan Medical Center, 1983.

13 Environmental diseases in the city Dweller West Port.

Conn. : Medical Education Programs, 1982.

14 Lectures in Toxicology.

Oxford . : Pergamon Press, 1980.

15. Mercury poisoning in man.

Lorain, Ohio : Dayton Laboratory, 1979 etc.

3.8.1.2 Motion projection materials

16mm and 8 mm films, kinescopes, videotapes come under this category. Motion projection materials consist of series of still pictures shown in rapid succession so that the viewer has an illusion of motion. This creates interest and extends the range of human experience. One source of information about audiovisual materials in the field of Toxicology can be had from the United States Environmental Protection agency, Washington D.C., U.S.A.

3.8.1.2.1 Audiocassettes

In the field of Toxicology, audiocassette publication of preliminary research results has developed as an alternative to the primary periodical i.e. a kind of news bulletin providing basic details and data on where to seek further information. The reproduction of sound recorded on tapes is now an indispensable part of our educational and recreational activities. Some of the important audiocassettes in the field of Toxicology are:

1. Acute Overdose.

   Buffalo, New York. : Communications in Learning, 1978

2. Additives and Hyperactivity.

   New York. : Huxley Institute for Biosocial Research, 1978.

3 Advanced Toxicology.

   Chicago. : Teach'em, 1979.

4 Clinical Drug interactions.

   Madison, Wis. : Extension Services in pharmacy at the University of Nisconsin, 1973.

5 Drug Interactions.

   Buffalo, New York. : Communication in Learning, 1975.

6 Drug Reactions.

   Buffalo, New York. : Communication in Learning, 1975.

7 How to manage acute poisoning and overdose.

   Chicago. : Teach'em, 1977

8 Management of acute poisoning.

   Chicago. : Teach'em, 1977.

9 Oxygen toxicity.

   Buffalo, New York. : Communications in Learning, 1975.

3.8.1.2.2 Videocassettes

Electronic Video Recording is a two-channel audiovisual tape in a special - inch cartridge that can be played on an attachment to a TV set. As in any other subjects, in Toxicology also topics of relevant interest are produced as electronic video recording so that the individual will be able to make his own selection and schedule in viewing to his convenience either at home or at library. Some of the important videocassettes in the field of Toxicology are:

1. Acute Digitalis Toxicity.

   Atlanta. : Emory Medical Television Network, 1982.

2. Antibiotic Toxicity.

   New Haven. : Yale University, CME productions, 1980.

3. Asbestos Diseases in Perspective.

   Atlanta . : Emory Medical Television Network, 1982.

4. Biological Effects of Ionising Radiation.

   Rockville, Md : Training Productions Center, Bureau of Radiological Health, 1977.

5. Cancer and the Environment.

   Bethesda, Md. : Clinical Center, National Institute of Health, 1980.

6. Chemical carcinogenesis.

   Berkeley, Calif. : Regents of the University of California, 1979.

7. Chernobyl .

   Robert P. Gale Reports, July 9, 1986 Seacaucus, N.J.: Network for continuing Medical Education, 1986.

8. Common Paediatric Poisons.

   Marshfield, Wis. : Marshfield Regional Video Network, 1983.

3.8. 2. News letters

Newsletters would often be of great value to libraries in their information function. They are rarely available to libraries on subscription. Newsletters are a fertile ground for discovering new developments in Toxicology. Newsletters tend to report recent findings and events in a brief journalistic format. Some present scientific findings and others focus more on the activities of the society sponsoring them. Most important newsletters in the field of Toxicology are the following :

1. **Action Bulletin - CCHW Inc.**

   Post office Box 926, Arlington, VA 22216.

   This informative newsletter produced by a resourceful, grassroots organization takes on government, industry and anyone else suspected of tampering with the environment and human health. A good source for finding out what hazardous waste activates really think.

2. **Air/Water Pollution Report**

   (Available from BPI, 951 Pershing Drive, Silver spring, MD 20910).

   This environmental newsletter provides coverage of environmental legislation, regulations, and litigation from Washington, plus special reports on state and local activities, pollution control industry news and research and development.

3. **At the Centre**

   (Available from the Canadian Centre for Occupational Health and Safety, 250 Main Street, Hamilton, Canada).

Covers news in the world of occupational safety and health. Also lists conferences, congresses and meetings. French and English versions bound together.

4. **Noise Control Report**

(Available from BPI, 951 Pershing Drive, Silver Spring, MD 20910). Report on developments from Capitol Hill and Federal agencies which influence noise control policy, state and local government regulations are also covered.

5. **Occupational Health and Safety Letter**

(Available from Environews, Inc.,1331 Pennyslvania Ave. N.W.).

6. **Pesticide and Toxic Chemical News**

(Available from Food Chemical News, Inc., 1101, Pennyslvania Avenue, Washington, DC.).

Weekly reports on hazardous wastes, pesticides, toxic substances and general issues of regulation and legislation.

7. **Right - to - Know News**

(Available from Thompson Publishing Group, 1725 K. street, NW, Suite 200, Washington, DC.).

A twice monthly newsletter with current information on legal, legislative, administrative and procedural developments relating to hazard communication standard enforcement and other federal, state and local requirements.

8. **Toxic Exposure Bulletin**

(Available from Thompson Publishing Group, 1725 K street, NW, Suite 200, Washington, DC.).

Provides current information on federal, state and community notice and disclosure requirements, community emergency response programs and needs, industry emergency response programs, liability issues, and litigation.

9. **Toxic Materials News**

(Available from BPI, 951 Pershing Drive, Silver Spring, MD. 20910)

News primarily about government regulatory agencies and legislation involving toxic substances.

10. **Toxic Materials Transport**

(Available from BPI, 951 Pershing Drive, Silver Spring, MD 20910)

Keeps the reader up-to-date on laws and regulations, at federal, state and local levels, about the transportation of hazardous materials.

11. **Toxicology Newsletter**

(Available from Charles L. Winlk, ed., Duquesne University School of Pharmacy, Pittsburgh, PA).

Presents news and announcements of workshops, meetings and new books.

12. **TSCA Chemicals-in-Progress Bulletin**

(Available from TSCA Assistance Office, EPA, Washington, DC).

Provides news on chemical procedures and progress within the office of Toxic substances, EPA.

13. **World Environment Report**

(Available from BPI, 951 Pershing Drive, Silver Spring, MD 20910).

Reports on environmental problems and solutions in other countries, offering coverage of international air and water pollution control, waste management and toxic substances, energy and natural resources, and other environmental protection issues.

3.9 Popular Works

Toxicology ranks high among the scientific disciplines now capturing the interest of the public and stimulating active involvement. From large scale environmental accidents such as Love Canal, Bhopal, and Chernobyl to personal incidents such as intentional or accidental poisoning, Toxicology is of concern to everyone. Questions about our environment, the foods we eat, the drugs we take, and how we dispose our wastes are all relevant to Toxicology. One way this public concern is expressed is through the many popular and technical works. Popular works tend to require minimal scientific background. This should not diminish their importance for they may serve as a starting point for a more in-depth study of an area and even become pivotal in moulding the nature and future course of the discipline. Toxicology is featured on all the news media. Our newspapers and television stations routinely report on radiation accidents, carcinogenic chemicals, oil spills, cosmetic recalls and drug tampering. Following is a selection of fascinating and informative, though not always objective, popular toxicology books:

1. Apfel, R. and Fisher, S.M.

   To do no harm : DES and the dilemmas of modern medicine.

   New Haven. : Conn : Yale University Press, 1984.

2. Benowicz, R.J.

   Non-prescription drugs and their side effects.

   New York : Perigee Books, 1983.

3. Calabrese, E.J. and Dorsey, H.W.

Healthy living in an unhealthy world.

New York. : Simon & Schuster, 1984.

4. Dadd, D.L.

The non toxic home : Protecting yourself and your family from everyday toxics and health hazards.

5. Elkington,J.

The poisoned womb : Human reproduction in a polluted world.

Harmondsworth, New York. : Viking, 1985.

6. Fasciana ,G.S.

Are your dental fillings hurting you ? The hazards of mercury in your mouth.

New Canaan, Conn. : Keats, 1986.

7. Fuller,J.G.

200,000,000 Guinea Pigs : New dangers in everyday foods, drugs and cosmetics.

East Rutherford, N.J. : Putnam, 1972.

8. Gofman, J.W.and Tamplin, A.R.

Poisoned Power, case against Nuclear Power Plants.

Emmaus, Pa. : Rodale Press, 1971.

9. Lucas ,J.

Our polluted food : A survey of the risks.

New York. : John Wiley & Sons, 1974.

10. Mackarness ,R.

Chemical victims

London. : Pan Books, 1980.

11. Makower, J.

Office Hazards : How your job can make you sick

Washington, D.C. : Tilden Press, 1981.

12. Nader, R.

Who's poisoning America ? corporate polluters and their victims in the chemical age.

San Francisco : Sierra Club Books, 1981.

13. Noorword, C.

At Highest risk : Environmental hazards to young and unborn children

New York : Mc Graw - Hill, 1979.

14. Orenberg, C.L.

DES : The complete story.

New York, : St. Martin's Press, 1981.

15. Schroeder, H.A.

The poisons around us : Toxic metals in food, air and water.

Bloomington, Ind. : Indiana University Press, 1974.

16. Verett, J.

Eating may be Hazardous to your health.

New York. : Simon & Schuster, 1974

17. Weir, D.

Circle of poison : Pesticides and people in a hungry world.

San Francisco : Institute for Food and Development Policy, 1981.

18. Welford, H.

Sowing the wind

New York. : Grossman, 1972

19. Whelan, E.M.

Preventing Cancer.

New York : W.W. Norton, 1978.

20. Whiteside, T.

The pendulum and the toxic cloud : The course of dioxin contamination.

New Haven, Conn.: Yale University Press, 1979.

21. Winter, R.

Cancer causing agents : A preventive guide.

New York. : Crown publishers, 1979.

22. Zamm, A.V.

Why your house may endanger your health

New York : Simon & Schuster, 1980.

3.10 Online databases

Online databases in the field of Toxicology are described in detail in the following sub heading Information system.

3.10.1 Toxicology Information System

Toxicology Information Systems have evolved swiftly from early, library-based bibliographic tools to advanced packages utilizing sophisticated ICTs (Information & communication Technologies). These systems have evolved concurrently with the rapid expansion of the of the science of Toxicology itself. Bibiliographic files such as TOXLINE represent first attempts to handle the Toxicology literature through online retrieval. Subsequent approaches applied the use of computers to provide literature - derived data, as in TDB (Toxicology Data Bank) or RTECS, on to capture data directly in the laboratory. Societal concerns about hazardous substances, manifested in legislation and regulations, have been responsible for the creation of many computerised systems.

Advanced, integrated information management systems are being explored as a method of accessing a large number of independently maintained Toxicology databases. Changes in information technologies such as the trend toward microcomputers and novel high-density storage devices will affect the future of Toxicology information systems as well impending developments in Toxicology itself related to biotechnology, analytical methodology, and alternatives to whole animal testing.

The field of Toxicology has witnessed unprecedented growth within the past 25 years. This explosion in subject matter is stemming largely from social concerns and matched by equally rapid technological innovation. This has resulted in a serendipitous marriage between toxicological information and advanced systems to collect, organise and distribute this information.

Toxicology deals largely with the effects of chemicals on biological systems. Toxicological information takes many forms: raw laboratory data (quantitative, qualitative, and descriptive), field data (eg:- poisoning, incidence, work place hazard monitoring), journal articles, books standards, patents, computerised information sources. Toxicology information systems arrange portions of these data in a concentrated plan or to serve a common purpose. One of the main difficulties for designers of Toxicology information systems has been the interdisciplinary nature of the field. This branch of science borrows heavily from Chemistry, Biology, Pharmacology and other Sciences, and a major challenge has been to manage this dispersed information efficiently.

3.10.1.1 History

One of the key documents in the field of Toxicology Information Systems is the 1966 Report of the President's Science Advisory Committee entitled "Handling of Toxicological Information"[76] referred to here as the PSAC Report. Surveying the status of toxicological information prior to and up to the time of this report will make its findings and recommendations all the more illuminating.

Through the first half of the century, Toxicology was frequently considered a subset of Pharmacology. A paper considering whether Toxicology was an independent scientific discipline, pointed out that "Our Toxicology is an infant, barely emerged from the womb of Pharmacology. We do not fully know how to utilize our strengths and talents"[77]. While the debt of Toxicology to Pharmacology was undisputed, the expanded role that Toxicology would play in broader environmental issues was starting to be recognized. The 1960 conference entitled "Problems in Toxicology" [78] brought together distinguished scientists who addressed not only food, drug, and cosmetic control but environmental chemicals, pesticides, industrial chemicals, radioactive materials, and more. According to the Chairman of the Conference, "Toxicity is suddenly upon us as a social problem"[79], then it took two more years with the 1962 publication of Silent Spring [80] to be joilted into an awareness of the dangers associated with the uncontrolled production and use of thousands of chemicals. These chemicals could produce chronic effects, sometimes not apparent until years after exposure, was a stunning revelation to the American public. The environmental movement was conceived in the 1960s and burgeoned in the 1970s; Toxicology became caught up in its tide.

Even today informal communication among scientists and professional meetings were the important means of transmitting new findings. Among the earliest journals, still linked to Pharmacology were the German Sammlung von Vergiftungsfaellen (1930), the Russian Farmakilogia i Toksikologia (1938) and the Danish Acta Pharmacologica et Toxicologica (1945). In the U.S., the journal 'Toxicology and Applied Pharmacology' (1959) was to become the official organ of the Society of Toxicology, founded in 1961. Many new Toxicology journals would be born thereafter.

Published Toxicology information was largely library based. Indexing and abstracting tools for major disciplines were well established. Such reliable standards are Biological Abstracts, Chemical Abstracts, Excerpta Medica, and Index Medicus offered means of tracking Toxicology literature, albeit in a limited way by today's standards. All these bibliographic tools would eventually see their automated counterparts, for widespread availability of computer technology was on the horizon. The batch processed MEDLARS (Medical Literature Analysis and Retrieval Systems) became operational at the National Library of Medicine in 1964 followed by MEDLINE, the on-line version of Index Medicus in 1971. Still, there were no information systems dedicated to serving the toxicologist, to pull together and make readily accessible the far-flung data being generated by increased testing and appearing in an increasing array of publications.

The 1966 Report of the President's Science Advisory Committee expressed its concern about the dispersion of toxicological information over a large area of published journal literature, published and unpublished reports, and unpublished information files of industrial companies and government agencies. The Panel's major finding was that "there exists an urgent need for a much more coordinated and more complete computer-based file of toxicological information than any currently available and further, that access to this file be more generally available to all those legitimately needing such information"[81]. The Panel also provided a useful definition of toxicological information as "all information descriptive of the effects of chemicals on living organisms or their component subsystems"[82]. The recommendations of the PSAC Panel led in 1967, to the establishment of the Toxicology Information Program at the National Library of Medicine (NLM) [83].

3.10.2 Computer Databases

3.10.2.1 TOXLINE

TOXLINE, the earliest on-line bibliographic system for Toxicology, was developed by National Library of Medicine's Toxicology Information Program in 1972 as a "One stop shopping Center" for bibliographic information in Toxicology. The original intent to follow the MEDLINE lead and "mechanize" an existing abstracting and indexing source for on-line bibliographic retrieval had to be adjusted because no one secondary source covered in the field of Toxicology sufficiently. Then it was decided to combine "Toxicology subsets" from various abstracting and indexing services into one file that would look reasonably homogeneous to the on-line user. Thus, TOXLINE initially incorporated relevant segments from Index Medicus, Biological Abstracts, Chemical Abstracts, and International Pharmaceutical Abstracts over the years, other segments have been added while some had to be deleted [84] [85].

3.10.2.1.1. On-line service

The online service of this database is provided by DIMDI; The Japan Information Center of Science and Technology (JICST) and the National Library of Medicine (NLM). TOXLINE contains citations, with abstracts, to the worldwide literature in the areas of Toxicology, including chemicals and pharmaceuticals, pesticides, environmental pollutants and mutagens and teratology, comprise 13 discrete files. They are the following:

- Abstracts on Health Effects of Environmental Pollutants (HEEP). Contains records from the BIOSIS PREVIEWS database and corresponds to the HEEP publication. Covers effects of environmental chemicals or substances, other than medicinals, on human health. Includes abstracts and Chemical Abstracts Service (CAS), registry numbers (1970 to date) ;

- Aneuploidy ;
- Chemical - Biological Activities (CBAC). Contains records from Chemical Abstracts that cover interactions of chemical substances with biological systems in vivo and in vitro. All records contain CAS registry numbers (1965 to date) ;
- Environmental Mutagen Information Center File (EMIC) ;
- Environmental Teratology Information Center File (ETIC) ;
- Hayes File on Pesticides. Contains citations to published articles on health aspects of pesticides is essentially a backfile for Pesticides Abstracts. Does not include Abstracts (1940 - 1968) ;
- Hazardous Materials Technical Center Bulletin (HMTC). Contains citations to published literature on the management of hazardous materials, including disposal, storage and transportation. Corresponds in part to the quarterly HMTC Abstract Bulletin ;
- International Labour Office ;
- International Pharmaceutical Abstracts (IPA) ;
- Pesticides Abstracts. Covers published reports on the epidemiological effects of pesticides on humans, from more than 1000 journals published in the U.S. and other countries. All records contain Chemical Abstracts Service Registry Numbers. (1967 to December 1981) ;
- Toxic Materials Information Center File (TMIC). Contains citations and abstracts in toxic materials prepared by the TMIC, Oak Ridge National Laboratory (1940 to 1973) ;
- Toxicity Bibliography. This is a subset of the MEDLINE database. Covers adverse effect, toxicity, poisoning, or environmental effects

caused by drugs and chemicals, as well as disease conditions induced by chemical substances or radiation. Records contain Chemical Abstracts Service Registry Numbers when applicable. (1965 to date) ;

- Toxicology/Epidemology. Research Projects (RPROJ) Contains descriptions of research projects supported by research grants and contract programmes of the Public Health Service, or conducted intramurally by the U.S. National Institute of Health (NIH) and the National Institute of Mental Health in the areas of Toxicology and Epidemology. Information is obtained from the NIH, Division of Research of Research Grants, CRISP system (Computer Retrieval of Information on Scientific Projects). (1983 to date) ;

- Toxicology Document and Data Depository (TD3). Contains citations to the report literature dealing with toxicology and related subjects. Information obtained from the NTIS database (1979 to date).

Language	English
Coverage	International
Updating	About 12,000 records a month.13

TOXLINE also served to validate the unity of whole-text searching without a controlled vocabulary. This was accomplished by creating one large inverted file of all searchable terms. Over the years, TOXLINE has grown to over 1.4 million records, has been divided chronologically into a current file and two back files, and now has over 10,000 h of on-line usage per year. Because of the continued rapid growth of the literature in this field, TOXILINE did not reach its goal of being the "one-stop shipping center" for Toxicology. Indeed, it has been shown by several authors that for really comprehensive searches in Toxicology, other on-line databases such as Biological Abstracts, Chemical Abstracts, and Excepta Medica must be consulted as well [86] [87].

Because Toxicology is concerned with the effects of chemicals on biological systems, the accurate identification of the chemical substances involved in a toxicologic event is critical preliminary to utilizing Toxicology information systems. For TOXLINE, this problem was met by building an on-line companion file, CHEMLINE, that derived its content mainly from the Chemical Abstracts Service (CAS) Registry System. CHEMLINE [88] became the first of the "online chemical dictionaries" that link nomenclature, structural information, and CAS Registry Numbers to the location of information about specific chemical or groups of structurally related chemicals in other files.

As the drive for computerization of its entire production system continued at CAS, larger portions of the CAS Registry System were made available to on-line information distribution organization, such as DIALOG [89] and SDC [90] which mounted CHEMNAME and CHEMDEX respectively. This process culminated, in a sense, when CAS made the entire CAS Registry System accessible for on-line search as the new service CAS ONLINE [91].

While the TOXLINE paradigm of a bibliographic service devoted to toxicology was not used by other information providers, many of the online files generated by the secondary services that covered the biomedical literature naturally included references to the literature in Toxicology. Numerous studies comparing on-line retrieval from TOXLINE with that from other on-line bibliographic services have been reported [92].

3.10.2.2 On-line databases on specialised areas of toxicology.

i) EMIC (Environmental Mutagen Information Center) &

ETIC (Enviromental Teratology Information Center)

Both files are available on-line through TOXLINE and the U.S. Department of Energy's RECON system.

ii) CANCERLIT AND EXPRESS

The Cancer-related literature including carcinogenesis is available through NLM system.

iii) AGRICOLA

A good source of information on pesticides and their toxicology can be found in the above online service by National Agricultural Library, available from DIALOG, BRS and SDC.

iv) NIOSHTIC

The literature on occupational exposure to chemicals is covered by the above service produced by the U.S. National Institute for Occupational Safety and Health.

3.10.2.3 BIOSIS (Bio-Science Information Services)

BIOSIS is the world's largest abstracting and indexing service for the life sciences. BIOSIS was founded by four leading agencies in America in the field of Biosciences and started publishing Biological Abstracts from 1926 onwards. The name BIOSIS was adopted in 1969.

Biological Abstracts include Personal or Corporate Author Index, Bio-systematic Index, Generic Index, Biological Abstracts/ RRM, Zoological Record, Abstracts of Entomology, Abstract or Mycology, Bioresearch Today, BIOSIS/CAS selects, International Bibliography series, BIOSIS Perspectives Series.

3.10.2.4 TOXIC MATERIALS NEWS

Type	Source (Full text)
Subject	Legislative Tracking, Occupational Safety & Health.
Online Service	News Net, Inc.
Conditions	Monthly subscription to News Net required ; differential charges for subscribes and non-subscribers to Toxic Materials News.
Content	Contains full text to Toxic Materials News, a newsletter on the toxic substances control programme of the U.S. Environmental Protection Agency. Covers the progress of regulations, from rough draft to final rulemaking. In such areas as pesticide and hazardous waste programs, toxic air and water pollutants, work place and household product carcinogens, and transportation of hazardous materials.
Language	English
Coverage	U.S.
Time span	1982 to date
Updating	Weekly

3.10.2.5 TOXIC MATERIALS TRANSPORT

Type	Source (Full text)
Subject	Environment; Legislative Tracking
Producer	Business Publishers, Inc
Online Service :	News Net, Inc.

Conditions	Monthly subscription to News Net required; differential charges for subscribes and non-subscribers to Toxic Materials Transport.
Content	Contains full text to Toxic Materials Transport, a news letter on the legal aspects of transporting toxic, flammable, corrosive, radioactive, and other hazardous substances. Covers investigations, litigations, legislation and regulations concerning carriers, packagers, and shippers. Also covers routing requirements, technological developments, and compliance efforts and costs.
Language	English
Coverage	U.S.
Time span	1985 to date
Updating	Every 2 weeks.

3.10.2.6 TOXICO

Type	Reference (Bibliographic)
Subject	Toxicology
Producer	Center de Toxicologie du Quebec
Online Service	IST - Informatheque Inc.
Content	Contains approximately 14,000 citations to the world wide literature on toxicology. Covers clinical toxicology, including acute or chronic poisoning from drugs, medicines, and chemicals; toxic risks in the work place; and environmental toxicology. Source include about 250 periodicals.

Language	French, with titles in original language
Coverage	International
Time span	1974 to date
Updating	About 250 articles a month.

3.10.2.7 TOXICS LAW REPORTER

Type	Source (Full text)
Subject	Legislative Tracking, Occupational Safety & Health
Producer	The Bureau of National Affairs, Inc., (BNA).
Online Service :	Executive Telecom System, Inc., Human Resource Information Network.
Conditions	Annual subscription to Executive Telecom System required.
Content	Contains full text of Toxics Law Reporter, covering major developments in Federal and State legislation, litigation and insurance issues related to hazardous substances. Covers personal injury and property damage liability, the Comprehensive Environmental Response, Compensation, and Liability Act, the Resource Conservation and Recovery Act and tort law reform.
Language	English
Coverage	U.S.
Time span	July 1986 to date
Updating	Weekly.

3.10.2.8 TOXIC INITIAL INVENTORY

Type		Source (Texual - Numeric)
Subject		Toxicology
Producer	:	U.S. Environmental Protection Agency (EPA), Office of Pesticides and Toxic substances.
Online Service	:	DIALOG Information Services, Inc. (TSCA INITIAL INVENTORY); ORBIT Information Technologies Corporation (TSCA PLUS)
Content		Contains information on the approximately 60,000 chemical substances in commerce in the U.S. covered in the Toxic Substances Contract Act (TSCA) Initial Inventory published June 1, 1979. Each record, providing information on one substance, includes the Chemical Abstracts Service (CAS) Registry Number, preferred name, molecular formula and synonyms. Synonyms in the records are only those received in the inventory reports; additional synonyms provided in the corresponding printed version are not included. Confidential substances and definitions of complex substances are also excluded.
Language		English
Coverage		U.S.
Time span		Inventory current of May 1, 1983
Updating		Irregularly.

3.10.2.9 TSCAPP (TSCA PLANT AND PRODUCTION)

Type : Reference (Referral); Source (Texual - Numeric)

Subject Toxicology

Producer U.S. Environmental Protection Agency (EPA), Office of Pesticides and Toxic substances.

Online Service : Chemical Information Systems, Inc.; a subsidiary of Fein - Marquart Associates (CIS); Information Consultants, Inc. (ICI); ORBIT Information Technologies Corporation.

Conditions Annual subscription fee of $ 300 to CIS required but free is waived for educational Institutions and non-profit public libraries world wide.

Content Contains about 1,27,000 references to non confidential plant and production information for approximately 55,000 unique chemical substances on the Toxic Substances Control Act (TSCA), Inventory published June 1, 1979, plus the 1981 supplement Data on each substance include manufacturer's name and address, chemical name, Chemical Abstracts Service Registry Number, volume produced at each site, manufacturing and import information and the manufacturer's identification number.

Language English

Coverage U.S.

Time span Inventory current of May 1, 1983

Updating Periodically, as new data become available.

3.10.2.10 TSCATS (TOXIC SUBSTANCES CONTROL ACT TEST SUBMISSIONS)

Type	Reference (Bibliographic); Source (Texual Numeric)
Subject	Environment; Toxicology
Producer	U.S. Environmental Protection Agency (EPA), Office of Pesticides and Toxic substances.
Online Service	Chemical Information Systems, Inc., a subsidiary of Fein - Marquart Associates (CIS).
Conditions	Annual subscription fee of $ 300 to CIS required but free is waived for educational Institutions and non-profit public libraries world wide.
Content	Contains over 5000 references to chemical substances mentioned in about 1600 unpublished health and safety reports submitted by chemical manufactures, users and importers to the EPA under the provisions of TOXIC Substances Control Act (TSCA). Approximately 1200 different chemical substances are referenced. Users can place orders online with the CIS or microfiche copies of studies.
Language	English
Coverage	U.S.
Time span	November 1982 to date
Updating	Quarterly

3.10.2.11 MEDLINE

Medline is the largest and best-known database indexing the clinical journal literature. The Unites States of America's National Library of Medicine (NLM) on the campus of National Institutes of Health (NIH) at Bethesda in Maryland is the world's largest medical library. NLM offers MEDLARS (Medical Literature Analysis and Retrieval system), the online databases and databanks. NLM can be accessed at http://www.nlm.nih.gov.

3.10.2.11.1 Internet Grateful Med (IGM)

For the effective search of MEDLINE, IGM, an interactive software package was developed by National Library of Medicine. Online Internet access to IGM has been provided at http://igm.nlm.nih.gov. since 1996. The IGM window - based version may be downloaded at http://www.nlm.nih.gov/databases,gmwin.htm and for Dos - based and Macintosh computers at http://www.nlm.nih.gov/databases/gmorig.html. On June 26, 1997 NLM made access to MEDLINE free and unlimited over www only through a new search interface called 'Pub Med'. Pub Med is a development project undertaken in association with the National Centre for Biotechnology Information at NLM, in conjunction with publishers of biomedical literature. The website address of Pub Med is http://www.ncbi.nlm.nih.gov/pubmed/

3.10.2.11.2 Full-Text Access

MEDLINE is a bibliographic database and does not contain full-text of articles. Commercial database providers such as OVID and Silverplatter produce and license a range of full-text databases which link with their own copies of MEDLINE. The website addresses of OVID and Silverplatter are :

OVID : http//www.ovid.com/

Silverplatter : http ://www.Silverplatter.com/

3.10.2.11.3 MeSH Vocabulary

Journal articles included in MEDILINE are indexed using over 17500 standardized thesaurus terms. This online dictionary is called Medical Subject Headings or MeSH. MeSH terms are divided into 15 main groups. Within these groups MeSH terms are arranged hierarchically, with broad topics branching into progressively narrower topics. This is often referred to as the MeSH tree structure.

3.10.2.11.4 NLM Databases

MEDLARS contain about 18 million references, grouped into two computer subsystems, ELHILL and TOXNET. They can be accessed through IGM and LOCATOR plus. The databases are updated daily, weekly, fortnightly, monthly, quarterly and annually.

3.10.2.11.4.1 ELHILL Databases

ELHILL databases containing information on subjects relating to bio-medicine. The databases are;

- AIDS DRUGS - a dictionary of substances being tested in AIDS - related clinical trials.
- AIDSLINE - (AIDS information on LINE) - contains over 1,56,000 bibliographical citations on AIDS and related topics.
- AIDSTRIALS (AIDS clinical TRIALS) - a part of the AIDS Clinical Trials Information Service.
- AVLINE (Audio-Visuals on LINE) - includes biomedical motion pictures, videocassettes, slide/cassette programmes etc.

- BIOETHICSLINE (Bioethics on LINE) - Bioethics Information Retrieval Project of the Kennedy Institute of Ethics.
- CATLINE (CATalog on LINE) - includes bibliographical biomedical science records catalogued in the NLM collection.
- CHEMID (Chemical Identification) - a dictionary of chemicals of bio-medical and regulatory interest.
- DIRLINE (Directory of Information Resources on LINE) - a directory of the United States and some International resources providing health and bio-medical Information Services.
- DOCUSER (Document Delivery User) - a directory of libraries and other information - related organisations.
- HEALTHSTAR (Health Services, Technology, Administration, and Research) - covers the clinical and non-clinical aspect of healthcare delivery.
- Histline (History of Medicine on LINE) cover the literature pertaining to the history of health.
- HSRPROJ (Health Services Research PROJECTS in Progress) - includes descriptions of health services research projects.
- MEDLINE - NLM'S premier bibliographical database covering the fields of medicine.
- MeSH vocabulary - online directory or thesaurus of bio-medical Subject Heading.
- OLD MEDLINE - bibliographical bio-medicine citations published from 1960 through 1965.

- POPLINE (Population Information on LINE) - bibliographical citations provide worldwide coverage of population.

- PREMEDLINE - Provides basic citation information and abstracts before the record frame more than 3,800 International bio-medical journals.

- SDILINE (Selective Dissemination of information on LINE).

- SERLINE (Serials on LINE) - contains biomedical serial titles.

- SPACE LINE - a co-operative venture of NASA & NLM

- TOXLINE (Toxicology Information on LINE) - contains bibliographical citations covering toxicological, pharmacological, bio-chemical and physiological effects of drugs and other materials.

3.10.2.11.4.2 TOXNET Files

Toxicology data NET works contains the following files on toxicology, hazardous chemicals and related areas which can be accessed through TOXNET on the web. They are

- CCRIS (Chemical Carcinogenesis Research Information System) The databank contains information on chemical carcinogens, mutagens, tumour promoters and tumour inhibitors.

- DART (Developmental and Reproductive Toxicology) - DART'S bibliographical citations include references on biology, chemical and physical agents that may cause birth defects.

- EMIC and EMIC BACK (Environmental Mutagen Information Center BACK file) - EMC contains bibliographical citations on mutagenicity and genotoxicity.

- ETICBACK (Environmental Teratology Information Centre BACK file)

ETICBACK contains bibliographical citations of teratology, developmental and reproductive toxicology and contains references on agents that may cause birth defects.

- GENE-TOX (GENEtic TOXicology)

GENE-TOX is an online data - bank created by the Environmental Protection Agency, which reviews and evaluates the existing chemicals tested for mutagenicity.

- HSDB (Hazardous Substances Data Bank)

HSDB covers toxic effects, environmental fate, safety and the handling of hazardous chemicals.

- IRIS (Integrated Risk Information System)

IRIS contains details of potentially toxic chemicals and regulatory information prepared by the Environmental Protection Agency.

- TRI (Toxic Chemical Release Inventory)

The series contains annual estimated release of toxic chemicals to the environment, amounts transferred to waste sites, and source reduction and recycling data.

3.10.3 Data or Fact Retrieval Systems

Bibliographic retrieval systems, on - line or in printed form, are fact locators in that they direct the user to journal articles or books that contain the sought for facts. In contrast, data or fact retrieval systems like handbooks provide user with the actual facts. Three such databanks are available in the field of Toxicology.

3.10.3.1 TDB (Toxicology Data Bank)

TDB was built and operated by NLM and was started in 1978 to provide users on-line, interactive access to evaluated toxicological data. In order to obtain 'evaluated' data for TDB, data statements were extracted from monographs and handbooks rather than from the primary journal literature. This was based on the assumption that the intellectual filtering process taking place while moving information from primary journals to tertiary sources will select proven or reasonable observations over those that are more speculative or are contradicted by later observations. Nonetheless, TDB is now being augmented with data from the primary literature because, for some chemicals, the monographic sources generally used for the file do not contain sufficiently up to date information.

TDB contents are further screened by a committee of toxicologists, the TDB Peer Review Committee, before they are released on-line [93]. This serves as a means of quality assurance, a critical feature of any data system intending to provide accurate and reliable information. The Committee is an offshoot of the National Institute of Health (NIH) Toxicology Study Section, which has as its main function the evaluation of grant applications in the area of Toxicology. This Committee has successfully transferred the consensus development methods used in grant review to the evaluation of toxicological data extracted from the literature. With over 60 data elements and 4000 compound records, TDB is organized as a matrix of compounds and their chemicals, physical, toxicological, and environmental attributes. TDB contains information about compounds that are hazardous and to which there is significant human exposure.

3.10.3.2 RTECS (The Registry of Toxic Effects of Chemical Substances)

RTECS is a compilation, which provides brief descriptions of substances for which acute or other toxic effects have been reported in the literature. RTECS provides nomenclature, CAS Registry Numbers, and some mutagenic, teratogenic and carcinogenic effects of data as well as references to government regulations and standards. While RTECS is still issued as publication [94] in hard copy as well as on microfiche, its machine - readable equivalent has been available for several years for on-line access from NLM and the Chemical Information System (CIS) [95]. The RTECS Editorial Review Board reviews a limited number of citations to resolve ambiguities.

3.10.3.3 OHMTADS

OHMTADS is a data bank developed by the Environmental Protection Agency (EPA), to provide data about compounds that might become involved in chemical spills. It carries some 126 data elements and describes over 1200 compounds [96]. OHMTADS content is also not peer reviewed, the file is available on-line on the CIS system.

Computerised systems to collect and process biological data developed during research and testing are becoming more prevalent [97] .One such system, developed by the National Center for Toxicological Research, allowed collection, processing and analysis of large - scale, rodent - based tests [98]. Beckman Instruments, Inc., developed this approach further into a free-standing data collection and processing system called TOXSYS, consisting of both specialized hardware and specialized software [99]. Another system for the collection and processing of data from large-scale animal experiments has been reported by the German Center for Cancer Research [100].

Most such data collecting and processing system are intented for support of research and testing in a given organization, and the resulting data banks are not usually accessible to outsiders. The Laboratory Animal Data Bank (LADB) developed and tested by NLM, was created to compile laboratory results for control animals in Hematology, Clinical Chemistry and Pathology from many laboratories and provide them to users on-line for analysis and reference [101].

3.10.4. Future of Toxicology Information Systems

For a scientific discipline predictions about future can be made by extrapolating present trends. Thus it is safe to predict that toxicology information systems will be affected by changes in two areas :

- information technologies ;
- Toxicology and related sciences.

3.10.4.1 Changes in Information Technologies

Over the last 25 years, information and data processing in the sciences have been changed fundamentally and irreversibly by the growth of computer technology. This growth can be expected to continue at a 20% annual rate for the next decade and beyond [102]. Therefore, further rapid and profound changes in the information field must also be expected. Many of these changes will affect the future development of toxicology information systems. The most important changes are:

i. the rapidly spreading use of increasingly more powerful microcomputers as personal work stations ;

ii. the impending introduction of optical disc based massive local storage devices and information distribution systems ;

iii. the increasing use of on-line, whole - text searching of journals and the coming into being of the "e - journals" [103].

3.10.4.2 Changes in Toxicology and related sciences

Toxicology and its information systems are bound to be affected by the revolution now taking place in Biology, "whose corner stone is the technique of gene cloning " [104], and the related disciplines of Biotechnology and Genetic Engineering. Since Toxicology deals primarily with "adverse effects", it is those aspects of these new developments with which will be concerned. Applications of these new technologies will involve the deliberate the inadvertent release into the environment of organisms with new genotypes. The health and environmental implications of such events are beginning to be considered in Congressional hearings [105]. The impending use of gene therapy in humans also may require changes in regulatory approaches. Draft regulation for biotechnology products have been issued.

Articles on these developments are being processed into the bibliographic retrieval systems by the relevant abstracting and indexing systems. Separate services covering these areas also have been established. e.g. TELEGENLINE on DIALOG [106]. More basic changes in the applicable information methodologies also will have to take place. Up to now, the information support functions for Toxicology focused on chemical substances. Information systems describing the inputs of Biotechnology will have to encompass biological entities as well. Classification systems may have to be modified or created, and the techniques used for dealing with data and information relevant to biological entities may have to be applied. These new areas also will require new types of data banks and data handling methodologies. Initial example here is the new NIH supported computational resource for biotechnology, BIONET, and GenBank, a nucleotide tide sequence data bank [107].

Biotechnology and advances in Electronics and Analytical Chemistry are also producing ever more subtle analytical techniques to detect trace amounts of contaminants and evidence that biological systems have been exposed to xenobiotics [108]. We can expect refinements in analytical methodology to alter the course of toxicologic evaluations, as well as regulations and information systems.

New journals such as Alternatives to Laboratory Animals [109] are being published. We may see broader use of mathematical modelling and extrapolation techniques including Quantitative Structure Activity Relationship (QSAR) methods that could produce results comparable to those now obtained from certain animal tests. Widespread replacement of whole animal toxicological testing will require changes in data collection, processing and reporting systems.

Also imminent are the likely effects on some toxicology information systems of the new "Hazard Communication" rule issued by the U.S. Department of Labour in 1983 [110]. Among other requirements, the rule mandates written hazard communication programs, labels as hazard warning, and extensive development of material safety data sheets.

To comply, chemical manufactures will have to make increasing use of toxicological data resources that emphasize work place hazards and protective measures, and market demands may make it possible for new data services in this area to be developed. It will be interesting to see whether the material safety data sheet will now become more reliable and constitute an avenue for the dissemination of unpublished toxicological data and information residing in the files of chemical manufacturers.

The foreseeable changes in Toxicology and its information systems, it is useful to remind ourselves that the information processed, stored and retrieved is only as good as the research and testing that first developed the supporting data. Even in our "brave new world" [111] of supermicro computers with billions of bytes of stored information, the quality and reliability of the data and information are the basic requirements for good decision making and progress in Toxicology as elsewhere in science.

3.10.5 Development of Advanced Systems

The sheer volume of toxicological literature and data, generated because of research, testing, legislation or is the immediate motivating factor for new information systems design. More than 100 journals currently devote most of their space to Toxicology. Many specialized toxicology organizations now exist, and some 110 U.S. Schools offer courses or programmes in toxicology. In short Toxicology data and information have become more dispersed, not less, and there is, therefore a greater need than ever before to order it in a logical manner.

Many other aspects of Toxicology information systems, and especially those related to computer communications technology, have also changed drastically over the last 25 years. In particular, the steady reduction in the cost of computer storage and the growth of the value-added communications networks such as Tymnet, Telenet and Uninet that made the nation wide spread of on-line, interactive information retrieval systems possible have had major impacts on all scientific information systems including those in Toxicology.

These technical developments created a market for the large, multi-file, on-line systems, vendors such as BRS, DIALOG and SDC. These vendors using bibliographic files usually created by other organisations now provide the information user with an impressive array of information resources that cover the entire spectrum of the published scientific and technical information. While these organisations provide access to toxicological information, none of them has specialized in this area so as to be classified as a Toxicology information system.

One on-line data retrieval facility that places emphasis on files relevant to Toxicology is the Chemical Information System (CIS), which has created and supported by NIH and EPA. For a while EPA was the main supporter of CIS, which has created and supported by NIH and EPA. For a while EPA was the main supporter of CIS, but as of 1984, it has ceased this support. Instead, the system is being offered by two private sector organizations. The system is an aggregate of data files including RTECS and OHMTADS. The SANSS (Structure and Nomenclature Search System) file supports the identification of relevant compounds and classes of compounds with pointers to the availability of information on these compounds in other CIS component files. The Commission of the European Communities developed ECDIN (Environmental Chemicals Data and Information Network), a somewhat similar system, accessible through EURONENT DIANE, TYMNET, and other facilities.

Another way to extracting toxicological information from large multi-file online systems without being expert in the intricacies of the varied retrieval languages employed by these systems was developed by the CSIN (Chemical Substances Information Network) project. It consists of software and an interface computer through which the user accesses one or more on-line systems. Information collected from one system can be transformed in CSIN for use in the query statement posed to another system. Most of the searching for chemical and toxicological information can be performed and pre-programmed query statements called scripts.

3.11 Conclusion

Toxicology concentrates mainly on problems of social concerns such as environmental pollution, food poison, drug poison, ecology, pharmacology, biotechnology etc. Literature is produced in abundance and for effective bibliographic control various information systems were developed, and out of which TOXLINE occupies top position with international coverage. The input to TOXLINE is derived from more than twelve countries of the world. Because of the wider coverage in space and subject, the data required for the present study is collected from the Toxicology literature indexed in TOXLINE.

REFERENCES

1. Khanna, J.K. : Libraries compendium : Subjects, sources and research methodology. New Delhi : Beacon Books, 1997.p.269.

2. Ebers, Papyrus. : Ancient Egyptian – about 1500 B.C. Ebbell, B. (Tr.).Copenhagen : Munksgaard ,1937.

3. Guthrie, D. A. : A History of Medicine. Philadelphia : J. B. Lippincott Co., 1946.

4. Meek, W.J. : The Gentle Art of poisoning. Medico – Historical Papers. Madison : University of Wiconsin,1954. reprinted from Phi Beta Pi Quarterly ; May 1928.

5. Thompson, C.J.S. : Poisons and poisoners with historical accounts of some famous mysteries in ancient and modern times. London : H. Shaylor,1931.

6. Pagel, W. Paracelsus. : An introduction to philosophical medicine in the Era of Renaissance. New York : S. Karger, 1958.

7. Orfila, M.J.B. : 'Traite des poisons Tires' des Rignes Meniral, vigital of Animal, ou, Toxicologie Generale consideree sour les Rapports de la physiologie, de la Pathologie" et de la Medecine (A general system of Toxicology or, a Treatise on poisons, found in the mineral, vegetable and animal kingdoms, considered in their relatives with physiology, pathology and medical jurisprudence (original in French-1814-1815). Philadelphia : M. Carey & Sons,1817.

8. Olmsted, J.M.D. Francois Magendie. New York : Schuman, 1944.

9. An introduction to the study of experimental medicine. Green, H.C. (Tr.). New York : Macmillian ,1927.

10. Lewin, Louis. : A text book of Toxicology. Berlin : Stilke ,1929.

11. Christison, R. : A treatise on poisons. 4th Ed. Philadelphia : Barrington & Howell ,1946.

12. Loomis, Ted A. , and Hayes, Wallace. A. : Loomis's essentials of Toxicology. 4th Ed. San Diego : Academic Press ,1996. p.5.

13. Encyclopaedia Americana. International ed. Vol.26. U.S.A. : Grolier Inc.,1981.p.884.

14. Macmillan Encyclopaedia. London: Macmillan,1983.p.972.

15. Collins Co-build English Language Dictionary. London Collins,1989.p1549.

16. Mc–Graw Hill Encyclopaedia of Science and Technology. 9th ed. Vol.18. New York : Mc–Graw Hill Book Company , 2002.p.533.

17. Encyclopaedia of Scientific Terms. Graham, E.C. (Eds.). Vol.2. New Delhi : Crest Publishing House ,1993.p.491.

18. Oxford English Dictionary. 2nd Ed. Oxford : Clarendon Press, 1989.p.327.

19. Webster's 3rd New International Dictionary of the English Language.Vol.3. Chicago : Encyclopaedia Britannica Inc., 1954.p.2419.

20. Webster's Comprehensive Dictionary. Encyclopaedic Ed. Vol.2. Chicago : Ferguson Publishing Company, 2001.p.1329.

21. Encarta World English Dictionary. Chennai : Macmillian India , 1999.p.1974.

22. Klein's Comprehensive Etymological Dictionary of the English Language. Amsterdam : Elsevier Scientific Publishing Company, 1971.p.774

23. Ibid.,p.774.

24. Ranganathan, S.R. : Colon Classification. 7th Ed. Gopinath, M.A. (Ed.). Bangalore : Sarada Ranganathan Enowdment for Library Science , 1987.pp.229-230.

25. Dewey Decimal Classification and Relative Index. Dewey, Melvil (Dev.). 22nd Ed. Mitchell, Joan (Ed.), Vol.3. Ohio : OCLC, 2003.pp.59.

26. Universal Decimal Classification. London :British Standard Institution, British Standards House,1961.pp. 316

27. Sear's List of Subject Headings. 15th Ed. Miller, Joseph (Ed.). New York : H.W. Wilson Company,1994.pp.694.

28. www.nlm.nih.gov/mesh/meshhome.html. Accessed on 8-10-2001.

29. Spines Thesaurus. Vol.I. France : UNESCO, 1988.p.662.

30. Harvey, J.M. : Types of periodical in periodicals administration in libraries : A collection of essay. Mayes, Paul (Ed.). London : Clive Bingly ,1978.pp.7-24.

31. Ross, S.S. : Toxic substance source book. New York : Environ. Inf ,1978.pp.153-147.

32. Kissman, H.M. : Information retrieval in Toxicology, In : Ann. Rew. of Pham Toxicology, 20 : 1980.pp.285-305.

33. Linden, Ronald. : Book and libraries : A guide for students. London : Cassell,1965.pp.1-2

34. Dhawan, K.S. : Multimedia library. New Delhi : Common Wealth Publishers,1997 .p.77.

35. Goldstein, A., Aronow, L. and Kalman. S.H. : Principles of drug action. New York : Harper & Row ,1974.

36. Spector, W.S. Handbook of toxicology. Philadelphia : Saunders,1956.

37. Stewart,C. P. and Stolman, A. : Toxicology, mechanisms and analytical methods. New York : Academic Press,1961.

38. Sunshine, I. : Handbook of analytical toxicology. Clevel : The Chemical Rubber Co ,1969.

39. Loomis, T.A. : Essentials of toxicology. Philadelphia : Lea & Febiger ,1968.

40. Boyd, E.M. : Predictive toxicometrics. England : Scientechnica Ltd ,1972.

41. Herrick, A.D. and Cattell, M. : Clinical testing of new drugs. New York : Revere ,1965.

42. Zaimis, E. and Elis, J. : Evaluation of new drugs in man. Oxford : Pergamon,1965.

43. Whipple, H.E., Spectzer, M.I. and Burns, J.J. : Conference on evaluation and mechanism of drug toxicity. New York : New York Academy of Sciences, 1965.

44. Gold Stein, A. Op .Cit.,p.18.

45. Gleason, M.N., Gosselin, R.E., Hodge, H.C. and Smith, R.P. : Clinical toxicology of commercial products. Baltimore : William & Wilkins , 1974.

46. Spencer, E.Y. : Guide to chemicals used in crop protection. 5th Ed. Ottawa : The Queen's Printer,1968.

47. Smith, C.R.: Proceedings of a symposium on the use of drugs in animal feeds. Washington : National Academy of Sciences, 1969.

48. Albert, A. : Selective toxicity. New York : Wiley ,1960.

49. O'Brien, R.D. : Insecticides : Action and metabolism. New York : Academic Press ,1960.

50. Browning, E. : Toxicity of industrial metals. London : Butterworths ,1969.

51. Patty, F.A. : Industrial and hygiene toxicology. New York : Inerscience Publishers Inc.,1958.

52. Fairhall, L.T. Industrial toxicology. New York : Hafner Publishing Company, 1969.

53. Trainter, D.C. : A handbook of Industrial toxicology. Sydney : Angus and Robertson Ltd., 1966.

54. Irvings. K . : Dangerous properties of industrial materials. New York : Reinhold Publishing Corporation, 1966.

55. Paget, G.E. : Methods in toxicology. Oxford & Edinburgh : Blackwell Scientific Publications,1970.

56. Radeleff, R.O. : Veterinary toxicology. U.S.A. : Lea & Fabiger , 1972.

57. Weiss, B. and Laties, V.G. : Behavioural toxicology. New York : Plenum Press , 1972.

58. Grant, M.W. :Toxicology of eye. Springfield : Charles C. Thomas, 1977.

59. Deichman, W.B. and Gorarde, H.W. : Toxicology of drug chemicals. New York : Academic Press,1969.

60. Casarett, L.J. and Doull, J. : Toxicology : A basic science of poisons. New York : Macmillan Company, 1980.

61. Moeschlin, S. : Poisoning. diagnosis and treatment. New York : Grune & Stratton ,1965.

62. Brookes, V.J. : Poisons. New York : Robert E. Krieger Publishing Company ,1975.

63. National Library of Medicine, Fact Sheet : Medical Subject Headings (MeSH) Last updated 4th December 2002. Available : http://www.nlm.nih.gov/pubs/factsheets/mesh.html.

64. National Technical Information Service (NTIS), "Products > New Products > MeSH". Available : http://www.ntis.gov/products/mesh.asp.

65. National Library of Medicine, Medical Subject Headings : MeSH Browser.Available :http://www.nlm.nih.gov/mesh/MBrowser.html.

66. Katz, William. : Introduction to reference work. Vol.1. Basic information sources. 6th Ed. New York McGraw-Hill, Inc.,1988.p.136.

67. Lancaster, F. W. : Indexing and abstracting in theory and practice. 2nd Ed. London : Library Association,1988.p.95.

68. Meyler, L. : Side effects of drugs. Amsterdam : Excepta Medica Foundation,1988.

69. Blood, F.R. : Essays in toxicology. Vol. 1-2. New York : Academic Press, 1969.p.170.

70. Meyler, L. and Peck, M.M. : Drug induced diseases . Assen : Koninklijke Van Gorcum and Comp. N.V. , 1962.

71. Stolman, A. : Progress in chemical toxicology. Vol.I. New York : Academic Press,1963.

72. Boyland, E. and Goulding, R. : Modern trends in toxicology. London : Butterworths, 1968.

73. Mehlman, M.A. : Advances in modern toxicology. U.S.A. : Hemisphere Publishing Corporation, 1976.

74. Thomas, E. : Handbook of food additives. Cleveland : The Chemical Rubber Co.,1972.

75. Boyd, E.M. : Toxicity of pure foods. Cleveland : The Chemical Rubber Co.,1976.

76. President's Science Advisory Committee (1966). "Handling of Toxicological information". Reprinted in "Symposium on the Handling of Toxicological Information. Cosmides, C.J. Ed. Springfield : NTIS, 1978.pp.201-223.

77. Smyth, H.F.Jr. : Recognition of toxicology as a scientific discipline. Federation of American Societies for Experimental Biology, 19 : 1960.pp.43-49.

78. Coon, J.M. and Maynard, E.A. : Problems in toxicology. Federation of American Societies for Experimental Biology, 19 : 1960.pp.1-52.

79. Coon, J.M. : Opening remarks. Federation of American Society for Experimental Biology, 19 : 1960.

80. Carson, R. : Silent Spring. Baston : Houghton Mifflin, 1962.

81. President's Science Advisory Committee. Op.Cit.,p.212.

82. Ibid.,p.202.

83. Miles, W.D. : History of the National Library of Medicine : The nation's treasury of knowledge. Washington : U.S. government Printing Office, 1982.

84. Schultheisz, R.J. : TOXLINE : Evolution of an online interactive bibliographic database. Journal of the American Society for Information Science, 32 : 1981.pp.421-429.

85. Bawden, D. : Chemical toxicology searching. Database, 2 : 1979.pp.11-18.

86. Bac, R. : Comparitive study by the PDR of Toxicology Information retrieval from online literature databases. Online, 4 : 1980.pp.29-33.

87. King, J. : Searching International databases : A comparitive evaluation of their performance in Toxicology. British Library. Library and Information Research Report, 3 : 1983.

88. Schultheisz, R.J. Walker, D.F. and Kannan, K.L. Design and implementation of an online Chemical Dictionary (CHEMLINE). Journal of the American Society for Information Science, 29 : 1978.pp.173-179.

89. DIALOG Information Systems, 3251 Hannover St., Palo Atto, CA 94394.

90. SDC (System Development Corp), 2050 Colorado Ave, Santa Monica, CA 90406.

91. Farmer, N.A. and O'Hara, M.P. : CAS Online : A new source of substance information form Chemical Abstracts Service, Database, 3 : 1980. pp.10-24.

92. Bawden, D. and Brock, A.M. : Chemical Toxicology Searching : A collaborative evaluation comparing information resources and searching techniques. Journal of Information Science, 5 : 1982.pp.3-18.

93. Decker, W.J. and Kissman, H.M. : National Library of Medicine's Toxicology Data Bank : An information source potentially useful to the clinical toxicologist. Veterinary and Human Toxicology, 19: 1977.pp.90-92.

94. Registry of toxic effects of Chemical Substances, 1981 – 82. Washington : U.S. Government Printing Office, 1982.

95. Mc Gill, R. and Milne, G.W.A. : Computer-based Toxicology Search System. Journal of Environmental Pathology and Toxicology, 2 : 1978.pp.539-551.

96. Oil and Hazardous Materials Technical Assistance Data System (OHMTADS). Office of Solid Wastes and Emergency Response. Washington : DC 20460 U.S. Environmental Protection Agency.

97. Mc Claim, R.M. : Generating, interpreting and reporting information in toxicity studies. Drug Information Journal, 17 : 1983.pp.245-255.

98. Lawrence, L.R. and Herrick, S.S. : Information systems as utilized by the National Centre for Toxicological Research. Drug Information Journal, 11 : 1977.pp.104-108.

99. Mc Guire, E.J. et al. :Toxicology laboratory interactive computer-based data acquisition and information systems. Drug Informatin Journal, 15 : 1981.pp.181-188.

100. Berg, H. et al. : ALIS – Ein Versuchstier informations system. A. versuchswerk, 20 : 1978.pp.145-157.

101. Altman, P.L. and Fisher, K.D. : Guidelines for development of biological data banks. Federation of American Societies for Experimental Biology, 3 : 1981.pp.12-18.

102. Gerola, H. and Gomory, R.E. : Computers in Science and Technology : Early indications. Science, 225 : 1984.pp.11-18.

103. Turoff, M and Hiltz, S.R. : Electronic Journal : A progress report. Journal of the American Society for Information Science, 33 : 1982.pp.195-202.

104. Blattner, F.R. : Biological frontiers. Science, 222 : 1983.pp.719-720.

105. Committee on Science and Technology, U.S. House of Representatives, 98th Congress "Environmental Implications of Genetic Engineering". In "Hearing before Sub Committee on Investigations and Oversight", June 22, 1983. Washington : U.S. Government Printing Office, 1983. No.36.

106. Database Directory : 1984-85. New York : Knowledge Industry, 1985.pp.108-386.

107. Lewin, R. :National networks for molecular biologists. Science, 223 : 1984.pp.1379-1380.

108. Maugh, T.H. :Tracking exposure to toxic substance. Science, 226 : 1984.pp.1183-1184.

109. ALTA (Alternatives to Laboratory Animals). FRAME, 5B The Poultry, Bank Pl., Nottingham NGI 2JR, England.

110. U.S. Department of Labour "Hazard Communication". Federal Register, 48 : 1983.pp.53280-53348.

111. Shakespeare, W. : The Tempest. Act V. Scene – I, line 183.

CHAPTER - 4

METHODOLOGY AND DATA COLLECTION

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METHODOLOGY AND DATA COLLECTION

4.1 Methodology

The primary purpose of research is to discover principles that have universal application. Research, therefore, needs adequate and accurate data for this purpose. In order to obtain these data, a researcher conducts investigations into a given population. Information thus derived with sufficient accuracy from a sample of the total. Sampling refers to the investigation of a part of the whole population or universe. A sampling procedure is a technique of selecting a sample from a given population. Sample means a small population of a universe selected for study. While using secondary data for research studies, it is essential that these data are properly edited. As the data have been collected by different agencies, there are certain restrictions for using as such for analyses. Hence there exits a need to change the format of the data to suit our own requirements. Computerised packages can be used as tools for accurate analysis of data.

4.1.1 Choosing the sample

Sample for the study is selected by first searching various entries of articles and their citations abstracted in the online database on Toxicology, TOXLINE. As TOXLINE is updating on monthly basis, numerous entries are added to it. As this number was very high, the informetric analysis cannot be concentrated on all these data, the period of study was restricted to 1998 January to December 2003.

4.1.2 Sampling Technique

The method used is random sampling. The articles and their citations abstracted in TOXLINE during 1998 to 2003 was accessed through the Internet and downloaded to a CD-ROM. A total of 2247 articles and 9585 citations were collected. This data is used for informetric analysis.

To study about journals, a rank list of 59 journals is prepared based on their frequency of occurrence in the database. All these journals are having wide subject coverage with almost all areas in Toxicology and are international in scope. From the ranked list 9 core journals are selected for core journal study having 1218 articles and 3411 citations.

4.1.3 Variables for Analysis

The following variables are employed for making detailed analysis :

- Authorship pattern
- Subject dispersion
- Language and types of documents
- Core books
    - Ranking of books
    - Currency of book citations
    - Time lag of citing books
    - Subject dispersion in book citations
    - Core authors
    - Productivity of authors relating to Lotka's law.
- Core journals
    - Decade-wise distribution of journals.

  - Subject wise scatter of journals.
  - Fit of rank distribution (Bradford Distribution)
  - Country-wise scatter of journals
  - Age of journals most cited
- Growth study
  - Rate of citation per article
  - Citing and non-citing articles in different journals
  - Growth of citing and non-citing articles
- Bibliographic coupling
  - Year-wise analysis of bibliographic coupling
  - Strength of bibliographic coupling
- Self-citation
  - Year-wise trend
  - Types of documents
  - Repetitiveness of self-citation
  - Age of self-citation
  - Recency of self-citation with five major categories of authors.
  - Self-citation habit of Indian & foreign authors
  - Categories of self-citation
  - Self-citing articles in different journals

4.2 Data Collection

Several on-line databases on specialised areas of Toxicology are available such as EMIC (Environmental Mutagen Information Center) & ETIC (Environmental Teratology Information Center), CANCERLIT

(CANCER - Related Literature), AGRICOLA (Agricultural On-Line Access), NIOSHTIC (National Institute for Occupational Safety and Health) etc. Among these TOXLINE deals with general topics on Toxicology. TOXLINE is an international, authoritative online database covering almost all the major aspects of toxicology. TOXLINE is provided by National Library of Medicine, (NLM), Washington, can be occurred through Internet at free of cost. Hence the data required for this study was collected from TOXLINE.

4.2.1 TOXLINE (Toxicology Information online)

TOXLINE is the National Library of Medicine's extensive collection of on-line interactive bibliographic database of Toxicology information since 1972 [1]. TOXLINE is covering the biochemical, pharmacological, physiological, toxicological and environmental effects of drugs and other chemicals [2] TOXILINE contains more than 3 million bibliographic citations, almost all with abstracts and/or indexing terms and CAs Registry Numbers. TOXLINE is a merged database composed of subsets from 13 different sources. Files from 11 secondary sources comprise the TOXLINE database. The sources supplied bibliographic records in different formats and data structures. Data from each supplier's format had to be converted into a format suitable for TOXILINE. Most of the citations in TOXLINE refer to journal articles; other publications types include meeting reports, monographs, patents, research projects reports, technical reports and theses. TOXLINE references are drawn from various sources grouped into two major parts - TOXLINE core and TOXLINE special - both of which operate under versatile search engines offering a variety of search and display capabilities [3].

4.2.1.1 TOXLINE Core

TOXLINE Core covers much of the standard journal literature in Toxicology. TOXLINE Core is a separately searchable subset of the much larger MEDLINE database of biomedical literature and is accessible through the PubMed system by selecting 'Toxicology' as a subset limit.

TOXLINE Core takes advantage of Pub Med's powerful search and retrieval engine to offer features such as MeSH term Selection, document delivery, saving search queries via Cubby, and linking out. A search link to TOXLINE Core is also available from the TOXLINE interface on TOXNET, as described under TOXLINE special below.

4.2.1.2 TOXLINE Special

As the name implies, TOXLINE Special is a component of TOXLINE, available on the TOXNET system at http://toxnet.nlm.nih.gov./. TOXLINE Special complements TOXLINE Core with references from an assortment of specialized journals and other sources. TOXNET allows to facilitate the search query between TOXLINE Special and TOXLINE Core. An array of special features on TOXNET such as relevancy ranking, flexible sorting and downloading options adds to TOXLINE Special's search effectiveness. The constituent component of TOXLINE Special are listed below :

- Special journal and other research literature :
  - (a) Development and Reproductive Toxicology (DART)
  - (b) International Labour Office (CIS)
  - (c) Swedish National Chemicals Inspectorate (RISKLINE)
- Technical Reports and Research Projects
  - (a) Federal Research in Progress (FEDRIP)
  - (b) Toxic Substances Control Act Test Submissions (TSCATS)
  - (c) Toxicology Document and Data Depository (NTIS)
  - (d) Toxicology Research Projects (CRISP)
- Archival Collection

(a) Aneuploidy (ANEUPL)

(b) Environmental Mutagen Information Center File (EMIC)

(c) Environmental Teratology Information Center File (ETIC)

(d) Epidemology Information System (EPIDEM)

(e) Hazardous Materials Technical Center (HMTC)

(f) International Pharmaceutical Abstracts (IPA)

(g) National Institute for Occupational Safety & Health (NIOSH)

(h) Pesticides Abstracts (PESTAB)

(i) Poisonous Plants Bibliogrpahy (PPBIB)

(j) Toxicological Aspects of Environmental Health (BIOSIS)

4.2.2 Accessibility

Previously, TOXLINE had been accessible in its entirety via the Elhill and TOXNET SYSTEMS. With the implementation of TOXLINE's current configuration, the file became segmented into TOXLINE come and TOXLINE special. TOXLINE core now essentially replaces TOXLINE'S former TOXBIB sub-file. TOXLINE'S BIOSIS and IPA have become static components and are no longer being updated [4], [5].

More information about TOXLINE can be had at

Specialized Information Services

National Library of Medicine

8600, Rockville Pike

Bethesda, MD 20894

Telephone (301) 496-1131

FAX (301) 480 - 3537

Email tehip@teh.nlm.nih.gov.

URL http : //sis.nlm.nih.gov/

4.2.3 Retrieval of Information

Three different successive retrieval systems were used for the TOXLINE database which required reformatting of the data. Algorithms for generating terms for inverted file search methods were tested. Special characters peculiar to the scientific literature were evaluated during search term generation. Developing search term algorithms for chemical names in the scientific literature required techniques different form those used for non-scientific literature. Problems with replication of bibliographic records form multiple secondary sources are described.

4.3 Computer programmes used

Although the collected data is in a standard format, the statistical analysis through SPSS is impossible. So the data is first converted to CDS/ISIS format and then analysed using SPSS. The data include a total of 2247 articles and 9585 citations. The major programmes used are:

4.3.1 CDS/1SIS

CDS/ISIS is an application software developed by the Computer Division of UNESCO in 1985 for the PC environment using MS-DOS. CDS/ISIS is a powerful software for database creation and information retrieval. The present version being 3.07 can be used in a networked environment. The software is distributed free by UNESCO for non-profit organisations in developing countries. In India, NISSAT, Department of Scientific and Industrial Research, New Delhi is the nodal centre for distribution.

➢ Capabilities

CDS/ISIS allows

- define databases containing the required data elements.
- enter new records into a given database.
- modify, correct or delete existing records.
- automatically build and maintain first access files to each database.
- retrieve records by their contents, through a sophisticated search language.
- sort the record in any sequence required.
- display the records or portions thereof according to out requirements.
- print partial or full catalogues, and/or indexes from any given database.

➢ File structure

CDS/ISIS has got two major files:

- Master file

  Master file contains all the records of a given database, each record consisting of a set of variable length fields. Individual records are identified by a unique number automatically assigned by CDS/ISIS and SUPERDOC.

- Inverted file

  Inverted file provides additional ways of accessing the Master file. Contains all terms which may be used as access points during the retrieval for a given database as well as the list of corresponding postings. The inverted file is essentially an index to the contents of the Master file.

4.3.2 SPSS (Statistical Package for Social Sciences)

SPSS is designed especially for the analysis of Social Sciences data. SPSS is a package of programmes covering a wide range of analysis. These programmes include frequency distribution, univariate and multivariate analysis variance, regression analysis, correlation analysis, factor analysis, cluster analysis, reliability analysis, long linear models etc. The sub commands direct precisely what analysis had to be performed. The GROUPS sub-command specifies which groups are to be discriminated between and the VARIABLES. Sub command specifies which variables are to be in operation .

The mainframe, PC and windows versions of SPSS are available. Internet, Discussion Group for SPSS Users has been formed to share and interact each other's experiences. The special characteristics of SPSS package in data analysis are:

- SPSS package has the provision to generate the summary of statistics including mean, median, mode, standard error, standard deviation, variance, range, skewness, kurtosis, minimum and maximum;
- SPSS package allows univariate distributions as well as bivariate distributions. The association between two variables can be done by bivariate analysis. The three major functions of multivariate analysis i.e. regression and multiple regression are also achieved through equations and subprograms. The bivariate tables and statistics for nominal and ordinal measures can be done with CROSSTABS procedure. The CORERELATIONS subprogram provides interval measure;

- From the data analysis any type of graphic representation can be derived from the graphic portion of the package. The Windows version provides a wider range of choices in graphic modules. The information on the sub programmes and their uses are provided by SPSS User's Guide. SPSS Windows Ver.6 is a well integrated Windows program that adheres to many typical windows conventions and commands. The typical windows commands File, Edit, Help, New, Open, Save, Exit, etc. are used in the package.

4.3.3 Standard Format

The basic format of data retrieved form TOXLINE is shown below. The articles and the citations are the basic unit of study. Articles include original research papers, short communications, pre-prints, review articles, technical notes etc. For each article and citation the following data elements were entered in the computer.

1. Name of the author/s
2. Title of the article
3. Source (Name of the journal)
4. Volume and Page Number
5. Publication Year
6. Title Abbreviation
7. Key words
8. Publication type
9. Total number of citations

A sample entry downloaded form the computer is given below.

1.	Name of the author/s	Lee PA; Freeman S

2.	Title of the article	Allergic contact dermatitis due to para- teritiary - butylcatechol in a resin operator.
3.	Source	Australas Journal of Dermatology
4.	Volume and Page No.	Vol. 40 & P 49 - 50
5.	Publication Year	1999
6.	Title abbreviation	Aus J Dermato
7.	Key words	Dermatitis, Occupational - Diagnosis, Allergic Contact, Synthetic - Adverse Effects.
8.	Publication type	Journal Article
9.	Total number of citations	12

A total of 9585 entries were prepared. Majority of the articles and citations were in English language. Articles in foreign languages having their abstracts and titles in English were also found. Such articles were also taken for study.

4.4 Organization of Data

The data of citations was sorted to get author index, keyword index and cumulated total citations. From the authors, individual, double, and more than two authors articles citations are counted for studying author collaboration (Table 5.1.1.2, 5.1.1.3, 5.1.1.4, 5.1.1.5, 5.1.1.6, 5.1.1.7.). Keyword is used for preparing subject wise scatter of citations (Table 5.2.3). Language-wise and publication type index is used for the study of language and type of document cited (Table 5.3.2, 5.3.3,5.3.4). The correlation and correlation coefficient of book and journal citations was done (Table 5.3.5).

The total number of book citation studied is 1174. The data collected was sorted by the name of the book, author, year and number of occurrence of these elements in the data. The study was focussed on ranking of books, core books (Table 5.4.2), currency of book citations (Table 5.4.3), subject dispersion in book citations (Table 5.4.5). From the author index, number of authors in each rank, ranking of authors (Table 5.5.2, 5.5.3), the productivity of authors is done using Chi-square test in relation to Lotka's law and K - S statistical test (Table 5.5.4, 5.5.5.), author contribution vs number of authors, values of observed and expected number of authors (Table 5.5.6,5.5.7) are presented.

The total number of journal citation studied is 6922. The data collected was sorted by the name of the journal, author and year which gave the number of occurrence of these elements in the data. This study is more concentrated on number of authors, number of journals, subject scatter, age of citation, self-citation, bibliographic coupling etc.

On the basis of citations received, a rank list and rank distribution of 59 most cited journals is prepared (Table 5.6.2,5.6.3). Using this index Bradford's theory of distribution was tested with the core journal data (Table 5.6.4). An alphabetical list of most cited journals was prepared (Table 5.6.5) with year of publication, country of publication and periodicity 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 5.6.6), decade-wise distribution of journals (Table 5.6.7), subject-wise scatter of most cited journals (Table 5.6.8), distribution of citation by subject of most cited journals (Table 5.6.9) were prepared. Graphs were plotted from these data showing Bradford distribution (Fig. 5.6.1, 5.6.2, 5.6.3). The country wise distribution of most cited journals, age of journals (Table. 5.6.13, 5.6.14) were also presented. Taking the first 9 journals from the core journal rank list, the growth of Toxicology literature and citations was analysed. The above 9 journals have a total of 1218 articles and 3411 citations. By using the above data, rate of citation per article (Table 5.7.2), percentage of contribution of citation in different journals (Table 5.7.3), rate of citation per article during different years (Table 5.7.4), citing and non-citing articles in different journals (Table 5.7.5), growth of citing and non-citing articles (Table 5.7.6.) were compiled. Bar diagram was prepared from the data showing citations per article of individual journals (Fig.5.7.1). Graphs were plotted from these data showing citation per article (Fig.5.7.2) and comparison of citing and non-citing articles (Fig.5.7.3) . Relative growth rate and doubling time for citations and publications (Table 5.7.7,5.7.9) were compiled. Graphs were prepared to study the growth pattern (Fig 5.7.4,5.7.5,5.7.6, 5.7.7).

To study bibliographic coupling, the above 9 core journals are taken. From the above data, bibliographic coupling in Toxicology journals (Table 5.8.2), bibliographic coupling during different years (Table 5.8.3) and strength of bibliographic coupling (Table 5.8.4) were prepared.

To study self-citation, the 9 core journals are taken. The self-citation in different journals (Table 5.9.1), year wise trend of self-citation (Table 5.9.2), types of documents self-cited (Table 5.9.3), repetitiveness of self-citations (Table 5.9.4), age difference of self-citations (Table 5.9.5), recency of self-citation within five major categories of authors (Table 5.9.6), self-citation habit of Indian and foreign authors (Table 5.9.7), rate of self-citations in different categories of self-citing articles (Table 5.9.8), categories of self-citations (Table 5.9.9), self-citation habits of single and two authored categories in different journals (Table 5.9.10), self citation habits of three and more than three authored categories in different journals (Table 5.9.11), year-wise distribution of categories of self-citations (Table 5.9.12), sequence of cited authors and self-citations (Table 5.9.13), self-citing articles in different journals (Table 5.9.14) and year-wise self-citing articles (Table 5.9.15) were compiled. Graphs were plotted showing different aspects of self-citation (Fig 5.9.1, 5.9.2, 5.9.3, 5.9.5). Bar diagram were drawn to show the percentage of self-citing articles in different journals (Fig.5.9.4).

The data required for the study was collected and organized by using the above methods. Through the analysis of the collected data, 55 tables and 25 graphs were prepared. This formed the basis for informetric analysis to test the hypothesis and objectives and formulate major findings and conclusions.

References

1. Schultheisz, R.J. : TOXLINE. : Evolution of an online interactive bibliographic database. Journal of the American Society for Information Science, 32 (6) :1981.pp.421-429.

2. Mcttale, C.G., Hawk, S.A. and Wagestaff, D.T. : TOXLINE : An information resource. Veterinary Human Toxicology, 28 (3) : 1986. pp.237-239.

3. http://www.medscape.com/textsearch. form. figi accessed on 27.2.2001/TOXLINE fact sheet.

4. http : //sis.nlm.nih.gov/whatsnew.cfm accessed on 2.8.2002.

5. http : //www.nlm.nih.gov/pubs/techbull/jfo1/jfo1 - Toxline.html.

CHAPTER - 5

ANALYSIS OF DATA

CHAPTER - 5

ANALYSIS OF DATA

5 Introduction

The variables identified for the analysis are examined in detail for the formulation of the findings correlating to the objectives of present study. The analysis is supported and supplemented by graphs, tables, charts, whenever possible. The fundamental laws laying the foundation for informetrics were studied in depth with data collected.

5.1 Authorship pattern

The literature on any subject reflects not only basic publishing pattern but also the characteristics of the authors themselves. Authorship pattern mainly deals with kind of authors, nature and degree of collaboration among them and impact of citation rate on collaborative trend of authors. The different kinds of authors appeared in publications are grouped as personal author, corporate body and anonymous publications. An author may publish his work independently or may participate with one or more number of authors to bring out a publication. In authorship study collaboration is the keen area, which indicates how authors work together to bring out a paper. With the advancement of Science and Technology, now-a-days maximum research works are being carried out on collaborative basis. The extent of collaboration depends on the number of participants involved in the work. Authorship study can also used to find out the names of organisation and the names of the country and state of the citing authors. From this the productivity of individual authors as regards to their country and organizations can be determined.

5.1.1 Techniques of authorship studies

The authors of publications are the focal points in authorship studies. The name and address of authors contributing the articles are collected from TOXLINE database. After the collection of data, they are to be grouped as per kinds of authors. The data may further be sub-grouped as single author, two author cases, three author cases and more than three author cases. A grouping was also made on the basis of their country of origin and organization where they are working i.e. author affiliation. The different facets of authorship studies are categories of authors, collaborative researches carried out by them, citation rate of different categories of authors, determination of values of group coefficient, rate of citation of authors of different country, the rate of productivity of authors, determination of core authors and the rank of authors as regards to their productivity.

5.1.1.1 Author collaboration

Subramanyam proposed a mathematical formula for calculating author's degree of collaboration in a discipline. i.e. the degree of collaboration among authors is the ratio of the number of collaborative publications to the total number of publications published in a discipline during certain period of time. The values of degree of collaboration can be calculated both for publications and citations. The formula can be mathematically expressed as

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

where g = Group coefficient of a discipline

N_m = Number of multiple authors during a specific period in a discipline.

N_s = Number of single - authored work in a discipline during a given period of time.

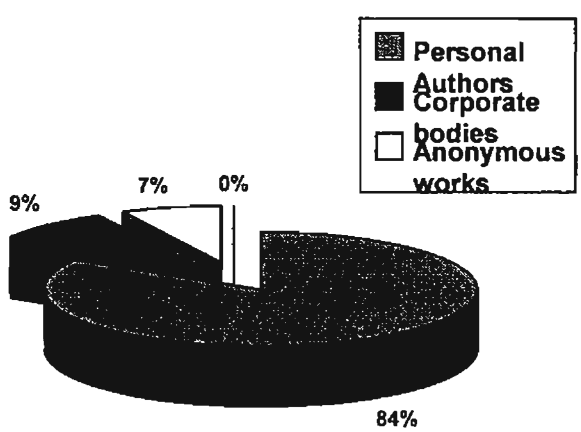
The 'g' for the publications may be represented as 'g_p' and the 'g' for the citations may be written as 'g_c'. When the value of 'g' increases it means that the level of collaboration is increasing and vis-versa.

The following paragraphs present the categories of authors, type and extent of collaborative trend of research available among the authors of articles indexed in TOXLINE during 1998 to 2003. The citations provided in these journals were also analysed to study authorship pattern.

5.1.1.2 Categories of authors and collaborative research

Out of the total 9585 citations, 83.59% were the personal authors of all categories and 8.92% of citations were the publications by corporate bodies. The rest 7.49% of came under the category of anonymous works. The personal author works were mostly referred in Toxicology journals during 1998 to 2003. (Fig.5.1.2).

Fig. 5.1.2 : Categories of author in citations



Among the 2247 citing articles of Toxicology journals published during 1998 to 2003, 27.04% were written by single authors, 72.98% belonged to co-authors and the rest 12 articles were not having the name of any authors. The extent of collaboration was much in the field of Toxicology. The value of group coefficient (g_p) was 0.72 is presented in the Table 5.1.1.2.

Table 5.1.1.2 : Value of group co-effective for collaborative authors of publications.

Number of authors article	Number of publications	Percentage from total publication	Value of $g_p = \frac{Nm}{Ns + Nm}$
Number of personal author publications	2235		
Number of single author publications	604 (Ns)	27.04	
Number of co-author publications	1631 (Nm)	72.98	0.72
Two authors publications	271	12.13	0.31
Three authors publications	531	23.75	0.47
More than three authors publications	829	37.09	0.58

The degree of collaboration among co-authors was maximum (0.58) in articles written by more than three persons and minimum (0.31) in two- author publications.

5.1.1.4 Collaborative trend and multiple authorship citation pattern

The number of personal authors with the value of 'g_c' for the co-authored citations are presented in the Table 5.1.1.4.

Table 5.1.1.4 : Year- wise distribution of single vs multiple authors citation pattern and the degree of collaboration

Year	Single authore dcitatio ns (%)	Two authored citations (%)	Value of 'g_c'	Three authore d citations (%)	Value of 'g_c'	More than three authore d citation (%)	Valu e of 'g_c'	Total
1998	203 (10.08)	118 (7.76)	0.36	104 (16.28)	0.34	379 (13.42)	0.65	804
1999	245 (12.18)	142 (9.34)	0.37	192 (11.60)	0.44	213 (7.54)	0.47	792
2000	312 (15.51)	110 (7.24)	0.26	221 (13.35)	0.41	415 (14.69)	0.57	1058
2001	359 (17.84)	373 (24.54)	0.51	317 (19.15)	0.47	470 (16.64)	0.56	1519
2002	402 (19.98)	365 (20.01)	0.48	388 (23.44)	0.49	638 (22.58)	0.61	1793
2003	491 (27.40)	412 (27.11)	0.45	433 (26.16)	0.48	710 (25.13)	0.59	2046
								8012

The single authored citations show a tremendous increase in their number during the year 1998 to 2003. In the year 1998, the number of single authored citations was only 203 (10.08%), in the next year the number was increased to 245 (12.18%). In 2000, the single authored citation was 312 (15.51%) and in the next year the number was increased to 359 (17.84%). In the next two years the number was increased from 402 (19.98%) to 491 (27.40%).

In the case of two authored citations also an increase in the number of citations was observed except in the year 2000. The number of citations was maximum in the year 2003 i.e. 412 (27.11%) and minimum during the year 2000 i.e. 110 (7.24%). The value of 'g_c' was a minimum of 0.26 in the year 2000 and a maximum of 0.51 in the year 2001.

The three authored citations show a uniform increase in the number of citations . In 1998, the number of three authored citations was 104 (16.28%) followed by 192 (11.60%) citations during the year 1999. In 2000, the number of three authored citations was 221 (13.35%) followed by 317 (19.15%) in the year 2001 and 388 (23.44%) in the year 2002 and a maximum number of 433 (26.16%) during the year 2003. The value of 'g_c' shows an increase from 0.44 to a maximum of 0.49. From the analysis it is clear that when the value of 'g_c' increases the level of collaboration is increasing and vice-versa.

In the case of more than three authored citations show a high degree of collaboration of authors. In 1998, the number of more than three authored citations was 379 (13.42%) and in the next year it showed or slight decrease in the number i.e. 213 (7.54%). In 2000, the number of citations was increased to 415 (14.69%) and 470 (16.64%) in the next year i.e. 2001. The maximum number of more than three authored citations was given in the year 2003 i.e. 710 (25.13%) and 638 (22.58) in the year 2002. The value of 'g_c' varies from 0.65 to 0.59 randomly. This value is maximum in the year 1998 (0.65) and minimum in the year 1999 (0.47).

5.1.1.5 Rate of citation of single and collaborated authors

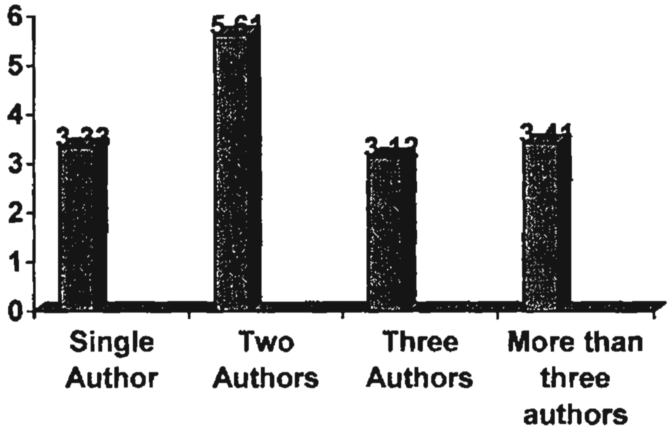
The rate of citations of single authors and collaborated authors is presented in the Table 5.1.1.5

Table 5.1.1.5 : Rate of citation of single and collaborated authors

Categories of authors	Number of articles	Number of citations	Rate of citation per article (C/A)
Single author	604	2012	3.33
Two authors	271	1520	5.61
Three authors	531	1655	3.12
More than three authors	829	2825	3.41

Of the different categories of authors, two authored articles had maximum citation rate (5.61) than any other category. Among the collaborated authors also the two authored articles had got maximum citation rate (5.61) and three authored articles had got minimum citation rate (3.12). The articles having more than three authors had got a citation rate of 3.4.1 From the Fig.5.1.3 it is clear that as the number of persons increases in a work, the rate of C/A decreases i.e. the joint authors will have a lesser number of citation rate.

Fig. 5.1.3 : Rate of citation of single and collaborated authors.



5.1.1.6 Application of Lotka's Law

The 5628 authors have contributed one paper, 1407 authors have two, 625 authors have three and 352 authors have four papers respectively for each to their credit. According to Lotka's law.

$$F\,(y^n) = \frac{A}{y^n} \quad =\alpha$$

Where F (y^n) stands for the authors productivity, 'y' number of papers 'A' and 'α' are constants, considering the equation i.e. $F\,(y^n) = \frac{A}{y^n}$

Table 5.1.1.6: Author contribution Vs Number of authors

Number of papers	Number of authors	%	Authorship	%
1	5628	70.24	5628	48
2	1407	17.56	2814	24
3	625	7.8	1875	16
4	352	4.4	1408	12
Total	8012	100	11725	100

$F(y^1) = 5628$

$y = 1$

$5628 = \frac{A}{1}$

$A = 5628 \times 1 = 5628$

When $y = 2$

$F(y^2) = \frac{5628}{2^2} = \frac{5628}{4} = 1407$

$y = 3$

$F(y^2) = \frac{5628}{3^2} = \frac{5628}{9} = 625$

$y = 4$

$F(y^4) = \frac{5628}{4^2} = \frac{5628}{16} = 352$

Table 5.1.1.7: Values of observed and expected numbers of authors

No. of papers	No. of authors (Observed)	No. of authors (expected)
1	5628	5628
2	1407	2814
3	625	1875
4	352	1408
Total	8012	11725

From the above table it is clear that the expected values are not close to observed values up to number of papers. Hence Lotka's Law does not fit for the study.

5.2 Subject Dispersion

Citation analysis is one of the most reliable tool through which the scattering of a subject can be revealed easily. The authors refer to publications not only to their own subject but also to other subjects which are closely related to it. Hence the citation analysis shows the scattering of the basic subject Toxicology to its related subjects.

5.2.1 Technique of subject dispersion study

To find out subject dispersion of Toxicology , the citations appended to the journal articles are analysed. Each of these citations is provided with important key words available in MeSH. The result of this classification gives the dispersion of Toxicology literature.

5.2.1.1 Subject dispersion in citations

A total of 9585 citations were grouped under 20 major subject headings. The citations which were not come under the preview of Toxicology and those in foreign languages not translated into English were grouped under the heading 'other category'.

Out of 9585 citations, 99.8 percent belonged to the subject and its related fields and the rest 0.2 percent belong to other subject but indirectly related to Toxicology The analysis brings out that in Toxicology documents belonging to other subjects were also referred to some extent.

Table 5.2.3: Dispersion of subjects in citations

Sl. No.	Subject	Number of references	Cumulative number of references	Percentage	Cumulative percentage
1.	Toxicology(General)	2103	2103	21.94	21.94
2.	Environmental Science	1507	3610	15.72	37.66
3.	Medicine	941	4551	9.82	47.48
4.	Drug Medicine	729	5288	7.61	55.09
5.	Analytical Chemistry	643	5923	6.71	61.8
6.	Applied Chemistry	598	6521	6.24	68.04
7.	Human Ecology	471	6992	4.91	72.95
8.	Fresh water Ecology	419	7411	4.37	77.32
9.	Pharmacology	340	7751	3.55	80.87
10.	Biology (General)	287	8038	2.99	83.86
11.	Pathology	250	8288	2.61	86.47
12.	Food Toxicology	201	8489	2.09	88.56
13.	Human Anatomy	198	8687	2.07	90.63
14.	Biochemistry	184	8871	1.92	92.55
15.	Zoology	181	9052	1.89	94.44
16.	Science (General)	160	9212	1.67	96.11
17.	Genetics	147	9359	1.53	97.64
18.	Biotechnology	98	9457	1.02	98.66
19.	Agriculture	86	9543	0.9	99.56
20.	Marine sciences	23	9566	0.24	99.8
21.	Other category	19	9585	0.2	100
	Grand Total		9585		100

Out of the 20 subject divisions, maximum citations were from Toxicology in general (21.94%) and the next position was occupied by Environmental Sciences (15.72%). Minimum citations were reported from the area of Marine Sciences (0.24%). The third position was occupied by Medicine (9.82%) followed by Drug Medicine (7.61%), Analytical Chemistry (6.71%), Applied Chemistry (6.24%), Human Ecology (4.91%), Freshwater Ecology (4.37%), Pharmacology (3.55%), Biology (2.99%), Pathology (2.61%), Food Toxicology (2.09%), Human Anatomy (2.07%), Biochemistry (1.92%), Zoology (1.89%), Science (1.67%), Genetics (1.53%), Biotechnology (1.02%), Agriculture (0.9%). The dispersion of subjects based on citations are provided in the Table 5.2.3.

5.3 Language and types of document cited

For writing articles authors in every field of literature cite different types of documents. Many factors like the subject matter, year of publication, country of origin, language, mode of work and its availability for selection of a document for citation, availability of the document occupies an important position. In the field of Social Sciences, more books are cited than journals but in Science & Technology, journals are cited in larger number than books.

5.3.1. Techniques of Language and types of documents used study

The citations are the chief source for analysis of language and types of documents used in the Toxicology literature. Each citation are analysed for the type of language they are used. Then the citations are grouped into different categories of documents such as periodicals, books, manuscripts, dissertations etc. Statistical techniques such as correlation coefficient and regression analysis are used for the analysis.

5.3.1.1. Language and types of documents used in Toxicology literature

The language and types of documents used by the toxicologists are analysed using the articles indexed in TOXLINE during the above years. The citations represent the language and types of documents used by the toxicologists.

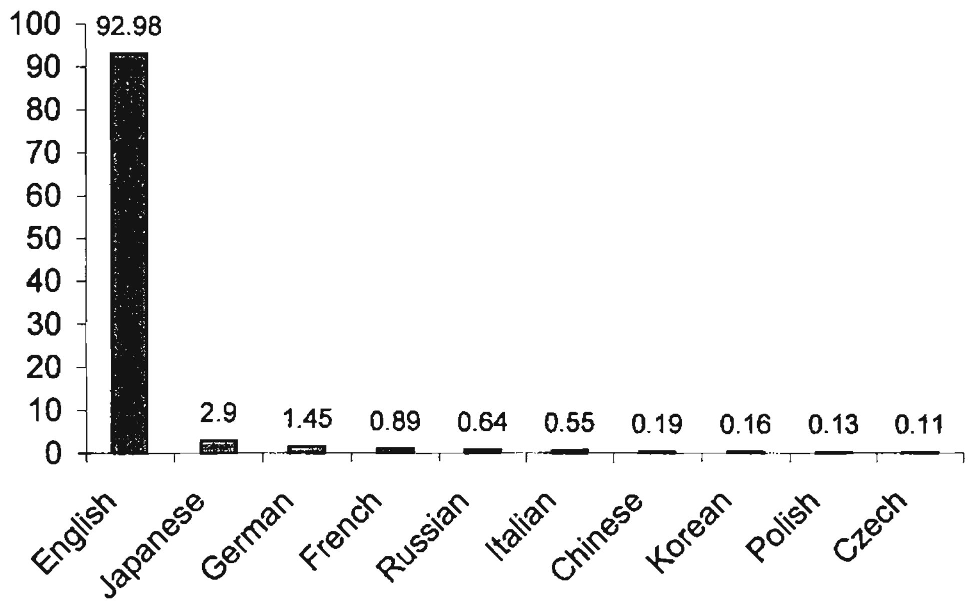
5.3.2. Languages of cited documents

As the Table 5.3.2. shows that out of a total 9595 citations, 8912 of them were in English language forming 92.98% of the total, while all the other languages account to 7.02%. The second place was occupied by Japanese language with 278 (2.90%) citations. The third rank goes to German with 139 i.e. 1.45% of the total. This is followed by French, Russian, Italian, Chinese, Korean, Polish and Czech with 86 (0.89%), 61 (0.64%), 53 (0.55%), 18 (0.19%), 15 (0.16%), 12 (0.13%) and 11 (0.11%) respectively.

Table 5.3.2: Language of cited documents of Toxicology Journals

Sl. No.	Languages	Rank	Total No. of citations	Percentage from total citations	Cumulative percentage
1.	English	I	8912	92.98	92.98
2.	Japanese	II	278	2.90	95.88
3.	German	III	139	1.45	97.33
4.	French	IV	86	0.89	98.22
5.	Russian	V	61	0.64	98.86
6.	Italian	VI	53	0.55	99.41
7.	Chinese	VII	18	0.19	99.6
8.	Korean	VIII	15	0.16	99.76
9.	Polish	IX	12	0.13	99.89
10.	Czech	X	11	0.11	100
	Total		9585	100	

Fig. 5.3.2: Language of cited documents of Toxicology journals



Based on the analysis, it is evident that English language occupied 1st rank with around 92.98% of the total and is the dominant language.

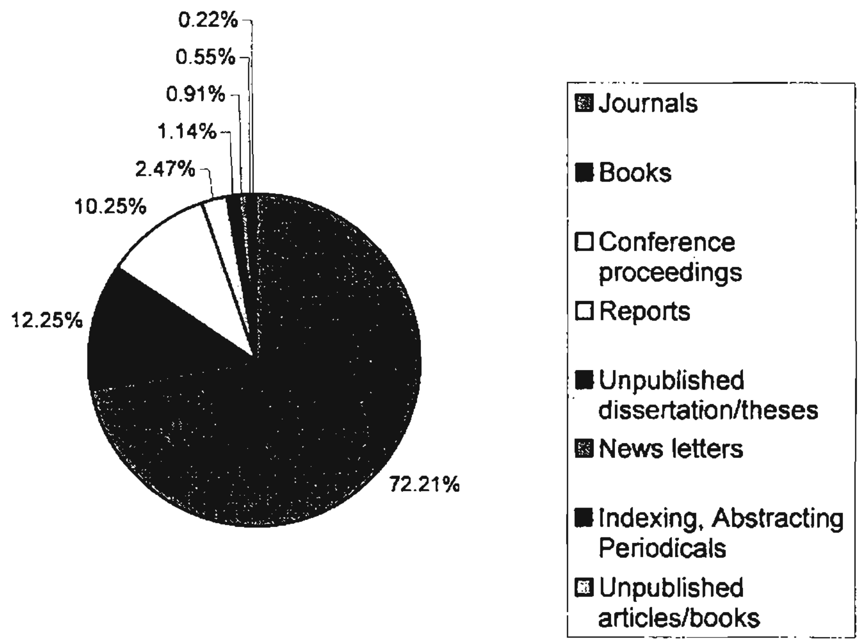
5.3.3 Types of documents cited

The distribution of document type of items is displayed in the Table 5.3.3. As expected, the most common are journal articles which contribute about 72.22% of the total literature in Toxicology. Books, the second most frequent type account for about 12.25%. Conference Proceedings contribute about 10.25%, Reports make up 2.47%, Unpublished dissertations and theses make up 1.14%, Newsletters for 0.91%, Indexing and abstracting periodicals for 0.55% and Unpublished articles and books for 0.22%.

Table 5.3.3 : Distribution of document types

Types of Document	Total number of citations	Percentage from total citations	Cumulative citations
Journals	6922	72.22	72.22
Books	1174	12.25	84.47
Conference proceedings	982	10.25	94.72
Reports	237	2.47	97.19
Unpublished dissertation/theses	109	1.14	98.33
News letters	87	0.91	99.24
Indexing, Abstracting Periodicals	53	0.55	99.79
Unpublished articles/books	21	0.22	100.01

Fig. 5.3.3: Percentage of journal, book, conference proceedings citations



5.3.4 Year-wise trend of types of cited documents

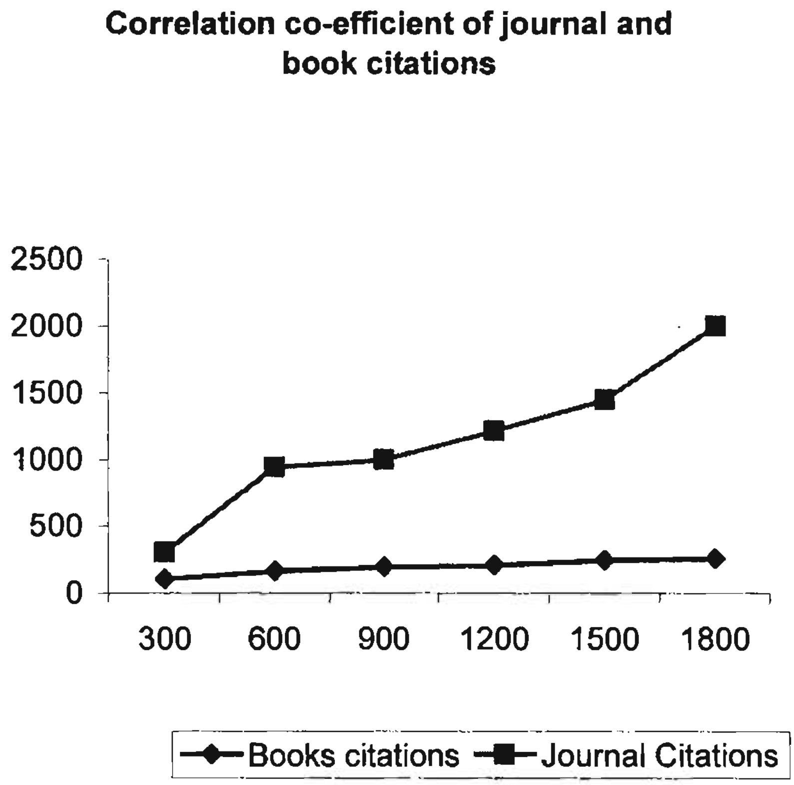
From 1998 to 2003, the year - wise trend of type of documents cited showed that the percentage of journal and books citations were much more than any other type of documents. The details of percentage of type of document cited are provided in the Table 5.3.4. The percentage of all type of citations had been increased in number since 1998. The minimum percentage of journal citation (62.94%) had shown in the year 1998 followed by a steep increase (75.72%), i.e. maximum in the year 1999. In the next year 2000, the % of journal citation was reduced (73.35%) followed by a slight decrease (72.41%) in the year 2001.

Table 5.3.4: Types of documents cited during 1998 to 2003

Year	Journ-als	Books	Confer-ence Procee-dings	Repo-rts	Unpublished dissertations/ theses	News letters	Index-ing & abstracting periodicals	Un publish-ed Articles/ Books
1998	304 (62.94)	104 (21.53)	48 (9.94)	12 (2.5)	6 (1.24)	5 (1.04)	4 (0.83)	-- --
1999	945 (75.72)	165 (13.22)	98 (7.9)	16 (1.3)	10 (0.8)	7 (0.6)	5 (0.4)	2 (0.2)
2000	1002 (73.35)	196 (14.35)	112 (8.2)	27 (1.98)	11 (0.81)	8 (0.59)	7 (0.51)	3 (0.22)
2001	1218 (72.41)	208 (12.36)	182 (10.82)	34 (2.02)	14 (0.83)	12 (0.71)	10 (0.59)	4 (0.23)
2002	1452 (71.17)	245 (12.01)	230 (11.27)	52 (2.54)	23 (1.12)	21 (1.02)	12 (0.58)	5 (0.24)
2003	2001 (72.34)	256 (9.25)	312 (11.27)	96 (3.47)	45 (1.62)	34 (1.22)	15 (0.54)	7 (0.25)

In the year 2002, the % of journal citation was again reduced (71.17%). But in the year 2003, the percentage of journal citation showed a slight increase (72.34%). The percentage of book citation was maximum (21.53%) during the year 2003. The year 1999 showed a decrease in book citation (13.22%) followed by an increase (14.35%) during the year 2000. The next year 2001 showed a decrease (12.36%) in book citation and the year 2002 had a book citation rate of 12.01%.

Fig. 5.3.4 : Trend of journal & book citations



5.3.5 Correlation of journal and conference proceedings citations

The citations from conference proceedings after 1998 showed a steady increase. During 1998 the % of conference proceedings citation was 9.94 followed by a decrease (7.9%) in the year 2000 and in the next year 2001 also showed an increase (10.82%) in the percentage of conference proceedings citations. In the years 2002 and 2003 showed the maximum and same (11.27%) % of conference proceedings citations. From the analysis it is interesting to note that during the year 2003, conference proceedings came in the second position after journals. Thus the communication channel through conference proceedings is occupying a prominent place in the field of Toxicology. In the case of reports, unpublished dissertations/theses, newsletters, indexing and abstracting periodicals and unpublished articles/books also the citation showed a regular increase from 1999 onwards and reached maximum in the year 2003. This analysis is a clear out evidence that the 21st century researchers and scientists are giving preference to journals and other documents listed in the Table 5.3.4 than the traditional books.

Fig. 5.3.5 : Correlation co-efficient of journal and book citations

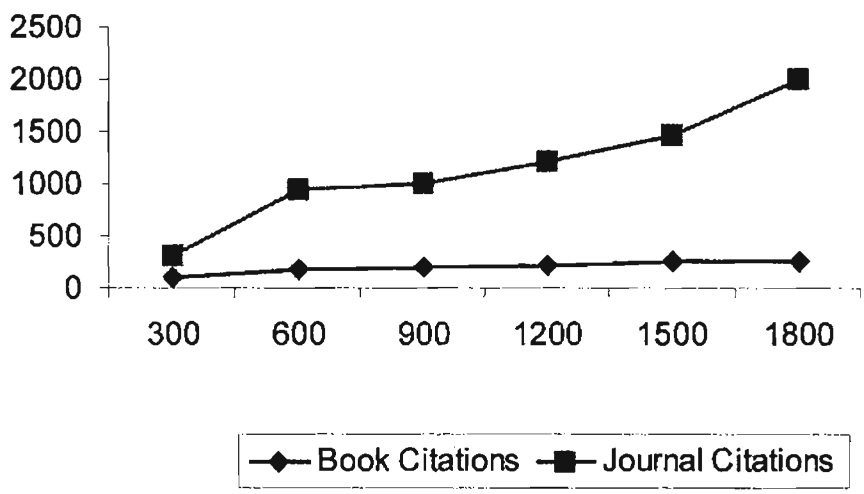
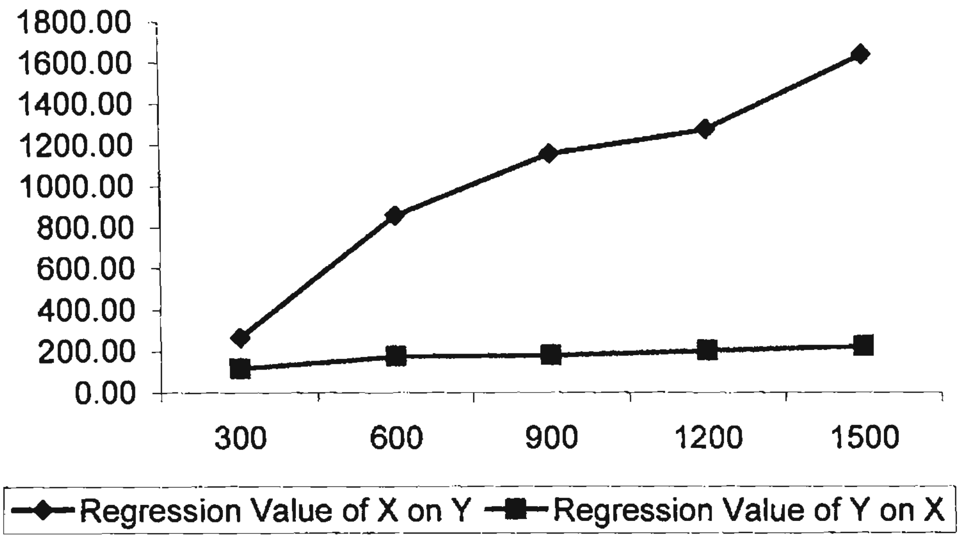


Fig. 5.3.6 : Extent of correlation between journal and book citations.



5.4. Core Books

In every subject field there are a few books which are frequently cited by the users. There exists a close relationship between the subject matter of the books and areas of research. The books which are frequently referred are more relevant in various areas of the subject but rest of the subjects are dispersed over a large number of books. These books which remain highly productive irrespective of age, time and provide highly relevant literature are called as core books in a particular subject. In the field of Science and Technology these core books provide basic information about the subject and are the most viable media for the communication of knowledge.

5.4.1. Technique of core books study

To conduct core books study the entries containing book citations provided in the TOXLINE are collected. These book citations are arranged alphabetically by titles and a ranked list is prepared according to their frequency of occurrence. The frequency of occurrence is plotted on a semi log graph and the highly cited books are marked as core books. The Bradford's Law can be tested using this graph. The subjects of individual books can be determined and a ranked list can be prepared. By deriving the difference of age between the cited book and the citing journal, the currency of book use can be calculated.

5.4.1.1. Core Books in Toxicology

On the basis of frequency of occurrence of a book citation, the core books in the field of Toxicology have been derived. In the following paragraphs, ranking list of books, the derivation of core books on the basis of Bradford's Law of scattering, subject dispersion among the book citations, currency of book use have been discussed in detail.

5.4.2 Ranking of books

On the basis of number of times a particular book was referred during 1998 to 2003, the rank of that book can be derived. The total 1174 book citations were derived. These books were placed in 28 different ranks. Within the first 12 ranks, only 12 books were available which had covered 25.89 per cent of the total book citations. More than 60 per cent (63.22%) of the citations were referred by about 213 books. The details of number of books available in each rank with citations are provided in the Table. 5.4.2. The book Casarett and Doull's Toxicology :The basic science of poisons, edited by Doull,J published by Macmillan topped the first rank.

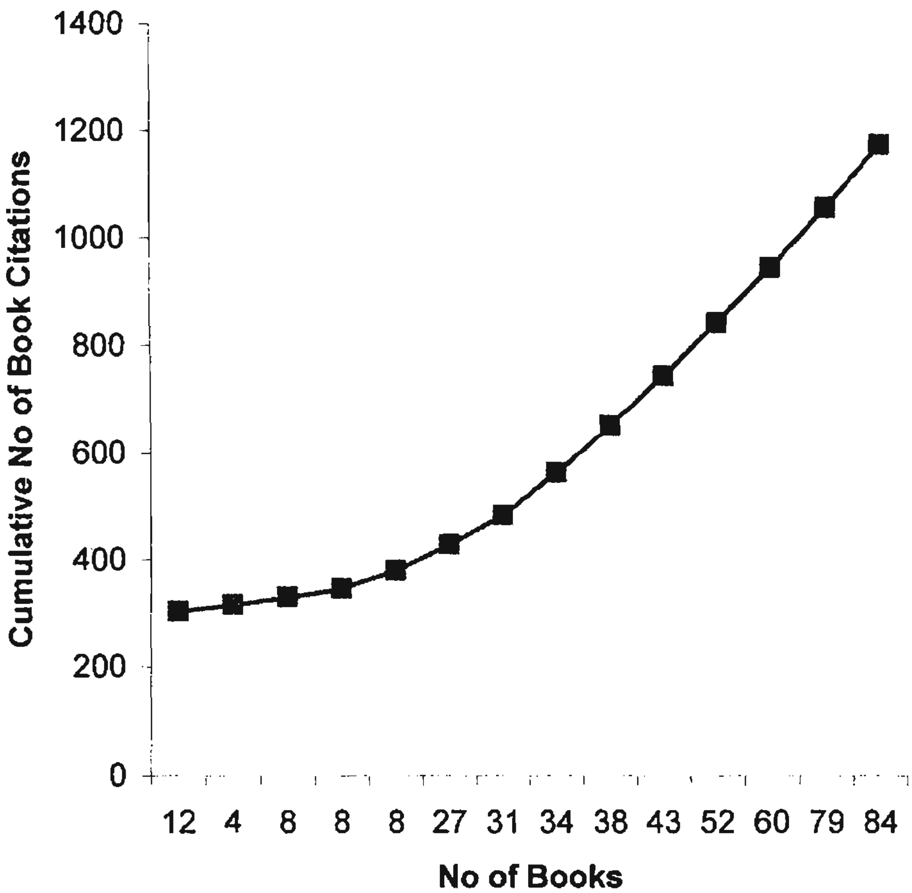
Table 5.4.2: Number of books in each rank

Sl. No.	Rank	Number of Books	Total citations	Cumulative citations	Percentage	Cumulative percentage
1	1 to 12	1 each	304	304	25.89	--
2	13	4	12	316	1.02	26.91
3	14	8	14	330	1.19	28.1
4	15 to 16	4 each	16	346	1.36	29.46
5	17	8	34	380	2.90	32.36
6	18 to 20	9 each	49	429	4.17	36.53
7	21	31	55	484	4.69	41.22
8	22	34	79	563	6.73	47.95
9	23	38	88	651	7.50	55.45
10	24	43	93	744	7.92	63.37
11	25	52	98	842	8.35	71.72
12	26	60	102	944	8.69	80.41
13	27	79	112	1056	9.54	89.95
14	28	84	118	1174	10.05	100
		488	1174		100	100

5.4.2.1 Core books

The cumulative number of citations were plotted against the number of books on a semi log graph. The Figure 5.4.2 showed a typical Bradford's curve initially rising and then became linear from the point X. It clearly indicates that the first 20 books described against the serial number 1 to 20 may be the core books in Toxicology. Here the core books covered nearly percent of the book citations. From this analysis it is clear that only a small amount of books in Toxicology literature was covered within the core group and there still remained quite a large amount of book literature that was scattered over a huge number of books. Hence the concept of core books phenomena is not fully satisfied.

Fig. 5.4.2 : Core book study showing Bradford's curve.



5.4.3 Currency of book citations

The currency of books are presented in the Table. 5.4.3. It was seen that 67.45 percent of the book citations were referred within a time lag of 10 years. It is observed that only a few books were cited after 40 years of their publication. This is because of the fact that in the field of toxicology, new and new information are generated every year. Hence there are more chances for a book to get maximum citations which is published in the last 10 years.

Table 5.4.3: Time lag in citing book literature with reference to year of publication.

Time gap (in years)	Number of book citations	Percentage	Cumulative percentage
0-5	474	40.38	40.38
6-10	318	27.09	67.47
11-15	102	8.69	76.16
16-20	91	7.75	83.91
21-25	74	6.3	90.21
26-30	42	3.58	93.79
31-35	31	2.64	96.43
36-40	22	1.87	98.3
More than 41	20	1.7	100
	1174	100	

5.4.4 Time lag of citing books

The time lag of citing books are given in the Table 5.4.4. from the table it is clear that during 1998 to 2003, maximum number of books were cited within a gap of 10 years. As the years pass , the number of citation on a particular book becomes less. In 1998, within the first years after the publication of books, they have got maximum citations (22). After next 5 years the number was reduced to 18 so as to 9, 7, 5, 2, 1, 1 and after 41 years or more there was no citation or the number of citation was reduced to zero. In the year 1999, within the first five years after the publication of books, they have got maximum citation of 34. After that it was reduced to 25, 11, 9, 8, 4, 3, 2. The same phenomenon can be seen in the following years. From the analysis, it is clear that as the time lag became more, the number of citations became less.

Table 5.4.4: Time lag in citing books with reference to year of its publication during individual years.

Years	0-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41 or more
1998	22	18	9	7	5	2	1	1	--
1999	34	25	11	9	8	4	3	2	2
2000	58	46	13	11	9	5	4	3	3
2001	89	53	18	16	14	5	2	1	1
2002	110	75	21	20	17	10	9	5	4
2003	161	101	30	28	21	16	12	10	10

5.4.5 Subject dispersion in book citations

The subject analysis of the book citations revealed that the books belonging to the general aspects of Toxicology came in the first position (33.82%).

Table 5.4.5: Subject dispersion in book citations

Sl. No.	Subjects	No. of citations	Percentage	Cumulative percentage
1.	Toxicology	397	33.82	--
2.	Environmental Science	222	18.91	52.73
3.	Medicine	161	13.71	66.44
4.	Chemistry	127	10.82	77.26
5.	Ecology	98	8.35	85.61
6.	Pharmacology	62	5.28	90.89
7.	Biology (General)	34	2.90	93.79
8.	Pathology	24	2.04	95.83
9.	Food Science	19	1.62	97.45
10	Science (General)	18	1.53	98.98
11.	Human Anatomy	12	1.02	100
	Grand Total	1174		100

The books dealing with Environmental Science came in the 2nd position (18.91%) followed by Medicine (13.71%), Chemistry (10.82%), Ecology (8.35%), Pharmacology (5.28%), Biology (2.89%), Pathology (2.04%), Food Science (1.62%), Science in General (1.53%) and Human Anatomy with minimum citation (1.02%). The subject dispersion in book citations are given in the Table 5.4.5.

5.5 CORE authors and scientific productivity of authors.

Growth of literature in all respect depends upon the contribution of authors to the subjects. Citation analysis helps us to identify the leading, prominent figures in each subject field. These personalities are the focal point to the concerned subject. In the field of Science and Technology some authors become famous in their works by being cited very often or many times. The citation analysis studies prove that these leading figures are the core authors in the concerned subject field. A detailed ranking list of authors can be prepared on the basis of citation analysis. This also helps us to determine the degree of recognition of authors among others in the subject.

5.5.1. Scientific productivity

The scientific productivity of individual authors is measured by the number of publications produced by them in a particular period of time. To know the impact of individual author's work on research and to determine the rank of authors, scientific productivity study has been done. Most of the authors contributing to a specific filed of literature and the number of highly productive authors is too small. This phenomenon is referred to as 'Lokta's Law of Inverse Square Law'.

5.5.1.1. Technique of core authors study

From the citations the frequency of occurrence of each author are recorded and a ranking table is prepared. Each author in joint author publications should be given equal weightage. The number of citations that particular author receives indicates the rank of an author. The productivity of an author can be determined by counting the publications published by individual authors during a specific period of time. The data available in the ranking list of authors are plotted on a semi-log graph to derive the core authors. The Bradford's law of scattering and Lotka's Law of scientific productivity are tested to these data. To find out nation-wise productivity of authors, the country-wise affinity of core authors are determined.

5.5.1.1.1 Core authors in Toxicology literature

The technique of analysis of core authors is presented in the following paragraphs. The Bradford's Law and Lotka's law are applied to the data. The country-wise productivity of core authors is also determined.

5.5.2 Ranking of authors

A total of 9265 author citations were actually drawn form 4125 number of authors. On the basis of the frequency of occurrence in the citations the authors were grouped into 43 ranks. The number of authors within 32 ranks varied from 1 to 7. Next ranks showed an increase in the number of authors in each rank and the last rank i.e. 43 contained maximum number (2935) of authors in a single rank.

Table 5.5.2 : Number of authors in each rank

Sl. No.	Rank	Number of authors	Total citations	Cumulat ive citations	Percentage	Cumulative percentage
1	1 to 9	1	962	962	10.38	10.38
2	10	2	108	1070	1.17	11.55
3	11 to 16	1	252	1322	2.72	14.27
4	17	2	64	1386	0.69	14.96
5	18 to 19	1 each	59	1445	0.64	15.6
6	20	4	68	1513	0.73	16.33
7	21	2	62	1575	0.67	17.00
8	22	1	98	1673	1.06	18.06
9	23	2	49	1722	0.53	18.59
10	24	1	23	1745	0.25	18.84
11	25 +27	2 each	119	1864	1.28	20.12
12	28	4	66	1930	0.71	20.83
13	29	6	98	2028	1.06	21.89
14	30	4	61	2089	0.66	22.55
15	31	3	42	2131	0,45	23.00
16	32	7	91	2222	0.98	23.98
17	33	17	192	2414	2.07	26.05
18	34	15	168	2582	1.81	27.86
19	35 to 36	22 each	381	2963	4.11	31.97
20	37	30	212	3175	2.29	34.26
21	38	62	378	2553	4.08	38.34
22	39	70	350	3903	3.78	42.12
23	40	122	488	4391	5.27	47.39
24	41	218	653	5044	7.05	54.44
25	42	565	1286	6330	13.88	68.32
26	43	2935	2935	9265	31.68	100
	Total	4125	9265			

The data clearly showed that in lower ranks more number of authors were available than in the upper rank. The number of authors in each rank and the percentage of citations are provided in the Table 5.5.2. The rank number 33 contained 17 authors, 34 accounted for about 15 authors. The rank number 35 to 36 contained 22 authors each. The rank number 37 contributed 30 authors, 38 for 62 authors, 39 for 70 authors, 40 for 122 authors, 41 for 218 authors and 42 for 565 authors.

Table 5.5.3 : Ranking of authors in Toxicology

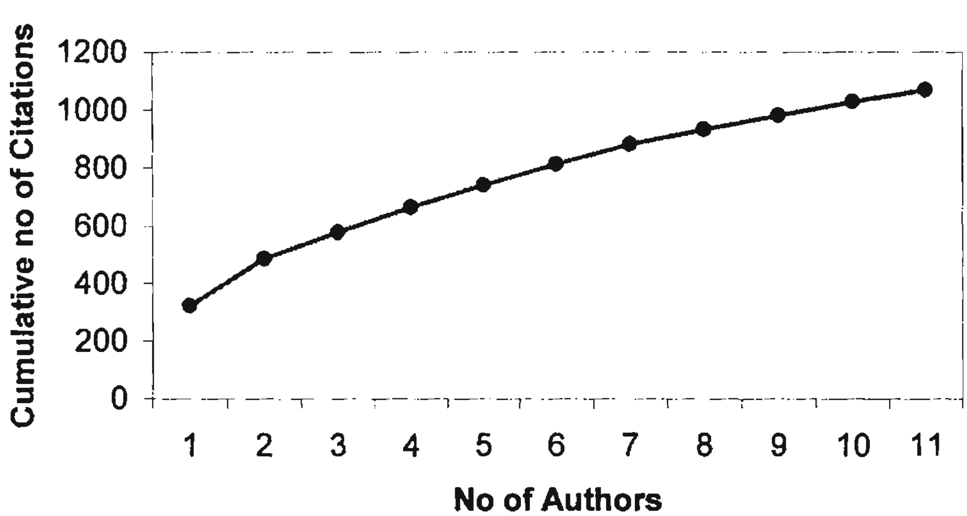
Sl. No.	Rank	Author	No. of citations	Cumulative No. of citations	Percentage	Cumulative percentage
1	I	Price C.J.	322	322	3.48	3.48
2	II	Chadwick, RW	164	486	1.78	5.26
3	III	Ashby. J.	93	579	1.00	6.26
4	IV	George J.D.	85	664	0.92	7.18
5	V	Real J.R.	76	740	0.83	8.01
6	VI	Page J.G.	73	813	0.79	8.8
7	VII	Hacker, MP	69	882	0.74	9.54
8	VIII	Gullmetta, RA	51	933	0.55	10.09
9	IX	Mauderly, JL	49	982	0.53	10.62
10	X	Halm, FF	47	1029	0.51	11.13
11	XI	Kitchen, KT	41	1070	0.44	11.57

The first five positions in the rank were occupied by C.J. Price (3.48% of citations), R.W. Chadwick (1.78% of citations), J. Ashby (1.00% if citations), J.D. George (0.92% of citations), J.R. Reel (0.83% of citations) respectively. The names of individual authors up to serial number 11 with the number of times they have been cited are provided in the Table 5.5.3.

5.5.3 Core authors

The cumulative number of citations or authors were plotted against the serial number of authors is a semi log graph: The citations of authors almost followed the typical Bradford's hyperbolic curve. From the Figure 5.5.1., it is clear that there were 11 core authors. These core authors contributed 1070 (11.57%) number of citations. The authors described against the serial number 1 to 11 are showed in the Table 5.5.3. The analysis revealed that the core group of authors covered only 11.57% of the total author citations which was a clear indication that core concept was not fully applied to these authors.

Fig. 5.5.1. Cumulative number of citations over authors.



5.5.4 Productivity of authors / Application and extension of Lokta's law

The productivity was measured in terms of the number of times a particular author was cited during 1998 to 2003. Out of the total 9265 citations, minimum number (15) of authors were cited for 10 times and maximum (2935) number of authors were cited only once. From the study it is clear that few authors had been cited more number of times. The number of citations received by the authors are provided in Table 5.5.4.

The Lotka's law is applied to author's productivity is presented in the Table 5.5.4. From the table it is evident that the observed percentage of authors varied from the expected percentage of authors as predicted by applying Lotka's equation. The Chi-square test was further applied to compare the observed values with the expected value of author's productivity according to Lotka's law. The calculated Chi-square value (228.54) was more than the Table Chi-square value i.e. 18.3, at a degree of freedom of 10, level of significance, α = 0.05 is shown in the Table 5.5.5. Here the Chi-square value was highly significant and Lotka's law was not applicable to this data.

Table 5.5.4: Productivity of authors in Toxicology.

No. of papers	Observed no. of authors (a_n)	Observed % of authors $\frac{100 \times a_n}{a_1}$	Expected no. of authors $a_n = \frac{a_1}{n^2}$	Expected % of author predicted by Lotka ($100/n^2$)	$\frac{(a_n - p)^2/p}{p}$
1	2935	100 (71.13)	2935	100	0
2	565	19.25 (13.70)	734	25	38.51
3	218	7.43 (5.28)	326	11.11	35.78
4	122	4.16 (2.96)	183	6.25	20.33
5	70	2.39 (1.70)	117	4.00	18.88
6	62	2.11 (1.50)	82	2.77	4.88
7	30	1.02 (0.73)	60	2.04	15
8	22	0.75 (0.53)	46	1.56	12.52
9	22	0.75 (0.53)	36	1.23	5.44
10	15	0.51 (0.36)	29	1.00	6.76
11	65	2.47 (1.58)	24	0.83	70.04
	4126	100	4572		228.54

Table 5.5.5 : Chi-square test on productivity of authors in relation to Lotka's Law

No. of citations 'n'	Observed no. of authors (as with 'n' citations (Fi)	Expected No. of authors with 'n' citations (Pi)	(Fi-Pi)	$(Fi-Pi)^2$	$\frac{(Fi-Pi)^2}{Pi}$
1	2935	2935	0	0	0
2	565	734	-169	28561	38.91
3	218	326	-108	11664	35.78
4	122	183	-61	3721	20.33
5	70	117	-47	2209	18.88
6	62	82	-20	400	4.88
7	30	60	-30	900	15.00
8	22	46	-24	576	12.52
9	22	36	-14	196	5.44
10	15	29	-14	196	5.44
11	65	24	41	1681	70.04
	4126				X^2=228.54

$X^2 > x^1_\alpha$

(df. = 10)

$(\alpha = 0.05)$

$((x^1_\alpha = 18.3)$

Table 5.5.6: Author contribution Vs Number of authors

Number of papers	Number of authors	%
1	2935	71.13
2	565	13.69
3	218	5.28
4	122	2.96
5	70	1.70
6	62	1.50
7	30	0.73
8	22	0.53
9	22	0.53
10	15	0.36
11	65	1.58
Total	4126	99.99

The 2935 authors have contributed one paper, 565 authors have two, 218 authors have three, 122 authors have four, 70 authors have five, 62 authors have six, 30 authors have seven, 22 authors have eight, another 22 authors have nine, 15 authors have ten and 65 authors have eleven papers to their credit. According to Lotka's Law,

$$F\ (y^n) = \frac{A}{y^n} = \alpha$$

Where (F (y^n) stands for the authors productivity, 'y' number of papers, 'A' and 'α' are constants, considering the equation i.e.

$$F\ (y^n) = \frac{A}{y^n}$$

When y = 1

$$F\ (y^2) = 2935$$

$$2935 = A/1$$

$$A = 2935 \times 1 = 2935$$

Similarly

$y = 2 \Rightarrow \qquad F\ (y^2) = \frac{2935}{2^2} = \frac{2935}{4} = 734$

$y = 3 \Rightarrow \qquad F\ (y^2) = \frac{2935}{3^2} = \frac{2935}{9} = 326$

$y = 4 \Rightarrow \qquad F\ (y^2) = \frac{2935}{4^2} = \frac{2935}{16} = 183$

$y = 5 \Rightarrow \qquad F\ (y^2) = \frac{2935}{5^2} = \frac{2935}{25} = 117$

$y = 6 \Rightarrow \qquad F\ (y^2) = \frac{2935}{6^2} = \frac{2935}{36} = 82$

$y = 7 \Rightarrow \qquad F\ (y^2) = \frac{2935}{7^2} = \frac{2935}{49} = 60$

$y = 8 \Rightarrow \qquad F\ (y^2) = \frac{2935}{8^2} = \frac{2935}{64} = 46$

$y = 9 \Rightarrow \qquad F(y^2) = \frac{2935}{9^2} = \frac{2935}{81} = 36$

$y = 10 \Rightarrow \qquad F(y^2) = \frac{2935}{10^2} = \frac{2935}{100} = 29$

and $\quad y = 11 \Rightarrow \qquad F(y^2) = \frac{2935}{11^2} = \frac{2935}{121} = 24$

Table 5.5.7: Values of observed and expected number of authors.

Number of papers	Number of authors (Observed)	No. of authors (expected)
1	2935	2935
2	565	734
3	218	326
4	122	183
5	70	717
6	62	82
7	30	60
8	22	46
9	22	36
10	15	29
11	65	24
Total	4126	4572

From the above table it is evident that the expected values are not close to the observed values up to number of papers. Hence Lotka's Law does not fit for the study.

Thus the law is extended accordingly as shown below.

$$\boxed{f\left(y^2\right) \approx \frac{A}{y^2 + (y-1)} = \beta}$$

"A" and "β" are constants and "y" is the number of papers.

When the data is applied on the above formula,

When $y = 1 \Rightarrow F\ (y^2) = \dfrac{2935}{1^2 + (1-1)} = 2935$

$y = 2 \Rightarrow F\ (y^2) = \dfrac{2935}{2^2 + (2-1)} = 587$

$y = 3 \Rightarrow F\ (y^2) = \dfrac{2935}{3^2 + (3-1)} = 266$

$y = 4 \Rightarrow F\ (y^2) = \dfrac{2935}{4^2 + (4-1)} = 154$

$y = 5 \Rightarrow F\ (y^2) = \dfrac{2935}{5^2 + (5-1)} = 101$

$y = 6 \Rightarrow F\ (y^2) = \dfrac{2935}{6^2 + (6-1)} = 71$

$y = 7 \Rightarrow F\ (y^2) = \dfrac{2935}{7^2 + (7-1)} = 53$

$y = 8 \Rightarrow F\ (y^2) = \dfrac{2935}{8^2 + (8-1)} = 41$

$y = 9 \Rightarrow F\ (y^2) = \dfrac{2935}{9^2 + (9-1)} = 33$

$y = 10 \Rightarrow F\ (y^2) = \dfrac{2935}{10^2 + (10-1)} = 27$

and $\quad y = 11 \Rightarrow F\ (y^2) = \dfrac{2935}{11^2 + (11-1)} = 22$

From the above derivation, the expected values are approximately close to the observed values up to number of papers. Hence this law can be fit for the study.

5.6 Core Journals

In the field of Science and Technology, in every subject there are some journals which are frequently referred by the researchers because of the close relation between the subject of the journals and the areas of research works. These highly cited journals are termed as 'core journals' of a specific subject. The core journals always contain a higher concentration of relevant articles on a particular discipline and the rest of the papers on the subject are scattered over a large number of journals. The concept of 'core journals' is derived from Bradford's Law, Samuel C. Bradford first formulated his law called 'Bradford Law of Scattering' which describes how the literature on a particular subject is scattered or distributed in the journals.

5.6.1 Technique of core journal analysis

All the entries containing records of citations to journals are collected. Then these entries are arranged according to the titles of the journals. Then the frequency of the citation for each journal can be calculated. The Bradford's law can be tested graphically and mathematically to derive the core journals and to test the Bradford law, the rank of journals and their citations can be plotted on a semi log graph. The time lag of journal citations can be calculated by subtracting the year of cited journal from that of citing journal. The rate of self-citation is calculated by citing journal with that of cited journal. The time lag of journal citations also gives the currency of the journal use.

5.6.2 Rank list of cited journals

By sorting data collected from citations of 5 journals indexed in TOXLINE during 1998 to 2003 is used for preparing the alphabetical list of cited journals. This list presents 59 journals with number of times each journal is cited. The most cited journals are searched and ranked by the decreasing order of citations. These 59 journals from the core journals in the field of Toxicology literature which altogether present a total citation of 6922.

Table 5.6.2: Rank-list of most cited journals

Sl. No.	Name of Journal	No. of times cited	Rank
1	Toxicology	807	I
2	Toxicon	612	II
3	International Journal of Toxicology	302	III
4	Neurotoxicology	301	IV
5	Ecotoxicology	286	V
6	Chemical Research in Toxicology	284	VI
7	Environmental Toxicology	280	VII
8	Chemosphere : Chemistry, Biology and Toxicology as related to Environmental Problems	275	VIII
9	Journal of Applied Toxicology	264	IX
10	Journal of Analytical Toxicology	260	X
11	Journal of Ecotoxicology and Environmental Monitoring	231	XI
12	Toxicologic Pathology	230	XII
13	Aquatic Toxicology	185	XIII
14	Archives of Toxicology	184	XIV
15	Cell Biology and Toxicology	115	XV

16	Human and Experimental Toxicology	112	XVI
17	Food and Chemical Toxicology	109	XVII
18	Toxicological and Environmental Chemistry	102	XVIII
19	Toxicology and Industrial Health	101	XIX
20	Current Issues in Toxicology	100	XX
21	Veterinary and Human Toxicology	97	XXI
22	Drug and Chemical Toxicology	96	XXII
23	Environmental Toxicology and Chemistry	96	XXII
24	Environmental Toxicology and Pharmacology	95	XXIII
25	Chemico-Biological Interactions	93	XXIV
26	Archives of Toxicology : Kinetic and Xenobiotic Metabolism	91	XXV
27	Toxicology and Applied Pharmacology	81	XXVI
28	Toxicology Invitro	81	XXVI
29	Current Topics in Environmental and Toxicological Chemistry	81	XXVI
30	Comments on Toxicology	80	XXVII
31	Ecotoxicology and Environmental safety	78	XXVIII
32	Inhalation Toxicology	68	XXIX
33	Critical Reviews in Toxicology	65	XXX
34	Journal of Toxicological Sciences	60	XXXI
35	Natural Toxins	58	XXXII
36	Regulatory Toxicology and Pharmacology	53	XXXIII
37	Archives of Environmental Contamination and Toxicology	49	XXXIV
38	Toxicology Letters	41	XXXV
39	Xenobiotica	37	XXXVI

40	Australian Journal of Ecotoxicology	35	XXXVII
41	Journal of Toxicology; Clinical Toxicology, Cutaneous and Occular Toxicology	30	XXXVIII
42	Neurotoxicology and Teratology	28	XXXIX
43	Journal of Environmental Pathology, Toxicology, Oncology	28	XXXIX
44	Reviews in Toxicology	27	XL
45	Journal of Pharmacological and Toxicological Methods	25	XLI
46	Bulletin of Environmental Contamination and Toxicology	20	XLII
47	Journal of Environmental Sciences and Health: Part A. Toxic and Hazardous substances and Environmental Engineering	20	XLII
48	Journal of Environmental Science and Health: Part C. Environmental Carcinogenesis and Ecotoxicology Reviews	20	XLII
49	Toxicology Mechanics & Methods	19	XLIII
50	Japanese Journal of Toxicology	18	XLIV
51	Journal of Toxicologic Pathology	16	XLV
52	Japanese Journal of Forensic Toxicology	15	XLVI
53	Trace Metals in the Environment	13	XLVII
54	Reviews of Environmental Contamination and Toxicology	13	XLVII
55	Acta Toxicologica Et Theraputica	12	XLVIII
56	Ambio	12	XLVIII
57	Ekologicheskaya Khimiya	11	XLIX
58	Journal of Toxicology : Toxin Reviews	11	XLIX
59	Journal of Toxicology and Environmental Health	9	L

5.6.3 Rank distribution of cited journals / Application and extension of Bradford's law

Here the number of cited journals are arranged by decreasing number of citations. The number of journals (x), cumulative number of journals (cum x), number of citations (y), cumulative citations (F (x)), log of cumulative citations (log f (x)) are given in the Table 5.6.3.

The journal 'Toxicology' came in the first position with 807 citations which is about 11.66% of the total citations received by journals. From the table it is clear that there is a wide variation in the number of citations received by the top ranking journals. The difference in citations between the first and the second rank is 195 and second and the third rank is 310. Following this, the difference becomes less and the differences in citation between the third and the fourth rank is 1 and after this there is an increase to 15 (i.e. between fourth and fifth rank). Journals receiving more than 100 citations are 19 in number which have a total of 5040 citations i.e. 72.81% of the citations received by the core journals. This data clearly shows that the relevant articles in the field of Toxicology are concentrated in a few journals while increasing number of less related journals are in circulation.

Table 5.6.3: Rank distribution of cited journals.

No. of Journals X	Cumulative No. of Journals (x)	No. of Citations (y)	Cumulative Citations F (x)	log (x)	log F (x)
1	1	807	807	0	6.693323
1	2	612	1419	0.693147	7.257708
1	3	302	1721	1.098612	7.450661
1	4	301	2022	1.386294	7.611842
1	5	286	2308	1.609437	7.744137
1	6	284	2592	1.791759	7.860185
1	7	280	2872	1.945910	7.962764
1	8	275	3147	2.079441	8.054205
1	9	264	3411	2.197224	8.134761
1	10	260	3671	2.302585	8.208219
1	11	231	3902	2.397895	8.269245
1	12	230	4132	2.484906	8.326517
1	13	185	4317	2.2564949	8.370316
1	14	184	4501	2.639057	8.412055
1	15	115	4616	2.708050	8.437284
1	16	112	4728	2.772588	8.461258
1	17	109	4837	2.833213	8.484050
1	18	102	4939	2.890371	8.504918

1	19	101	5040	2.944438	8.525161
1	20	100	5140	2.995732	8.544808
1	21	97	5237	3.0445252	8.563504
2	23	192	5429	3.135494	8.599510
1	24	95	5524	3.178053	8.616858
1	25	93	5617	3.218875	8.633553
1	26	91	5708	3.258096	8.649624
3	29	243	5951	3.367295	8.691315
1	30	80	6031	3.401197	8.704668
1	31	78	6109	3.433987	8.717518
1	32	68	6177	3.465735	8.728588
1	33	65	6242	3.496507	8.739056
1	34	60	6302	3.526361	8.748622
1	35	58	6360	3.555348	8.757784
1	36	53	6413	3.583518	8.766082
1	37	49	6462	3.610917	8.773694
1	38	41	6503	3.637586	8.780019
1	39	37	6540	3.663561	8.785692
1	40	35	6575	3.688879	8.791030
1	41	30	6605	3.713572	8.795582

2	43	56	6661	3.761200	8.804025
1	44	27	6688	3.784189	8.808070
1	45	25	6713	3.806662	8.811801
3	48	60	6773	3.871201	8.820699
1	49	19	6792	3.891820	8.823501
1	50	18	6810	3.912023	8.826147
1	51	16	6826	3.931826	8.828494
1	52	15	6841	3.951243	8.830689
2	54	26	6867	3.988984	8.834483
2	56	24	6891	4.025351	8.837971
2	58	22	6913	4.060443	8.841159
1	59	9	6922	4.077537	8.842460

The core journal data was tested by applying Bradford's theory of distribution which states that, '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 groups or zones containing the same number of articles as the nuclear when the zones will be $1: n : n^2 \ldots$".

It is found that 2308 (1/3) citations are contained in 5 journals, 4616 citations in 15 journals and 6922 citations in 59 journals. The actual distribution is shown below.

No. of citations (each 1/3) x	Cumulative No. of Citations Σx	No. of journals (observed) y	Cumulative No. of journals Σy	Ratio (Observed)	Ratio (expected)
2308	2308	5	5	1	1
2308	4616	10	15	2	2
2306	6922	44	59	8.8	4

Here n^2 is found to be 4 whereas it comes to 8.8

Hence the Bradford's law can be extended accordingly as shown below :

1 : n : 4n

When the above value is applied on the equation :

1 : 2 : 4 x 2

1 : 2 : 8 Hence the extended law is found exactly fit for the study.

5.6.4 Cumulative distribution of journals

The Table 5.6.4 shows cumulative distribution of journals in the increasing order of number of citations. The number of citations (x). number of journals (y), total citations (x.y), cumulative citations (εxy), cumulative journals (εy) are given. The percentage of cumulative journals and citations shows that it does not conform the 80/20 rule. According to this rule 20% of the journals must contain 80% of citations. From the table it is clear that 20% (11 Nos.) of journals from 2% (149 Nos.) of citations and 80% (47 Nos). of journals contain 40% (2790 Nos.) of citations. This shows that as a trans disciplinary field, in Toxicology the relevant articles are scattered in a variety of journals which are cited frequently by researches.

Table 5.6.4 : Cumulative distribution of journal citations

Sl. No.	Citations (x)	Journals (y)	Total x-y	Cumulative Citations $\sum xy$	Cumulative Journal $\sum y$
1	9	1	9	9	1
2	11	2	22	31	3
3	12	2	24	55	5
4	13	2	26	81	7
5	15	1	15	96	8
6	16	1	16	112	9
7	18	1	18	130	10
8	19	1	19	149	11
9	20	3	60	209	14
10	25	1	25	234	15
11	27	1	27	261	16
12	28	2	56	317	18
13	30	1	30	347	19
14	35	1	35	382	20
15	37	1	37	419	21
16	41	1	41	460	22
17	49	1	49	509	23

18	53	1	53	562	24
19	58	1	58	620	25
20	60	1	60	680	26
21	65	1	65	745	27
22	68	1	68	813	28
23	78	1	78	891	29
24	80	1	80	971	30
25	81	3	243	1214	33
26	91	1	91	1305	34
27	93	1	93	1398	35
28	95	1	95	1493	36
29	96	2	192	1685	38
30	97	1	97	1782	39
31	100	1	100	1882	40
32	101	1	101	1983	41
33	102	1	102	2085	42
34	109	1	109	2194	43
35	112	1	112	2306	44
36	115	1	115	2421	45
37	184	1	184	2605	46
38	185	1	185	2790	47
39	230	1	230	3020	48
40	231	1	231	3251	49

41	260	1	260	3511	50
42	264	1	264	3775	51
43	275	1	275	4050	52
44	280	1	280	4330	53
45	284	1	284	4614	54
46	286	1	286	4900	55
47	301	1	301	5201	56
48	302	1	302	5503	57
49	612	1	612	6615	58
50	807	1	807	6922	59

5.6.5 Alphabetical list of most cited journals

The 59 journals are listed alphabetically giving their country of origin, number of citations, year of origin and periodicity. When periodicity is taken into account, bi-monthly (14), quarterly (9) and monthly (8) are more in number. The journal 'Toxicology' with 33 issues per year is ranked first while 'Toxicon' with monthly periodicity stood second. The journal, 'International Journal of Toxicology' with bi-monthly periodicity was ranked in the third position where as 'Neurotoxicology' with 6 issues in a year was ranked in the fourth position. The fifth position was occupied by the journal 'Ecotoxicology' with bi-monthly periodicity and so on. From this analysis it is evident that periodicity of the journal has no influence on the number of citations. The alphabetical list of most cited journals with country of publication, number of citations, year of origin and periodicity are given in the Table 5.6.5

Table 5.6.5 : Alphabetical list of most cited Journals

Sl. No.	Title	Country of publication	No. of times cited	Year of origin	Periodicity
1	Acta Toxicologica Et Theraputica	IT	12	1980	Q
2	Ambio	U.S	12	1972	BI - M
3	Aquatic Toxicology	NLD	185	1981	20/yr
4	Archives of Environmental Contamination and Toxicology	U.S	49	1972	8/yr
5	Archives of Toxicology	GER	184	1930	M
6	Archives of Toxicology : Kinetic and Xenobiotic Metabolism	YUG	91	1993	Q
7	Bulletin of Environmental Contamination and Toxicology	U.S	20	1966	M
8	Cell Biology and Toxicology	NLD	115	1984	BI-M
9	Chemical Research in Toxicology	U.S	284	1988	M
10	Chemico-Biological Interactions	IRE	93	1969	18/yr
11	Chemosphere : Chemistry, Biology and Toxicology as Related to Environmental Problems	UK	275	1972	32/yr
12	Comments on Toxicology	UK	80	1986	B1-M
13	Critical Reviews in Toxicology	U.S	65	1971	B1-M
14	Drug and Chemical Toxicology	U.S	96	1977/78	Q

15	Ecotoxicology	U.S	286	1992	B1-M
16	Ecotoxicology and Environmental safefy	U.S	78	1977	9/yr
17	Ekologicheskaya Khimiya/Ecological Chemistry	RUS	11	1991	Q
18	Environmental Toxicology	U.S	280	1986	BI-M
19	Environmental Toxicology and Chemistry	U.S	96	1982	M
20	Environmental Toxicology and Pharmacology	NLD	95	1992	6/yr
21	Food and Chemical Toxicology	UK	109	1963	M
22	Human and Experimental Toxicology	UK	112	1981	M
23	Inhalation Toxicology	U.S	68	1989	14/yr
24	International Journal of Toxicology	UK	302	1982	B1-M
25	Japanese Journal of Forensic Toxicology	JAP	15	1983	3/yr
26	Japanese Journal of Toxicology	JAP	18	1988	4/yr
27	Journal of Analytical Toxicology	U.S	260	1977	8/yr
28	Journal of Applied Toxicology	UK	264	1981	B1-M
29	Journal of Ecotoxicology and Environmental Monitoring	IND	231	1991	Q
30	Journal of Environmental Pathology, Toxicology and Oncology	U.S	28	1978	Q

31	Journal of Environmental Science and Health : Part A. Toxic and Hazardous Substances and Environmental Engineering	U.S	20	1966	10/yr
32	Journal of Environmental Science and Health: Part C. Environmental Carcinogensis and Ecotoxicology Reviews	U.S	20	1983	S-A
33	Journal of Pharmacological and Toxicological Methods.	U.S	25	1978	6/yr
34	Journal of Toxicologic Pathology	JAP	16	1976	S-A
35	Journal of Toxicological Sciences	JAP	60	1976	Q
36	Journal of Toxicology : Clinical Toxicology, Cutaneous and Ocular Toxicology	U.S	30	1982	Q
37	Journal of Toxicology: Toxin Reviews	U.S	11	1982	Q
38	Journal of toxicology and Environmental Health	U.S	9	1975	S-M
39	Natural Toxins	U.S	58	1992	BI-M
40	Neurotoxicology	NLD	301	1979	6/yr
41	Neurotoxicology and Teratology	U.S	28	1979	6/yr
42	Regulatory Toxicology and Pharmacology	U.S	53	1981	BI-M
43	Review of Environmental Contamination and Toxicology	U.S	13	1962	I
44	Review in Toxicology	NLD	27	1996	S-A

45	Toxicologic Pathology	U.S	230	1978	BI-M
46	Toxicological and Environmental Chemistry	UK	102	1972	B1-M
47	Toxicology	UK	807	1973	33/yr
48	Toxicology and Applied Pharmacology	U.S	81	1959	24/yr
49	Toxicology and Industrial Health	UK	101	1985	10/yr
50	Toxicology In Vitro	UK	81	1987	B1-M
51	Toxicology Letters	IRE	41	1977	24/yr
52	Toxicology Mechanisms and Methods	U.S	19	1991	Q
53	Toxicon	UK	612	1962	M
54	Trace Metals in the Environment	NLD	13	1991	IRR
55	Veterinary and Human toxicology	U.S	97	1958	BI-M
56	Xenobiotica	UK	37	1971	M
57	Australian Journal of Ecotoxicology	AUS	35	1995	S-A
58	Current Issues in Toxicology.	U.S	100	1984	I
59	Current Topics in Environmental and Toxicological Chemistry	CHE	81	1976	I

Abbreviations

I - Irregular, M - Monthly, BI - M- Bimonthly, Q - Quarterly, S-A -Semi Annual, S-M, Semi Monthly, GER - Germany, IND - India, IRE - Ireland, IT - Italy, JAP - Japan, NLD - Netherlands, RUS - Russia, UK - United Kingdom, US - United States, AUS - Australia, CHE - Chekoslovakia.

5.6.6 Ranking of most cited journals by year of origin

The most cited 59 journals are arranged by the increasing order of year of first publication.

Table 5.6.6: Ranking of most cited journals by year of origin

Sl. No	Year	Name of Journal	Rank in Table
1	1930	Archives of Toxicology	14
2	1958	Veterinary and Human Toxicology	21
3	1959	Toxicology and Applied Pharmacology	26
4	1962	Reviews of Environmental Contamination and Toxicology	47
5	1962	Toxicon	2
6	1963	Food and Chemical Toxicology	17
7	1966	Bulletin of Environmental Contamination and Toxicology	42
8	1966	Journal of Environmental Science and Health: Part A. Toxic and Hazardous Substances and Environmental Engineering	42
9	1969	Chemico - Biological Interactions	24
10	1971	Critical Reviews in Toxicology	30
11	1971	Xenobiotica	36
12	1972	Ambio	49
13	1972	Archives of Environmental Contamination and Toxicology	34
14	1872	Chemosphere : Chemistry, Biology and Toxicology as related to Environmental Problems	8
15	1972	Toxicological and Environmental Chemistry	18

16	1973	Toxicology	1
17	1975	Journal of Toxicology and Environmental Health	51
18	1976	Journal of Toxicology Pathology	45
19	1976	Current Topics in Environmental and Toxicological Chemistry	26
20	1976	Journal of Toxicological Science	31
21	1977	Ecotoxicology and Environmental Safety	28
22	1977	Journal of Analytical Toxicology	10
23	1977	Toxicology Letters	35
24	1978	Journal of Environmental Pathology, Toxicology and Oncology	39
25	1978	Journal of Phamacological and Toxicological Methods	41
26	1978	Toxicologic Pathology	12
27	1978	Drug and Chemical Toxicology	22
28	1979	Neurotoxicology	4
29	1979	Neurotoxicology and Teratology	39
30	1980	Acta Toxicologica Theraputica	49
31	1981	Aquatic Toxicology	13
32	1981	Human and Experimental Toxicology	16
33	1981	Journal of Applied Toxicology	9
34	1981	Regulatory Toxicology and Pharmacology	33
35	1982	Environmental Toxicology and Chemistry	22
36	1982	International Journal of Toxicology	3
37	1982	Journal of Toxicology : Clinical Toxicology, Cutaneous and Ocular Toxicology	38
38	1983	Journal of Toxicology : Toxin Reviews	50

39	1983	Journal of Environmental Science and Health : Part C. Environmental Carcinogenesis and Ecotoxicology Reviews	42
40	1983	Japanese Journal of Forensic Toxicology	46
41	1984	Cell Biology and Toxicology	15
42	1984	Current issues in Toxicology	20
43	1985	Toxicology and Industrial Health	19
44	1986	Comments on Toxicology	27
45	1986	Environmental Toxcicology	7
46	1987	Toxicology In Vitro	26
47	1988	Chemical Research in Toxicology	6
48	1988	Japanese Journal of Toxicology	44
49	1989	Inhalation Toxicology	29
50	1991	Ekologicheskaya Khimiya	50
51	1991	Journal of Ecotoxicology and Environmental Monitoring	11
52	1991	Toxicology Mechanisms and Methods	43
53	1991	Trace Metals in the Environment	48
54	1992	Ecotoxicology	5
55	1992	Environmental Toxicology and Pharmacology	23
56	1992	Natural Toxins	32
57	1993	Archives of Toxicology : Kinetic and Xenobiotic Metabolism	25
58	1995	Australian Journal of Ecotoxicology	37
59	1996	Reviews in Toxicology	40

5.6.7 Decade wise Distribution of Journals

Table 5.6.7: Decade wise distribution of journals

Decade	No. of Journals	% of Journals	Cumulative %
1930 - 1940	1	1.7	1.7
1940 - 1950	--	--	--
1950 - 1960	2	3.4	5.1
1960 - 1970	6	10.17	15.27
1970 - 1980	20	33.89	49.16
1980 - 1990	17	28.81	77.97
1990 - 2000	13	22.03	100
	59		

The 1930's and 1940's showed a sharp decrease in the number of journals. This may be due to the fact that the study was concentrated more in the year 1998 to 2003. The decade 1970 - 80 showed the maximum number of journals 20 (33.89%) and 1940's showed that no journals was reported to this decade. In 1980 - 90, 17 (28.81%) journals were reported where as in 1990 - 2000, 13 (22.03%) journals were reported. Besides research output are reported in publications like bulletins, house journals etc.

5.6.8 Subject wise scatter of most cited journals

The 59 core journals are grouped on the basis of their basic subject.

Table 5.6.8 : Subject wise scatter of most cited journals

Sl. No.	Subjects	No. of Journals	% of Journals	Cumulative %
1	Toxicology	18	30.51	30.51
2	Environmental Science	11	18.64	49.15
3	Chemistry	9	15.25	64.4
4	Medical Science	9	15.25	79.65
5	Ecology	3	5.08	84.73
6	Pharmacology	3	5.08	89.81
7	Biology	2	3.4	93.21
8	Pathology	2	3.4	96.61
9	Food Science	1	1.7	98.31
10	Anatomy	1	1.7	100.01

From the table it is clear that most of the core journals are in the field 'Toxicology' (30.51%) and 'Environmental Sciences' (18.64%). This may be due to the fact that people as well as scientists all over the world are more alert in the environmental and toxicological effects that not only affects our gifted world but also human beings, plants and animals. The subject scatter showed that next two positions are occupied by the subjects 'Chemistry' (15.25%) and 'Medical Sciences' (15.25%). The journals on 'Ecology' (5.08%), 'Biology' (3.4.%), 'Pathology' (3.4%) are reported. As toxicology is an interdisciplinary subject articles of general interest are published in journals having broad coverage in subjects like Biology, Pathology and Pharmacology. Journals on 'Food Science' (1.7%) and 'Anatomy' (1.7%) showed the minimum percentage.

5.6.9 Distribution of citation by subject of most cited journals

The 59 core journals are arranged according to the subject and the number of citation and percentage of citation.

Table 5.6.9 : Distribution of citation by subject of most cited journals

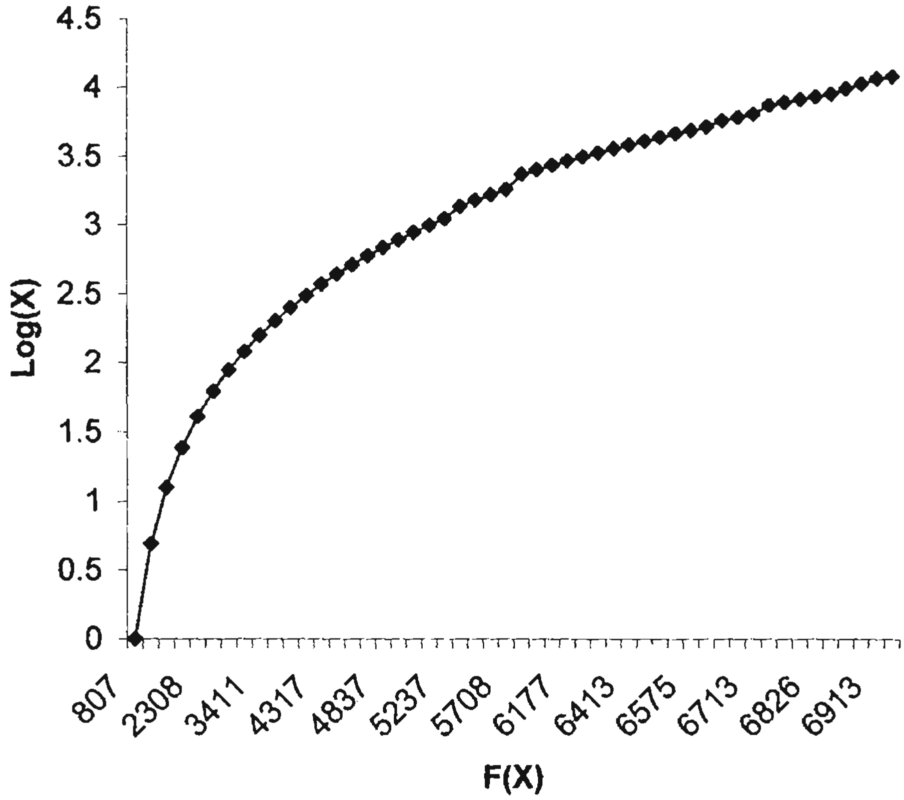
Sl. No.	Subject	No. of Journals	No. of citations	% of citation
1	Toxicology	24	3417	49.36
2	Environmental Science	9	592	8.55
3	Medical Science	6	458	6.62
4	Chemistry	5	1017	14.70
5	Ecology	5	641	9.26
6	Pharmacology	3	173	2.5
7	Biology	3	142	2.05
8	Pathology	2	258	3.73
9	Food Science	1	109	1.57
10	Anatomy	1	115	1.66
		59	6922	100

The subject 'Toxicology' came in the first position in respect of the number of journals (24) as well as in the number of citation (49.36%) followed by 'Environmental Sciences' with 9 journals and with 8.55% of the citations in 59 core journals. The total of the above two subject forms about 60% of the total citations. In 'Medical Science' the numbers of journals is 6 and the citation is about 6.62%. Even though in 'Chemistry' the number of journals are less (5), citations are more (14.7%) when compared to 'Ecology' having the same number of journals but less in the number of citations (9.26%). The subjects 'Pharmacology' and 'Biology' got same number of journals (3) but former had greater number of citation (2.5%) and later had less number (2.05%). Even though in 'Pathology' the number of journals are less (2), citation are more (3.73%) when compared to 'Pharmacology' and 'Biology'. The subjects 'Food Science' and 'Anatomy' stands in the same line in the number of journals (1) but later got higher number of citations (1.66%) than the former (1.57%).

5.6.10 Fit of rank distribution (Bradford Distribution)

To test whether the data fits Bradford's distribution graphically, the graph is prepared by plotting log of cited journals (x) against cumulative citations (F (x)) from the Table 5.6.4. On the basis of the observations, S.C. Bradford suggested the following linear relation to describe the scattering phenomenon as, $F(x) = a + b \log x$, where 'F(x)' is the cumulative number of references contained in the first 'x' most productive journals, 'a' and 'b' are constants.

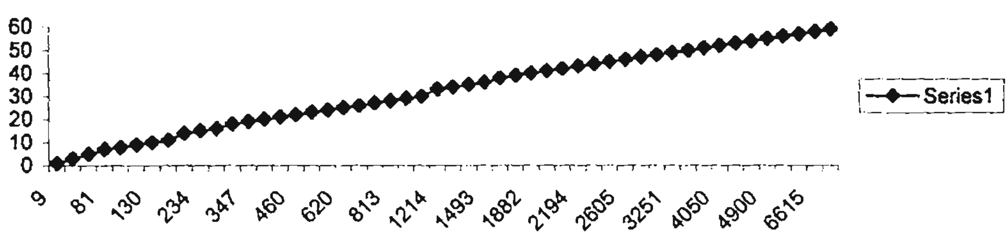
Fig. 5.6.1: Fit of rank distribution (Bradford Distribution)



5.6.11 Frequency curve of distribution of citations

The graph is plotted with number of citations (x) against number of journals (y) according to data provided on the Table.5.6.3

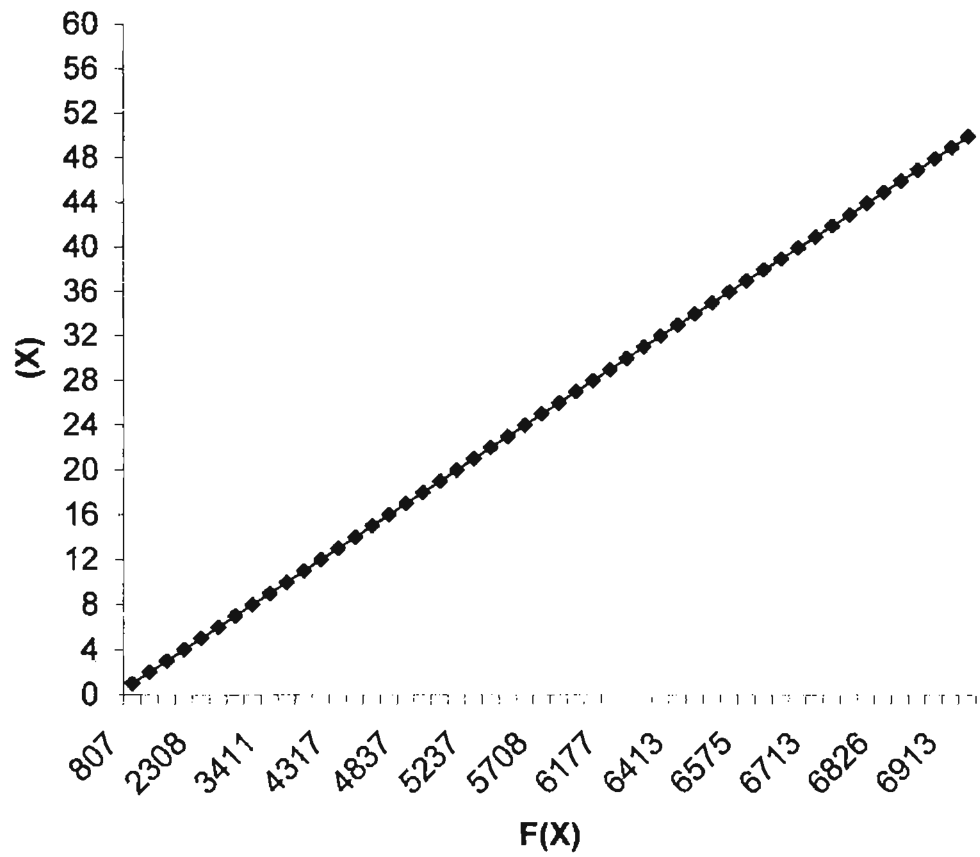
Fig. 5.6.2: Frequency curve of distribution of citations



5.6.12 Cumulative distribution of journal citations

To prepare this graph, cumulative number of journals (x) is plotted against cumulative citations (F (x) as provided in the Table.5.6.3.

Fig. 5.6.3: Cumulative distribution of journal citations



5.6.13 Country wise distribution of most cited journals

Country wise analysis shows that journals from U.S and U.K have contributed around 67.79% of the cited journals. Of these U.S stands in the first position (47.45%) U.K in the second position (20.34%) followed by Netherlands (10.17%), Japan (6.78%) and Ireland (3.38%).

Table 5.6.13: Country wise distribution of most cited journals

Sl. No.	Country	No. of Journals	Cumulative %
1	U.S	28	47.46
2	U.K	12	20.34
3	Netherlands	6	10.17
4	Japan	4	6.78
5	Ireland	2	3.39
6	Australia	1	1.69
7	Chekoslovakia	1	1.69
8	Germany	1	1.69
9	India	1	1.69
10	Italy	1	1.69
11	Russia	1	1.69
12	Yugoslavia	1	1.69
		59	99.97

Australia, Chekoslovkia, Germany, India, Italy, Russia, Yugoslavia each had one journal which altogether contribute 11.83% of the cited journals. The vast and quick progress of research and development in the field of Science and Technology in U.S and U.K led to an increase in the number of journals published from the above two countries.

5.6.14 Age of the journals most cited

The most cited 10 journals with more than 100 citations are selected to study the age of journals. These most cited journals are studied for a period of 10 years i.e. from 1994 to 2003. Total citations of each year and its cumulations are tabulated .

Table 5.6.14 : Age of the journals most cited

Year	X	No. of ref. f (x)	x.f. (x)	Cumulative frequency f (x)
2003	0	148	148	148
2002	1	243	243	391
2001	2	381	762	772
2000	3	512	1536	1284
1999	4	630	2520	1914
1998	5	741	3705	2655
1997	6	782	4692	3437
1996	7	753	5271	4190
1995	8	870	6960	5060
1994	9	935	8415	5995

The average age of journals can be calculated as

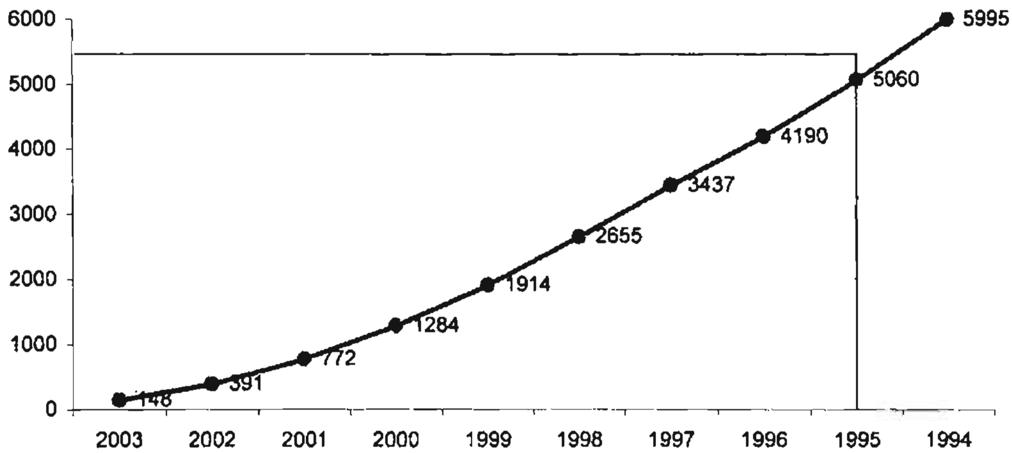
$$x = \frac{\varepsilon \times f(x)}{\varepsilon f(x)}$$

$$= \frac{34252}{5995}$$

= 5.7 years

A graph-plotting year of citation against cumulative citation is drawn. From the graph the period during which half of the citation occurred or the median citation age is found (Fig.5.6.4).

Fig. 5.6.4: Age of the journals most cited



5.7 Growth study

The number of citations provided in different journals are collected. Then various growth fitting formulae are applied to the observed data to assess the nature of growth of literature and citation in the field of toxicology.

5.7.1 Growth of literature and citations in Toxicology journals

The following analysis brings out the nature of growth of Toxicology literature. For this purpose the data have been collected from nine core journals in Toxicology form the Table 5.6.2.The total 6922 journal citations were actually drawn from 59 journals. The nine top ranked core journals are selected for the study contains 1218 articles and 3411 citations.

5.7.2 Rate of citation per article (C/A)

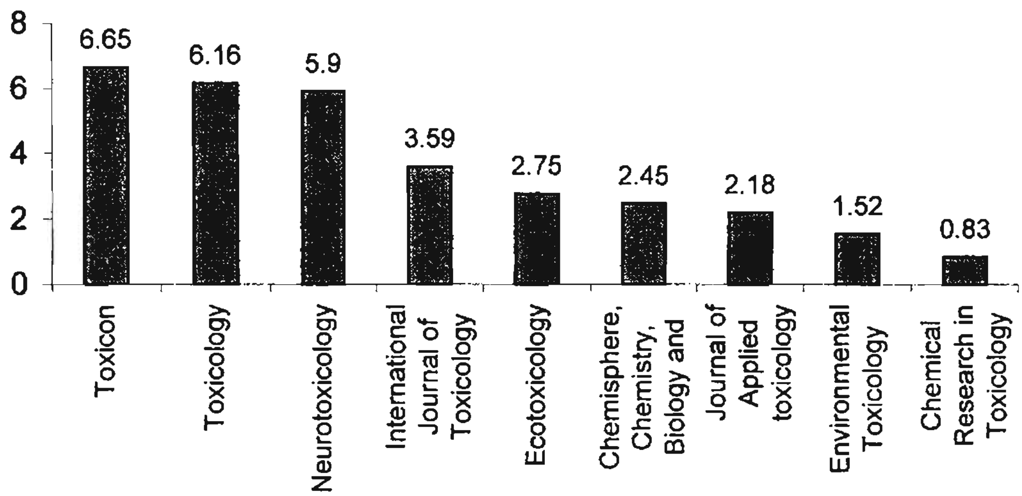
The rate of citation per article varied from 6.65 to 0.83. The names of individual journal along with the total articles published, total citations appended in the articles and the rates of citations per article are provided in the Table 5.7.2.

Table 5.7.2: Citation per article (C/A) in individual journals

Sl. No.	Name of the Journal	Total number of articles	Total number of citations	C/A
1	Toxicon	92	612	6.65
2	Toxicology	131	807	6.16
3	Neurotoxicology	51	301	5.9
4	International Journal of Toxicology	84	302	3.59
5	Ecotoxicology	104	286	2.75
6	Chemosphere: Chemistry, Biology and Toxicology as related to Environmental Problems	112	275	2.45
7	Journal of Applied Toxicology	121	264	2.18
8	Environmental Toxicology	184	280	1.52
9	Chemical Research in Toxicology	339	284	0.83
	Grand Total	1218	3411	2.8

The average rate of citation per article is 2.8. Among the nine top ranked core journals, 'Toxicon' contains highest number of citation per article (6.65) and the lowest rate is reported by 'Chemical Research' in 'Toxicology' (0.83). The second position is occupied by the journal 'Toxicology' (6.16) followed by 'Neurotoxicology' (5.9), 'International Journal of Toxicology' (3.59), 'Ecotoxicology' (2.75), 'Chemosphere' (2.45), 'Journal of Applied Toxicology'(2.18) and 'Environmental Toxicology' (1.52).

Fig. 5.7.1 : Citation per article in individual journals



5.7.3 Percentage of contribution of citation in different journals

Out the nine journals the journal 'Toxicology' had contributed maximum number of citations (23.66%) followed by 'Toxicon' (17.94%). The 'International Journal of Toxicology' occupied the next position (8.85%) followed by 'Neurotoxicology' (8.82%), 'Ecotoxicology' (8.38%), 'Chemical Research in Toxicology' (8.33%), 'Environmental Toxicology' (8.21%) and 'Chemosphere' (8.06%). The 'Journal of Applied Toxicology' had scored minimum number of citations (7.74%). It is noted that more than 60% of the citations are contributed by first five journals. The names of the different journals along with the percentage and cumulative percentage of citations are given in the Table 5.7.3.

Table 5.7.3 : Percentage of citation in different journals.

Sl. No.	Name of the Journal	Total no. of Citations	% of Citations	Cumulative %
1	Toxicology	807	23.66	23.66
2	Toxicon	612	17.94	41.6
3	International Journal of Toxicology	302	8.85	50.45
4	Neurotoxicology	301	8.82	59.27
5	Ecotoxicology	286	8.38	67.65
6	Chemical Research in Toxicology	284	8.33	75.98
7	Environmental Toxicology	280	8.21	84.19
8	Chemosphere : Chemistry Biology and Toxicology as related to Environmental Problems.	275	8.06	92.25
9	Journal of Applied Toxicology	264	7.74	99.9
		3411		

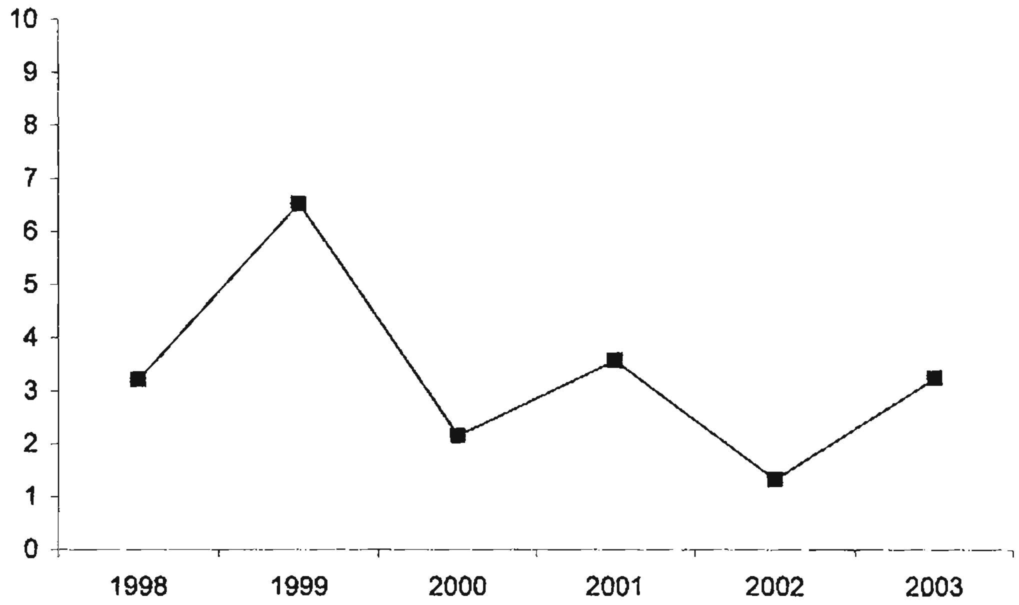
5.7.4 Rate of citation per article during different years

The rate of citation per article varies from a minimum of 1.32 to 6.52. The growth rate of citation per article is not in a steady order from 1998 to 2003. The rate of citation per article i.e. 3.21 in 1998 followed by a maximum of 6.52 in 1999. The year 2000 showed a sharp decrease in the rate of citation to 2.15 and in the next year 2001 showed a slight increase to 3.57. The year 2002 showed the minimum rate of citation per article to 1.32 and 2003 showed a slight increase in the citation rate to 3.25. The number of citations per article over 1998 to 2003 are presented in the Table 5.7.4 and in the Figure 5.7.2.

Table 5.7.4: Rate of citation per article during different years

Year	Total number of articles	Total number of citations	C/A
1998	53	170	3.21
1999	62	404	6.52
2000	270	582	2.15
2001	245	875	3.57
2002	275	362	1.32
2003	313	1018	3.25

Fig. 5.7.2: Citations per article during 1998 to 2003



5.7.5 Citing and non-citing articles in different journals

Out of the 1218 articles, 922 (75.7%) were citing articles and 296 (24.3%) were non-citing articles. The journal 'Toxicology' came in the first position which contained maximum percentage of citing articles (97.71%) and minimum percentage of non-citing articles (2.29%) followed by 'Toxicon' (citing 88.04% and non-citing 11.96%), 'International Journal of Toxicology' (citing 82.14% and non-citing 17.86%), 'Journal of Applied Toxicology' (citing 80.99% and non-citing 19.01%), 'Chemosphere' (citing 79.46% and non-citing 20.54%), 'Ecotoxicology' (citing 78.85% and non-citing 21.15%), 'Neurotoxicology' (citing 74.51% and non-citing 25.49%), 'Environmental Toxicology' (citing 69.02% and non-citing 30.98%). The journal 'Chemical Research in Toxicology' showed minimum percentage of citing articles (61.95%) and maximum percentage of non-citing articles (38.05%). The ranking of journals on the basis of percentage of their citing and non-citing articles are presented in the Table 5.7.5.

Table 5.7.5 : Citing and non-citing articles in different journals

Sl. No.	Name of the Journal	Number of citing articles	% from total articles of the specific journal	No. of non-citing articles	%from total articles of the specific journal
1	Toxicology	128	97.71	3	2.29
2	Toxicon	81	88.04	11	11.96
3	International Journal of Toxicology	69	82.14	15	17.86
4	Journal of Applied Toxicology	98	80.99	23	19.01
5	Chemosphere	89	79.46	23	20.54
6	Ecotoxicology	82	78.85	22	21.15
7	Neurotoxicology	38	74.51	13	25.49
8	Environmental Toxicology	127	69.02	57	30.98
9	Chemical Research in Toxicology	210	61.95	129	38.05
	Grand Total	922	75.7	296	24.3

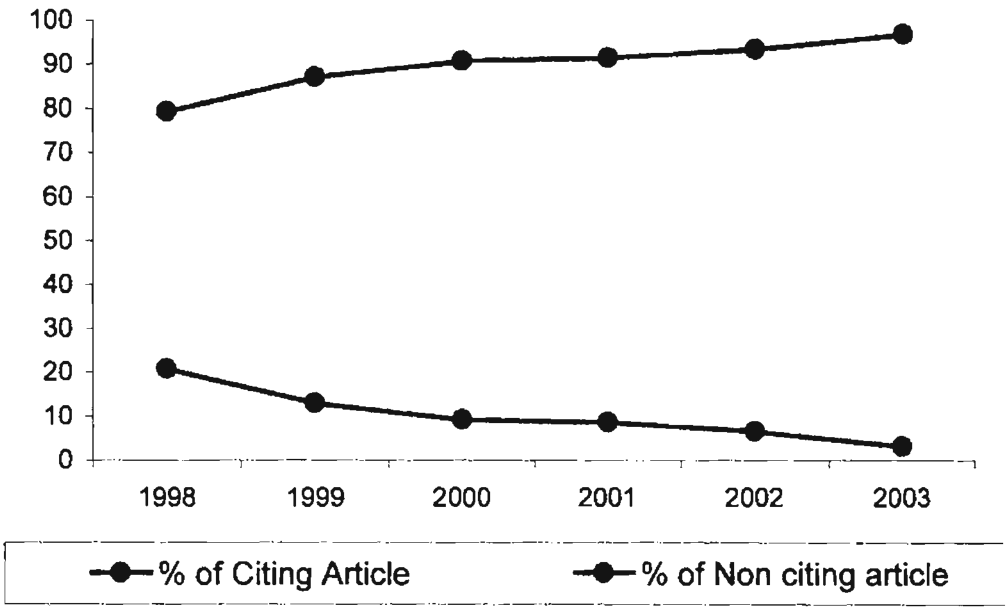
5.7.6 Growth of citing and non-citing articles

In the year 1998, the percentage of number of citing articles were less (79.24%) when compared to the rest of the years and the percentage of non-citing articles were maximum (20.75%) when compared to the rest of the years. The next years showed a steady increase in the percentage of citing articles (1999 - 87.1%, 2000 - 90.74%, 2001 - 91.43%, 2002 - 93.45%). The year 2003 showed maximum percentage (96.81%) of citing articles. On the other hand the percentage of non-citing articles was maximum (20.75%) in the year 1998, reduced (12.9%) in 1999. Thereafter the percentage of non-citing articles showed a gradual reduction (2000 - 9.26%, 2001-8.57%, 2002-6.55%) and the year 2003 had minimum (3.19%) percentage of non-citing articles. The analysis clearly depicts that there is an increasing trend among the number of citing articles and simultaneous decreasing trend among the number of non-citing articles. The year - wise percentage of the citing and non-citing articles was presented in the Table 5.7.6. A comparison of citing and non-citing articles during 1998 to 2003 was showed in the Figure 5.7.3 .

Table 5.7.6 : Growth of citing and non-citing articles

Year	No. of citing articles	% from the total articles of the year	No. of non citing articles	Percentage from the total articles of the year
1998	42	79.24	11	20.75
1999	54	87.1	8	12.9
2000	245	90.74	25	9.26
2001	224	91.43	21	8.57
2002	257	93.45	18	6.55
2003	303	96.81	10	3.19
Grand Total	1125	92.36	93	7.64

Fig.5.7.3: Comparison of citing and non-citing articles during 1998-2003



The Figure 5.7.3. represents the trend of citing and non-citing articles. The difference between the percentage of citing and non-citing articles gradually became more in number during 1998 to 2003.

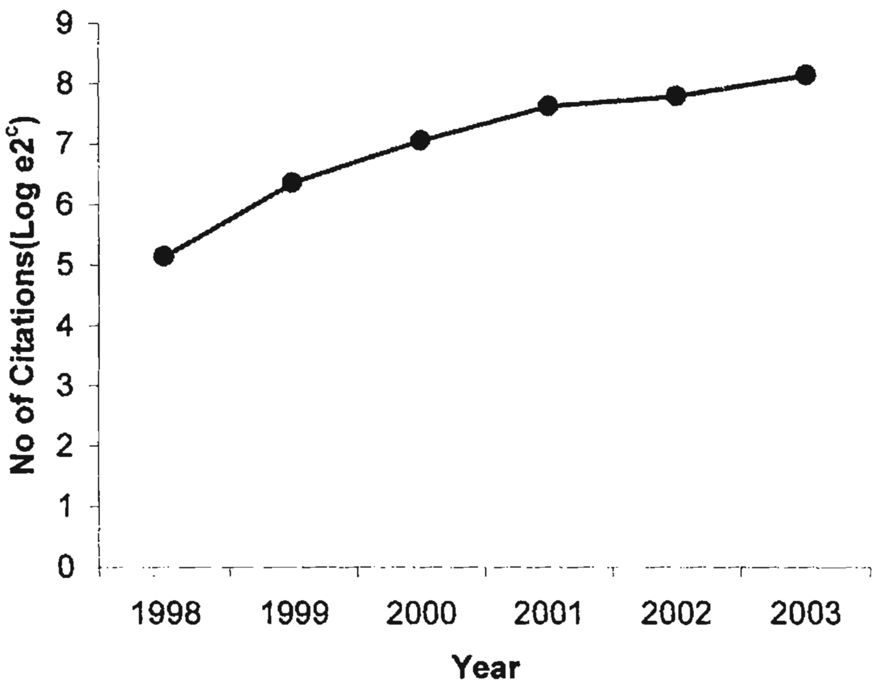
5.7.7 Relative growth and doubling time of citations [R (c)]

The relative growth and doubling time [Dt (c)] of citation were determined and provided in the Table 5.7.7. In the case of citations it was observed that the relative growth rate of citations was gradually decreased from 1.21 to 0.35. The mean relative growth [R (c)] of citations during the first three years (i.e. 1998 to 1999) was higher (0.96) than the last three years i.e. during 2000 to 2003 (0.36). The corresponding doubling time also indicated an increasing trend of 0.57 in 1999 to 1.98 in 2003. The mean doubling time [Dt (c)] during the first three years (i.e. 1998 to 2000) was 0.78 which was increased to 2.51 during 2001 to 2003. Then the rate of growth of citations been gradually reduced and corresponding doubling times has been increased.

Table 5.7.7: Relative growth rates [R (c)] and doubling time [Dt (c)] for citations

Year	No. of citations	Cumulative No. of citations	Log $e1^c$	Log $e2^c$	[R (c)]	Mean [R (c)]	[Dt (c)]	Mean
1998	170	170	--	5.14	--			
1999	404	574	5.14	6.35	1.21	0.96	0.57	0.78
2000	582	1156	6.35	7.05	0.7		0.99	
2001	875	2031	7.05	7.62	0.57		1.22	
2002	362	2393	7.62	7.78	0.16	0.36	4.33	2.51
2003	10.18	3411	7.78	8.13	0.35		1.98	

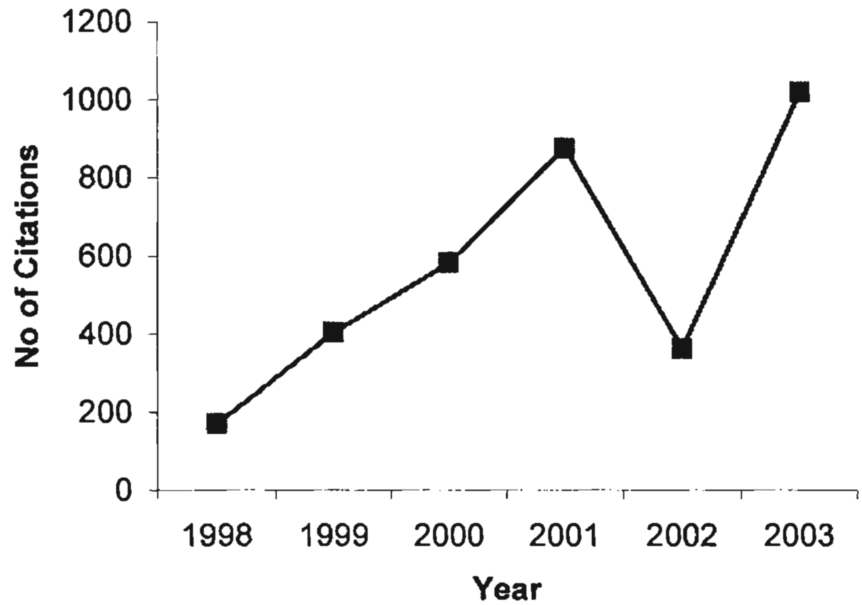
Fig. 5.7.4: Logistic pattern of growth of citations



5.7.8 Nature of growth of citations

The citations had a gradual reduction in the relative growth rate and simultaneous increase of doubling time. The nature of growth of citations was neither exponential nor linear. The number of citations was plotted against the corresponding years on a graph as in Fig. 5.7.5. The values of relative growth rate and doubling time of citations indicated that logistic pattern of growth would be more appropriate in this case. The equation for logistic growth was applied and the expected values were plotted on the graph (Fig. 5.7.4.) From the figure it is evident that the growth of citations is approaching towards saturation.

Fig. 5.7.5. Actual Growth of Citations

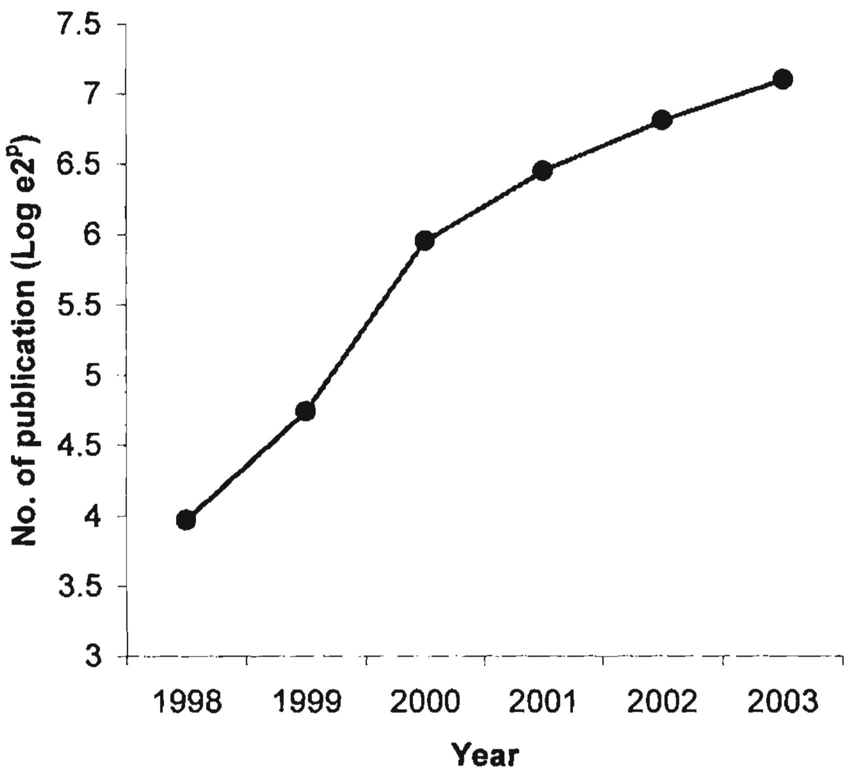


5.7.9 Relative growth rate and doubling time of publications

The relative growth rate [R (p)] and doubling time [Dt (p)] of publications were derived and presented in the Table 5.7.8. The relative growth rate of publications [R (p)] decreased from 0.77 in 1998 to 0.29 in 2003. The mean relative growth for the first three years (i.e. 1998 to 2000) showed a growth rate of 0.99 whereas the mean relative growth for the last three years (i.e. 2001 to 2003) is reduced to 0.38. The corresponding doubling time for different years [Dt (p)] gradually increased from 0.9 in 1998 to 2.39 in 2003.

Table 5.7.2 : Relative

Fig. 5.7.6. Logistic pattern of growth of publications.

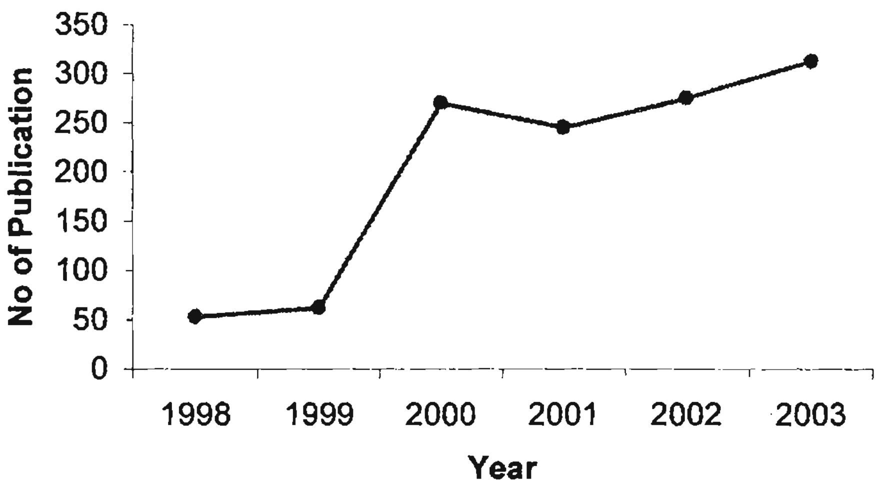


The mean doubling time for the first three years (i.e. 1998 to 2000 was only 0.74 which was increased to 1.9 during the last three years 2001 to 2003. Thus the rate of growth of publication was decreased the corresponding doubling time was increased.

5.7.10 Actual growth of publication

The number of publications are plotted against their corresponding years in the Fig. 5.7.7. The relative growth rate and doubling time indicated that the logistic pattern of growth curve would more appropriated to find out the specific trend of growth, the Logistic growth equation was applied and expected values were plotted on the graph. From the figure we can get an idea that the saturation in the number of publication has almost attained and within a few years the growth of publication would follow the logistic pattern of growth.

Fig. 5.7.7: Actual growth of publications



5.8 Bibliographic Coupling

The citations play an important role in the growth of all types of literature. Citations are frozen footprints in the landscape of scholarly achievements and bear witness to the passage of ideas. Kessler introduced the concept of bibliographic coupling. To documents are bibliographically coupled if their reference lists share one or more of the same documents. Kessler reported two types of coupling. Of the two the first was related to coupling strength and the second was measured by links to one another. Small introduced the concept of co-citations and compared the co-citations analysis with that of bibliographic coupling.

5.8.1 Method of Analysis

To calculate bibliographic coupling, the number of common references available against two articles and then in other articles of that issue are taken into account.

5.8.2 Bibliographic coupling in Toxicology journals

Out of the 1218 articles published in the 9 core journals in Toxicology during the year 1998 to 2003, 68 pairs of articles had common citation entries.

Table 5.8.2 : Bibliographic coupling in Toxicology journals

Sl. No.	Name of the Journal	No. of pairs of articles having coupling	Total number of articles	% from the total articles of the journal
1	Chemical Research in Toxicology	16	339	9.44
2	Environmental Toxicology	14	184	15.22
3	Toxicology	10	131	15.3
4	Journal of Applied Toxicology	9	121	14.87
5	Chemosphere	7	112	12.5
6	Ecotoxicology	6	104	11.54
7	Toxicon	3	92	6.52
8	International Journal of Toxicology	2	84	4.8
9	Neurotoxicology	1	51	3.92
	Grand Total	68	1218	

The journal 'Toxicology' had a total of 131 articles, 10 pairs i.e. 20 articles published the highest percentage of articles (15.3%) which had common citations. The next positions were occupied by 'Environmental Toxicology' (15.22%) and 'Journal of Applied Toxicology' (14.87%)

followed by 'Chemosphere' (12.5%), 'Ecotoxicology' (11.54%), 'Chemical Research in Toxicology' (9.44%), 'Toxicon' (6.52%) and 'International Journal of Toxicology' (4.8%). The journal 'Neurotoxicology' had the minimum number of bibliographically coupled articles (3.92%). The bibliographic coupling in journals and their percentage from total articles of the journal are provided in the Table 5.8.2.

5.8.3 Bibliographic coupling during different years

The number of bibliographically coupled articles during 1998 was minimum (5) which showed on increase to 7 immediately in 1999 and then to 9 in the next year in 2000. The next year 2001, there was a sharp increase to 15 in the number of bibliographically coupled articles. But in the next year 2002, the number of bibliographically coupled articles was reduced to 12 and the year 2003 showed an increase in the number to 20. The details. of bibliographic coupling during different years are provided in the Table 5.8.3.

Table 5.8.3 : Bibliographic coupling during different years

Years	No. of pairs of articles having bibliographic coupling	Total articles	% from the total articles
1998	5	53	18.9
1999	7	62	22.6
2000	9	270	6.7
2001	15	245	12.24
2002	12	275	8.73
2003	20	313	12.8

5.8.4 Strength of bibliographic coupling

Among the bibliographically coupled articles, maximum pair of articles (48.52%) were published in Toxicology journals during 1998 to 2003 had only one common citation entry. The number of articles coming under each category on the basis of their bibliographic coupling strength are provided in the Table 5.8.4. It is observed that the number of coupled articles decreased as the coupling strength increased. Only one pair of article was available where there are five common citation entries. 18 pairs of articles were reported when the bibliographic coupling strength was 2, i.e. (26.5%), 9 pairs of articles were present when the bibliographic coupling strength was 3, i.e. (13.23%), 7 pairs of articles were present when the bibliographic coupling strength was 4, i.e. (10.27%).

Table 5.8.4 : Strength of bibliographic coupling

Strength of bibliographic coupling	Total articles	% from the total articles
1	33	48.53
2	18	26.47
3	9	13.24
4	7	10.29
5	1	1.47

5.9 Self-citation

5.9.1 Rate of Self - citations

Out of the 3411 citations, about 265 (7.87%) were observed as self-citations. Among the journals, Toxicology had got maximum number of self-citations (32.83%) from total self-citations. The individual journal self-citation is 10.78%. The percentage of self-citations in individual journals are provided in the Table 5.8.5. From the table a comparative study can be made on the basis of percentage of self-citations from total self-citations and total citations of the individual journals. The second position was occupied by the journal 'Toxicon' having a self-citation rate of 24.52% and 10.62% self-citation from its own total citations followed by 'International Journal of Toxicology' having a self-citation rate of 12.45% and 10.93% self-citation from its own total citations. The journal 'Neurotoxicology' having a self-citation rate of 10.6% and 9.3% self citation from its own total citations. The 'Journal of Applied Toxicology' had got minimum number of self-citations (0.75%) and minimum individual journal self-citation (0.75%).

Table 5.9.1 : Self - citation in different journals

Rank	Name of the Journal	No. of self citations	% from total self citations	% from total citations of the individual journal
1	Toxicology	87	32.83	10.78
2	Toxicon	65	24.52	10.62
3	International Journal of Toxicology	33	12.45	10.93
4	Neurotoxicology	28	10.6	9.3
5	Ecotoxicology	20	7.54	6.9
6	Chemical Research in Toxicology	17	6.42	5.98
7	Environmental Toxicology	9	3.4	3.21
8	Chemosphere	4	1.5	1.5
9	Journal of Applied Toxicology	2	0.75	0.75
	Grand Total	68	1218	

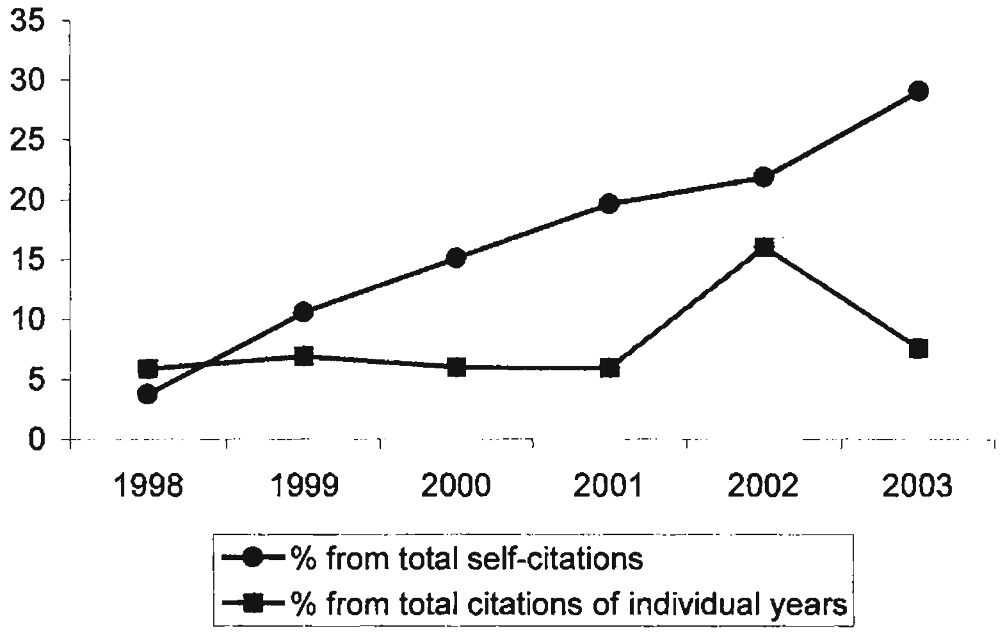
5.9.2 Year wise trend of self-citations

The year-wise trend of the growth of self-citations was in a steady order during the last 6 years in the development of Toxicology as a transdisciplinary subject. The year-wise trend of self-citations are provided in the Table 5.8.6 Maximum self-citations were reported in the year 2003 (77) and minimum in 1998 (10). The growth of the number of self-citations during 1999, 2000, 2001, 2002 and 2003 showed an increase (28, 40, 52, 58 & 77). The percentage of self-citation from total citations of individual years is also increasing since 1998.

Table 5.9.2: Year-wise trend of self-citations

Year	Number of self-citations	% from total self-citation	Total citations	% from total citations of the individual journal
1998	10	3.77	170	5.88
1999	28	10.56	404	6.93
2000	40	15.1	582	6.87
2001	52	19.62	875	5.94
2002	58	21.88	362	16.02
2003	77	29.05	1018	7.56
Total	265	99.98	3411	

Fig 5.9.1 : Year-wise trend of self-citations.



5.9.3 Types of documents self-cited

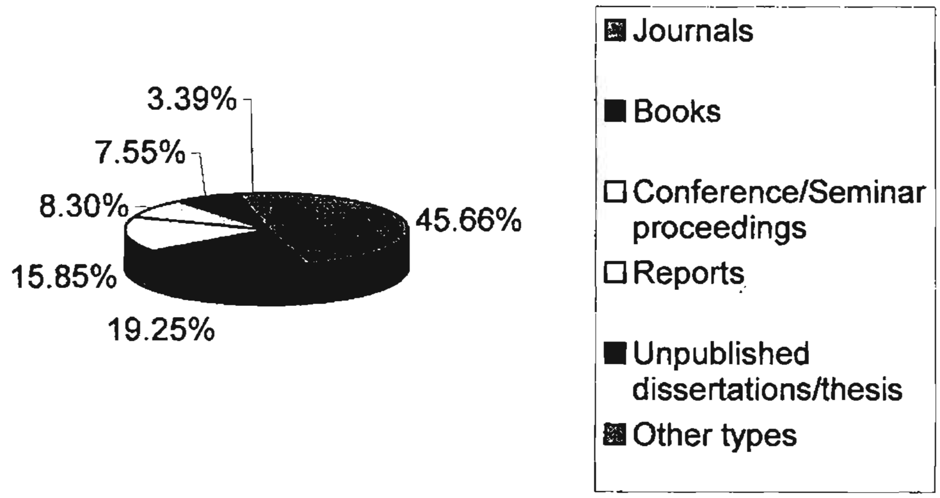
The types of documents self-cited were categorised into 6 groups. The types of documents self-cited with their percentage are given in the Table 5.9.3. The number of self-citations obtained in each group was then compared with that of the total citations of each of the type of documents.

Table 5.9.3 : Types of documents self-cited

Type of document	Number of self-citations	% from the total self citations
Journals	121	45.66
Books	51	19.25
Conference/Seminar proceedings	42	15.85
Reports	22	8.3
Unpublished dissertations/thesis	20	7.55
Other types	9	3.39
	265	100

Out of the total 265 self-citations, maximum number of articles are published in the journals (121) were self-cited followed by books (51). The number of conference/seminar proceedings self-cited were 42 which came almost nearer to the percentage of total citations when compared with unpublished dissertations/theses. Reports occupied a distinct place i.e. 22 self-citations.

Fig. 5.9.2: Types of documents self-cited



5.9.4 Repetitiveness of self-citations

Repetitiveness among the self-citations were observed to be very less (10.18) in Toxicology journals. Repetitiveness of self-citations were given in the Table. 5.9.4. Out of the 13 documents repeatedly self-cited, 10 (76.92%) had been cited two times and 3 (23.08%) had been cited 3 times each. Hence most of repetitive self-cited articles are not so much similar in their content to the citing article.

Table 5.9.4 : Repetitiveness of self-citations

No. of occurrence	No. of documents	% of documents	Total entries of citation	% of total self-citation
02	10	76.92	18	6.79
03	3	23.08	9	3.39
Total	13	100		10.18

5.9.5 Age of self-citations

The age of self-citations are provided in the Table 5.9.5. Maximum number of self-citations were done within two years (17.74%). Minimum number of self-citation were made after ten years (2.64%).

Table 5.9.5 : Frequency of distribution of age - difference of self-citations

Age	Number of Self-citations	% from total	Cumulative percentage
- 0	21	7.92	--
- 1	47	17.74	25.66
- 2	33	12.45	38.11
- 3	25	9.43	47.54
- 4	21	7.92	55.46
- 5	18	6.8	62.26
- 6	19	7.17	69.43
- 7	17	6.42	75.85
- 8	16	6.04	81.89
- 9	9	3.4	85.29
- 10	7	2.64	87.93
11	20	7.55	95.48
-11 or more	12	4.52	100
	265		

5.9.6 Recency of self-citation within five major categories of authors

The recency of self-citation was provided in the Table 5.8.10. It was observed that in all four major categories of self-cited works, maximum number of references belonged to very recent group and minimum to less recent group.

Table 5.9.6 : Recency of self-citation within five major categories of authors

Currency	Single Author	Two Authors	Three Authors	Four Authors	More than Four Authors
Very recent (0, -1, -2, -3)	82	23	13	8	5
Recent (-4,-5,-6,-7)	51	18	10	6	--
Less recent (-8, -9, -10, -11, more)	34	7	5	2	1
Total	167	48	28	16	6

5.9.7 Self-citation habit of Indian and foreign authors

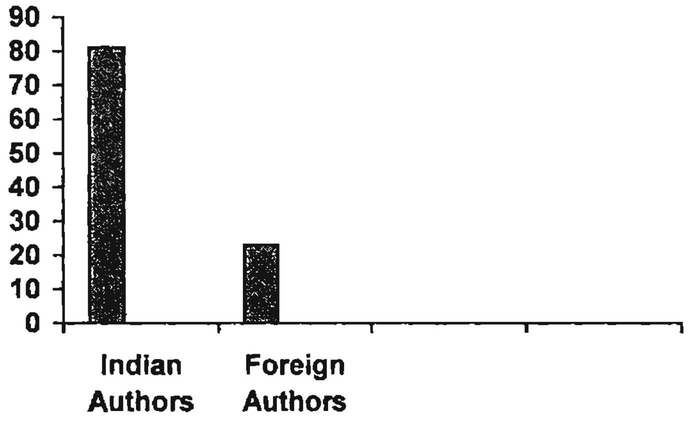
Of the total 1218 articles, 81 articles having self-citations are written by authors of Indian origin (6.7%). In the meanwhile, the counter part of foreign origin are 23 self-citing articles (1.1%). The self citation habits of Indian and foreign authors are shown in the Table 5.9.7.

Table 5.9.7 : Self - citation habit of Indian and foreign authors

Authors	Number of self citing articles	Percentage from total self-citing articles	Percentage from total articles
Indian authors	81	77.88	6.7
Foreign Authors	23	22.12	1.1
Total	104	100	

The study clearly showed that articles written by Indian toxicologists had more self-citations (77.88%) than articles written by foreign authors (22.12%). The habit of self-citation is common among Indian authors.

Fig. 5.9.3: Self-citation habit of Indian and foreign authors



5.9.8 Impact of number of citing authors on self-citations

Out of the total 459 number of single author articles, 58 (12.64%) were self-citing articles. The percentage of two authored, three authored and more than three authored self-citing articles were 11.26%, 9.2% and 4.8% respectively. Different categories of authors showing self-citation habits are provided in the Table 5.9.8.

Table 5.9.8 : Rate of self-citations in different categories of self-citing articles

Categories of authors	No. of self-citing articles	No. of citations	Rate or self-citations per articles (S/A)	% from total articles of the category	% from total self-citing articles	% from total articles
Single Author	58	172	2.97	12.64	55.76	4.76
Two Authors	34	69	2.03	11.26	32.69	2.79
Three Authors	9	20	2.22	9.2	8.65	0.74
More than three authors	3	4	1.33	4.8	2.9	0.25

5.9.9 Categories of self-citation

Among the different categories of articles, single author articles were referred most of the time. The single authors citing their own works were also maximum (38.86%) when compared to other categories of authors. The number of categories of self-citations provided by different types of self-citing articles are presented in the Table 5.9.9.

Table 5.9.9 : Categories of self-citations

Sl. No.	Categories of self-citations	No. of self-citation	% from the total self-citations	% from total citations
1	S/S	103	38.86	3.02
2	S/J	48	18.11	1.41
3	S/T	12	4.52	0.4
4	S/M	9	3.39	0.3
5	J/S	42	15.84	1.23
6	J/J	16	6.03	0.5
7	J/T	8	3.01	0.23
8	J/M	3	1.13	0.1
9	T/S	12	4.52	0.4
10	T/J	5	1.88	0.15
11	T/T	2	0.75	0.06
12	T/M	1	0.37	0.03
13	M/S	2	0.75	0.06
14	M/J	1	0.37	0.03
15	M/T	1	0.37	0.03
16	M/M	--	--	--

From the table it is clear that

S/S - Single author self-citing his/her own work, which he/she had written single - handed is 103 (38.86%),

S/J - Single author self-citing his/her own work, which had been prepared jointly is 48 (18.11%),

S/T - Single author self-citing article referred to his/her own article, which had been written by three authors is 12 (4.52%),

S/M - Single author self - citing article referred to his/her own article, which had been done by 4 or more than 4 authors is 9 (3.39%),

J/S - Two authors self - citing his/her own publications done single - handed is 42 (15.84%),

J/J - Two authors self-citing their own publications, which was written jointly is 16 (6.03%)

J/T - Two authors self-citing their own publications, which was written by three authors is 8 (3.01%),

J/M - Two authors self-citing their own publications, which was written by 4 or more authors is 3 (1.13%),

T/S - Three authors self-citing their own publications written single handed is 12 (4.52%),

T/J - Three authors self - citing their own publications written jointly by authors is 5 (1.88%),

T/T - Three authors self - citing their own publications written by three authors is 2 (0.75%),

T/M - Three authors self - citing their own work contributed by 4 or more author is 1 (0.37%), M/S - Four or more authors self-citing their own publications written single handed is 2 (0.75%),

M/J - Four or more authors self- citing their own publications contributed jointly by any two of the citing authors is 1 (0.37%),

M/T - Four or more authors self - citing their own publications contributed by any three of the citing authors is 1 (o.37%),

M/M - Four or more authors self - citing their own publications written by 4 or more than four citing authors is none ie. 0%.

5.9.10 Self - citation habits of single and two - authored categories in different journals

The self - citation habits of single and two-authored articles of different journals are shown in the Table 5.9.10. In all the journals, the S/S category of self-citations are more in number. S/T and S/M category of self-citations are less in number when compared with S/S and S/J category of self - citations.

Table 5.9.10 : Self - citation habits of single and two-authored categories in different journals

Name of the Journal	S/S	S/J	S/T	S/M	J/S	J/J	J/T	J/M
Toxicology	30	11	1	1	12	5	1	--
Toxicon	25	8	2	1	10	4	1	1
International Journal of Toxicology	20	4	2	--	4	--	--	--
Neurotoxicology	18	3	2	--	4	3	1	3
Ecotoxicology	10	5	3	1	5	3	1	--
Chemical Research in Toxicology	12	4	--	1	3	2	--	--
Environmental Toxicology	3	2	--	--	2	1	--	--
Chemosphere	1	1	--	--	2	--	--	--
Journal of Applied Toxicology	1	--	--	---	1	--	--	--

In the case of two authors self-citing their own publications, J/S category of self-citations stood first. J/M category of self-citations are very less in number when compared with the rest of the categories.

5.9.11 Self-citation habits of three and more then three-authored categories in different journals

The self-citation habits of three and more than three authored articles of different journals are shown in the Table 5.9.11. Three authors self-citing their own work contributed single handed, jointly or by three authors are less in number and by four or more authors became very less. More than three numbers of authors self-citing their articles were very less.

From the analysis, it is crystal clear that the works of a single author had been self-cited in the later years in the articles written by the author, either single handedly or as co-authors.

Table 5.9.11: Self-citation habits of three and more than three-authored categories in different journals

Name of the Journal	T/S	T/J	T/T	T/M	M/S	M/J	M/T	M/M
Toxicology	4	1	1	--	--	--	--	--
Toxicon	3	--	1	--	1	--	--	--
International Journal of Toxicology	2	1	--	--	--	--	--	--
Neurotoxicology	1	--	--	--	--	--	--	--
Ecotoxicology	2	1	--	--	1	--	--	--
Chemical Research in Toxicology	1	--	--	1	--	1	--	--
Environmental Toxicology	--	--	--	--	--	--	1	--
Chemosphere	--	--	--	--	--	--	--	--
Journal of Applied Toxicology	--	--	--	--	--	--	--	--

5.9.12 Year-wise distribution of categories of self - citations

The year-wise distribution of categories of self-citations are provided in the Table 5.8.16. The S/S category of self-citations showed a sharp increase in the year 2003 (38), the rate of self-citation showed a steady increase from the year 1999 to 2003 (5,10, 18, 22, 27 and 38). The S/J category of self-citations had remarkably increased from 1999 to 2003. (3, 4, 5, 7, 9 and 10). But other types almost remained the same. In T/M, M/S, M/J, M/T and M/M categories, the number of corresponding articles became very less during the years 1999 to 2003. This analysis indicated a clear cut evidence that the authors did not give much priority to cite collaborated works in their articles.

Table 5.9.12 : Year wise distribution of categories of self - citations

Year	S/S	S/J	S/T	S/M	J/S	J/J	J/T	J/M	T/S	T/J	T/T	T/M	M/S	M/J	M/T	M/M
1998	5	3	--	1	11	4	--	1	3	1	--	--	1	--	--	--
1999	10	4	2	--	--	3	--	1	--	--	--	--	--	--	--	--
2000	18	5	2	--	5	1	1	1	--	--	--	--	--	--	--	--
2001	22	7	1	1	12	1	--	--	2	--	1	--	--	1	--	--
2002	27	9	2	--	6	4	2	--	2	1	--	--	1	--	--	--
2003	38	10	3	2	9	5	1	1	6	1	1	1	--	--	1	--

5.9.13 Sequence of cited authors

To study the sequence of authors and self-citations, all the multiple authored self-cited references were individually analysed with that of citing authors to determine the number of cases, where first, second and third or all the authors were self-cited. The cases of multiple authors were also derived. The sequence of cited authors and self-citations are given in the Table 5.9.13.

Table 5.9.13 Sequence of cited authors and self-citations

Sequence of cited author	No. of citations in multiple author articles	Percentage from total self citation of multiple author article	Percentage from total self citations
First author	80	61.54	30.18
Second author	18	13.85	6.79
More than one author	11	8.46	4.15
All the authors	21	16.15	7.92
Total	130	100	49.04

Out of the 120 self-citations, 80 (61.54%) citations belonged to the first author only. In all the categories of cited articles written by multiple authors, the first author had the highest number of self-citations. This may be due to the fact that first authors are generally more experienced, accepted and influential personalities in the concerned subject field. The second position was occupied by articles written by all the cited authors 21 (16.15%).

5.9.14 Self-citing articles in different journals

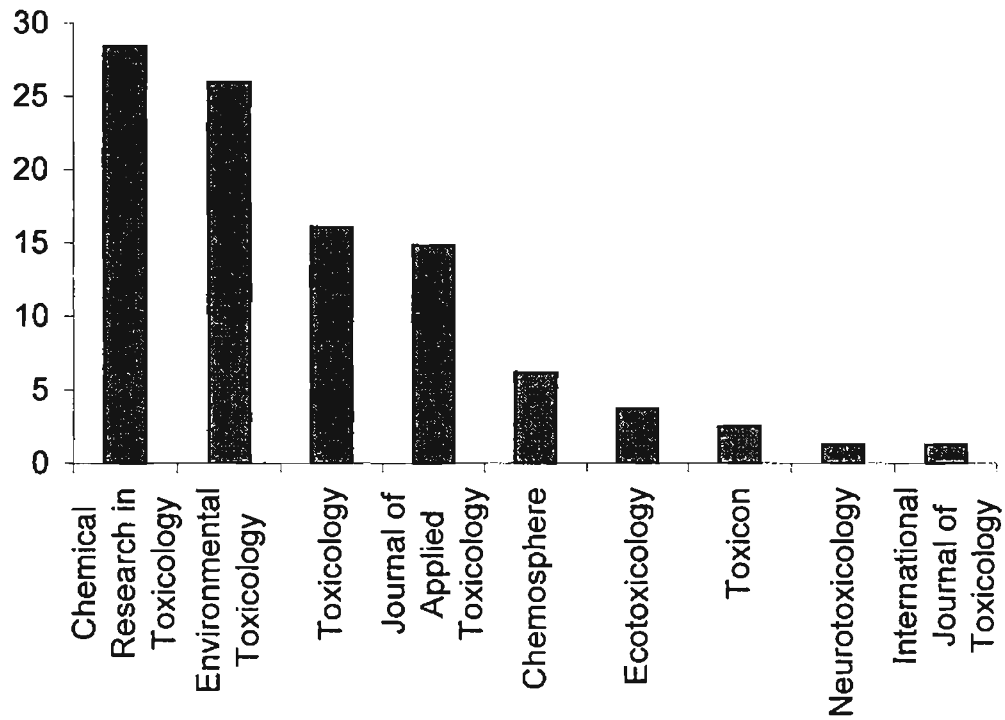
Out of the total 1218 articles 81 (6.7%) were self-citing articles. The journal 'Chemical Research in Toxicology' had got highest number of self-citing articles, 23 (28.39%) followed by 'Environmental Toxicology' 21 (25.93%) articles.

Table 5.9.14: Self-citing articles in different journals

Rank	Name of the Journal	Number of self-citing articles	% from self citing articles	% from total articles of the specific journal
1	Chemical Research in Toxicology	23	28.39	6.78
2	Environmental Toxicology	21	25.93	11.41
3	Toxicology	13	16.04	9.92
4	Journal of Applied Toxicology	12	14.81	9.91
5	Chemosphere	5	6.17	4.46
6	Ecotoxicology	3	3.7	2.88
7	Toxicon	2	2.5	2.17
8	Neurotoxicology	1	1.23	1.96
9	International Journal of Toxicology	1	1.23	1.19
	Grand Total	81	100	

The journal 'Toxicology' had got third position i.e. 13 (16.04%) self-citing articles followed by 'Journal of Applied Toxicology' 12 (14.81%), 'Chemosphere' 5 (6.17%), 'Ecotoxicology' 3 (3.7%) and 'Toxicon' 2 (2.5%) of self -citing articles. The minimum number of self-citing articles were reported in two journals 'Neurotoxicology' and 'International Journal of Toxicology' having one article each (1.23%). The self-citing articles in different journals are shown in the Table 5.9.14.

Fig. 5.9.4: Self-citing articles in different journals



5.9.15 Year-wise self-citing articles

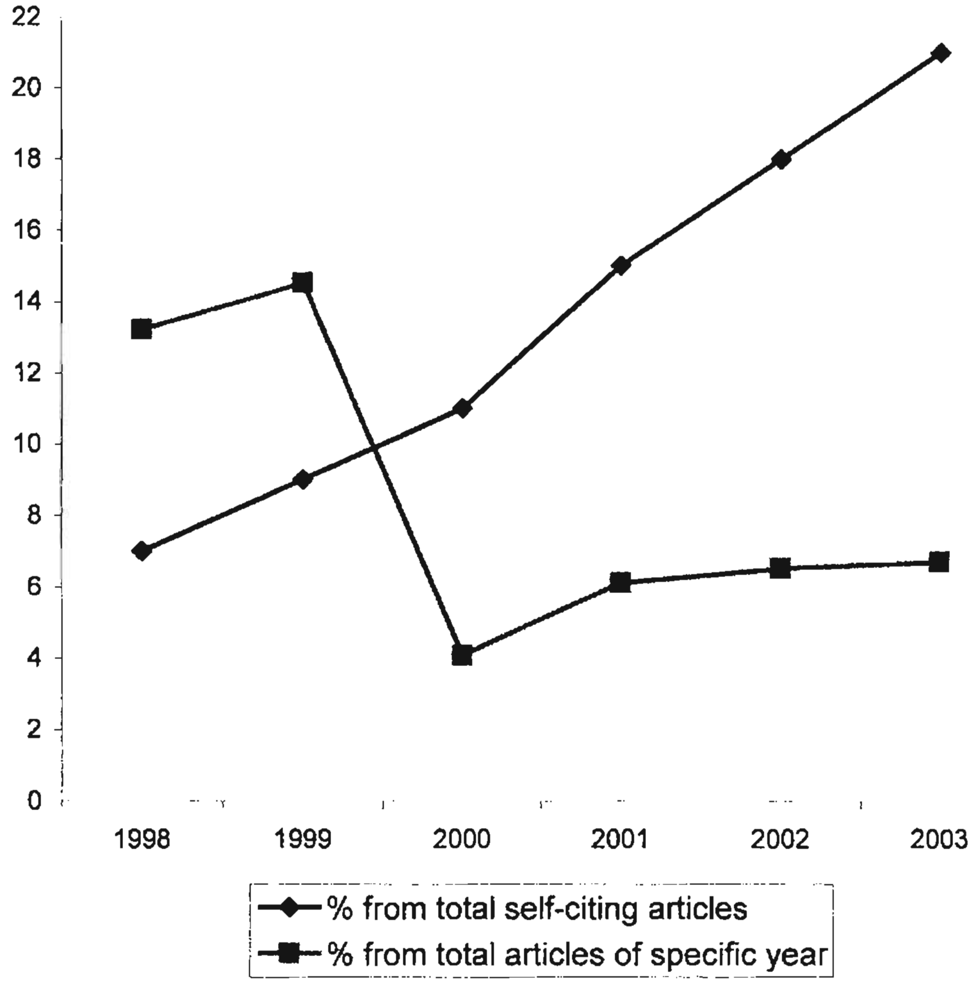
The analysis of year-wise self-citing articles showed that there was an increasing growth in the number of self-citing articles as the years pass.

Table 5.9.15 : Self-citing articles during 1998 - 2003

Year	Number of self citing articles containing self-citations	Percentage from total self-citing articles	Percentage from total articles of specific year
1998	7	8.64	13.21
1999	9	11.11	14.52
2000	11	13.58	4.07
2001	15	18.52	6.12
2002	18	22.22	6.54
2003	21	25.93	6.71
Grand Total	81	100	

The minimum percentage of self-citing articles were available in 1998 (8.64%). The next years showed a steady increase in the percentage of self-citing articles i.e. in 1999 the increase is 11.11 %, in 2000, 13.58 % in 2001, 18.51 % in 2002, 22.22% and in 2003 the maximum number of self-citing articles appeared i.e. 21 (25.93%).

Fig. 5.9.5: Year-wise trend of self-citing articles



CHAPTER - 6

FINDINGS, AREAS FOR RESEARCH AND CONCLUSION

CHAPTER - 6

FINDINGS, AREAS FOR RESEARCH AND CONCLUSION

6 Introduction

The culmination of the study, resulted in the formulation of certain number of findings. The findings correlating to each objective are furnished below :-

6.1 Findings

Objective - i - To assess the growth and development of Toxicology literature

1. Toxicology is one of the oldest field in Medicine.

2. Toxicology borrowed ideas freely from the principles of Chemistry, Biochemistry, Physiology, Pathology, Pharmacology, Forensic Medicine, and Veterinary Science for its growth and development.

3. Toxicology is recognized as a transdisciplinary subject.

4. Today Toxicology became an important field of research all around the world.

5. Ebers papyrus (Circa 1500 B.C.) was the earliest medical record contains information about toxin. The founder of Toxicology is Matlieu Joseph Bonaventura Orfila, a Spanish Physician.

6. Rapid development in Toxicology occurred during 20^{th} century.

7. The first journal in Toxicology, "Archiv fur Toxicologie, was published in 1930's from Europe.

8. The multidisciplinary nature of Toxicology has led to the publication of many journals books, reviews, reports, patents etc.

9. The publication of conference proceedings increased every year.

10. Number of scholarly textbooks and reference books were available in Toxicology as referred in page 144 to 147.

11. Subject dictionaries, handbooks, thesauri, indexing and abstracting services, monographs, treatises, bibliographies, review of progresses were available as secondary sources (page 147 to 158).

12. Eminent scientists, organisations, institutions were authoritative sources in gathering information in Toxicology.

13. Filmstrips, microforms, slides, transparencies, videotapes were available in subjects of public interest in toxicology as well as on traditional topics. The recent developments on Toxicology can be viewed through the above sources.

14. New letters contribute a major role in the development of toxicology literature as seen in page no.165 to 168.

15. Rank high among the scientific discipline, popular books constitute a major literature aimed at common man listed as in page 168 to 171.

16. The field of Toxicology has witnessed unprecedented growth with the past 25 years. The explosion in subject matter is large from social concerns as well as by rapid technology innovation.

17. Out of fourteen online databases only four were having international coverage. Most of them were published form U.S. Online databanks include three.

18. More than 100 journals publish articles related to Toxicology. About 110 U.S. Schools offer courses or programmes in Toxicology.

19. The vendors such as BRS, DIALOG and SDC provided an array of information resources that cover the entire spectrum of the published scientific and technical information in Toxicology.

20. Major areas of toxicology are environmental, economic and medical toxicology.

21. The rate of citation per article varied from 6.65 to 0.83.

22. An increasing trend among the number of citing articles and simultaneous decreasing trend among the number of non-citing articles.

23. The value of relative growth rate and doubling time of citations pointed out a logistic pattern of growth of citations in Toxicology literature.

24. The saturation in the number of publications had almost been attained. Within a few years the growth of publications would follow the logistic pattern of growth.

Objective - ii - To analyse the literature scatter employing standard variables in informetrics.

25. Regarding the subject dispersion in citations, out of the 20 subject divisions, as in page no.236 maximum number of citations were from Toxicology (21.94%) and minimum citations were reported form the area of Marine Sciences (0.23%).

The second position was occupied by the subject Environmental Sciences (15.72%).

General aspects of Toxicology and Environmental Sciences are the thrust areas of study. Scientists and researchers are utmost alert in the toxicological aspects of environmental issues, the literature of this area occupied a prominent place in toxicology study. Besides the traditional subject areas, newly emerging fields like Food toxicology, Biotechnology, Marine Science found keen positions i.e. along with the growth of traditional components of Toxicology, other specialised areas are also getting popularity.

26. The subject dispersion of book citations showed that books on general aspects of Toxicology came in the first position (33.82%) followed by Environmental Science (18.91%) etc.

    Besides the books on their basic subject, toxicologists also refer to a great extent book of other allied subjects due to the transdisciplinary nature Toxicology.

27. Subject dispersion of journals showed that core journals are in the field of 'Toxicology (30.51%) and 'Environmental Science' (18.64%). Scientists all over the world are more alert in the environmental and toxicological effects that not only affect our planet but also the human beings, plants and animals. As Toxicology is an interdisciplinary subject articles of general interest are published in journals having broad coverage in subjects like Biology, Pathology and Pharmacology.

Objective - iii - To identify prominent areas of research in Toxicology

28. Minimum citations were reported from the areas of Marine Sciences, Medical Sciences, Drug Medicine, Analytical

Chemistry, Applied Chemistry, Human Ecology, Fresh water Ecology, Pharmacology, Biology, Pathology, Food Toxicology, Human Anatomy, Biochemistry, Zoology, General Science, Genetics, Biotechnology, Agriculture.

Besides the traditional subjects areas, newly emerging areas like Food Toxicology, Marine Sciences, Biotechnology found keen positions. This is a clear indication that along with the growth of traditional components of the subject, other specialised areas are also getting popularity.

29. The books coming under the category of general aspects of Toxicology came in the first position (33.82%) followed by books dealing with Environmental Sciences. Next positions were occupied by Medical Sciences, Chemistry, Ecology, Pharmacology, Biology, Pathology, Food Sciences, General Sciences, and Human Anatomy.

    Besides the books on their basic subject, toxicologists also refer to a great extent book of other allied subjects. This revealed the transdisciplinary nature of Toxicology.

30. Most of the core journals are in the field of Toxicology (30.5%) and Environmental Science (18.64%) other subjects which came in order are Chemistry, Medical Sciences, Ecology, Biology, Pathology, Food Sciences and Anatomy.

    The subject scatter showed the value of journals in the interdisciplinary subjects like Environmental Sciences, Medical Sciences, Chemistry, Ecology, Biology etc in the field of Toxicology.

31. The distribution of citation by subject of most cited 50 core journals, the subject 'Toxicology' came in the first position with 24 journals and maximum citation (49.36%) followed by

Environmental Sciences with 9 journals and with 8.55% of citations. Other subjects which got a position in the list are Medical Sciences, Chemistry, Ecology, Pharmacology, Biology, Pathology, Food Sciences and Anatomy.

The prominent areas of research in Toxicology were general Toxicology and Environmental Sciences. The newly emerging research areas were in Marine Sciences, Drug Medicines, Analytical and Applied Chemistry, Human Ecology, Fresh water Ecology, Pharmacology, Pathology, Food Toxicology, Biotechnology and Agriculture.

The citations from the 59 core journals were on subjects closely related to Toxicology.

Objective - iv - To study the authorship pattern

32. The personal author works predominate in toxicology literature. The publications by corporate bodies and anonymous works were less when compared to personal authors. The extent of collaboration was much less.

33. The value of group co-efficient for publications (g_p) was 0.73. The degree of collaboration among co-authors was maximum in articles written by more than three persons and minimum in two author publications.

34. The value of group co-efficient for citations (g_c) was 0.75. The degree of collaboration was maximum in more than three authored citations and minimum in two authored citations. Research in the field of Toxicology was predominant by team research. As a multidisciplinary field scientists and researchers from other fields contribute their knowledge and prefer more to teamwork than solo.

35. The year-wise analysis of value of group co-efficient for citation (g_c) for single author works showed maximum (0.48) in the year 2002. In the case of three authored citations, the maximum value of g_c (0.49) was observed in the year 2002 and in more than three authored citations, the maximum value of 'g_c' (0.61) was also observed in the year 2002.

    The year 2002 and 2003 witnessed the emergence of citations which were have collaborative nature.

36. The rate of citation of single and collaborated authors showed two authored articles had maximum citation rate (1.84) and more than three authored articles had got minimum citation rate (1.4).

    As the number of persons increases in a work, the rate of C/A decreases i.e. the joint authors will have a lesser number of citation rate.

Objective-v -To analyse the type of language and documents cited

37. English was observed to be the most dependable language. The majority of the citations were form the documents published in English language. This trend has been observed in other science subjects also. Authors from non-english speaking countries especially from developing countries are writing in English to get a vast spectrum of readership. The dominant use of English language in Toxicology literature may be due to the fact that English is still the common language of communication among toxicologists and to the problem in accessibility of literature written in regional languages and ignorance of regional languages.

38. Among the types of documents cited, journal articles contributed maximum, books and conference proceedings occupied next positions.

The years 1998 to 2003 marked the emergence of conference literature in Toxicology. More than 10% of total literature comprises of conference/symposia documents. The proceedings of conferences are becoming very important today. Such a communication channel is more effective and speedier, though restricted only to research by conference participants, than publication of ideas in primary journals. Thus the journal articles, books and conference proceedings constitute 94.72% of the total toxicology literature.

Objective - vi - To examine how far the literature scatter satisfy the existing laws of informetrics

39. The core books in Toxicology were placed in 28 different ranks. Within the first 12 ranks, only 12 books were available which covered 25.89% of the total book citations. More than 60% of the citations were referred by about 213 books. The Casarett and Doull's Toxicology: The basic science of poisons, edited by Dull,J. topped the first rank. When the cumulative number of citations were plotted against the number of books on a semi-log graph, it is seen that the typical Bradford's curve initially rising and then became linear.

The first 20 books described against the serial number 1 to 20 may be the core books in Toxicology. There is only a small number of books *in Toxicology literature was covered within the core group and there still remained quite a large amount of book* literature was scattered over a huge number of books. Hence the core book phenomena is not fully satisfied.

40. The scientific productivity of core authors showed that in lower ranks more number of authors were available than in the upper rank. The first five positions in the rank were occupied by C.J. Price (3.48%), R.W. Chadwick (1.78%), J. Ashby (1.00%), J.D. George (0.92%), J.R. Reel (0.83%).

41. The citations of authors almost followed the typical Bradford's hyperbolic curve. The analysis revealed that the 11 core authors contributed only 11.57% of the total author citations which is a clear indication that core concept was not fully applied to these authors.

42. The Lotka's Law is applied to author productivity and found that the observed percentage of authors varied from the expected percentage of authors as predicted by the law when chi-square test was applied, the calculated Chi-square value (228.54) was more than the table Chi-square value i.e. 18.3 at a degree of freedom 10, level of significance $\alpha = 0.05$. The Chi-square value was highly significant and Lotka's law cannot be applied to this data.

43. The core journal data tested by Bradford's theory found 2308 (1/3) citations were contained in 5 journals, 4616 citations in 15 journals and 6922 citations in 59 journals. The value of n^2 is found to be 4 whereas it comes to 8.8. Bradford law does not confirm to the study.

Objective - vii - To examine the literature scatter in Toxicology in the light of laws of informetrics and suggests deviation if any.

44. In the case of number of paper of the authors, the expected values were not close to the observed values, hence Lotka's law does not fit for the study.

The law can be extended as

$$f\left(y^2\right) \approx \frac{A}{y^2 + (y-1)} = \beta$$

Where 'A' and 'β' are constants and 'y' is a number of papers.

When Bradford's law is applied to core journals, the value of 'n^2' is found to be 8.8.

Hence the law can be extended as **1 : n : 4n**

6.1.1 Other findings

Bibliographic Coupling

45. The journal "Toxicology" had highest percentage of articles (15.3%) which had common citations, i.e. 10 pairs.

    The journals 'Toxicology, Environmental Toxicology', 'Journal of Applied Toxicology', 'Chemosphere', Ecoxicology' and 'Chemical Research in Toxicology' had published articles whose basic subjects were mostly similar nature in individual volumes, because of high rate of common bibliographic entries. But the rest of the journals 'Toxicon', 'International Journal of Toxicology' and 'Neurotoxicology' had published articles whose subject coverage were mostly different in nature in individual volumes, because of their low rate of common bibliographic entries which gave us an indication that the articles published in individual volumes were mostly distantly related.

46. Every year some of the articles published in the different journals of Toxicology had little similarities in relation to their subject content. There was no fixed trend in the development of number of bibliographically coupled articles in different journals in Toxicology.

47. The maximum pair of articles (33) were reported when the bibliographic coupling strength was 1. The number of coupled articles decreased as the coupling strength increased. Only one pair of article was available when there were five common citation entries.

    Few of the articles had perhaps some similarities and the rest of the articles were not related to their original subject content. The strength of bibliographic coupling was very weak because only few articles were having more than 5 common citations i.e. each of the volumes of the journals, published articles are of trans-disciplinary nature which belong to different areas of research. Hence the diversity and transdisciplinary nature of Toxicology can be evident from this analysis.

Self-citation

48. Maximum number of self-cited articles were published in journals (121) followed by books(51). The number of conference proceedings self-cited were 42 which came almost nearer to the percentage of total citations when compared with unpublished dissertations/ theses.

49. In comparison to other subjects such as Physics, Life Sciences and Botany, the rate of self-citation in Toxicology is not very low (7.87%). The authors in the field of Toxicology conduct researches based on their previous work or continuation of the first work.

50. The growth in the number of self-citations showed a steady increase. This increase in self-citation during the last 6 years revealed the development of Toxicology as a transdisciplinary subject.

51. Repetitiveness of self-citations were observed to be very less (10.18) in Toxicology journals. Out of the 13 documents repeatedly self-cited, 10 (76.92%) had been cited two times and 3 (23.08%) had been cited 3 times each.

    Most of the self-cited articles were not so much similar in their content to the citing article. This trend can be observed only in subjects having tremendous multi-disciplinary growth. Like in Toxicology, active R & D results new and new discoveries and as a by product nascent literature are producing every year.

52. Regarding the age of self-citations, maximum number of self-citations were found within two years (17.74%) and minimum after ten years (2.64%).

    As the age of self-citation increase, the number of self-citation decrease. Maximum number of self-citations were made within 5 years of the publications or occurrence. The age of self-citations was an important factor which highlighted the probable reason of self citations. Scientists, researchers of high scientific productivity came under this category. If the self-citations are of recent origin it usually points of to the fact that the work is an extension of the author's previous work, which he is presently doing. As maximum number of self-citations were found within two years, it can be concluded that most of the works in the field of Toxicology doing presently are extension of previous works.

53. Recently self-citation with five major categories of authors, maximum number of reference belonged to very recent group. Recent articles had more chances to be self-cited then the older ones.

54. Indian toxicologists had more self-citations (6.7%) than foreign authors (1.1.%). More number of Indian authors like to self-cited

than by foreign authors i.e. self-citation is more among Indian authors than foreign authors.

55. The number of multiple authors articles published were less when compared with single author cases, the self-citing articles in multiple authors cases were more in number. In three author cases, the rate of self-citation per article was more than that in the case of two authors and more than three authors. When the number of authors were more, the number of individual works became more and there were more chances to cite their earlier works. Co-author works contained more number of self-citations than single author. As there are more number of authors in an article, there are more chances of self-citations.

56. Among different categories of self-citations single author works were self-cited in maximum number.

57. Year-wise analysis of self-citing articles revealed that maximum number of self-citing articles (25.93%) appeared in the year 2003 and minimum (8.64%) in the year 1998.The self-citing tendency is increasing among authors as years pass.

58. The third author did not have any self-cited articles. The absence of third author citations may be due to the fact that while giving citations, authors had given priority in selecting articles of first and second citing author only or all the authors but not the article of third author alone. The works of the third authors were generally not considered for the extensive study and hence did not get any citations. Thus the authors are senior, authentic and experienced have got a large number of publications to their credit.

Core Journals

The rank list of 59 journals most cited, have an international coverage and based their study the following findings were done.

59. The librarians and information mangers working in libraries specialising Toxicology can effectively use the core list for acquisition of journals. Along with the growth of Science and Technology and increase in the number of scientific journals and cost no library is self sufficient in the procurement of journals.

60. Scientists and researches working in the field of Toxicology can be made aware of the core journals. So that they can publish their research results in these journals and can get a wider exposition.

61. In certain areas of Toxicology only a few journals were available. Publishers can be informed of the core journal list so that they can assess the weaker areas and can start new journals.

62. There was a wide variation in the number of citations received by top ranking journals. Journals receiving more than 100 citations are 19 in number, which have a total of 5040 citations i.e. 72.81/% of the citations received by the core journals.

    The relevant articles in the field of Toxicology are concentrated in a few journals while increasing number of less related journals are in circulation.

63. The percentage of cumulative journals and citations showed that it does not conform the 80/20 rule. The 20% (11 Nos.) of journals from 2% (149 Nos.) of citations or 80% (47 Nos.) of journals contain 40% (2790 Nos.) of citations.

In Toxicology the relevant articles are scattered in a variety of journals which are cited frequently by researchers.

64. The journal "Toxicology" with 33 issues per year is ranked first while 'Toxicon' with monthly periodicity stood second. The journal, 'International Journal of Toxicology' with bi-monthly periodicity was ranked in the third position. Ranking of most cited journals by year of origin found that from 1970's a total of 20 titles were started, 1980's witnessed the origin of same number of titles.

    The increase in the number of journals during this period indicated the emergence of new branches of toxicology i.e. medial, environmental and economic toxicology. The core journals in Toxicology originated in the 20^{th} century which showed the rapid development of the subject during the period.

65. U.S. was found to be the most productive country with 28 journals (47.45%) and U.K. in the second position with 12 journals (20.34%). Only one journal from India was seen in the rank list.

    The vast and quick progress of research and development in the field of Science and Technology in U.S. and U.K. led to an increase in the number of journals published from the above two countries. The developed countries stood forefront in publishing journals of international reputation because they have all facilities for research, communications, education etc. than the developing countries like India, Japan, China etc.

66. Age of journals cited was calculated as 5.7 years The journals became obsolete after this period. The low age may be due to increased research and development in the field of toxicology which results in the discovery and publication of new research

out put. Median citation age plotted in graph showed the low age which is an indication that this is a growing subject. Rapid obsolescence is directly proportional to high popularity of the subject.

6.2 Tenability of Hypothesis

The data collected form TOXLINE were analysed with appropriate statistical tools and the results derived were drawn out and summarized as the findings of the study. In the light of the major findings, tenability of the hypothesis was tested. The following statements are the outcome of the testing of the hypothesis.

1. Bradford's Law was applied to core journals, the value of n^2 was found to be 4, where as it came to 8.8. Bradford Law did not fit for the study.

   The expected values were not close to the observed values, hence Lotka's Law did not confirm for the study. Thus Toxicology literature will not satisfy the existing laws of informetrics.

2. The age of journals in Toxicology is calculated as 5.7 years. Increased research and development in this field account for this low age. After this period the journal article became obsolate. Hence the obsolescence or aging of journals in Toxicology is quick. In Biochemistry the age of journals is calculated as 8.3 years.

3. According to 80/20 rule, 20% of the journals must contain 80% of citations. Whereas in the present study 20% of journals form only 2% of citation. But the percentage of cumulative journals and citations does not conform the rule. 80/20 rule is not applicable to Toxicology.

4. U.S. and U.K. account for the publication of 40 international journals in Toxicology. Online databases on Toxicology are mostly

published from U.S. Thus input of literature in Toxicology is mostly produced from developed countries.

6.3 Areas for Research

1. Hypertext Links

Citation concepts have been applied to hypertext systems. Citation analysis methods have recently been applied to the Web environment. The term 'citation' has been used by Rousseau to represent a hypertext linkage between Web sites, to distinguish between citations received by published works and hypertext linkages between two documents. The domain names and links between Toxicology web sites may be adequately modelled with a Lotka's distribution.

2. Web impact factor

The concept of Web impact factor proposed by Ingwersen can be applied to Toxicology literature, where the Web site and its individual pages correspond to journals and articles. The impact factor is calculated as the number of link pages pointing to a given site/domain, both the external and internal link, divided by the number of pages on a given Web site. The Toxicology Web impact factor may serve a an indicator of a Toxicology Web site's significance.

3. Co-word studies

Co-word analysis has been used to determine the strength of relationship among textual-containers, i.e. full-text documents, their surrogates, fields within documents, or queries submitted to Toxicology information retrieved systems. Co-occurrence analysis of document content is usually performed on substantive keywords appearing in a Toxicology bibliographic database record field such as the title, description, or abstract. The results of co-word analysis can be mixed depending on the application.

4. Electronic Resource Usage

Now-a-days electronic resource usage extend to records accessed within databases, or hits on Web sites. Many issues associated with usage of electronic resources, particularly on the Internet, remain to be explored. In the same way Toxicology Websites can be analysed to study their use.

5. Literature growth of Toxicology Information Retrieval systems

Like growth studies applied to literature, the same methods may be applied to the growth of indexes in Toxicology information retrieval systems. Growth investigations may focus on different components of an information retrieval system i.e. rate of document growth, growth of terms to the index, growth in the number of Web servers etc. Document growth is measured by the number documents indexed over time i.e. monthly, yearly. Index growth can continue at higher rates in distributed environments as in Web. Internal growth studies on Toxicology Web sites help to assess number of Toxicology Web sites, pages and search services available in the field.

6. Science Indicators Policy Development

The results of this informetric study can lead to recommendations for science policy of a country. Informetric measures such as citations, publication productivity, author productivity are core scientific indicators. The policy development can extend to more regional or local applications.

7. Generalized Distribution for Informetric Modelling

A simple visual inspection of equations used in informetrics reveal that many of the 'reverse J-shaped' models used in different areas of informetrics are very similar to one another. The models developed for specific data measures may be generalized so that a unified approach may be adopted when undertaking informetric research. In future by taking commonalities between different informetric phenomena, relatively simple models developed for specific data types evolve into more sophisticated models with additional parameters to make models more flexible for a broader range of data.

Most of the univariate informetric models have taken into account the influence of important contributing factors such as time on the resulting distribution. But multivariate models, in which one variable is dependent on one or more other variables, can deal with changes in distribution shapes over time. This will form a milestone in the future of informetrics. The comparative newness and broad usage of information environments such as the web and communication tools informetric models can be applied.

6.4 Conclusion

In recent years Library and Information Science field has witnessed a large number of informetric studies where data was collected from particular subject area. Invariably the studies attempted to analyse the data using certain number of parameters and concluded whether the fundamental laws in informetrics are in conformity with the existing data. Very rarely some researchers have seriously taken the problem to the extend of extending the existing laws. Whatever extensions suggested by the researchers were not very popularly known to the profession. Because of the IT developments sufficient data can be derived for informetric analysis from the Web. As a result of wide scale interest in electronic information access and use facilitated by the Internet, informetric analysis can legitimately hope to derive new fundamental laws in the field in future. The present study could derive formulae for the extension of the Bradford and Lokta's laws, how far they can be applied to other fields collecting data form the Web, is a matter for future research. This study has ample scope for research in this direction.

APPENDICES

APPENDIX - I

CORRELATION OF BOOK & JOURNAL CITATION

Determination of correlation Coefficient

Book citation during 1998 to 2003 denoted by 'y'
Journal citation during 1998 to 2003 denoted by 'x'

S1. No.	X	Y	X^2	Y^2	XY
1	304	104	92416	10816	31616
2	945	165	893025	27225	155925
3	1002	196	1004004	38416	196392
4	1218	208	1483524	43264	253344
5	1452	245	2108304	60025	355740
6	2001	256	4004001	65536	512256
Total	6922	1174	9585274	245282	1505273

$$\bar{x} = \frac{\Sigma x}{n} = \frac{6922}{6} = 1153.6667 \ ; \qquad \bar{y} = \frac{\Sigma y}{n} = \frac{1174}{6} = 195.6667$$

$$r = \frac{Cor(x,y)}{\sigma x . \sigma y} = \frac{\frac{1}{n}\Sigma xy - \bar{x}\,\bar{y}}{\sqrt{\left(\frac{1}{n}\Sigma x^2 - \bar{x}^2\right)\left(\frac{1}{n}\Sigma y^2 - \bar{y}^2\right)}}$$

$$= \frac{\frac{1505273}{6} - (1153.6667 \times 195.6667)}{\sqrt{\left[\frac{9585274}{6} - (1153.667)^2\right]}\sqrt{\left[\frac{245282}{6} - (195.6667)^2\right]}}$$

$$= \frac{250878.8333 - 225734.1561}{\sqrt{266598.812 \times 2594.8758}} = \frac{25144.6772}{\sqrt{691790805.6}}$$

$$= \frac{25144.6772}{26301.9164} = \underline{\underline{0.956001715}}$$

APPENDIX - II

REGRESSION VALUE OF JOURNALS (x) AND BOOKS (Y)

S1. No.	Year	No. of Journals cited (x)	Regression value x on y i.e. x $x = \bar{x} + 9.69 \times (y - \bar{y})$	No. of Books cited (y)	Regression value of Y on x i.e. Y= $y = \bar{y} +$ $0.0943 \times (x - \bar{x})$
1	1998	304	265.42	104	115.54
2	1999	945	856.51	165	176
3	2000	1002	1156.90	196	181.36
4	2001	1218	1273.18	208	201.73
5	2002	1452	1631.71	245	223.8
6	2003	2001	1738.30	256	275.57
Total					

$\bar{x} = 1153.667$; $\bar{y} = 195.6667$

$\Sigma x^2 = 95885274$; $\Sigma y^2 = 245282$

r = 0.956

$$b_y = r \times \frac{\sigma y}{\sigma x} = \frac{0.956x50.94}{516.332} = 0.943$$

$$b_x = r \times \frac{\sigma_x}{\sigma_y} = \frac{0.956x516.332}{50.94} = 9.69$$

APPENDIX - III

GENERAL BIBLIOGRAPHY

A. Books

1) Broadus, R.N. : The applications of citation analysis to library collection building. Advances in Librarionship.Vol.7.New York : Academic Press,1997 .

2) Braun.T., Glanzel,W. and Schubert, A. : Scientometric indicators A 32 country comparative evaluation of publishing performance and citation impact. Singapore : World Scientific Publishing Company,1985.

3) Buckland, M.K. : Book availability and the library user. New York : Pergamon Press, 1975.

4) Donhue, J.C. : Understanding scientific literature: A bibliometric approach. Cambridge : MIT Press, 1972.

5) Fano, R.M. : Bibliographic coupling: In documentation in action. New York: Reinhold, 1956.

6) Fano. R.H. : Documentation in action. New York : Reinhold, 1956.

7) Fellee, W. : An introduction to probability theory and its application Ed.3 (Vol.1) New York : John Wiley and Sons, 1978.

8) Feller, W. : An introduction to probability theory and its applications Ed. 2 (Vol.2) New York : John Wiley and Sons, 1979.

9) Fussler, H. H. and Simon, Julian C. : Patterns in the use of books in large research libraries. Chicago : University of Chicago, 1969.

10) Garfield, E., Sher, I. H. and Thorpie. : The use of citation data in writing the history of science. Philadelphia :Institute of Scientific Information, 1964. 76 p.

11) Garfield, E. : Essays of an Information Scientist forward by Joshwa Ledeberg, Philadephia : ISI Press, Vol.I.1962-1973, Vol.2. 1974-1976.

12) Garfield, E. : Citation Indexing . New York : John Wiley,1979.

13) Goffman, W. and Warren, K.S. : Scientific information systems and the principle of selectivity. New York : Prager Press, 1980.

14) Guha, B. : Documentations and information services techniques and systems. Ed. 2. Calcutta: World Press, 1984.

15) King, D.W. : Statistical indicators of the scientific and technical communication. Vol.1.Rochwille : King Research Inc., 1976.

16) Martyn, J. and Gilchrist, A. : An evaluation of British scientific periodicals. London: ASLIB, 1968.

17) Meadows. A.J. : Communication in science. London: Butterworths, 1974.

18) Mehard, H.W. : Science growth and change. Massachussets : Hard Ward University Press, 1971.

19) Merton, R.K. and Garfield, E. : Forward to little science, big science and beyond by D J de Solla Price. New York : Columbia University Press, 1963.

20) Narin , F. : Evaluative bibliometrics :The use of publication and citation analysis in the evaluation of scientific activity. New Jersey : Computer Horizons, Cherry Hill,1976.

21) Nicholas, D. and Ritchie, M. : Literature and bibliometrics. London : Clive Bingley, 1978. 183p.

22) Price, D.J.S. : Science since Babylon. New Haven :Yale University Press,1961.

23) Price, D.J.S. : Little Science, big science. New York : Columbia University Press,1963.118p.

24) Pritchard, A. : Statistical Bibliography : An interim bibliography. London : New Western Polytechnic School of Librarianship, 1969.

25) Ravichandra Rao, I.K. : Quantitative methods for library and information science. New Delhi : Wiley Eastern, 1983.

26) Rowley, J.E. and Turner, E.M.D. : Dissemination of Information. London : Andre Deutsch (Grafton Books),1978.

27) Sardana, J.L. and Sehghl, R.L. : Statistical methods for librarians. New Delhi : Ess Ess publications,1982.

28) Sengupta, I.N. : Bibliometric research Vol.I. Growth of biomedical literature. Calcutta : SBA Publications, 1988. 366 p.

29) Subba Rao, C.V. : Librametry : Case studies . New Delhi : ABC Publishing House, 1993.

30) Tagliacozzo, R. : Citations and citation indexing : Its theory and applications in Science, Technology and Humanities. New York : Wiley, 1967.

31) Zipf, G.K. : Human behaviour and the principle of least effect. New York : Addison Wesley,1949.

B. Theses and Dissertations

32) Chung, Young M. :A non-Bradfordian model for scattering of articles in a subject among periodicals. Ph.D. Thesis, U.S.A. : Case Western Reserve University, 1977.

33) Cline, G S. : A bibliometric study of two selected journals in library science. 1940-1974. Ph.D. Dissertation. University of Southern California.

34) Finney, B. : The reference characteristics of scientific texts. M.Sc. Dissertation, London. Centre for Information Science, City University, 1979.

35) Gosnell, C.F. : The rate of obsolescence in college library book collection. Ph.D. Dissertation, New York University,1943.

36) Hodges, T. : Citation indexing its potential for bibliographic control. Ph.D. Thesis. Berkeley : University of California, 1978.

37) Maheswarappa, B.S. : Characteristics of phytopathology literature : A bibliometric study based on primary phytopathology periodicals (1965-85). (Ph.D. Thesis), Gulberga University, Dept. of Library Science, 1992.

38) Narendra Kumar, P. : An international bibliometrics survey of periodical articles on bibliographical control . MLISc dissertation. Bangalore University,1994.

39) Parker, C.B., Paisely, W.J. and Garrett. R. : Bibliographic citations as unobstructive measure of scientific communication. Institute for Communication Research .Stanford :Stanford University,1967.

40) Parvathamma, N. : Trends in the growth of Indian earth science literature (1978-88): A bibliometric study. (Ph.D. Thesis). Gulberga: Gulberga University, 1990.

41) Ravichandra Rao, I.K. : Distribution of transactions over users and over documents in Canadian academic libraries (a dissertation proposal). London : School of Library and Information Science, The University of Western Ontario.

42) Ravichandra Rao, I.K. : Documents and user distribution in transaction records of Canadian University libraries. Ph.D. Thesis. Canada : University of Western Ontario, 1981.

43) Sangam, S.L. : Citation analysis of doctoral dissertations in social sciences accepted by the Karnataka University, Dharward during 1964-1982. (Ph.D.Thesis). Gulbarga: Gulbarga University, 1985.

44) Sengupta, I.N. : Bibliometric analysis of the impact of the growth of biochemical knowledge on other biological and medical sciences. Ph.D. Thesis. Dharwad : Karnataka University, 1983.

C. Articles

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

46) Abdulla, S.B. and Lancaster, F.W. : 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 :1991. pp.55-64.

47) Adeniran, O.R. : Bibiliometrics of Computer Science Literature in Nigeria. International Library Review, 20 :1998. pp.347-359.

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

49) Aiyepeku, W.O. : Towards a methodology of bibliometrics. Nigerian Librarian, 1- (2-3) :1974. pp.85-90.

50) Aiyepeku, W.O. : The productivity of geographical authors : A case study from Niegeria. Journal of Documentation, 32 :1976. pp. 105-117.

51) Ajiferuke, I, et al . :Collaborative coefficient : A single measure of the degree of collaboration in research . Scientometrics, 14 :1988. pp.421-433.

52) Alabi, G.A. : The citation pattern of Niegerian scientists. International Library Review , 21 (1) :1989. pp. 129-137.

53) Al-Kharafi, F, et al. : Science research in Kuwait : A bibliometric study. Journal of Information Science, 13 (1) :1987. pp.37-34.

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

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

56) Arjun Lal. : Ranking of periodicals in the field of social sciences. Annals of Library Science and Documentation, 37 (2) :1990. pp. 67-73.

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

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

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

60) Arunachalam,S . and Hirannian, S. : Journal preference of Indian researchers in physical and chemical sciences. Proceedings of the Seminar on Primary Communication in Science and Technology in India. 4-8 Dec.1978. pp. 141-148.

61) Arunachalam, S. et al. : International collaboration in Science : Participation by the Asian Giants . Scientometrics. 30 (1):1994. pp. 7-22.

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

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

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

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

66) Arunachalam,S. and Manoharan, K . : Status of scientific journals in India as seen through Science Citation Index. Journal of Scientific and Industrial Research 47 :1988. pp.359-367.

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

68) Arunachalam. S . and Singh, U.N. : Where do Israeli scientists publish? Journal of Information Science , 14 :1988. pp.221-231.

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

70) Ashok Jain .and Gang, K.S. : Laser research in India : Scientific study and model projection. Scientometrics, 23 (3):1992. pp 395-415.

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

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

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

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

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

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

77) Baburajan, A. : IEEE Transactions on computers : A bibliometric analysis. IASLIC Bulletin, 33 (2-3) :1988. pp.53-59.

78) Baird, L.M. and Oppenhein, C. : Do citations matter? Journal of Information Science, 20 (1) :1994. pp.2-15.

79) Baker, D. : Recent trends in the growth of chemical literature. Chemical Engineering News, 54 :1976. pp.23-27.

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

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

82) Banik, B.D. and Bandhopadhyaya, S. : Recent growth of periodicals on glass and ceramics-their rank. IASLIC Bulletin, 30 (1) :1983. pp. 23-30.

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

84) Barre, R. : Do not look for scapegoats : Link bibliometrics to social sciences and address societal needs. Scientometrics, 30 (2) :1994. pp. 419-424.

85) Bartlet, M.S. : The square root transformation in the analysis of variance. Journal of Royal Statistical Society suppl. 3 :1936. pp.68.

86) Basak, N.D. and Das, B.B. : Scatter of Indian Mathematician's contributions in primary periodicals. IASLIC Bulletin, 5 :1983. pp.6773.

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

88) Bavakutty, M. and Mohamed Taheer. : Flow of Islamic information through journal articles : A bibliometric analysis. Lucknow Librarian, 22 (34) :1991. pp. 75-80.

89) Beall, C. : The transformation data from entomological field experiments so that the analysis of variance become applicable. Biometrika, 32:1945. pp. 243-262.

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

91) Beck, M.T. : Editorial statement. Scientometrics, 1 :1978. p.i.

92) Benal, J.D. : Preliminary analysis of pilot questionnaire on the use of scientific literature. Report of the Scientific Information Conference of the Royal Society London. Paper No.46.pp.589-561.

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

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

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

96) Biog, F.S. and Loftman, K.A. : Domestic and foreign periodicals in the field of petroleum chemistry : A statistical analysis. Oil and Gas Journal, 47 :1949. pp. 199-208.

97) Bird, P.R. : Same sampling characteristics of bibliometric distributions . Journal of Information, 1 (2) :1977. pp.64-80.

98) Blake, V.L.P. : Faculty productivity, journal prestige and school library media faculty. School Library Quarterly, 22 (3) :1994. pp.153-158.

99) Bliss, N.J. : International relationship : A bibliometric analysis of the field. Library and Information Science Research, 16 (2) :1994.pp. 177-80.

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

101) Bonitz,M. : Journal ranking by different parameters Pt. 11. Individual or collective : Which parameters are best suited for journal ranking? Scientometrics, 18 (1-2) : 1990.pp.75-93.

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

103) Bookstein, A. : Explanations of the bibliometric laws. Collection Management,3(2-3):1979.pp.151-162.

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

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

106) Bookstein, A. : Scientometrics : New opportunities. Scientometrics, 30(2-3):1994.pp.455-460.

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

108) Bookstein, A. : The bibliometric distributions. Library Quarterly, 46(4) :1976.pp.416-423. Bookstein,A. : Informetric distributions. Pt. I. Unified overview. Journal of American Society for Information Science.41 (5) :1990.pp. 368-375.

109) Bookstein, A. : Theoretical properties of the informetric distributions: Some open questions. In : Ravichandra Rao, I.K. Ed. : Informetrics-91. Sarada Ranganathan Endowment in Library Science, Bangalore, 1990a.pp.17-35.

110) Bookstein.A. : Patterns of scientific productivity and social change : A discussion of Lotka's law and bibliometric symmetry. Journal of American Society for Information Science, 28 (4):1977.pp. 206-210.

111) Booth, Andrew D.A. : 'Law' of occurrence for words of low frequency. Information and Control, 10:1967. pp. 386-393.

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

113) Bradford, S.C. : Documentation. London : Crossly Lockwood, 1948. Braun,T. Glanzel, W. and Schcebut, A. : The bibliometric assessment of U. K scientific performance . Scientometrics, 20 :1991. pp.359-362.

114) Braun, T. et al. : Publication productivity, from frequent distribution to scientometric indicators. Journal Information Science, 16 :1990.pp. 37-44.

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

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

117) Brookes, B.C. : The derivation and application of the Bradford-Zipf distribution. Journal of Documentation, 24 (4) :1968.pp. 247-265.

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

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

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

121) Brookes, B.C. : 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(3) :1977.pp. 180-209.

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

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

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

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

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

127) Brookes, B.C. : Obsolescence of special library periodicals : Sampling errors and utility contours. JASIS, 21 :1970. pp.320-329.

128) Brookes, B.C. :The complete Bradford-Zipf bibliography. Journal of Documentation, 25 (1) :1969. pp.58-60.

129) Brookes, B.C. : The foundation of Information Science. Part II : Quantitative aspects : classes of things and the challenge of human individuality. Journal of Information Science, 2 (209) :1980. pp.21.

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

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

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

133) Bulick, Stephen. : Book use as a Bradford-Zipf Phenomenon. College and Research Libraries ,1978. pp.215-9.

134) Burell, Q. L. and Rousseau, R. : Fractional counts for authorship attribution: A numerical study. JASIS, 46 (2) :1995. pp.97-102.

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

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

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

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

139) Burrell, Q.L. : The dynamic nature of bibliometric processes : A case study. In : Ravichandra Rao, I.K. Ed : Informetrics-91,1992.pp.97-129.

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

141) Burton, H.D. : Use of a virtual information system for bibliometric analysis. Information Processing and Management, 24 (1) :1998.pp. 39-44.

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

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

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

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

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

147) Ceare, R.D. : The evaluation of G.C. impact in physical science using bibliometric indicators : Preliminary results. Proceedings of the 1st International Conference on Grey literature held at the RAI Congress Centre, Amsterdam, The Netherlands, 13-15 Dec. 1993, compiled by D.J. Frace. Amsterdam : Trans Atlantic, 1994.

148) Chakraborty, R. : Citation analysis of Petrological literature, Lucknow Librarian. 15 :1988. pp.99-104.

149) Chandrasekhar Rao, B and Divakar, P. : A bibliometric analysis of mathematical biology literature. Proceedings of 15th IASLIC Conference, Bangalore,1985. pp.17-22.

150) Chemyi, A.I. : Distributions of the Zipfian type : An attempt at content interpretation. International Forum on Information and Documentation , 19 (1) :1994. pp.3-7.

151) Chen, C.C. : Scientific and technical libraries : Use of scientific and technical literature. In : Encyclopaedia of Library and Information Science.New York : Marcel Dekker, 1979.pp.1-13.

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

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

154) Chen, Y.S., Chong, P.P. and Tong, M.Y. : Dynamic behaviour of Bradford's law .Journal of American Society for Information Science, 46 (5):1966. pp.370-383.

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

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

157) Chubin, D.E. and Moitra, S.D. : Content analysis of references : Adjunct or alternative to citation counting. Social Studies of Science, 5 :1975.pp.423-441.

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

159) Chung, Y.K. : Core international journals of classification systems : An application of Bradford's law. Knowledge Organisation, 21(2);1994.pp.75-83.

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

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

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

163) Cole, F.J. and Eales, N.B. : History of comparative anatomy Pt. I. Statistical analysis of literature. Science Progress, 11(4) :1917.pp.578-596.

164) Cole, P.F. : Analysis of reference questions records as a guide to the information requirements of scientists. Journal of Documentation, 14 :1958. pp.197-207.

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

166) Coleman, A.M., Dhillon, D.I. and Coulthrad, B.A. : Bibliometric evaluation of the research performance of British University Politics Department : Publications in leading journals. Scientometrics, 32 (1):1995. pp.49-66.

167) Coleman, S.R. : Disciplinary variables that affect the shape of Bardford's bibliography . Scientometrics, 29 (1):1993. pp. 59-81.

168) Conrad, G.M. : Growth of biological literature and future of biological abstracts. Fed. Proc., 16:1957. pp.711-715.

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

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

171) Daniel, R.S. : Bibliometrics and scholarly impact. American Psychologist, 34 (8) :1979. pp.725-728.

172) De Bruin, R.E., Braam, R.R. and Mode, H.F. : Bibliometric lines in the sands. Nature, 349 : 1991.pp.559-562.

173) Delendick, T.J. : Citation analysis of the literature of systematic Botany : A preliminary survey. Journal of American Society for Information Science, 41 :1992.pp. 535-543.

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

175) Dennis, W.: Bibliography of eminent scientists. Science, 79:1959. pp.180-183.

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

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

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

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

180) Dobrov, G.H. and Korennoi, A.A. : The informational basis of scientometrics on theoretical problems of informetrics. Hague : FID 435, 1969.

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

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

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

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

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

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

187) Drott, M.C. : Re-examining the role of conference papers in scholarly communication. Journal of American Society for Information Science, 46 (4):1995. pp.299-305.

188) Earle, P. and Vickery, B. : Social science literature use in the U.K. as indicated by citations. Journal of Documentation, 25 :1969.pp. 123-141.

189) Edge, D. : Why I am not a co-citationist. Society for Social Studies of Science New letter, 2 : 13-19 Reprinted In : Essays of an Information Scientist, 3 :1977.pp. 240-245.

190) Edwords, S. : Bibliographic instruction research : An analysis of the journal literature from 1977 to 1991. Research Strategies, 12 (2) :1994. pp.68-78.

191) Egghe L. : Special features of the author publication relationship and new explanation of Lotka's Law based on convolution theory.

Journal of American Society for Information Science, 45 (6):1994. pp.433-437.

192) Egghe, L. and Ravichandra Rao, I.K. : Citation age data and the obsolescence function; fits and applications. Information Processing and Management. 28 (2) : 1992.pp.201-217.

193) Egghe, L. and Rousseau, R. : Introduction to informetrics : Quantitative methods in library, documentation and information science. Amsterdam : Elsevier,1990.

194) Egghe, L .and Rousseau, R. : Eds. Informetrics 87/88. Select proceedings of the first International Conference on Bbibiliometrics and Theoretical Aspects of Information Retrieval, Diepenbeek ,Belgium ,25-28, August 1987. Amsterdam : Elsevier,1988.

195) Egghe, L and Rousseau, R, Eds. Informetrics 89/90. Selections of papers submitted for the second International Conference on Bibliometrics, Scientometrics and Informetrics, London 5-7 July 1987, Amsterdam : Elsevier,1990.

196) Egghe, L. and Rousseau, R. : Evolution of information production processes and its relation to the Lorenz dominance order. Information Processing and Management, 29 (4) :1993.pp. 499-513.

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

198) Egghe, L. : Pratt's measure for some bibliometric distributions and its relation with 80/20 rule. Journal of American Society for Information Science, 38 :1987.pp. 288-297.

199) Egghe, L. : Mathematical relations between impact factors and average number of citations. Information Processing and Management, 24 (5) :1988.pp. 567-576.

200) Egghe, L. : Methodological aspects of bibliometrics. Library Science, 25 :1988a.pp. 179-191.

201) Egghe, L. : On the classification of classical bibliometric laws. Journal of Documentation, 44 (1):1988b.pp. 53-62.

202) Egghe, L. : 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) :1990a.pp. 469-492.

203) Egghe, L. : The duality of informetric systems. Journal of Information Science, 16 :1990b. pp. 17-27.

204) Egghe, L. : A theory of continuous rates and applications to the theory of growth and obsolescence rates. Information Processing and Management, 30 (2) :1994.pp. 279-292.

205) Egghe, L. : Bridging the gaps : Conceptual discussions on informetrics. Scientometrics, 30 : 1994a.pp.35-47.

206) Egghe, L. : Little Science, big science and beyond. Scientometrics, 30 (2-3) :1994b.pp. 389-392.

207) Egghe, L. : An exact calculation of Price's Law for Law of Lotka. Scientometrics ,11 :1987. pp.81-97.

208) Egghe, L. : Consequences of Lotka's law for the Law of Bradford. Journal of Documentation, 41 :1985. pp.173-191.

209) Egghe. L. : A note on different Bradford multipliers. Journal of American Society for Information Science, 41 :1990.pp. 204-209.

210) Elisha Raju.E. and Kavitha . : Core journals in synthetic organic chemistry. Annals of Library Science and Documentation, 32 (3-4) : 1985.pp.115-121.

211) Estabrook, L. : Sociology and library research. Library Trends, 32 (4) :1983.pp. 461-476.

212) Eto, H and Candelaria, P.M. : Applicability of the Bradford distribution international science and technology indicators. Scientometrics, 11 (1-2) :1987.pp.27-42.

213) Eto, H. : Rising tail in Bradford distribution : Its interpretation and application. Scientometrics, 13 (5-6) :1988.pp. 227-237.

214) Eto, H. : Bradford's law in R & D expending of firms and R&D concentrations. Scientometrics, 6 (3) :1984.pp. 183-188.

215) Fairthorne, R.A. : Empirical hyperbolic distributions (Bradford - Zipf - Mandelbrot) for bibliometric description and prediction. Journal of Documentation, 25 (40):1969.pp. 319-343.

216) Fedorowicz, J. : A zipfian model of an automic bibliographic system : An appliction of Medline. Journal of American Society for Information Science, 33 : 1982.pp.223-232.

217) Fedorowicz, J. : The theoretical foundations of Zipf's law and its application to the bibliographic database environment. Journal of American Society for Information Science, 33 :1982 a.pp. 285-293.

218) Ferrante, Barban Kopelock. : Bibliometrics : Access in the library literature. Collection Management, 2 (3):1978. pp.199-204.

219) Ferreiro, L. and Ugena, S. : Citation mechanics in journals covered by the Journal citation reports. Scientometrics, 24 (1) :1992. pp. 149-162.

220) Folly, G. : Some methodological problems in ranking scientists by citation analysis. Scientometrics, 3 (2) :1981. pp. 135-147.

221) Fox, Mary, F. and Favu, Catherine, A. : Independence and corporation in research. Journal of Higher Education, 55 :1984. pp. 347-359.

222) Frost, C. :The use of citations in library research : Preliminary classification of citation functions. Library Quarterly, 49 (4):1979. pp. 399-414.

223) Fung, P.H. and Fang, J M. : A modification of Lotka's function for scientific productivity. Information Processing and Management, 31 : 1995. pp.133-137.

224) Fussler, H.H. : Characteristic of the research literature used by physicists in the United States. Library Quarterly 19 :1949 pt. I . pp. 19-35 and pt. II .pp. 119-143.

225) Gapen, D.K. and Milner, S.P. : Obsolescence. Library Trends, 30 (summer):1981.pp.107-124.

226) Garfield, E. : Citation indexes for science, a new dimension in documentation through association of ideas. Science, 122 :1955. pp. 108-111.

227) Garfield, E. : What is a significant Journal? In : Essays of an Information Scientists, 1 :1970 a. pp. 106-107.

228) Garfield, E. : Citation analysis as a tool in journal evaluation. Science, 178 :1972. pp. 471-479. Reprinted In : Essays of an Information Scientist, 1 : 527-544.

229) Garfield, E. : 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 Scientist, 1 :1977.pp. 222-223.

230) Garfield, E. : Cost-benefit analysis and core journal collections in scientific libraries. In : Essays of an Information Scientist, 1 :1977a .pp. 247-248.

231) Garfield, E. : Is citation frequency a valid criterion for selecting journals. In : Essays of an Information Scientist, 1 :1977 b. pp. 289-290.

232) Garfield, E. : Restating fundamental assumptions of citation analysis. In : Essays of an Information Scientist, 3 :1980. pp. 232 - 245.

233) Garfield, E. : Bradford's law and related statistical patterns. In : Essays of an Information Scientist, 4 :1980 a. pp. 476-483.

234) Garfield, E. : Scientometrics comes of age. In : Essays of an Information Scientist, 4 :1981. pp. 313-318.

235) Garfield, E. and Sher, I. H. : New factors in the evaluation of scientific literature through citation indexing. American Documentation,14(4):1963.pp.195-201.

236) Garfield, E. : Citation indexes in sociological and historical research. American Documentation, 14 (4) :1963.pp. 289-291.

237) Garfield, E. : Citation frequency as a measure of research activity and performance. Current Contents, 5 (31) :1977. pp. 5-7.

238) Garfield, E. : Highly cited articles XXVI: Some classic papers of the late 19th and early 20th century. Current Contents, 21:1976. pp. 5-9.

239) Garfield,E. : Citation indexing for studying science. Nature, 689-671. Reprinted In : Essays of an Information Scientist, 1 : 1970.pp.133-138.

240) Garfield,E. : How to use citation analysis for faculty evaluations and when it is relevant. In : Essays of an Information Scientist, 6 :1983.pp. 363-372.

241) Garfield. E. : Bradford's law and related statistical patterns. In : Essays of an Information Scientist, 4 :1981.pp. 476 - 483.

242) Garfield., E. : Significant journals of science. Nature, 264 :1976. pp. 609-617.

243) Garg K.C. and Lalitha Sharma. : A study of R & D indicators in Indian Industry using Bradford's law. Journal of Scientific and Industrial Research, 53 (2) :1994. pp.81-87.

244) Garg, K.C. and Dutt, B. : Bibliometrics of Agricultural research in India. Quarterly Bulletin of the International Association of Agricultural Information Specialists, 37 (3) :1992. pp. 133-137.

245) Garg, K.C. and Karki, M.M.S. : Bibliometrics of research communications of INSA fellows. Journal of Scientific and Industrial Research, 51 (12) :1992.pp. 929-935.

246) Garg, K.C. and Rao, M.K.D. : Bibliometric analysis of scientific productivity : A case study of an Indian Physics Laboratory. Scientometrics,13 :1988. pp. 262-289.

247) Garg, K.C. and Dutt, B. : Bibliometrics of Indian Science as reflected through Science Citation Index. Journal of Scientific and Industrial Research, 31 (4) :1992. p. 329.

248) Garrison, H.H. and others. : Measuring characteristics of scientific research: A comparison of bibliographic and survey data. Scientometrics, 24 (2) : 1992. pp.359-370.

249) Garudadwajan, B, et al. : Use of library documents in specified fields in NAL library. Library Science with a Slant to Documentation , 18 (4) :1981 . paper Q.

250) Garvey, W.D., Lin, N. and Tomita.K. : Research studies in scientific communication by productive scientists. Information Storage & Retrieval, 8 :1972 . pp. 265-276.

251) Glanzel, W . and Schoepflin, U. : Little scientometrics, big scientometrics and beyond. Scientometrics, 30 (2-3) :1994 . pp. 375-384.

252) Glanzel, W. and Schoepflin, U.A. : Stochofic model for the ageing of scientific literature . Scientometrics, 30 (1):1994. pp.49-64.

253) Goffman, W. and Morris, T.G. : Bradford's law and library acquisitions. Nature, 226 :1964. pp. 922-923.

254) Goffman, W. and Newin, V.A. : A generalisation of the theory of epidemics : An application to the transmission of ideas. Nature, 204 :1965 .pp. 225-228.

255) Goffman, W. : A mathematical model for analysing the growth of a scientific discipline. Journal of Association of Computer Mechanics, 18:1971.pp.173-185.

256) Goffman, W. and Warren, K.S. : Distribution of papers among journals based on mathematical analysis of two diverse medical literature. Nature, 221:1969. pp.1205-1207.

257) Gopinath, M.A. : Across the frontiers , impact of foreign journals in library science in India : A citation analysis. Library Science, 30 (1) :1993. pp.17-24.

258) Gopinath, M.A. : Ranganathan : A profile in relation to librametry. Herald of Library Science, 32 (1-2) :1993 . pp. 7-11.

259) Gosnell, C.F. : Obsolescence of books in college libraries. College and Research Libraries. 5 :1994. pp. 115-125.

260) Griffith, B.C. : Exact fits to large ranked bibliometric distributions. Journal of American Society for Information Science, 39 :1988 .pp. 423-427.

261) Griffith, B.C. : Exact fits in bibliometrics : Some tools and results. In : Egghe and Rousseau, Ed : Informetrics 87/88. 1988 a .pp. 85-95.

262) Griffith, B.C., Drott, M.C. and Small, H.G. : On the use of citations in studying scientific achievements and communication. Society for Social Studies of Science. Newsletter. 2 . 9-13, Reprinted In : Essays of an Information Scientist, 3 :1977. pp. 232-245.

263) Griffith, B.C., Servi, D.N., Anker, A.L. and Drott, M.C. : The aging of scientific literature : A citation analysis. Journal of Documentation, 35 (3) :1979 .pp.179-196.

264) Griffith, B. C. et al. : Informal contracts in science : A probabilistic model for communication process. Science, 173 :1971 .pp.164-165.

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

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

267) Grupp. H. and Hinze, S. : International orientation, efficiency of and regard for research in East and West Germany : A bibliometric investigation of aspects of technology genesis in the United Germany. Scientometrics, 29 (1) :1994. pp.83-113.

268) Gundu Rao. : Citation of documents in radio engineering : A case study. DRTC Seminar 9. 1971; Paper B.E.

269) Gupta, A.K. : Characteristics of documents cited by the Indian physicists: A case study. 1964; DRTC Seminar, 7.paper .13.

270) Gupta, B.M. : Citation analysis of solar energy research in USSR. Journal of Library and Information Science, 2 :1977 .pp. 202-219.

271) Gupta, B.M. and Nagpal, M.P.K. : Citation analysis and its applications : A review. Herald of Library Science, 18 (1-2) :1979.pp. 86-93.

272) Gupta, D.K. : Citation analysis : A case study of most cited author and his most cited article in seafloor spreading. IASLIC Bulletin, 28 (1) :1983.pp. 1-2.

273) Gupta, D.K. : Lotka's Law and the productivity patterns of entomological research in Nigeria for the period 1900-1973. Scientometrics, 12 (1-2) : 1987.pp.33-46.

274) Gupta, D.K. : Bibliometric study of the AIDS literature 1981-84. Annals of Library Science and Documentation, 35 (1) :1988.pp. 34-44.

275) Gupta, D.K. : 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) :1989 .pp. 11-21. Pt. II. Application of Lotka's law to psychological literature of Africa 1966-1975. Herald of Library Science, 28 (1-4) :1989.pp. 318-326.

276) Gupta, D.K. : Scientometric study of biochemical literature of Nigeria 1970-1984 : Application of Lotka's law and the 80/20 rule. Scientometrics, 15 (3-4) :1989a.pp. 171-179.

277) Gupta, D.K. : Application of Bradford's law to citation data of Ethiopian Medical Journal. Annals of Library Science and Documentation, 38 (3) :1991.pp. 85-98.

278) Gupta, D.K. : Author productivity pattern : Geoscientific literature of Nigeria for the period 1904-1974. Library Science, 30 (2) :1993.pp. 76-89.

279) Gupta, D.K. and Gupta, S. Periodical literature of petroleum geology : A citation analysis study do determine obsolescence factors and patterns IASLIC Bulletin, 28 (2) :1983. pp.75-86.

280) Gupta, Usha. : 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 :1990.pp. 282-287.

281) Hadagalt, P.B. : Frequently cited periodicals by Indian agricultural economists : A citation analysis. IASLIC Bulletin, 28 : 1983.pp. 59-66.

282) Haiqi, Z. : A bibliometric study on Medicine, Chinese tradidional (SIC) in Medicine database. Scientometrics, 31 (3) : 1994. pp.241-250.

283) Hall, D.H. : Growth and citation selection rates in rapidly growing sciences from date stacking and bibliographic databases. In : Egghe and Rousseau, Ed : Informetrics 89/90. Amsterdam : Elsevier,1990.pp.163-192.

284) Hall, D.H. : Rate of growth of literature in geoscience from computerised data bases. Scientometrics , 17:1989. pp.15-38.

285) Harau, J.D. et al. : Accumulative of advantage and disadvantage in research groups. Scientometrics, 29 (1) :1994. pp.239-251.

286) Hardie, B.G. and Voight, M.J. : Use of periodicals in petroleum research. Oil and Gas Journal, 49 :1950. pp.121-126.

287) Hasso, M.H. : 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) :1984.pp. 85-90.

288) Hawkins, D.T. : Unconventional uses of on-line information retrieval systems : On-line bibliometric studies. Journal of American Society for Information Science, 28 (1) :1977. pp. 13-18.

289) Hayes, R.M. : Measurement of information. Information Processing and Management, 29 (1) :1993.pp. 1-11.

290) He, C. and Pao, M.L. : A discipline specific journal selection algorithm. Information Processing and Management, 22 :1986.pp. 405-416.

291) Henkle, H.H. : Periodical literature of Biochemistry. Bulletin of Medical Library Association, 27:1988. pp.139-147.

292) Hertzel, Dorothy, H. : Bibliometrics, history of development of ideas. In : Encyclopaedia of Library and Information Science, 42 : 1987.pp.144-219.

293) Hill, B.M. : The rank frequency form of Zipf's law. Journal of American Statistical Association, 69 (348) :1970.p. 542.

294) Hill, B.M. : Zipf's law and prior distribution for the composition of population. Journal of American Statistical Association, 65 :1970. pp.1220-1232.

295) Hirst, G. : Disciplinary impact factors - a method for determining core journals. Journal of American Society for Information Science, 29 : 1978.pp. 171-172.

296) Hjerppe, R. : A bibliography of bibliometrics, citation indexing and analysis. The Royal Institute of Technology Library, Stockholm (TRITA - 2013).

297) Hjreppe, R. : Supplement to a Bibliogrpahy of bibliometrics and citation indexing. Scientometrics, 4 :1982. pp.241-273.

298) Hooydonk, C.V. et al. : A bibliotheonomic analysis of the impact factors of scientific disciplines. Scientometrics, 30 (1) : 1994.pp.65-81.

299) Houston, W. : The application of bibliometrics in Veterinary Science primary literature. Quarterly Bulletin of the International Association of Agricultural Librarians. 28 (1) :1983.pp. 6-13.

300) Hubert, J.J. : General bibliometric models. Library Trends, 30 (1) :1981.pp. 65-81.

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

302) Hubert, J.J. : A relationship between two forms of Bradford's law. Journal of American Society for Information Science,29 (3) : 1978.pp.159-161.

303) Hubert, J.J. : A rank frequency model for scientific productivity. Scientometrics, 3 (3) :1981.pp. 191-202.

304) Hubert, J. J. : On the Naranan intepretation of Bradford's law. Journal of the American Society of Information Science, 27:1978. pp.339-341.

305) Humayoon Kabir, S. : Citations in bibliometrics research : An analysis. Library Science with a Slant to Documentation and Information Studies, 30(4) :1993. pp.155-159.

306) Humayoon Kabir, S. : Citations in Indian agriculture: An analysis. Annals of Library Science with a slant to Documentation and Information Studies, 30 (4):1993. pp.155-159.

307) Humayoon Kabir, S. Citations in Indian agriculture : An analysis. Annals of Library Science and Documentation, 37 (3) :1990. pp.102-109.

308) Hurt, C.D. : A correlation study of the journal article productivity of environmental scientists. Information Processing and Management, 13 :1977.pp. 305-309.

309) Hurt, C.D. : Important literature identification in Science : A critical review of the literature. Advances in Librarianship, 13 :1984. pp. 239-258.

310) Ijari, S.R. and Kannappanavar , B.U. : Periodical literature of Geology : A citation analysis study to determine obsolescence factors and patterns. Indian Journal of Information Library and Society, 2 (1) : 1989.pp.77-84.

311) Ijari, S.R. and Kannappanavar, B.U. : Information use pattern of Indian clinical psychologists . A citation study. Journal of Library and Information Science, 15 (2) : 1990.pp.179-189.

312) Ikpahindi, L. : An overview of bibliometrics its measurements, laws and their applications. Libri, 35 :1985.pp. 163-177.

313) Kalyane, V. : Informetrics on Neem research in India. Library Science, 30 :1993.pp. 139-145.

314) Kapoor, S.K. : Citation analysis of earth science literature. Annals of Library Science and Documentation, 31 (1-2) :1984.pp. 56-62.

315) Karisiddappa, C.R. et al. : Authoriship pattern and collaborative research in Psychology. IASLIC Bulletin, 35 (2) : 1990.pp.73-78.

316) Karmeshu, N., Lind, N.C. and Cano, V. : Rationales for Bradford's law. Scientometrics, 6 (4) :1984.pp. 233-241.

317) Ken, M.C. : Bradford law and the journal titles cited by research scholars in Zoology at Ibadan University, Nigeria. IASLIC Bulletin, 34 (3) :1989. pp. 97-104.

318) Kendall, M.G. : The bibliography of operational research. Operational Research Quarterly, 11 (1-2) : 1960.pp. 31-36.

319) Kessler, M.M. : Bibliographic coupling between scientific papers. American Documentation, 14 (1) :1963.pp. 10-15.

320) Kessler, M.M. : An experimental study of bibliographic coupling between technical papers. IEEE Transactions in Information Theory, 1963a.pp.49-51.

321) Kessler, M.M. : Some statistical properties of citations in the literature of Physics. In : Stevens, M.E. Ed : Statistical Association methods in Mechanised Documentation, Proceedings,1965. pp.193-198.

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

323) Kochhar, V.B. and Verma, R.K. : Indian Biotechnological literature : A bibliometric study. Annals of Library Science and Documentation, 34(2):1987.pp.61-70.

324) Koening, M. and Harrl, T. : Lotka's law , Price's law and electronic publishing. Journal of the American Society for Information Science, 46 (5) :1995. pp.386-388.

325) Koening, M.E.D. : The information environment and the productivity of research. In : Ravichandra Rao, I.K. Ed : Informetrics - 91. 1992.pp. 261-288.

326) Kopelock, B. : Bibliometrics : Access in the library literature. Collection Management, 2 (3) : 1978.pp. 199-204.

327) Kraukopf, M. : Epistermometia, a term contributing to express the meaning and potential methodologies of scientometrics in Spanish speaking countries. Scientometrics, 30 (2-3) :1994. pp.425-428.

328) Kretschmer, H. : Quantity and quality in 'Science of Science'. Scientometrics, 30 (2-3) : 1994.pp.533-7.

329) Kuch, T.D.C. : Relation of the title length to number of authors in Journal articles : In a brief communication in the Journal of American Society for Information Science. JASIS, 29 1978.pp.200-202.

330) Lalithakumari and Sengupta, I.N. : Analysis of growth of lectin literature 1983-86. Journal of Scientific and Industrial Research, 47 :1988.pp. 692-696.

331) Lalithkumari and Sengupta, I.N. : Bibliometric evaluation of biochemical research in India - Part III. Library Heralad, 27 (3-4) : 1989.pp. 77-95.

332) Lancaster, F.W. : Bibliometric methods in assessing productivity and impact of research. Bangalore : Sarada Ranganathan Endowement for Library Science, 1991. 52p.

333) Lancaster, F.W. and Lee, J.L. : Bibliometric techniques applied to issues management : A case study. Journal of American Society for Information Science, 36 (6) : 1985.pp.389-397.

334) Lancaster, F.W., Susan, B. and Yuan, M. L. : Kochen's influence examined bibliometrically. Library Trends, 41 (4) :1993.pp. 549-566.

335) Lawani, S.M. : Bradford's law and the literature of agriculture. International Library Review ,5 :1972 .pp. 341-350.

336) Lawani, S.M. : Citation analysis and quality of scientific productivity. Bioscience, 27 (1) :1977 .pp. 28-29.

337) Lawani, S.M. : Bibliometrics its theoretical foundations, methods and applications. Libri, 31 :1981. pp.294-315.

338) Lawani, S.M. : Some bibliometric correlates of quality in scientific research. Scientometrics, 9 (1-2) :1986. pp.13-25.

339) Lawani, S.M. and Serika, T.A.B. : Some characteristics of the world literature on rice. International Rice Commission Newsletter, 23 (1) : 1974 .pp.1-5.

340) Lawson, J., Kostrewski, B. and Oppenheim, C. : A bibliometric study of a new subject field : Energy analysis. Scientometrics, 2 (3) :1980. pp.227-237.

341) Lazarev, V.S. : Notion of a document : A centre of "gravity attraction" for getting metricians together. Scientometrics, 30 (22-3) : 1994 .pp.511-516.

342) Lazorick, Gerald, J. : Patterns of book use using the negative binomal distribution. Library Research, 1:1979 .pp.171-188.

343) Leimkuhler, F.F. : The Bradford distribution. Journal of Documentation, 23 (3) :1967. pp.197-207.

344) Leimkuhler, F.F. : An exact formulation of Bradford's law. Journal of Documentation, 36 (4) :1980 .p.285.

345) Leimkuhler, F.F. : On bibliometric modelling. In : Egghe and Rousseau, Ed :Informetrics 87/88,1988.pp.97-104.

346) Liang, L. and Mu, Y. : Frequency distribution of Chinas scientific papers in terms of ranks. Journal of Library and Information Science, 20 (2) : 1994.pp.13-92.

347) Lifshin, A. : Citation analysis of Geochimica et cosmochimica Acta. 1951-1960. Journal of American Society for Information Science, 44 (6) :1993 .pp.322-326.

348) Lindsey, D. : Using citation counts as a measure of quality in science :Measuring what is measurable rather than what is valid. Scientometrics, 15 (3-4) :1989.pp.189-203.

349) Line, M.B. : The half-life of periodical literature :Apparent and real obsolescence. Journal of Documentation , 26 (1) :1970 .pp. 46-54.

350) Line, M.B. : Rank lists based on citations and library uses as indicators of journal usage in individual libraries. Collection Management,2 (4) :1978.pp.313-315.

351) Line, M.B. : The influence of type of source used on the result of citation analysis. Journal of Documentation, 35 (4) :1979. pp.265-284.

352) Line, M.B. : Relation between productivity and obsolescence. Journal of American Society for Information Science, 38 : 1987.pp.307-308.

353) Line, M.B. : Changes in the use of literature with time:Obsolescence revisited. Library Trends, 41 (4) :1993.pp.665-668.

354) Line, M.B. and Sandison, A. : Obsolescence and changes in the use of literature with time. Journal of Documentation ,30 (3) :1974.pp.283-350.

355) Line, M. B.:Practical interpretation of citations and library use studies, College and Research Libraries, 9 :1975. pp .393-396.

356) Lipetz, B.A. :Improvement of the selectivity of citation indexes to science literature through the inclusive of citation relationship indicators. American Documentation, 16 (2) :1965.pp.81-90.

357) Little, A.E.,Harris, R.M. and Nicholls, P.T. : Text to reference ratios in scientific journals. In : Egghe and Roussesu, Ed : Informetrics 89/90.1990.pp.211-216.

358) Liu, M. : A study of citing motivation of Chinese scientists.Journal of Information Science, 19 (1) :1993.pp.13-23.

359) Logan, E.L. and Shaw, W.M. : A bibliometric analysis of collaboration in a medical speciality. Scientometrics, 20 (3) :1991.pp. 417-426.

360) Looze, M-A.D . : The application of scientometric tools to the analysis of a sector in plant biotechnologies : Nitrogen fixation. Scientometrics, 30 (1) :1994. pp.23-24.

361) Lopez, S.J. : Characteristics of cassava literature. Cassava Newsletter, 8 :1980.pp.10-15.

362) Lotka, A.J. : The frequency distribution of scientific productivity. Journal of Washington Academy of Science, 16 :1926 .pp.317-323.

363) Luukkonen, T. : Are we longing for the golden era lost or far the one to come. Scientometrics, 30(2-3) :1994.pp.481-485.

364) Lynch, M.F. : Variety generation a reinterpretation of Shannon's mathematical theory of communication and its applications for information science. Journal of American Society for Information science. 1977; pp.19-25.

365) Mac Roberts, M.H. and Mac Roberts, B.R. : Problems of citation analysis: A critical review. Journal of American Society for Information Science, 40 : 1983.pp.342-349.

366) Macrae, D. : Growth and decay curves in scientific citations. American Sociology Review, 34 (5) :1969.pp .641-645.

367) Magyar,G. : Bibliometric analysis of a new research subfield. Journal of Documentation, 30 (1) :1974. pp.32-40.

368) Mahapatra, Gayatri and Kaul, Rama . : Bibliometric analysis of citation classics in life sciences. Library Science, 31 :1994. pp.129-133.

369) Mahapatra, Gayatri. : Post-Ranganathan era a bibliometric analysis of Ranganathan's contributions. IASLIC Bulletin, 37 (3) :1992.pp.177-182.

370) Mahapatra, Gayatri. : Correlation between growth of publications and citations. Annals of Library Science and Documentation, 41 :1994.pp.8-12.

371) Mahapatra,M. : On the validity of the theory of exponential growth of scientific literature. Proceedings of the 15th IASLIC Conference, Bangalore,1985.pp.61-70.

372) Maheswarappa, B. S. and Mathias, S. A. : Multiple authorship and collaborative research in Biological Science in India : A bibliometric study. Library Herald, 27 (3-4) : 86-94.

373) Maheswarappa, B.S. and Nagappa, B. : Research collaboration in the field of phytopathology : A bibliometric study. Annals of Library Science and Documentation. 34 (4) :1987. pp.173-176.

374) Maheswarappa, B.S. and Nagappa, B. : Indian phytopathology literature : A bibliometric study based on review of plant pathology. Journal of Library and Information Science, 9 (1):1984. pp. 36-47.

375) Maheswarappa, B.S. and Ningoji, N.M. : Growth of literature in the field of applied science in India (1965-1989). International Information Communication and Education , 12 (2) : 1993. pp.191-200.

376) Maheswarappa, B.S. and Ningoji, N.M. : Growth of literature in the field of S & T in India. International Information, Communication and Education (INICAE), 11 (2) :1992. pp.359-370.

377) Maheswarappa, B.S. and Prakash, B.P. : Literature use pattern by researchers in the field of Botany. Journal of Library and Information Science, 7 (1) :1982. pp.15-32.

378) Maheswarappa, B.S. and Savadatti, S.G. : Authorship pattern and collaborative research in plant breeding. IASLIC Bulletin, 35 (3) :1990.pp.119-124.

379) Maheswarappa, B.S. and Surya Rao, K. : Journal literature of food science and technology : A bibliometric study. Annals of Library Science and Documentation, 29 (3) :1982.pp. 126-134.

380) Maheswarappa, B.S. and Surya Rao, K. : Information use pattern of American, British and Indian food scientists as indicated by citations in journals : A comparative study. Library Herald, 28 (1-2) :1989. pp. 32-42.

381) Maheswarappa, B.S., Nagappa, B. and Mathias, S.A. : Collaborative research in Science and Technology in India. Journal of Library and Information Science, 9 (2) : 1984.pp.154-159.

382) Maheswarappa, B.S. : Research collaboration in different disciplines of applied science in India (1965-83): A bibliometric study. IASLIC Bulletin, 32 (3) :1987. pp.105-114.

383) Maheswarappa,B.S., Nagappa. B. and Onkaramurty, B.N. : Information use pattern of Indian scientists : A citation study. Library Herald, 25 (2-3) :1986.pp. 68-79.

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

385) Malwad, N.M. : Oh to be quoted : Citation indexes and analysis. Science Today, 13 (4) : 1978.pp.10-19.

386) Manorama, K. and Anita Bhutiani. : Strengthening the coverage of Indian scientific journal. Journal of Scientific and Industrial Research, 47 :1988.pp. 23-27.

387) Margolis, J. : Citation indexing and evaluation of scientific papers. Science, 155 :1967.pp. 1213-1219.

388) Maricic, S. : A fourfold bibliometric evaluation of journals from less developed scientific communities - the pattern of references in medical journals form Yugoslavia. Annals of Library Science and Documentation, 30 (2) :1983.pp. 45-62.

389) Martens, B. and Saretzki, T. : Quantitative analysis of thematic structures in the field of biotechnology : A study on the basis of conference data. Scientometrics. 30(1) :1994. pp.117-128.

390) Martin, B.R. : British Science in the 1980s has the relative decline continued. Scientometrics, 29 (1) : 1994.pp.27-56.

391) Martyn, J. : Citation analysis. Journal of Documentation, 31 (4) :1975. pp. 290-297.

392) Martyn, J. : Bibliographic coupling. Journal of Documentation, 20 :1964. pp.136-142.

393) May, K.O. : Quantitative growth of mathematical literature. Science,154 :1966. pp.1672-1673.

394) Mc Allister, P.R. et al. : Comparison of peer and citation assessment of the influence of scientific journals. Journal of American Society for Information Science, 5 :1980. pp.147-154.

395) Mc Cain, K.W. : Core journal networks and citation maps : New bibliometric tools for serials research and management. Library Quarterly, 61 (3) :1991.pp. 311-336.

396) Mc Cain, K.W. : Mapping economics through the Journal literature : An experiment in journal citation analysis. Journal of American Society for Information Science, 42 : 1991a.pp.290-296.

397) Mc Grath, W.E. : Correlating the subjects of books taken out of and books used within an open-stock library. College and Research Libraries, 280 :1971. pp.5.

398) Mc Grath, W.E. Inter-library loan analysis in collection development : A comment. Library Research and Technical Services, 20 (1) :1976. pp.101-113.

399) Mc Grath, W.E. : Relationship between hard/soft, pure/applied and life/non life disciplines and subject book use in a university. Information Processing and Management, 14 :1978. pp.17-28.

400) Mc Grath, W.E. : Little, scientometrics, big scientometrics and beyond.Scientometrics , 30 (2-3) :1994. pp.439-442.

401) Mc Grath, W. E. : Predicting book circulation by subject in a university library. Collection Management, 1 (3-4) :1976-77. pp.7-25.

402) Mc Cain, K.W. and Bobick, J.E. : Pattern of journal use in a departmental library : A citation analysis. Journal of American Society for Information Science, 32 (4) :1981.pp. 257-267.

403) Mc Cain, K.W. and Turner, K. : Citation context analysis and aging patterns of journal articles in molecular genetics. Scientometrics, 17 (1-2) :1989.pp. 127-163.

404) Meadows, A.J. : The citation characteristics of astronomical research literature. Journal of Documentation, 23 (1) :1967.pp. 28-33.

405) Meadows, A.J. : Little scientometrics, big scientometrics and beyond-Scientometrics, 30(2-3) :1994. pp.447-449.

406) Mehrotra, R. and Lancaster, F.W. : Where Indian scientists publish. Current Science ,1984. pp.684-687.

407) Mendez, A . and Gomez, I. : The Spanish scientific productivity through eight international databases. Scientometrics, 10 :1986. pp.207-219.

408) Midorikawa, N. : Citation analysis of physics journals, comparison of sub field of physics. Scientometrics, 5 (6) :1983 .pp.361-374.

409) Miguel, J.H. : Little scientometrics, big scientometrics and beyond. Scientometrics, 30 (2-3) :1994.p. 420.

410) Miquel, F.J. and Okubo, Y. : Structure of international collaboration in Science: Part 1. Comparisons of profiles in countries using a link indication. Scientometrics, 29 (2) : 1994.pp.271-97.

411) Moed, H.F. : The use of on-line databases for bibliometric analysis. In : Egghe and Rousseau, Ed . Informetrics 87/88.1988.pp.133-146.

412) Moed, H. F. : Bibliometric measurement of research performance and Price's theory of differences among the sciences. Scientometrics, 15 (5-6) : 1989.pp.473-483.

413) Moed, H.F., Burger, W.J.M., Frankfort, J.C. and Van Raan, A.F.J. : The application of bibliometric indicators; Important field and time-dependent factors to be considered . Scientometrics, 8 (3-4) :1985a.pp.177-203.

414) Mohammed Thaher . : A bibliometric analysis of literature in the field of Islamic studies. Library Herald, 29 (1-2) :1990 .pp.96-98.

415) Moll, J.K. : Bibliometrics in Library collection management. Collection Management, 2 :1978.p. 195.

416) Molylev, V.M. : The main problems of studying literature aging. Scientometrics, 15 :1989 .pp. 97-109.

417) Morales, M. :Informetrics and its importance. International forum for Information and Documentation, 10 (2) :1985. pp. 15-21.

418) Moravcsik, M.J. and Murugesan, P. : Citation patterns in scientific revolutions. Scientometrics, 1 (2) : 1979.pp.161-169.

419) Moravcsik, M.J. and Murugesan, P. : Some results on the function and quality of citations. Social Studies of Science, 5 :1975. pp.86-92.

420) Morse, P.M. : Implications of the exact Bradford distribution. Journal of American Society for Information Science. 32 (1) :1981. pp.43-50.

421) Morse, P.M. : The underlying characteristic of the Bradford distribution. Scientometrics, 3 (6) :1981a.pp. 425-436.

422) Mosher, P.H. : Quality and library collections : New directions in research and practice in collection evaluation. Advances in Librarianship, 13 :1984.pp. 211-238.

423) Munshi, V.M., et al. : Indian medical journals and Science Citation Indexes. IASLIC Bulletin , 35 (1) :1990. pp.43-46.

424) Murphy, L.J. : Lotka's law in the Humanities. Journal of American Society for Information Science, 24 :1973.pp. 461-462.

425) Nag, D.K., et al. : Patterns of use of earth science literature by Indian geologists : A citation analysis. Proceedings of 15th IASLIC Conference. Bangalore : pp.101-108.

426) Nagappa, B. and Maheswarappa, B.S. : Most frequently cited journals by Indian Phytopathologists. Journal of Library and Information Science, 6 (1) :1981.pp. 1-17.

427) Nagappa.B. and Maheswarappa, B.S. : Journals cited most frequently by Indian plant physiologists. Library Herald, 20 (2-4) :1982 .pp. 130-138.

428) Nagpal, P.S. : Contribution of Indian universities to the mainstream scientific literature: A bibliometric assessment. Scientometrics, 32 (1) :1995. pp.11-36.

429) Nakamoto, H. : Synchronous and diachronous citation distributions. In : Egghe and Rousseau, Ed : Informetrics 87/88. Amsterdam : Elsevier,1988.pp.153-165.

430) Naranan,S. : Bradford's law of bibliography of science : An interpretation. Nature, 227 :1970.pp. 631-632.

431) Naranan,S. : Power law relations in science bibliography : A self consistent interpretation. Journal of Documentation, 27 1972.pp.83-97.

432) Narendra Kumar, P. : Citation study as a tool for evaluation of journal collection use : A case study. Journal of Library and Information Science, 9 (1) :1984.pp. 48-64.

433) Narendra Kumar, P. : Literature contribution in journal of Environmental Biology : A bibliometric study. Annals of Library Science and Documentation, 33 (1-2) :1988. pp.31-40.

434) Narin, F. and Moll, J.K. : Bibliometrics : Annual Review of Information Science and Technology, Vol.12. New York : Knowledge Industry publications Inc., Whiteplains,1977.pp .35-58.

435) Nazim Ali, S. : Subject relationship between articles determined by co-occurrence of keywords in citing and cited titles. Journal of Information Science, 19 (3) :1993.pp. 225-231.

436) Nederhof, A.J. and Meiju, R.F. : Development of bibliometric indicators for utility of research to users in society : Measurement of external knowledge transfer via publications in trade journals. Scientometrics, 32 (1) : 1995. pp.37-48.

437) Neelameghan, A., et al. : Discovery and duplication of antibiotics : A correlation. Current Science, 34 :1970. pp.511-512.

438) Neelameghan, A., et al. : Universe of subjects and duplication of discovery: A case study using statistical methods. DRTC Seminar 7. Bangalore :DRTC, 1969.

439) Neelameghan, A. : Librametry. DRTC Seminar 7, Bangalore. Paper L.C. 1969.

440) Newke, K.M.C. : 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) :1989.pp. 139-147.

441) Nicholls, P.T. : Emprical validation of Lotka's law. Information Processing and Management, 22 (5) :1986.pp. 417-419.

442) Nicholls, H.B. : Citation statistics of publications in the Marine Sciences. Proceedings fourth Canadian Conference on Information Science, University of Western Ontaria, London,1976.pp.179-187.

443) Nicholls, P.T. : Bibliometric modelling processes and the empirical validity of Lotka's law. Journal of American Society for Information Science, 40 : 1988.pp.379-385.

444) Nicholls, P.T. : Price's square root law : Empirical validity and relation to Lotka's law. Information Processing and Management, 24 (4) :1988a.pp. 469-477.

445) Nijayunappa, R and Nijayunappa, P. : Core journals used by Indian geoscientists. (1978-82). Journal of Geological Society of India, 26 :1985. pp.10-15.

446) Noma, Elliot. : Untangling citation networks. Information Processing and Management, 18 (2) :1982.p. 43.

447) Noor, Matyvonne, M.A. : Quantitative analysis of the research articles published in core library journals of 1980. Library and Information Science Research, 7 : 1985.pp.261-273.

448) Nordstrom, L.O. : Bradford's law and the relationship between ecology and biogeography. Scientometrics, 18 (3-4) : 1990. pp.193-203.

449) Novak, B. : Use of books and journals in a large library for technological research. International Library Review, 9 (2) :1977. pp.241-246.

450) O' Neill, E.T. : Generalised Bradford distribution. Research Memorandum School of Information and Library Studies. Buffalo: State University of New York, 1972.

451) O' Neill, E.T. : Effect of demand level on the optional size of journal collections. Collection Management, 2 (3) : 1978.pp.205-216.

452) O'Connor, D. and Voos, H. : Empirical laws, theory construction and bibliometrics, Library Trends, 30 (1) :1981. pp.9-20.

453) O'Connor, J.G. : Growth of multiple authorship. DRTC Seminar 7. Paper JA. Bangalore: DRTC, 1969.

454) O'Neill, E.T. : Limitations of Bradford's distribution. Proceedings American Society for Information Science, 11 :1973. pp.177-178.

455) Olsen, W.C. : The current core literature of the agricultural sciences. Journal of Agricultural and Food Information, 2 (3) : 1994.pp.99-109.

456) Oluic-Vukovic, V. : Impact of productivity increase on the distribution pattern of journals. Scientometrics, 17 (1-2) :1989. pp. 97-109.

457) Oppenheim, C and Renn, S.P. : Highly cited old papers and the reasons why they continue to be cited. Journal of American Society for Information Science, 29(5) :1978.pp. 225-231.

458) Packer, C.V. : Applying row column permutation to matric representations of large citation networks. Information Processing and Management, 25 (3) :1989.pp. 307-314.

459) Pair, C.I. : Puberty or mild-life crisis. Scientometrics, 30 (2-3) : 1994.pp.517-520.

460) Pan, Elizabeth. : Journal citation as a predictor of journal usage in libraries. Collection Management, 2 (1) : 1978.pp.25-38.

461) Pangannaya. N.B. and Kumaraswamy.S. : Leisure : Subject scatter, journal dispersion and other characteristics - citation analysis. Journal of Library and Information Science, 6 (2) :1981.pp. 28-72.

462) Pao, M.L. : Lotka's test. Collection Management, 4 (12) :1982.pp. 111-124.

463) Pao, M.L. : Lotka's law : A testing procedure. Information Processing and Management, 21 (4) :1985.pp. 305-320.

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

465) Pao, M.L. and Mc Creery , L. : Bibliometric applications of Markov Chains. Information Processsing and Management, 22 (1) :1986.pp. 7-17.

466) Pao, M.L. : Collaboration in computational musicology. Journal of American Society for Information Science, 33 :1982. pp.38-43.

467) Paravathamma.N., Gunjal, S.R. and Nijagunappa, R. : Growth pattern of literature and scientific productivity of authors in Indian Earth Science (1978-88) : A bibliometric study. Library Science, 30 (2) :1993.pp. 54-64.

468) Parvathamma, N. : Bibliometrics : Its origin and applications. In : Current Studies in Library and Information Science. Ed : C.R. Karisidappa and others. Delhi: Manak Publications, 1993: pp.163-181.

469) Parvathamma, N., et al. : Core journals in earth science: A comparative study. Journal of Geological Society of India., 38 : 1991. pp.387-395.

470) Patel, D.R. : Bibliometrics, citation study selective dissemination of Information (SDI) service using SCI CD-ROM. Journal of Information Science. 16 I2) :1991. pp.113-128.

471) Paul Mohan Roy. : Towards a theory of citing in citation analysis studies. In : Sharma K.C. Ed : Developing Horizons in Library and Information Science. Vol . 2,1983. pp.223-235.

472) Peritz, B.C. : Little scientometrics, big scientometrics and beyond .Scientometrics, 30 (2-3) :1994. pp.414-416.

473) Peritz, B.C. : A Bradford distribution for bibliometrics. Scientometrics, 18 (5-6) :1990.pp. 323-329.

474) Peritz, B.C. : On the association between journal circulation and impact factor. Journal for Information Science, 21 (1) :1995. pp.63-67.

475) Peritz, B.C. : A classifcation of literature roles for the social science and related fields. Scientometrics, 5 (6) :1983. pp.303-312.

476) Persson,O. : Online bibliometrics, a research tool for every man. Scientometrics, 10 (1-2) :1985. pp.69-75.

477) Pettigrew, K.E. and Nicholls, P.T. : Publication patterns of LIS faculty from 1982-1982 : Effects of doctoral programs. Library and Information Science Research, 16 (2) :1994. pp.139-56.

478) Pichappan, P. : Indian Agricultural Science journals. IASLIC Bulletin, 35 (2) :1990. pp.83-86.

479) Pierret, J-D .et al., Bibliometric analysis applied to scientific review coverage of various aspects of sudden infant death syndrome. Documentaliste, 319(4-5) :1994. pp.205-210.

480) Pinski, G. and Narin, F. : Citation influence for journal aggregates of scientific publications. Information Processing and Management, 12 : 1976.pp.297-312.

481) Pontigo, J. and Lancaster, F.W.: Qualitative aspects of the Bradford distribution. Scientometrics, 9 (1-2) :1986. pp.59-70.

482) Pope, A. : Bradford's law and the periodical literature of information science. Journal of American Society for information Science, 26(4):1975. pp.207-213.

483) Portal, S.G. and Thompson, A.C. : CUIB-METRIC : An intergral system for metric analysis of bibliographic information. Information Bibliotechlogica, 8 (6):1994. pp.27-31.

484) Porter, A.L., Chubin, D.E. and Jin, X.Y. : Citations and scientific progress comparing bibliometric measures with scientists judgement. Scientiometrics, 13 (3-4) :1988.pp. 103-214.

485) Porter, A.L. : Citation analysis queries and caveats. Social Studies of Science, 7 : 1977.pp.257-267.

486) Potter, W.G. : Lotka's law revisited. Library trends, 30 (1) :1981. pp.21-40.

487) Potter, W.G. : Introduction to bibliometrics. Library Trends, 30 :1981. pp.5-7.

488) Pouris. A . : Scientometric assessment of Agricultural research in South Africa. Scientometrics, 17 (5-6) :1989. pp.401-413.

489) Pravdic, N. and Pekorari, R. : The citing practices of the authors to the national journals in Mathematics, Physics, and Chemistry. Scientometrics, 8 (3-4) :1985. pp.233-246.

490) Price, D.J.S. : Network of scientific papers. Science, 149 :1963a. pp.510-515.

491) Price, D.J.S. : Some remarks on elitism in information and the invisible college phenomenon in science. Journal of American Society for Information Science, 27 (2) :1971.pp. 348-349.

492) Price, D.J.S. : A general of bibliometric and other cumulative advantage process. Journal of American Society for Information Science. 27 :1976.pp. 292-307.

493) Price, D.J.S. : The citation cycle. In : Essays of an Information Scientist. Vol. 4.1981.pp.621-633.

494) Pritchard, A. and Witting, G.R. : Bibliometrics : A bibliography and index. England : AAIM Books, 1960.

495) Pritchard, A. : Statistical bibliography or bibliometrics ? Journal of Documentation, 25 (4) :1969.p.358.

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

497) Pritchard, A. : Bibliometrics and information transfer. Research in Librarianship, 4 :1972.pp. 37-46.

498) Proceedings of the 15th IASLIC Conference on Bibliometric Studies and Current Information. Bangalore : IASLIC, Dec. 1985.

499) Qin, J. : An investigation of research collaboration in the sciences through the philosophical transactions 1901-1991. Scientometrics, 29 (2) :1994. pp.219-238.

500) Qiu, L. : An empirical examination of the existing models for Bradford's law. Information Processing and Management, 26 :1990. pp.655-672.

501) Radhakrishnan, T. and Kernizan, R. : Lotka's law and computer science literature. Journal of American Society for Information Science, 29 :1979. pp.253-254.

502) Raghavan, K.S. : Journal acquisitions and cost effectiveness in a special library : A case study. Annals of Library Science Documentation, 25 :1978.pp. 98-100.

503) Raghavan, K.S. and Shalini ,R. : 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) :1977.pp. 34-41.

504) Raising, L.M. : Statistical bibliography in Health Sciences. Bulletin of the Medical Library Association, 50 :1962.pp. 450-461.

505) Rajan, T.N. and Sen, B.K. : An essay on informetrics : A study on growth and development. Annals of Library Science and Documentation, 33 (1-2) :1986. pp.1-12.

506) Rann, A.F.J.V. : Little scientometrics, big scientometrics and beyond. Scietometrics , 30 (2-3) :1994. pp.529-531.

507) Ranga Rao, B.V. : Scientific research in India : Analysis of publications. Journal of Scientific and Industrial Research, 26 :1969. pp.166-176.

508) Ranganathan, S.R. Librametry and its scope. D.R.T.C. Seminar 7 D. A Bangalore: DRTC, 1969: pp.285-301.

509) Rangarajan, K.S. and Gupta, B.M. : Analysis of journals for publications by Indian physicists. Journal of Library and Information Science, 4 (2) :1979. pp.144-161.

510) Ratan Chakraborty. : Citation analysis of petrological literature. Lucknow Librarian, 15 (3) :1983. pp.99-104.

511) Ravichandra Rao, I.K. : Obsolescence and utility factors of periodical publications. DRTC Seminar 9, Paper J.1971. also Library Science, 10 :1973.p. 297.

512) Ravichandra Rao, I.K. : Distribution of scientific productivity and social change. Journal of American Society for Information Science, 31 (2) :1980. pp.111-122.

513) Ravichandra Rao, I.K. : 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) pp.1-133.

514) Ravichandra Rao, I.K. : Probability distributions and inequality measures for analysis of circulation data. In : Egghe and Rousseau, Ed : Informetrics .pp.87-88.Amsterdam : Elsevier, 1988.pp.231-248.

515) Ravichandra Rao, I.K. : Journal productivity in Economics In : Egghe and Rousseau, Ed Informetrics, 89/90 .Amsterdam : Elsevier, 1990.pp. 251-278.

516) Ravichandra Rao, I.K. : Informetric models. Library Science , 30 (3):1993. Guest editorial. i-ii.

517) Ravichandra Rao, I.K. : Library to bibliometrics to informetrics. Library Science, 30 (2) : 1993a.Guest editorial. p. i-ii

518) Ravichandra Rao, I.K. : Little scientometrics, big scientometrics and beyond. scientometrics, 30(2-3) : 1994. pp.465-469.

519) Ravichandra Rao, I.K. and Meera, B.M. : Growth and obsolescence of literature : An empirical study. In : Ravichandra Rao, I .K. Ed. Informetrics-91 P.377-394. Paper presented at the third International Conference on Informetrics. Bangalore, 9-12 August 1991.

520) Ravichandra Rao, I.K. and Neelameghan, A. : From librametry to informetrics. An overview and Rangathan's contributions. Libri, 42 :1992 .pp. 242-257.

521) Ravichandra Rao, I.K. : Ed. Informetrics, 91 Selected papers from the third International Conference on Informetrics 9-12 August 1991, Sarada Rangathan Endowment for Library Science, Bangalore. 577p.

522) Ravichandra Rao, I.K. : Workshop on scientific communication and bibliometrics. Calcutta, 1988.

523) Ravinchandra Rao, I.K. : Dispersion on survey analysis : Bradford and Pare to distributions. Library Science with a Slant to Documentation. 1972. Paper T.

524) Rees – Potter. L.K. : 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) :1989.pp. 677-692.

525) Reguant, S. and Casadella, J. : English as a Linga Franga in geological scientific publications : A bibliometric study. Scientometrics, 29 (3) : 1994.pp.335-351.

526) Robinson, M.D. : Applied bibliometrics : Using citation analysis in journal submission process. Journal of American Society for Information Science, 42 : 1991.pp.308-310.

527) Rothman, H. and Lester, G. : The use of bibliometric indicators in the study of insecticide research. Scientometrics, 8 (3-4) : 1985. pp. 247-262.

528) Rousseau, R. : Citation distribution of pure Mathematics journals. In : Egghe and Rousseau, Ed : Informetrics, 87/88,1988.pp.249-261.

529) Rousseau, R. : Constraint propagation applied to co-citation analysis : An example. Information Processing and Management, 25 (6) :1989 .pp. 721-725.

530) Rousseau, R. : A bibliometric study of Nieuwenhuysen's bibliography of microcomputer software for online information and documentation work. Journal of Information Science, 16 :1990. pp.45-50.

531) Rousseau, R. : Double exponential models for first citation process. Scientometrics, 30 :1994.pp. 213-227.

532) Rousseau, R. : Similarities between informetrics and economics. Scientometrics, 30 :1994a. pp.385-387.

533) Rousseau, R. Relation between continuous versions of bibliometric laws. Journal of American Society for Information Science, 41 :1990a. pp.68-75.

534) Rousseau, R. : Determination of a core of a bibliography. IASLIC Bulletin, 38 (2) :1993.pp. 49-57.

535) Rousseau, R. : Bradford curve. Information Processing and Management, 30 (2) :1994b .pp. 267-277.

536) Rousseau, R. : Suggestions for research topics in citation and publication analysis. Library Science, 32 (1) : 1995.pp. 3-12.

537) Russell, J.M. : Back to the culture of informetrics. Scientometrics, 30 (2-3) :1994. pp.407-410.

538) Sancho,R. : Bibliometric approach to research performance in the field of refractory materials used in iron and steel making process. Scientometrics; 24 (1) :1992. pp.115-136.

539) Sandison, A. : The use of older literature and its obsolescence. Journal of Documentation. 27 (3) :1971. pp.184-189.

540) Sandison, A. : Thinking about citation analysis. Journal of Documentation, 45 (1) :1989.pp. 59-64.

541) Sangam, S.L. and Biradar, B.S. : Pattern of information use by Indian surgical scientist : A citation study. Annals of Library Science and Documentation, 37 (4) :1990. pp .133-142.

542) Sangam, S.L. : Obsolescence of literature in economics. ILA Bulletin : 25 (2) :1989. pp.59-66.

543) Sanjay, M. : IASLIC Bulletin : A bibliometric study. IASLIC Bulletin, 35 (3) :1990. pp.125-128.

544) Saracevic, T. and Perk, L.J . : Ascertaining activities in a subject area through bibliometric analysis. Journal of American Society for Information Science, 24 (2) : 1973. pp .120-134.

545) Saurer, W . and Weinberager, R. : Planetary nebule : Some statistics on a continuously growing field and its contributions. Scientometrics, 31 (I) :1994. pp.85-95.

546) Scales, P.A. : Citation analysis as indicator of the use of serials : A comparison of ranked title lists produced by citation counting and from use data. Journal of Documentation, 32 (1) :1976. pp. 17-25.

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

548) Schorr, A. E. : Lotka's law and map librarianship. In the brief communication in the Journal of the American Society for Information Science, 26 (3) :1975. pp. 189-190.

549) Schrader, A. M. : Teaching bibliometrics. Library Trends, 30 (6) :1981. p. 151.

550) Schubert, A. : Quantitative studies of Science : A current bibliography. Scientometrics, 5 :1983. pp.125-133, 397-403, 6 :1984. pp. 55-59, 197-202 and 359-367.

551) Schubert, P. and Glanzel, W. : Statististical reliability of comparisons based on the citation impact of scientific publications. Scientometrics, 5 (1) :1983. pp.59-74.

552) Sen, S.K. and Chatterjee, S.K. : An introduction to researches in bibliometrics. Part 2. Glossary. IASLIC Bulletin, 35 (4) : 1990. pp. 155-170.

553) Sen, B.K. : From Bibliometrics to Informetrics : Workshop on Scientific Communications and Bibliometrics, Calcutta ,15-26 February, 1988.pp.84-98.

554) Sen, B.K. and Kumar, K. : Evaluation of recent scientific research output by bibliometric method. Paper presented at International Conference on Science Indicators for developing countries, UNESCO, Paris,1990.

555) Sen, B.K. and Kumar, N. : Indian contributions in bibliometrics (1958-84) : A review. Annals of Library Science and Documentation, 33(3) : 1986. pp.85-103.

556) Sen, B.K. and Lakshmi, V.V. : Bibliometrics in India 1988 : A review. ILA Bulletin, 26 (4) :1991. pp.198-206.

557) Sen, B.K. and Shailendra, K. : Evaluation of recent scientific research output by a bibliometric method. Scientometrics, 23 (1):1992. pp.21-30.

558) Sen, B.K., Karanjali, A . and Munshi, U.M. : A method for determining the impact factor of non-SCI journal. Journal of Documentation, 45 (2) : 1989.pp. 139-141.

559) Sen, S.K. : 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.

560) Sen, S.K. and Kundra, R. : Bibliometrics of English language alcohol fuel literature : A new empirical equation of scatter. Scientometrics, 10 : 1986. pp. 43-54.

561) Sen, S.K. and Chatterjee, S. K. : An introduction to researches in bibliometrics, Part I. Background and perspectives. IASLIC Bulletin, 35 (3) :1990.pp. 105-117.

562) Sengupta, I.N. : Weightage formula to re-rank biochemical periodicals. International Library Review, 16 : 1984.pp. 447-458.

563) Sengupta, I.N. : Bibliometrics : A bird's eye view. IASLIC Bulletin, 30 (I) :1985. pp.16 7-174.

564) Sengupta, I.N. : Three new parameters in bibliometric research and their application to re- rank periodicals in the field of Biochemistry. Scientometrics, 10 : 1986. pp.235-242.

565) Sengupta, I.N. : Three new bibliometric parameters and Physiology periodicals. Annals of Library Science and Documentation, 35 (3) : 1988.pp.124-127.

566) Sengupta, I.N. : Three new bibliometric parameters to re-rank Microbiology periodicals. Annals of Library Science and Documentation. 36 (3) : 1989.pp.69-74.

567) Sengupta, I.N. : Bibliometrics and identification of core periodicals. Herald of Library Science, 29 (3-4) :1990. pp.226-247.

568) Sengupta, I.N. and Ghosh, B.N. : The role of bibliometry in journal selection and library management. IASLIC Bulletin, 25 (2) : 1980. pp.87-92.

569) Sengupta, I.N. and Lalitha Kumari. : Bibliometric analysis of AIDS literature. Scientometrics ,20 (1) : 1991. pp.297-315.

570) Sengupta, I.N. : Bibliometrics and its applications. In : Information science and libraries . Ed. by Pushpa Dhyani. New Delhi : Atlanta, 1990.

571) Sengupta, I.N. : Choosing Pharmacology periodicals : Study of the growth of literature in the field. Annals of library science and documentation, 21 : 1974. pp.1-21.

572) Sengupta, I.N. : Growth of bio-chemical literature. Nature, 244 :1973. pp.75-76.

573) Sengupta, I.N. : Impact of scientific serials in the advancement of medical knowledge : An objective method of analysis. International Library Review, 4 :1972. pp. 169-195.

574) Sengupta, I.N. : Physiology periodicals. International Library Review, 6 :1974. pp.147-165.

575) Sengupta, I.N. : Recent growth of the literature in Biochemistry and changes in ranking of periodicals. Journal of Documentation, 29 : 1973. pp. 192-211.

576) Sengupta, I. N. : Workshop on scientific communication and bibliometrics. Herald of Library Science, 27 (1-2) : 1988. pp.91-92.

577) Shailendra, K., et al. : Bibliometrics : A total for scientific evaluation. ILA Bulletin , 24 (4) :1989. pp. 194-207.

578) Shalaja, T.S. : Characteristics of the literature used by the nutritionists : A citation study. Annals of Library Science and documentation, 32 (3-4) :1985. pp.122-128.

579) Shalini, R. : Journal acquisition and cost effectiveness in special libraries : A case study. International Library Review, 13 (2) : 1981. pp.189-194.

580) Shalini, R. : Citation profile to improve relevance in two stage retrieval system : A proposal. Information Processing and Management, 29 (4) :1993.pp. 463-470.

581) Sharada, B.A. : Bibliometric studies in linguistics and bibliometric laws. Library Science, 30 (2) : 1993. pp.71-75.

582) Shtrikman, S. Some comments on Zip's law for the Chinese language. Journal of Information Science, 20 (2) : 1994. pp. 142- 143.

583) Sichel, H.S. : A bibliometric distribution which really works. Journal of American Society for Information Science, 36 (5) : 1985. pp. 314-321.

584) Simon, H.A. : On a class of skew distribution functions. Biometrika, 42 : 1955. p.425.

585) Singh, R.S. : Ranking of periodicals in Chemistry form the point of view of Indian scientists. Annals of Llibrary Science and Documentation , 21 : 1974. pp. 55-67.

586) Singleton, A. : Journal ranking and selection : A review in Physics. Journal of Documentation, 32 (4) : 1976. pp.258-289.

587) Sinha, S.C. : 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) :1993. pp.21-31.

588) Small, H. : Co-citation in the scientific literature : A measure of the relationship between two documents. Journal of American Society for Information Science, 24 (4) :1973. pp.232-239. Reprinted In : Essays of an Information Scientist 2 : pp.28-31.

589) Small, H. : Co-citation context analysis and structure of paradigms. Journal of Documentation, 36 (3) : 1980. pp.183-196.

590) Small, H. : The synthesis of speciality narratives form co-citation clusters. Journal of American Society for Information Science, 37 : 1986. pp.97-110.

591) Smith, L.C. : Citation analysis. Library Trends, 30 (1) : 1981. pp.83-106.

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

593) Stewart, J.A. : The poisson lognormal model for bibliometric scientometric distributions. Information Processing and Management, 30 : 1994.pp.239 – 251.

594) Stinson, E.R. and Lancaster, F.W. : Synchoronous Vs diachronous methods in the measurement of obsolescence in citation studies. Journal of Information Science, 13 (2) : 1937. pp.65-74.

595) Subramanyam, K. : Core journals in Computer Science. IEEE Transactions in Professional Communication, 19 (2) :1976. pp.22-25.

596) Subramanyam, K and O' Pecko, M.M. : Environmental research journals. Environmental Science and Technology, 13 :1979. pp. 327-929.

597) Subramanyam, K. and Stephens, Eisie, M. : Research collaboration and funding in Biochemistry and Chemical Engineering. Internaitonal Forum of Information and Documentation, 7:1982. p.26.

598) Subramanyam, K. : Scientific journals : A review of current trends and future prospects. Unesco Bulletin of Libraries, 29 (4) : 1975. pp. 192-201.

599) Subramanyam, K. : Lotka's law and library literature. Library Research, 8 : 1981.p167.

600) Subramanyam, K. : Bibliometric studies of research collaboration. Journal of Information Science, 6 (1) : 1983. pp. 333-338.

601) Sujatha Rao, E. and Suresh, P. : Citation pattern in Leather Science. Annals of Library Science and Documentation, 32 (3-4) : 1985.pp.109-114.

602) Summers, E.G. : A review and application of citation analysis methodology to reading research journal literature. Journal of American Society for Information Science, 35 (6): 1984. pp.332-343.

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

604) Swanson, D.R. : Intervening in the life cycles of scientific knowledge. Library Trends, 41 (4) : 1993 .pp.606-631.

605) Sylvan, C. : Canadian research activity in Aquaculture : A bibliometric analysis. Scientometrics, 27 (3) : 1993. pp.295-316.

606) Synder, H., Cronin, B. and Davenport, E. : What's the use citation? Citation analysis as a literature topic in selected disciplines of the Social Science. Journal of Information Science, 21 (2) : 1995. pp. 75-85

607) Szava - Kovats,E. : First fact - finding examination of a phenomenon of Scientific literature. Journal of Information Science, 20 (1) : 1994.pp.155 -170.

608) Tague, J. and Nicholls, P. : The maximal value of a Zipf size variable : Sampling properties and relationship to other parameters. Information Processing and Management, 23 (3) : 1987. pp. 155-170.

609) Tague, J. : Success breeds success phenomenon and bibliometric processes. Journal of American Society of Information Science, 32 :1981.pp. 280-286.

610) Tague, J. : What's the use of bibliometrics? In : Egghe and Rousseau, Ed : Informetrics 87/88.Amsterdam : Elsevier,1988.pp. 271-278.

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

612) Tague, J., Beheshti, J. and Rees – Potter, L. : The law of exponential growth : Evidence, implications and forecasts. Library Trends, 30 (1) :1981. pp.125-149.

613) Thorne, F.C. :The citation index : Another case of spurious validity. Journal of Clinical Psychology, 33 :1997. pp. 1157-1161.

614) Thorpe, P. : Inter-library's loan analysis for journal organization. Aslib Proceeding, 31 (7) : 1979.pp. 352-359.

615) Thyer, B.A. and others. : Academic affiliation of social work journal article authors: A publication productivity analysis from 1984-1988.Journal of Social Service Research, 18(3-4) : 1994. pp.153-167.

616) Tijssen, R.J.W. and Van Raan, A.F.J. : Net citation balances a measure of influence between scientific journals. Journal of American Society for Information Science, 41 :1990. pp.298-304.

617) Tijssen, R.J.W., Leeuw, J. De. and Van Raan, A.F.J. : A method for mapping bibliometric relations based on field classification and citations of articles. In Egghe and Rousseau, Ed : Informetrics 87/88.Amsterdam : Elsevier, 1988. pp.279-292.

618) Todorov, R. and Glanzel, W. : Journal citation measures : A concise review. Journal of Information Science, 14 :1988. pp.47-56.

619) Todorov, R. : Facts or imposed names on facts ? Scientometrics, 30 :1994. pp.461-464.

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

621) Trueswell, R.W. : Some behavioral patterns of library users : The 80/20 rule. Wilson Library Bulletin, 43 : 1969. pp.458-461.

622) Turner, W.A. : What's in an R. Informetrics or Informetrics? Scientometrics, 30 : 1994. pp.471-480.

623) Vaiishnav, A.A. and Deo, V.N. : Literature of computerised library and information service : A bibliometric study. Library Science, 30 (2) : 1993. pp.45-53.

624) Van Heeringen, A. and Dijkwel, P.A. : The relationships betweeen age, mobility and scientific productivity. Pt. I.Effect of mobility on productivity. Scientometrics, 11 (5-6) : 1987. pp.267-280. Pt. II. Effect of age on productivity. Scientometrics, 11 (5-6) :1987.pp. 381-293.

625) Van Hooydonk, G., Gevart, R., Mills – Proost, G., Van de Sompel, H. and Debackere, K. : A bibliotheeconomic analysis of the impact factors of scientific disciplines. Scientometrics, 30 : 1994. pp.65-81.

626) Van Raan, A.F.J. and Hartman. : The comparative impact of scientific publications and journals : Methods of measurement and graphical display. Scientometrics, 11 (5-6) : 1987. pp.325-331.

627) Velho, L. : The meaning of citation in the context of a scientifically peripheral country. Scientometrics, 9 (1-2) :1986. pp.71-89.

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

629) Vickery, B.C.: Indicators of the use of periodicals. Journal of Librarianship, 1 (3) : 1969. pp.170-182.

630) Vinkler, P.: Evaluation of some methods for the relative assessment of scientific publications. Scientometrics, 10 (3/4) 1986. pp.157-177.

631) Vinkler, P. : Bibliometric analysis of publication activity of a scientific research Institute. In : Egghe and Rousseau, R. Ed : Informetrics 89/90. Amsterdam :Elsevier,1990.pp.308-334.

632) Vlachy, J. : Frequency distribution of scientific performance : A bibliography of Lotka's law and related phenomenon. Scientometrics, I :1978. pp.109-130.

633) Voos, H. : Lotka and Information Science. Journal of American Society for Information Science, 25 :1974. pp.270-272.

634) Wade, N. : Citation analysis : A new tool. Science, 188 : 1975. p.430.

635) Wagher- Dobler, R. and Barg, J. : The dependence of Lotka's Law on the selection of time periods in the development of Scientific areas and authors. Journal of Documentation, 51(1):1995. pp. 28-43.

636) Wallace, D.P. : The relationship between journal productivity and obsolescence. Journal of American Society for Information Science, 37 (3) :1986. pp.136-145.

637) Wallace, D.P. : A solution in search of a problem : Bibliometrics and libraries. Library Journal, 112 (8) :1987. pp.43-47.

638) Weinberg, B.H. : Bibliographic coupling : A review. Information Storage and Retrieval, 10 :1974. pp.189-196.

639) Weinstock, M. : Citation Indexes. In : Encyclopaedia of Library and Information Science, Vol.5. New York : Marcell Dekker ,1971. pp.16-40.

640) White, H.D. and Mc Cain, K.W. : Bibliometrics . Annual Review of Information Science and Technology, 24 :1989. pp.119-186.

641) White. Emile, C. : Bibliometrics: Curiosity to convention. Special Libraries, Winter :1985. pp. 35-42.

642) Whitney, G. : Asian authorship in major international bibliographic databases. In : Ravichandra Rao, I.K. Ed : Informetrics – 91,1992.pp.501-526.

643) Whitney, G. : Pattern of authorship in major bibliographic databases. Scientometrics,26(2) : 1993.pp. 275-292.

644) Wiberly, S.E. : Journal rankings form citation studies : A comparison of national and local data form social work. Library Quarterly, 52 (4) :1982. pp.348-359.

645) Wilkinson, E.A. : The ambiguity of Bradford's law. Journal of Documentation, 28 (2) :1972. pp.122-130.

646) Williams, C. B. : Number of publication written by Biologists. Annals of Human Genetics, 12 :1994. pp. 145-146.

647) Windsor, D.A. : De-acquisitioning journals using productivity/cost rankings. Acquisitions Librarian, 1 (1) :1976. pp.8-10.

648) Windsor, D.A. : Could bibliometric data be used to predict clinical success in drugs . Journal of Information Science, 19 :1976a. pp.363-376.

649) Wissman, C. : Techniques of data retrieval for scientometric research in ISI citation indexes. Journal of Information Science, 19 : 1993.pp.363-376.

650) Witting, Glenn R. : Statistical bibliography : A historical footnotes . Journal of Documentation, 34(3) :1978.pp. 240-241.

651) Wolfram, D., Chu, C.M. and Lu, X. : Growth of knowledge : A bibliometric analysis using online database. In : Egghe and

Rousseau, Ed Informetrics 89/90. Amsterdam: Elsevier, 1990.pp.355-372.

652) Wood, J.B. : The growth of scholarship : An online bibliometric comparison of dissertations in Science and Humanities. Scientometrics, 13 (1-2) :1988. pp.53-62.

653) Workshop on Scientific Communication and Bibliometrics 15-26 Feb. 1988. Calcutta : IICB and INSDOC, 1988.

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

655) Worthen, D.B. :. Application of Bradford's law to monographs. Journal of Documentation, 31 (1) :1975. pp.19-25.

656) Woutess, P. and Ley, C. : Has Price's dream come true? Is scientometrics a hard science: Scientometrics. 31(2): 1994. pp. 193-222.

657) Wyllys, R.E. : Measuring scientific prose with rank-frequency (Zipf) curves : A new use for an old phenomenon. Information Revolution, 12 :1975. pp.30-31.

658) Xhingnesse, L.V. and Osgood, C.E. : Bibliographical citation characteristics of the psychological journal network in 1950 and 1960. American Psychologist, 22 :1967.pp. 778-791.

659) Yablonsky, A. I. : On fundamental regularities of the distribution of scientific productivity. Scientometrics, 2 (1) :1980. pp.3-34.

660) Yanovsky, V.L. : Citation analysis : Significance of scientific journals. Scientometrics, 3 (3) : 1981.p.233.

 G8942

661) Yitzhaki, M . and Ben-Tamar, D. : Number of references in Biochemistry and other fields : A case study of the journals of biological chemistry throughout 1910-1985. Scientometrics, 21 :1991. pp.3-22.

662) Yitzhaki, M. : Relation of title length of journal articles to number of author. Scientometrics, 30 (1) :1994. pp.321-332.

663) Yuasa, M. : Centre of Scientific activity, its shift from the 16th to 20th century. Japanese Studies in the History of Science, 1:1962. p.527.

664) Yuthavong.Y. : Bibliometric indicators of scientific activity in Thailand. Scientometrics, 9 (3-4) :1986.pp. 139-143.

665) Zuker Man.: Nobel Laureates in Science, patterns of productivity, collaboration and authorship. American Social Review, 32 : 1967.pp.391-403.

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