

ON THE RELATIONSHIP BETWEEN THE EPIDEMIC THEORY
AND THE BRADFORD LAW OF DISPERSION

by

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Abstract

by

ROBERT KENNETH DIKEMAN

Bradford's law of dispersion and the epidemic theory are two bibliographic methods which have been used productively to study subject literatures. Bradford's law has been used to establish structural relationships for the periodicals of a subject literature. The epidemic theory has been previously applied to author data to trace the growth or decline of a subject literature. To date no study has attempted to compare the results of these two bibliometric techniques on the same subject literature.

The purpose of this study is to investigate any existing relationships between the epidemic theory and the Bradford distribution for the diachronic study of the symbolic logic subject literature. The bibliographic data base was gathered from (1) A Bibliography of Symbolic Logic and Additions and Corrections to "A Bibliography of Symbolic

Logic" by Alonzo Church and (2) the "Reviews" section of the Journal of Symbolic Logic for the time period, 1841-1960. The periodical data was ranked by productivity by year, tabulated and analyzed using both the Bradford law of dispersion and the epidemic theory.

By the study of the diachronic growth of a subject literature, a number of interesting relationships can be explored. The nearly identical nature of the epidemic curves based on periodical and author data indicates the direct interaction between the author and the periodicals in the epidemic analysis. The usefulness of the epidemic theory in the analysis of the periodical structure of a subject literature, the stability of each recurring epidemic cycle and the changing environmental conditions of each epidemic cycle are all demonstrated. Thus, this diachronic study of this subject literature has conclusively shown the interrelationship of the Bradford distribution and the epidemic theory. Various phases of the epidemic cycle, the cumulative Bradford distributions, period studies of the Bradford distribution, and the internal structure of a subject literature were also studied.

One immediate benefit of this study is to illustrate, by example, how the periodical structure of a subject literature may be analyzed. The use of such an analysis would

be an invaluable aid in periodical acquisitions for a research library. This study also provides the first observational evidence to support the mathematical model for information transfer that has been derived from the epidemic studies of the disease, schistosomiasis. And finally, the current dilemma of rapidly expanding subject literatures will only be solved through an understanding of the interrelationships of the structural properties of subject literatures. Any attempts to modify the current scientific literature system without an understanding of these properties may result in its collapse.

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I

INTRODUCTION

The field of librarianship in modern times has been criticized for its seeming devotion to clerical-like concerns while ignoring the development of a theoretical body of knowledge. Many library leaders and critics such as Pierce Butler, William Goode and Jesse Shera have published statements detailing the need for the establishment of a firm theoretical base for librarianship.^{1, 2, 3, 4}

One area of research that has recently showed much promise in providing at least a portion of the needed theoretical foundation is the investigation of possible structural properties of subject literatures. Presently, the only knowledge a librarian can obtain concerning possible structural properties of recorded knowledge is derived through the same ad hoc observational pattern that is common to all areas of librarianship. Many see the investigation of possible structural properties of subject literatures in terms of observable and quantifiable parameters as a first step toward the establishment of an theoretical

body of knowledge.

In recent years, there have been many studies of the structural properties of subject literatures that have clearly established the existence of such properties. These studies pertinent to this investigation will be reviewed later in this chapter.

The overall purpose of this study is to continue the research into the existence of structural properties of subject literatures. To accomplish this broad purpose, this study's objective is to investigate the possible relationship(s) that may exist between the epidemic theory and the Bradford law of dispersion through the diachronic study of the symbolic logic literature.

Subject Literatures

Subject knowledge, according to Rawski "...involves a body of knowledge organized as a subject field--characterized by ends, methods, techniques, etc., related to the situation and requirements of the subject matter."⁵ The production of new subject knowledge requires the use of subject knowledge as expressed by others. The articulation of a subject knowledge as a literature unit requires that it be purposively expressed in terms of the goals, concepts, forms, etc., that are characteristic of the subject itself. The subject literature unit is also constrained

by the device(s) used to record, store, display and transmit subject knowledge. Thus, the subject literature not only reflects the goals, concepts, techniques, methodologies, etc., used by the practitioners of that subject area, but it also reflects the means by which producers of subject knowledge communicate with each other through indirect communication channels. In terms of present day technology, this indirect communication is done almost exclusively via the printed word.

In addition to reflecting the goals, concerns, methodologies, etc., of a subject knowledge, the subject literature also documents the growth of knowledge. The documentation of this new knowledge enables one to create a map, if you will, comprising areas of both known and unknown knowledge. This map not only assists one in establishing relationships between areas of known knowledge, but it also identifies areas which should be explored in order to obtain new subject knowledge.

Since the creation of a subject literature is a purposive activity which intends as its primary function the use of the literature to all having a desire or need, it must also require the establishment of some sort of control procedures for its effective use and dissemination. The need for effective control of subject literatures is one of the most fundamental problems facing

researchers, publishers and librarians.

Price and a host of others have constantly discussed the present growth rate of scientific subject literatures using such emotive terms as information explosion and knowledge explosion.⁶ The rapid physical growth of subject literatures regardless of the emotional rhetoric must be faced by all research libraries. These libraries are staggering under mounting pressure from students and faculty alike to acquire materials at an ever increasing rate while library material budgets are cut or held constant by governing boards feeling the shrinkage of funds necessary to underwrite the library's entire operation.

The need to understand the structural characteristics of a subject literature is essential before one can consider the adoption of various mathematical modeling techniques. Without this ability to model present and future trends of a subject literature, it is absolutely impossible for any one to form any sort of rational basis for solving the current crises in scientific subject literatures that are bringing research libraries to the brink of financial collapse.

Levi-Strauss in one of his many essays has outlined the basic requirements for a structural model:

"First, the structure exhibits the characteristics of the system. It is made up of several elements none of which can undergo a change without effecting changes in all other elements.

In the second place, for any given model there should be a possibility of ordering a series of transformations resulting in a group of models of the same type.

In the third place, the above properties make it possible to predict how the model will react if one or more of its elements are submitted to certain modifications.

And last, the model should be constructed so as to make immediately intelligible all the observed facts."⁷

The ability to construct models of subject literatures is essential if one is to achieve the desired goal--the ability to predict future developments of a subject literature. In order for the librarians of the future "to provide the knowledge most worth having in terms of the available knowledge records and the user," Rawski strongly believes that "librarians must be able to assign priorities, to predict."⁸ The need to explore new methodologies in the investigation of structural properties of subject literatures is a prerequisite to achieving the ability to predict future developmental patterns in a subject literature.

Bibliometrical Analysis

One methodological approach successfully used

for the establishment of structural properties of a subject literature has been the utilization of numerical bibliographic techniques. In an attempt to find a suitable name for these techniques, Fairthorne has popularized the term 'bibliometrics' "resuscitated by Alan Pritchard" as denoting a "quantitative treatment of the properties of recorded discourse and behaviour appertaining to it."⁹

The two bibliometric techniques of concern to this study are the use of the Bradford law of dispersion and the epidemic theory. The Bradford law of dispersion has been used to develop quantitative relationships concerning the productivity of the periodical literature of a given subject. The epidemic theory derived from medical epidemiology has been employed in the area of information transfer. Each of these bibliometric techniques provides a different approach to the study of structural properties.

Bradford Law of Dispersion

The Bradford law of dispersion is an empirical relationship between the dispersion of a set of journals over a given set of articles comprising a subject literature. This relationship was first observed by Samuel Clement Bradford, Keeper of the Science Library, London. Bradford's initial concern was the abstracting and

indexing coverage (or, more importantly, the lack thereof) of the current (1934) scientific and technical literature. By his estimates of the more than 300 abstracting and indexing services covering a sum of 750,000 papers which he approximates to be the total current (1934) sci-tech papers published per year, Bradford states that in reality, "owing to duplication of effort, only 250,000 different articles are dealt with and 500,000 are missed."¹⁰

Pursuing this study with his deputy, E. Lancaster Jones, Bradford formulated an hypothesis that "the aggregate of periodicals can be divided into classes according to relevance of scope to the subject concerned, but the more remote class will, in the aggregate, produce as many references as the more related classes."¹¹ Thus, the full set of journals that comprise a subject literature when divided into a given number of subsets in which the number of articles per subset remains constant, the number of journals per subset will increase as one progresses from the most productive journal to those of lowest productivity.

Using a 4 year (1928-31) time span for the field of applied geophysics and a 3 year (1931-June, 1933) time span for the field of lubrication, Bradford and Lancaster Jones constructed two complete bibliographies. When the journal data was ranked by productivity from the most

productive journal to the least (those journals producing only one article in the time span covered), a distinct regularity did, indeed, exist. Bradford's statement of this regularity is as follows:

"If scientific journals are arranged in order of decreasing productivity of articles on a given subject, they 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, where the number of periodicals in the nucleus and succeeding zones will be as
 $1 : n : n^2 : n^3 \dots$ "

Applying this set of calculations to the literature of applied geophysics, Bradford found a nucleus of 9 journals containing 429 articles, a first zone of 59 journals containing 499 articles and a second zone of 258 journals containing 404 articles. In addition to the above algebraic statement, Bradford also presented a graphic interpretation by plotting the $\log_{10}$ of the sum of the journals versus the sum of the articles.

The material contained in the last zone drew Bradford's greatest concern. He felt that a combined effort should be made by both libraries and abstracting and indexing services to bring this material into the existing bibliographic network.

In 1948 Vickery attempted to clarify some of the

ambiguities left by Bradford between the algebraic and graphic statements of his law of dispersion. Vickery showed that Bradford's algebraic and graphic expressions were not mathematically equivalent.¹³ Rather than giving rise to a unique distribution, Vickery found that Bradford's graphic solution gives rise to a family of possible solutions. This clearly indicates that Bradford's law of dispersion is independent of the number of zones selected.

In a recent article Wilkinson again raises the same question: Which form of Bradford's law of dispersion best fits the observational data? Wilkinson found that Bradford's graphic formulations provide the closest values to the given observed data. Wilkinson, however, concludes that "there is little to be gained from trying to establish which formulation Bradford would have adopted had he realized the disparity. In theory Bradford predicted the verbal (algebraic) formulation; in practice, he observed the graphic formulation."¹⁴ The important point is that Bradford provided us with a point of departure to explore potential relationships, not a final statement on the subject.

Several other investigators have also contributed different formulations or statements of Bradford's law. Leimkuhler, using Bradford's verbal statement as a starting

point, derived several formulations of this expression for discrete and for continuous variables. Leimkuhler makes a distinction between Bradford's law of dispersion which concerns the number of journals required to obtain a given portion of the references and what he terms as Bradford's distribution which predicts the number of references for a given portion of journals.¹⁵ Unlike Bradford, Leimkuhler emphasizes the productivity of the nucleus and first zone from which, using Leimkuhler's methodology, one can compute the theoretical scatter. Unfortunately, Leimkuhler's method involves calculations from data not readily obtainable from a subject bibliography.

Naranan in two recent articles has expressed Bradford's law of dispersion in what he terms a power law frequency function. Using both algebraic and graphic means, Naranan proposes that his formulation of Bradford's law is consistent with other formulations. Naranan, using data previously published by others in the literature, has sought to provide an explanation for Bradford's law and the growth of scientific subject literatures by means of a power law function.^{16, 17} Though Naranan has constructed several different mathematical expressions for rates of literature growth, his growth model requires further

supporting bibliographic data to test the validity of his expressions.

Brookes has approached Bradford's law primarily through graphic techniques in which the typical Bradford curve is expressed in terms of two components.¹⁸ Using Figure 1 below as a typical Bradford graph, curve BC represents the exponential component and CD is the linear component. Brookes labels the graph as a Bradford-Zipf bibliograph.

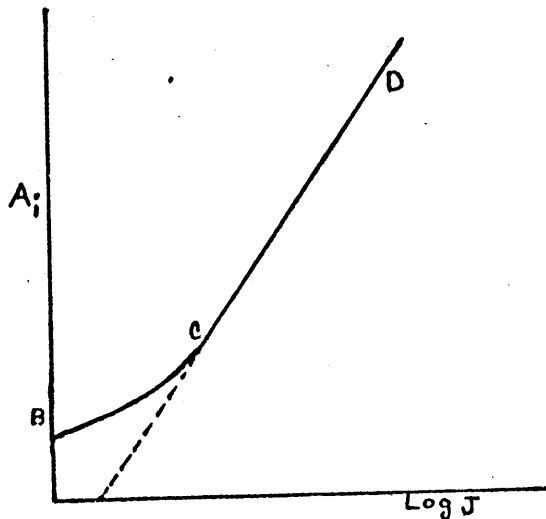


Figure 1. A Typical Bradford Graph.

A_i = cumulative sum of all relevant articles.

J = cumulative sum of all journals.

C = point of linearity.

Brookes, Leimkuhler, Kendall and Fairthorne have all shown or discussed the Bradford-Zipf relationship.^{19, 20, 21, 22} Zipf's law formulated from linguistic studies simply states that if all individual words of a given text were ranked by decreasing frequency of occurrence, then the resulting distribution can be approximated as

$$R \cdot F = C$$

where F is the frequency of the word ranked R and C is a constant.²³ Both Zipf's law and Bradford's law are hyperbolic distributions, i.e. the product of fixed powers of the variables is a constant. Brookes proposes that the curved portion of the Bradford graph (Figure 1-curve BC) is Bradfordian while the linear portion of the graph (Figure 1-curve CD) is Zipfian in character.²⁴

Brookes, for the most part, has emphasized several practical applications of Bradford's law. One of these applications is the estimation of the completeness of a bibliography. Though Leimkuhler had previously published an algebraic method for the estimation of completeness, Brookes' graphic approach is more simple and practical in terms of readily available data.²⁵ He has also investigated the possible application of Bradford's law in such problem areas as obsolescence of material and the utility of acquisition and retention of periodicals.^{26, 27}

Goffman and Warren have taken Leimkuhler's statement of Bradford's law of dispersion and have restructured it in more precise fashion. The Goffman-Warren statement of Bradford's law of dispersion is as follows:

"Consider a collection of periodicals J containing all articles A on a given subject. If these periodicals are arranged in descending order of publication of articles in this subject area and divided into k groups containing numbers of periodicals $J_1, J_2, \dots, J_k$ such that each group contains the same number of articles on the subject, then according to Bradford's law:

$J_i = b_k J_{i-1} = b_k^{i-1} J_1$ if $i = 1, 2, \dots, k$
 $k = 2, 3, \dots, m$
 where J_1 is the nucleus and $b_k > 1$ is the so-called Bradford multiplier for k divisions of the J periodicals."²⁸

Applying Vickery's earlier findings that a graphic solution to Bradford's law gives rise to a family of possible solutions rather than a single unique solution. Goffman and Warren found that as one increased the number of k divisions, the Bradford multiplier, b_m , decreased. Since the number of journals and articles in a given subject literature are always finite, there must exist for a maximum number of k divisions a minimum value for the nucleus of journal(s) and the Bradford multiplier, b_m . This nucleus, then, would represent the most significant material for a given literature. The methodology presented by Goffman

and Warren for the calculation of this minimal nucleus is given in the passage below.

"The smallest number of articles A/m which can possibly effect a maximal division of a set of journals containing the literature of a given subject is the number of relevant articles j belonging to the most productive journal on that subject. In this case, the minimal nucleus consists of a single periodical. This situation, however, may not always exist. Consider the set of Z journals, each of which contains a single paper on the subject. The smallest number of articles, A/m , which can effect a division of the J journals in the sense of Bradford must be greater than $Z/2$, otherwise there would exist succeeding zones (the last two) with equal numbers of journals containing the same number of articles, contrary to Bradford's law. Thus, the minimal nucleus can consist of a single periodical only if j , the number of relevant papers in the most productive journal, is greater than $Z/2$. If on the other hand, j is less than or equal to $Z/2$, then the minimal nucleus will consist of the smallest number of journals at the top of the ordered list, the sum of whose publications on the subject of interest is greater than $Z/2$."²⁹

The usefulness of this methodology has been shown by Goffman and Warren to be applicable in many diverse medical literatures.

Goffman and Morris have applied these techniques to problems of library acquisition and collection maintenance. The authors using the Goffman-Warren formulation of Bradford's law compiled a Bradford type of distribution of periodical use and a distribution of users based on subject

interest profiles.³⁰ By coupling these two distributions, Goffman and Morris were able to demonstrate a scientific technique upon which library administrators can construct an acquisition and retention policy for periodicals.

Other significant uses of the Bradford law have been in the analysis of subject interactions with neighboring disciplines, the analysis of the coincidence of quantity and quality in a subject literature and the bibliometric analysis of such diverse subject literatures as art history and information science.^{31, 32, 33, 34}

Epidemic Theory

The introduction of mathematical analysis of epidemic diseases was first suggested by Ross in his work with malaria epidemics. Briefly stated, Ross found that future epidemic states of the disease could be predicted if given the rates of infection, recovery, birth and death plus information on the number of people susceptible and the number of people contracting the disease.³⁵ Kermack and McKendrick showed that if the density of persons susceptible to the disease was below a certain threshold value, regardless of the number of persons having contracted the disease, the disease would not reach an epidemic state.³⁶ Thus, through these early developments in medical epidemiology, one can with the use of known quantifiable data,

predict the future state of an infectious disease.

The basic parameters involved in the spread of an infectious disease are: (1) a specified population and (2) exposure to the infectious material. Within a given population (N), there are three distinct groups of individuals at any point in time: (1) "infectives" (I), those individuals that have contracted the disease; (2) "susceptibles" (S), those individuals who, with effective contact with the infectious material, will contract the disease and themselves become infectives; (3) "removals" (R), those individuals who, having been earlier infectives or susceptibles, have been removed from the given population through such processes as death, immunity or recovery. This entire process of the transmission of infectious material from the infective to the susceptible is time dependent.

Using the following set of nonlinear differential equations one can mathematically express the epidemic process for a direct contact condition:

$$dS/dt = -\beta SI - \delta S + \mu \quad (1)$$

$$dI/dt = \beta SI - \gamma I + \nu \quad (2)$$

$$dR/dt = \delta S + \gamma I \quad (3)$$

S, I and R and their respective derivatives are continuous functions of time t. β is the rate of infection, δ and γ are the respective removal rates for susceptibles and infectives, and μ and ν are the respective influx rates

of new susceptibles and infectives. This 2-factorial epidemic process requires that the susceptible be placed in direct contact with the infective or infectious material.

The epidemic curve which relates to the course of the epidemic process (change in the number of infectives as it develops with respect to time is given by the following differential equation:

$$dI/dt = f(t) \quad (4)$$

The ability to predict the course of an epidemic involves the extrapolation of the epidemic curve. If the rate of infection with regard to time is positive ($d^2I/dt^2 > 0$), the process is said to be in epidemic state. If the rate of infection with regard to time is negative ($d^2I/dt^2 < 0$), then the epidemic is in a state of decline. When the epidemic curve has reached its peak ($d^2I/dt^2 = 0$, transition from $d^2I/dt^2 > 0$ to $d^2I/dt^2 < 0$), it may become stable, begin a new epidemic cycle or it may go into a state of decline.

Goffman and Newill first linked epidemiology to the communication of information. The transmission of infectious material from an infective to a susceptible in the case of infectious diseases and the transmission of information between the author of a document and the reader of that document are two examples of a more generalized process of communication.³⁷ On one hand, medicine tries to surpress the spread of infectious diseases while librarianship, on

the other, seeks to enhance the communication of information. A comparison of elements in a disease epidemic and an information epidemic is presented in Table 1.

TABLE 1
A COMPARISON OF THE ELEMENTS IN THE EPIDEMIC
THEORY (AFTER GOFFMAN AND NEWILL)

Elements of an Epidemic Theory	Disease Epidemic	Information Epidemic
Infective	Person with the disease	Person with an idea (author)
Susceptible	Person who may get the disease	Person who has read an idea (reader)
Removal	Person who dies or is immune	Person who dies or looses interest
Infectious material	Disease germs	Ideas

There are numerous historical examples to illustrate the epidemic process in the transfer of information. One of the most famous examples is that of Mendel's experiments on genetic inheritance. It has been widely written that Mendel's work on genetic inheritance was not recognized by the then scientific community because it was published in an obscure journal. This is historically incorrect. It is well documented that Mendel sent reports of his genetic experiments to the leading 19th Century scientists (susceptibles). Without the necessary conceptual

background these individuals could not visualize the utility of Mendel's descriptive data. A half century passed before Mendel's work was rediscovered (the susceptible population reached the threshold value). It was during this 50 year time period that the prerequisite conceptual knowledge was introduced into the knowledge base of the susceptible population.

Goffman has quantitatively applied the epidemic theory to several comprehensive and diverse bibliographies: mast cell research, symbolic logic literature and schistosomiasis.^{38, 39, 40, 41} In these three studies, the applicability and versatility of epidemiological methods is readily demonstrated.

In the mast cell and symbolic logic studies, Goffman utilized a 2-factorial epidemiological theory. This methodology considers the subject literature only in terms of the transmission of ideas between infectives (authors) and susceptibles (readers). In both studies, Goffman's work reveals a pattern of subject development that can be studied as a series of overlapping epidemics. By the use of author (infectives) data from the respective subject bibliographies, Goffman was able to trace the rise of each individual epidemic and predict its subsequent fall.^{42, 43}

Recently, Goffman and Warren have studied the application of the Kermack-McKendrick epidemic theory to the

disease, schistosomiasis. Schistosomiasis is a four stage epidemic disease. The four stages are definitive host, miracidium, intermediate host and cercaria. The life cycle of the helminthic parasite is as follows. The adult worms that inhabit the circulation system of man and other animal hosts deposit eggs which are excreted in the urine or feces. The eggs upon reaching fresh water hatch, liberating the free-swimming miracidia to seek out certain species of fresh water snails. Once the larval miracidia have penetrated the snail (intermediate host), they multiply and transform into cercariae which return to the water. The cercariae penetrate the skin of man and other animals (definitive host), migrate to the blood vessels of the intestine and urinary bladder where they become adult. The adult worms mate, completing this four stage life cycle.

To develop a mathematical model for the disease schistosomiasis one must first develop from Equations 1-3 the necessary equations to describe the epidemic process in terms of a definitive host and an intermediate host. The mathematical model for this epidemic process involving the host populations (both definitive and intermediate) has been described by Goffman and Warren using the following systems of nonlinear differential equations:

Definitive Host	Intermediate Host
$dS/dt = -\beta SI' - \delta S + \mu \quad (5)$	$dS'/dt = -\beta' S'I - \delta' S' + \mu' \quad (8)$

$$dI/dt = \beta SI' - \gamma I \quad (6) \quad dI'/dt = \beta' S'I - \gamma' I' \quad (9)$$

$$dR/dt = \delta S + \gamma I \quad (7) \quad dR'/dt = \delta' S' + \gamma' I' \quad (10)$$

where I, S, R, I', S' and R' represent the infectives, susceptibles and removals of the definitive and intermediate hosts, respectively; I, S, R, I', S', R' and their derivatives are continuous functions with respect to time t ; β, β' are the respective rates of infection for the definitive host and intermediate host; δ, δ' and γ, γ' are the respective removal rates for susceptibles and infectives; and μ, μ' the influx rate of new susceptibles.

To complete the mathematical model for a four stage disease like schistosomiasis, two additional parameters for the miracidia and cercariae must be introduced. The equations to represent these parameters are as follows:

$$dM/dt = -aM - bM(S' + I') + cI \quad (11)$$

$$dM'/dt = -a'M' - b'M'(S + I) + c'I' \quad (12)$$

where M and M' denote the larval miracidia and cercariae, respectively; M, M' and their derivatives are continuous functions with respect to time t ; c, c' are the respective rates of liberation of miracidia and cercariae; b, b' are their respective rates of penetration and a, a' , the respective death rates.⁴⁴

The development of a formal mathematical model for a four stage disease has immediate application to the analysis of the structural properties of a subject

literature. One can illustrate the relationship between a four stage disease like schistosomiasis and the transmission of information via the journal literature as in Figure 2.

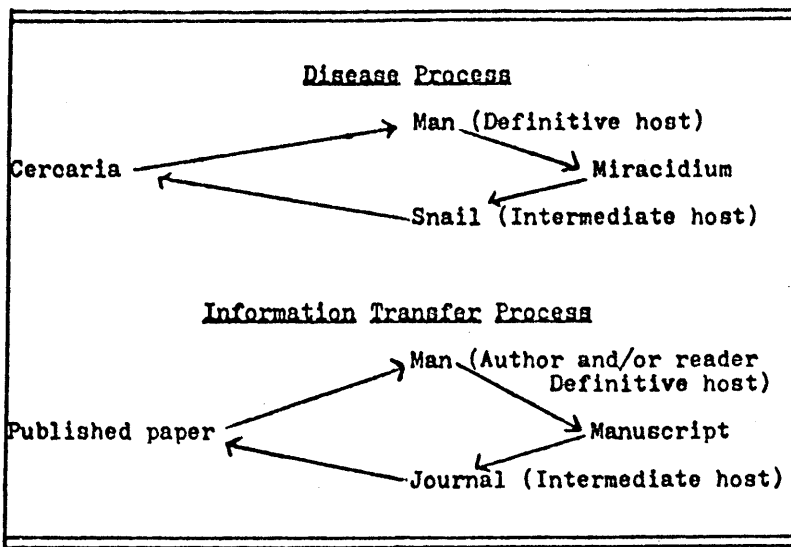


Figure 2. A Comparison of Elements in a Four Stage Disease and the Transmission of Information Through the Journal Literature.

The significance of using this four stage mathematical model is that one can study the dynamics of the epidemic process in terms of the author/reader (definitive host) and/or the journal (intermediate host). Goffman has studied the epidemic process in terms of the authors; however, to date there have been no studies of the epidemic process in terms of the intermediate host.

The mathematical model has several interesting implications for the transmission of information via a journal structured literature: (1) there is a direct relationship between the number of definitive hosts (authors and/or readers) and the intermediate hosts (journals) whether or not the total intermediate host population is constant; (2) there is a sequence of recurring epidemics that stabilize each cycle which peak and return to the threshold values; and (3) each epidemic cycle represents a different set of environmental conditions (different aspects of the development of a subject literature). Thus, according to Goffman and Warren, it is possible to control the information transfer process of the journal literature by controlling the intermediate host population (journals) alone.⁴⁵ Goffman and Warren state that these are implications derived from the logical extension of mathematical statements. There is neither confirming nor negative evidence for the validity of these mathematical deductions. It is hoped by this author that the following study may support our understanding of this information transfer process.

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II

STATEMENT OF THE RESEARCH PROBLEM AND GENERAL METHODOLOGICAL APPROACH

Statement of the Research Problem

Although both Bradford's law of dispersion and the epidemic theory have been reported in the literature, no apparent attempts have been made to establish a link between these two bibliometric techniques. Brookes, however, believes that such a link should exist. He states:

"One of the next steps proposed is to combine this model of Bradford scatter with Goffman's model of dissemination so that a three-dimensional model with the effects of time, growth and scatter of disseminating sources relating to any topic from its origination can be examined. It seems likely that, once the epidemic stage of development of a topic has been reached, the model of subsequent development will be found to be closely similar for all topics."¹

The aim of the research discussed here is to examine the diachronic growth of a subject literature using both the Bradford law of scattering and the epidemic theory. To accomplish this goal, the study seeks:

- (1) to show the applicability of the epidemic theory to

an examination of the journal structure of a subject literature;

(2) to determine the utility of a diachronic incremental application of Bradford's law from a subject literature's amorphous beginnings to maturity;

(3) to demonstrate a linkage between the Bradford law of dispersion and the epidemic theory.

Before one can proceed, some definitions and assumptions must be explicitly stated to avoid possible confusion. For the purposes of this study, the terms journal, periodical and serial, though technically not the identical bibliographic object, will be used interchangeably.

A degree of confusion exists concerning the terms: Bradford's law of scattering, Bradford's law of dispersion, Bradford's law and the Bradford distribution. Bradford himself used the term "law of scattering" to describe the empirical phenomenon that now bears his name. However, this author favors the use of the term "dispersion" in place of "scattering" as a more accurate reflection of the empirical phenomenon. As stated in Chapter I, Leimkuhler made a distinction between Bradford's law of dispersion and the Bradford distribution. Most authors including this author use these terms in a generic sense to describe the overall phenomenon.

General Methodology

The data base for this study is composed of all the serial references (including conference proceedings) found in the literature of symbolic logic from 1841 through 1960 as they appeared in (1) A Bibliography of Symbolic Logic by Alonzo Church, (2) Additions and Corrections to "A Bibliography of Symbolic Logic" by Alonzo Church and (3) the "Reviews" section of the Journal of Symbolic Logic. 2, 3, 4

The basic Church Bibliography and Additions and Corrections cover the literature from its earliest beginnings with Leibniz in 1666 through 1935. It is generally agreed that there were some early contributions made to the field of symbolic logic prior to 1840; however, most scholars believe the discipline of symbolic logic began in the 1840-1860 time period. This has been confirmed by a study done by E. W. Beth. Using the Church "Bibliography" Beth found for the period 1798-1887 that in the first five succeeding decades (1798-1807,.....,1838-1847), the total literature production for symbolic logic was one article per decade. In the four remaining decades (1848-1857,.....,1878-1887) he found that the productivity of symbolic logic literature had risen to 3, 8, 31 and 100 articles per decade respectively. The critical point in this ninety year period is the 1840-1860 period. Before

this critical period there was a small constant production of papers (one per decade). Subsequent to this critical period the production of articles in symbolic logic proceeds at an exponential rate. Beth stated that:

- "(1) up to 1847, publications on symbolic logic were not evoked by those immediately preceding them, but by a more or less constant stimulus originating from a remote past;
- (2) after 1847, publications are evoked by those immediately."⁵

In addition both George Boole and Augustus de Morgan (excluded by Beth in his study) began publishing their work in 1847. Therefore, this study begins with the 1840 decade.

The remaining time period 1936-1960 is covered exclusively by the "Reviews" section in the Journal of Symbolic Logic (JSL). No other source was used to augment this collective bibliography. The acceptance of material from the "Reviews" section is based on the following statement:

"It is intended that this section of the JOURNAL shall serve as a complete bibliography of current literature in the field of symbolic logic, from January 1, 1936. To this end, an effort will be made to include in it, at least by title, all publications in this field, both books and articles in journals, and as far as possible these will be accompanied by signed reviews."⁶

Although no material bearing a bibliographic

publication date more recent than 1960 was included in this study, the "Reviews" section was searched for all time relevant material through Journal of Symbolic Logic. XXXVII (1971-1972). The reason for the cutoff date of 1960 and the search of material through 1972 is that there is a significant time delay of 5 to 10 years for some of the more obscure material to be published. Since one of the requirements for a Bradford study is the establishment of a large bibliography, every attempt was made to include all time relevant material. In fact, in the last issue surveyed (JSL, 37(4) published 12/72), there were 3 bibliographic citations to work published prior to 1960.

As stated before, this work includes only serial citations. All references to monographic materials and edited collections have been excluded. The categories of material included in this study are articles published in periodicals or conference proceedings and book review citations. It is assumed that the contributions made by the monographic and edited collections to the total literature of symbolic logic will be reflected in the book reviewing media of the scholarly periodicals. A monograph of great importance will be more widely reviewed in the scholarly press than one of little importance. Thus, the field of symbolic logic as reflected in the Church bibliographies and the JSL "Reviews" has determined the subject

literature of symbolic logic that is to be examined in this study.

Once the bibliographic material was extracted from the Church bibliographies and the JSL "Reviews" sections, the completed bibliography was transferred to a journal by year order; a count of articles per journal per year was compiled and placed in machine readable format retaining a journal identity code, number of articles and year. From this data base, a ranked productivity listing for any time period could be obtained. For the purposes of this study, three listings were compiled: (1) a 5 year interval cumulative listing beginning with the time period 1841-1850 through 1841-1960; (2) a 10 year interval listing beginning with the time period 1841-1850 through 1951-1960 and (3) a 5 year interval listing beginning with the time period 1846-1850 through 1956-1960. The largest listing, the complete cumulative 1841-1960 listing, contained 10,265 articles in 871 unique periodicals. From the data in these listings, it was a simple matter to trace the growth (or decline) of any single or group of periodicals containing material germane to the subject of symbolic logic.

All data needed for the graphs and calculations used in the epidemic theory portion of this study were taken from the ranked productivity listings for each time period.

These listings were tabulated in ranked order removing all references to individual titles. The format for these listings was identical to that used by Bradford and others with the exception that $\log_e$ was used instead of $\log_{10}$ as suggested by Brookes.^{7, 8} The tabulated productivity listing data upon which all Bradford distribution calculations and graphs are based can be found in Appendix A.

NOTES

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III

RESULTS

General Observations

The symbolic logic literature is a typical subject literature in which material published in a periodical format provides the vast bulk of the original research material, indeed most of the total literature itself. Figures 3 and 4 illustrate the typical exponential growth curves for the total number of articles and journals, respectively. These cumulative growth curves are almost identical in nature and are basically the same as previously described by Price.¹ The state of the current symbolic logic literature is represented by the steep exponential portions observed in each curve.

Table 2 presents the cumulative growth patterns for the articles and journals. It is significant that while the cumulative number of articles is approximately doubling every ten years, the number of periodicals is increasing by a factor of 1.3 to 1.4 for the same time span. This exponential growth is also revealed by the continuous increase in the average cumulative articles/journal ratio. In the 1841-1850 time period, the ratio

is at its lowest point of 1.0 and peaks in 1841-1960 at 11.8. The cumulative article/journal ratio may be taken as an indicator of internal organization and compactness.

When one studies the change in the symbolic logic literature using articles or journals per time period (Figures 5 and 6 respectively), one no longer observes an exponential curve, but rather a broken curve with a series of peaks. The broken curve illustrates the fact that a literature does not grow in a smooth pattern, but rather in a series of spurts. Again note the identical nature of these curves (Figures 5 and 6).

The effects of World Wars I and II are dramatically reflected in very marked decreases in the number of articles and journals published during the war years. This war effect (especially World War II) can also be seen on the cumulative curves by a marked break in the exponential growth. Because the cumulative function is insensitive to all but the severest disturbances in the growth patterns of a literature, the war effect in Figures 3 and 4 is much subdued.

Table 3 also reflects the increase in the article per journal ratio from a low of 1.0 in 1846-1850 to a peak of 7.7 in 1951-1955. Notice, however, that this increase is not regular as seen in Table 2 nor is it as large, ie. 7.7 versus 11.8 respectively. The irregular increase in

the article/journal ratio can be explained by the overall irregular growth of the literature itself. Secondly, the literature studied as a total cumulative body may exhibit a greater degree of organization and compactness that is lacking when one looks at the literature in each time period.

Epidemic Analysis

The great potential for the epidemic theory as a numerical bibliographic technique lies in its ability to chart the rate of growth (or decline) of a subject literature. In analyzing the development of the symbolic logic literature through its periodical structure using the epidemic theory, one must consider that at any given point in time there are three disjointed classes of periodicals: (1) periodicals that are currently publishing articles on some aspect of symbolic logic (infectives); (2) periodicals which may publish a symbolic logic article in the future (susceptibles); and (3) periodicals which have published an article in the past, but no longer do so (removals).

Since exact solutions are not always possible with the systems of nonlinear differential equations (given in Chapter I) for the rate of change for the variables I, S and R with respect to time, one must use in their place and adequate approximation. One can obtain these

approximations by an examination of the observational data. In place of dI/dt (Equation 4) one can determine $\Delta I/\Delta t$ for each time period. In order to calculate the ΔI (infective journal) the following definitions were used:

I_1 = Number of titles occurring only in the given time period;

I_2 = Number of titles which were contained in the previous time period, but ended in the given time period;

I_3 = Number of titles occurring in the preceding, given and succeeding time periods;

I_4 = Number of titles beginning in the given time period and continuing on into the succeeding time period.

The individual periodical codes within each time period were assigned to one of the four above categories and the tabulated results are shown in Table 4. For any given time period, the number of new infectives, I_T , and the removals, R , can be calculated from the following expressions:

$$I_T = I_1 + I_4 \quad (13)$$

$$R = I_1 + I_2 \quad (14)$$

Since the rate of change of the infectives with respect to time (ΔI) is the number of new infectives minus removals, ΔI is as follows:

$$\Delta I = I_T - R \quad (15)$$

$$\Delta I = (I_1 + I_4) - (I_1 + I_2) \quad (16)$$

$$\Delta I = I_4 - I_2 \quad (17)$$

When the resulting ΔI values from Table 4 are plotted versus time, the epidemic curve based on periodicals results (Figure 7). The first significant epidemic outbreak occurs in 1880. From that point in time the symbolic logic literature assumes a recurring epidemic character with major periods of activity occurring at 1895-1905, 1925-1935 and 1950. It is interesting to note the approximate 25 year period between each major period of activity. If the epidemic process continues to function in this cyclic manner, one can then predict that the next major peak of activity should occur in the 1975-1980 time period.

The epidemic curve for the symbolic logic literature based on periodicals (Figure 7) can be compared to the author epidemic curve for the symbolic logic literature (Figure 8) previously published by Goffman.^{2, 3} The reader is cautioned that a two year shift in values exists. In this study the total time period examined is 1841-1960 (broken down by five year intervals, 1841-1845, 1846-1850, etc.) whereas in the Goffman study the total time period examined is 1847-1962 (broken down by five year intervals, 1848-1852, 1853-1857, etc.). Hence, Goffman's data and graph are presented using a 3-7, 8-2 time cycle while the data used in this study is on a 1-5, 6-0 time cycle.

In comparing Figures 7 and 8, the great similarity between these two curves is apparent. There are several differences also worth noting. In the periodical epidemic curve (Figure 7), distinct shoulder peaks occur prior to the main peak of the epidemic cycle in 1905 and 1935; however, these shoulder peaks are lacking in the author epidemic curve (Figure 8). A second difference is in the position of the last observed peak. In the author epidemic curve (Figure 8), the peak occurs at 1957 whereas the periodical epidemic curve (Figure 7) demonstrates a peak at 1950. Since this difference occurs so close to the cutoff point for both studies, an interpretation cannot be offered without the gathering of additional data.

It is also of interest to study the curves for the different categories of periodicals (I_1 through I_4) found in Table 4. The curve for the I_2 periodicals in practice represents the removals (Figure 9). The I_4 (Figure 10) represents the introduction of new sustaining infectives. When these curves (Figures 9 and 10) are merged, the result is the periodical epidemic curve in Figure 7.

Figures 11 and 12 represent I_1 and I_3 periodicals respectively. These elements of the periodical structure are not represented in the calculation for the epidemic process calculations since the I_1 periodicals are cancelled

out and the I_3 periodicals are never involved in the calculations (see Equations 13-17). The curve for the I_1 periodicals (Figure 11) shows the most rapidly fluctuating element in the periodical structure. This curve represents those periodicals which have appeared only once within the given time interval ± 5 years, i.e. a 15 year total time period.

The curve for the I_3 periodicals (Figure 12) illustrates the most stable element of the periodical structure. I_3 periodicals are the journals that are present over the 15 year time period defined above. While I_1 , I_2 and I_4 periodical curves are broken with a number of peaks (Figures 11, 9 and 10), the I_3 curve (Figure 12) indicates a marked rise during periods of the epidemic increase, but it plateaus during periods of the epidemic decline. When I_1 and I_3 (Figures 11 and 12) are plotted together, one can see their complementary effect (Figure 13). Though the I_1 curve (Figure 11) strongly resembles the periodical epidemic curve (Figure 7), there are several interesting differences. The major epidemic peaks (1905, 1935, 1950, Figure 7) are delayed by a 5 year period in the I_1 curve (Figure 11) with the shoulder peaks (1895, 1925, Figure 7) totally missing.

It is also of interest to compare the individual curves for the I_1 , I_2 , I_3 and I_4 periodicals (Figures 11, 9, 12 and 10).

9, 12 and 10 respectively) with the overall periodical change curve of the symbolic logic literature (Figure 6). One can see that I_1 and I_4 curves (Figures 11 and 9) resemble the overall periodical change curve (Figure 6).

Bradford Analysis

From the tabulated summary data for each time period (See APPENDIX A), a Bradford calculation was performed according to the Goffman-Warren method.⁴ The Goffman-Warren procedure for a Bradford calculation standardizes the method by which one establishes the minimum nucleus of articles for the time period under consideration. These calculations are shown in Tables 5, 6 and 7. The first Bradfordian analysis was done on the cumulative literature from 1841-1960. The data was organized cumulatively by 5 year periods with the summary Bradford calculations given in Table 5.

The first calculation that is shown is for the 1841-1865 time period. During the first 25 year period, the development of the field of symbolic logic is so small that earlier analysis is unwarranted. The first time the literature shows a true Bradford analysis is the 1841-1880 and 1841-1885 intervals (Table 5: IV and V). During the next 10 year period, the Bradford relationship weakens

rebuilt, and by 1900 and 1905 (Table 5: VIII and IX), the Bradfordian distribution has been established once again. From 1905 through 1955, the cumulative literature remains Bradfordian (Table 5: X-XIX).

It is most interesting to consider the last time period, 1841-1960 (Table 5: XX). The total distribution is Bradfordian; however, the first three zones are decidedly Zipfian in character.

One can also study the zone pattern exhibited by this data. As the literature of symbolic logic grows in an exponential manner (Figures 3, 4 and Table 2), one would expect the number of zones to continually expand also. This, however, is not the case. From 1841-1865, a gradual expansion in the number of zones occurs from a minimum of two in 1841-1865 to a maximum of sixteen in 1841-1945. Beginning with the period 1841-1950 to the last period 1841-1960, the number of zones decreased from the maximum of sixteen to thirteen even though the literature had added 6328 additional articles and 406 additional periodicals to its structure-- almost a doubling of the number of articles and nearly equal to the number of periodicals for the 1841-1945 period. This transition point occurs during the same period that the Journal of Symbolic Logic assumes the rank of most productive journal in the cumulative literature (Table 10, code JSBL).

The Bradford graphs for the cumulative Bradford study are most interesting (Figures 14-22). One can readily see the gradual change from linear graphs (Figures 14 and 15) through a transition state (Figures 16 and 17) to the typical Bradford curves (Figures 18-22). The graphs for this cumulative Bradford analysis tend to support Brookes' statements concerning the transition between Zipfian graphic character and the Bradfordian character.⁵

In studying the smaller 5 or 10 year time periods, one sees a different situation. Looking at the Bradford calculations for the 10 year periods beginning with 1861-1870 through 1951-1960, the Bradford distribution does not materialize before the period 1921-1930 (Table 6: VII). During the war decade the Bradford distribution is not maintained (Table 6: IX), but is resumed for the time period 1951-1960 (Table 6: X).

The Bradford graphs for this 10 year incremental study exhibit many of the same characteristics discussed earlier (Figures 23, 24, 25, 26 and 27). Again we have the early linear graphs (Figures 23 and 24), the typical Bradford graphs (Figures 25, 26 and 27), but with no transition graphs. It is interesting to note that Figure 26 shows a Bradford type curve; however, the Bradford distribution is not maintained (Table 6: IX).

When one looks at a smaller time increment-- a period of 5 years, the establishment of a Bradford distribution seems to be accomplished with greater ease at much lower periodical and article values. Using as the only criterion for a Bradford distribution $1 : n : n^2$, etc., one observes the establishment of Bradford distributions much earlier for the 5 year periods than with the 10 year periods (Table 7: III, IV, VI versus Table 6: VII respectively).

In an examination of the Bradford calculations for each 5 or 10 year period (Table 6 and 7), no point exists at which the Bradford distribution is stabilized for remaining time periods in contrast to the stabilized cumulative Bradford distributions. Instead, a series of fluctuating distributions occurs in which some are acceptable while others are not. A comparison of these fluctuations for the 5 year period (Table 7) to the periodical epidemic curve (Figure 7) indicates that as the epidemic curve builds to a peak, the Bradford distributions are quite regular (Table 7: IV, VII, VIII, XIII, XIV, XVII and XVIII). After the maxima is reached and the epidemic curve descends, a disintegration of the Bradford distribution at its lower end occurs (Table 7: V, X, XI, XVI and XIX). The Bradford graphs for the 5 year increments show much the same trends as stated for the cumulative and 10 year incremental studies

(Figures 28-39). We observe the linear graphs (Figures 28, 29, 33 and 36), the transitional graphs (Figures 30, 31, 32, 34 and 37) and the typical Bradford graphs (Figures 35, 38 and 39). The fluctuations previously mentioned are readily noted.

Dispersion Ratios

In looking at the least productive periodicals (periodicals producing one article per time period), an interesting situation occurs. The ratio of the number of single articles per time period to the total number of articles for the same time period (Art. Ratio) is a different measure for the article growth of a subject literature. In the formative stages of a subject literature, the material is widely dispersed in many journals containing only one or two articles. As a subject literature grows more journals accept more than one article pertaining to a given subject. These journals began to devote an ever increasing proportion of their space to this subject. As this process continues the overall subject literature becomes less and less diffuse. This concentration of a subject literature is reflected in the decrease of the article ratio. This was found to be true for both the cumulative literature and the 5 year incremental literature (Art. Ratio; Tables 9 and 10). In both cases, the

beginning value for the article ratio was 1.0, ending with 0.03 and 0.05 respectively. While the cumulative article ratio exhibited a steady decrease, the five year incremental article ratio decreased irregularly. The article ratios (Tables 8 and 9) and the average A/J ratios (Tables 2 and 3) both document the development of an internal structure of a subject literature.

This same measure can be applied to periodicals. If one takes the ratio of periodicals containing a single article per time period to the total number of periodicals per time period (Per. Ratio), one can again obtain a different measure for the growth of a subject literature. In the early phase of a literature's development, one would expect to see the same results observed for the article ratio. This, in fact, is observed. Both the cumulative and incremental periodical ratios for the beginning period start with values of 1.0 and decrease as the literature slowly begins to grow. However, it was observed that as the literature grows a point is reached at which the periodical ratio will stabilize (Tables 8 and 9).

The cumulative periodical ratio shows a remarkable stabilization at 0.40 ± 0.05 . This stabilization occurs at the completion of the first epidemic cycle (Figure 7). This is also the point at which the cumulative Bradford

distribution becomes firmly established (Table 5; VIII and IX).

The five year incremental periodical ratio like the corresponding incremental article ratio exhibits more fluctuation than the ratio for the cumulative periodicals. The basic reasons for this irregularity of these incremental article and periodical ratios can again be seen in the epidemic curve for the symbolic logic literature (Figure 7). As the epidemic curve rises, the incremental ratios decrease whereas when the curve descends, the ratios increase (Tables 8 and 9). This effect is completely lacking in the cumulative article and periodical ratios.

Symbolic Logic Literature

The bibliometric study of a subject literature can also identify the major individual periodicals that contain the most significant portion of that literature. Table 10 represents the cumulative top fifty periodicals for symbolic logic as of 1960. These periodicals had the largest number of articles cumulated over the 120 year period. Compare Table 10 to Table 11. Table 11 uses the same list of journals as Table 10, but indicates the individual journal's contribution for each time period surveyed. It should be noted that the oldest continuously publishing journals--
American Journal of Mathematics, Jahrbuch ueber die

Fortschritte der Mathematik (ceased in 1944), Mind and Revue philosophique de la France et l'etranger--all commenced publication or began carrying symbolic logic material in the 1876-1880 period. Hence, both surveys (Tables 10 and 11) began with 1876. Although numerous relationships can be derived from these two tables, this study will present the relationships most relevant to this study.

When one relates the periodical epidemic curve (Figure 7) to Tables 10 and 11, one observes an interesting situation. As the first epidemic peak (1880) is reached, the top ranked journal is not significant in cumulative symbolic logic literature. At the second epidemic peak (1905), Mind, Revue de Metaphysique et du Morales and Rivista di Matematica are the top ranked journals, respectively (Table 11). During the next complete epidemic cycle (1905-1935), the first rank position fluctuates among Mind, Revue de Metaphysique et du Morales, Monist and Przeglad filozoficzny.

In 1936, Journal of Symbolic Logic (JSBL), the first journal exclusively devoted to the field of symbolic logic was founded. Within 5 years, 1936-1940, JSBL became the leading symbolic logic journal publishing 10.1% of the total citations for that period. During the third epidemic cycle, JSBL flourished and by 1946-1950, it was the dominant

cumulative periodical as well. In 1956-1960, JSBL was by far the dominant journal. A new journal, Zeitschrift fuer mathematische Logik und Grundlagen der Mathematik (ZEML), which began publication in 1955, ranked second.

Several periodicals ranked in the top 50 cumulative listing (Table 10) ceased publication many years prior to 1960, but due to their important contributions to the earlier literature, they retain their cumulative significance. Some of the most important ceased journals are: Rivista di Matematica (1891-1906, 35th), Erkenntnis (1930-1939, 21st), Monist (1890-1936, 20th), Koninklijke Nederlandse Akademie van Wetenschappen, Proceedings, (1898-1950, 19th), Annalen der Philosophie und Philosophischen Kritik (1919-1930, 32nd). One can see how a journal like Erkenntnis which existed for only a brief 10 year period can influence the core cumulative structure of a subject literature.

One should also be aware of the reverse situation. Studia Logica and ZEML (see above), although ranked sixth and second respectively in the period 1956-1960, have relatively low cumulative rankings of 25th and 26th respectively.

Tables 10 and 11 can also be used to study changes in editorial policy toward a given subject field as reflected in a single periodical. Philosophical Review

(PHCR) began publication in 1892+ and first carried material on symbolic logic literature. Then a marked shift to include more symbolic logic literature occurred (Table 10: 1930, 30th; 1935, 15th; 1940, 12th versus Table 11: 1930, 37th; 1935, 6th; 1940, 9th). By 1945, PHCR was well established as a leading journal in the field of symbolic logic (Table 10: 1945, 5th versus Table 11: 1945, 4th). From 1946-1960, PHCR remained a leading symbolic logic periodical. Similar studies may be done with each journal listed.

Another important use for Tables 10 and 11 is the establishment of a core list of journals for acquisition and reference purposes. By detecting an increase or decline in journal productivity, a library can alter their long range subject acquisition policies to meet the needs of their collection.

NOTES

¹Derek J. de Solla Price, Science since Babylon (New Haven: Yale University Press, 1961), p. 105.

²William Goffman, "An Application of the Epidemic Theory to the Growth of Science (Symbolic Logic from Boole to Godel)," in Progress in Cybernetics (New York: Gordon and Breach, 1970), vol. III, p. 976.

³William Goffman, "A Mathematical Method for Analyzing the Growth of a Scientific Discipline," Journal of the Association for Computing Machinery, XVIII (April, 1971), 176.

⁴William Goffman and Kenneth S. Warren, "Dispersion of Papers among Journals based on a Mathematical Analysis of Two Diverse Medical Literatures," Nature, CCXXI (March 21, 1969), 1206.

⁵B. C. Brookes, "Bradford's Law and the Bibliography of Science," Nature, CCXXIV (December 6, 1969), 954.

IV

CONCLUSIONS AND SPECULATIONS

In direct response to the stated objectives, this study has conclusively shown:

- (1) the direct application of the epidemic theory to the journal structure of a subject literature;
- (2) the utility of a diachronic incremental application of Bradford's law; and
- (3) the direct linkage between the Bradford law of dispersion and the epidemic theory.

The application of the epidemic theory to the periodical structure of a subject literature is most important. This study has established a direct relationship between the definitive host and intermediate host populations. This relationship was graphically demonstrated by the great similarity of the periodical (intermediate host) epidemic curve to the author (definitive host) epidemic curve.

This study has supported the implication concerning stability of recurring epidemics. The cumulative periodical structure provides an important stability factor.

This is evidenced by the cumulative periodical ratio shown in Table 8.

Another point concerns the environmental conditions of an epidemic cycle. Within each epidemic cycle the subject literature explores a different phase of the subject knowledge. Tables 10 and 11 dramatically support this contention by showing that within each epidemic cycle a different set of periodicals dominate the core journal collection.

The application of the epidemic theory has also shown the need to identify all the contributing elements in a periodical structure (I_1 , I_2 , I_3 and I_4) and to examine the role each is playing in the overall periodical structure. This examination is necessary in that only two of the periodical elements (I_2 and I_4) are utilized in the calculation of the epidemic curve.

While the I_2 and I_4 elements combine to form the epidemic curve, the I_1 and I_3 elements represent equally important aspects of the total periodical structure. The I_1 elements are those periodicals that are primarily found as significant journals in other subject literatures. The curve for the I_1 elements represents a measure of the interdisciplinarity with which a given subject literature interacts with the periodical structure of adjoining subject literatures. As a subject discipline grows and develops,

it inherently draws on material from allied disciplines to nurture and develop its own ideas and concepts. The degree to which any of these allied subject literatures contributes to the given subject literature varies at any given point in time. Hence, the literature linkages between the given subject literature and adjacent literatures is in a constant state of flux.

In contrast, the I_3 periodical element represents the degree to which the internal periodical structure has developed. This curve illustrates the growth of the core journals that stabilize a subject literature. Without the establishment of these journals, it is most unlikely that a discipline can be established. Thus, this element can be seen as a measure of the maturity which a subject discipline has achieved.

In any attempt to curtail the periodical growth of a subject literature, one must determine how any curtailment will affect each element in the periodical structure. As Ziman has said: "The invention of a mechanism for the systematic publication of fragments of scientific work may well have been the key event in the history of science."¹

The use of the Bradford analysis is most significant. One can readily see the inter-relationship of the Bradford distribution and the epidemic process. As the literature reaches its first epidemic peak from its early

formative development, the first cumulative Bradford distribution is established. During the first epidemic cycle the Bradford distribution weakens and rebuilds itself at the second epidemic peak. During the second epidemic cycle with the cumulative Bradford distribution well established, the internal periodical structure develops, but there is no single journal that dominates the field.

Upon completion of the second epidemic cycle, the discipline establishes a single journal which in a short period of time, not only establishes itself as the primary journal within the incremental time period, but ranks first among all the cumulative periodicals. One can measure the virulence of a particular periodical by its rapid rise within a subject literature. The more virulent a journal becomes, the faster the rise within a subject literature's journal productivity list.

During the third epidemic cycle, the single periodical absorbs a great part of the subject literature leading to a decrease in the total number of zones, yet allowing the number of articles to continuously expand. By the end of the third epidemic cycle, the Bradford distribution achieves a Zipfian character in the first three zones indicating the degree to which the core journals have become saturated. At this point, fragmentation of the central journal(s) occurs, allowing new sub-disciplines

to be established such as the application of symbolic logic to computer science, etc. These new sub-disciplines then begin their own epidemic processes.

As the subject literature grows to the point that new disciplines break off and begin their own epidemic cycles, the question arises: What happens to the Bradford distribution of the overall literature? This study provides a very incomplete answer at best. As stated in the previous paragraph the cumulative Bradford distribution in the first three zones has a Zipfian character for the last time period observed, 1841-1960. What the Bradford distribution would be at the end of the fourth epidemic cycle is unknown at this time. Although Brookes has also posed this question, neither Brookes nor this study can indicate a complete answer except that further observational data on a large topical discipline is needed before one can attempt to answer this question.²

Other structural properties that warrant further investigation are the article/journal ratio, the article dispersion ratio and the periodical dispersion ratio. Each of these different ratios can be used to measure the degree to which a subject literature is organized.

The conclusions and speculations presented in this study are based on the analysis of only one subject literature. There have been no such analysis published for

any other subject literature upon which one can draw any comparative material. Hence, the results, conclusions and speculations presented may be unique only to the literature of symbolic logic or they may be generalizable to other subject literatures. Only future epidemic and Bradford studies done on other diverse subject literatures can answer this question.

NOTES

¹J. M. Ziman, "Information, Communication, Knowledge," Nature, CCXXIV (October 25, 1969), 318-324.

²B. C. Brookes, "The Derivation and Application of the Bradford-Zipf Distribution," Journal of Documentation, XXIV (December, 1968), 247-265.

v
TABLES

TABLE 2

CUMULATIVE GROWTH OF THE SYMBOLIC LOGIC LITERATURE

Time Period	Cumulative Number of Articles	Cumulative Number of Journals	Average A/J
1841-1850	3	3	1.0
1841-1855	5	5	1.0
1841-1860	6	5	1.2
1841-1865	12	7	1.7
1841-1870	18	12	1.5
1841-1875	24	14	1.7
1841-1880	77	32	2.4
1841-1885	128	42	3.0
1841-1890	157	50	3.1
1841-1895	243	65	3.7
1841-1900	316	77	4.1
1841-1905	457	101	4.5
1841-1910	642	127	5.1
1841-1915	800	149	5.4
1841-1920	928	156	5.9
1841-1925	1096	187	5.9
1841-1930	1486	226	6.6
1841-1935	2078	305	6.8
1841-1940	3192	405	7.9
1841-1945	3931	465	8.5
1841-1950	5638	589	9.6
1841-1955	8065	741	10.2
1841-1960	10259	871	11.8

TABLE 3
GROWTH PATTERNS OF THE SYMBOLIC LOGIC LITERATURE
FOR EACH FIVE YEAR PERIOD

Time Period	Total Number of Articles	Total Number of Journals	Average A/J
1841-1850	3	3	1.0
1851-1855	2	2	1.0
1856-1860	1	1	1.0
1861-1865	6	3	2.0
1866-1870	6	5	1.2
1871-1875	6	5	1.2
1876-1880	53	20	2.7
1881-1885	51	20	2.6
1886-1890	29	22	1.3
1891-1895	86	23	3.7
1896-1900	73	26	2.8
1901-1905	141	46	3.1
1906-1910	185	62	3.0
1911-1915	158	65	2.4
1916-1920	128	37	3.5
1921-1925	168	66	2.5
1926-1930	390	97	4.0
1931-1935	592	145	4.1
1936-1940	1114	205	5.4
1941-1945	739	158	4.7
1946-1950	1707	252	6.8
1951-1955	2427	315	7.7
1956-1960	2200	313	7.0

TABLE 4

EPIDEMIOLOGICAL VALUES FOR THE SYMBOLIC LOGIC

LITERATURE BASED ON PERIODICAL TITLES

Time Period	# of Per.	I ₁	I ₂	I ₃	I ₄	I _T	R	ΔI
1846-1850	3	3	0	0	0	3	3	0
1851-1855	2	2	0	0	0	2	2	0
1856-1860	1	0	0	0	1	1	0	1
1861-1865	3	2	1	0	0	2	3	-1
1866-1870	5	3	0	0	2	5	3	2
1871-1875	5	2	2	0	1	3	4	-1
1876-1880	20	12	0	1	7	19	14	5
1881-1885	20	7	5	4	4	11	12	-1
1886-1890	22	11	5	3	3	14	16	-2
1891-1895	23	8	3	3	9	17	11	6
1896-1900	26	8	2	9	7	15	10	5
1901-1905	46	17	1	15	13	30	18	12
1906-1910	62	21	9	18	14	35	30	5
1911-1915	65	24	15	17	9	33	39	-6
1916-1920	37	6	9	17	5	11	15	-4
1921-1925	66	20	4	19	23	43	24	19
1926-1930	97	26	14	28	29	55	40	15
1931-1935	145	50	11	43	41	91	61	30
1936-1940	205	79	41	43	42	121	120	1
1941-1945	158	48	34	51	25	73	82	-9
1946-1950	252	100	16	60	76	176	116	60
1951-1955	315	109	40	93	73	182	149	33
1955-1960	313	-	-	-	-	-	-	-

TABLE 5

DISPERSION OF THE SYMBOLIC LOGIC LITERATURE
CUMULATIVELY BY 5 YEAR INTERVALS

I 1841-1865				II 1841-1870				III 1841-1875			
Zone	Papers	Journals	b_m	Papers	Journals	b_m		Papers	Journals	b_m	
1	6	1		6	1			7	1		
2	5	5	5.0	6	5	5.0		5	2	2.0	
3				6	6	1.2		5	4	2.0	
4								7	7	1.8	
	11	6	Av. 5.0	18	12	Av. 3.1		24	14	Av. 1.9	
	j=6	z=5		j=6	z=10			j=7	z=10		
IV 1841-1880				V 1841-1885				VI 1841-1890			
Zone	Papers	Journals	b_m	Papers	Journals	b_m		Papers	Journals	b_m	
1	16	1		26	1			27	1		
2	16	2	2.0	23	2	2.0		26	2	2.0	
3	12	3	1.5	27	5	2.5		29	5	2.5	
4	15	8	2.6	26	9	1.8		29	8	1.6	
5	18	18	2.3	26	25	2.8		24	12	1.5	
6								22	22	1.8	
	77	32	Av. 2.1	128	42	Av. 2.3		157	50	Av. 1.9	
	j=16	z=21		j=26	z=24			j=27	z=25		

j = Number of articles in most productive journal.
 z = Number of journals containing a single article.
 b_m = Bradford multiplier.

TABLE 5-CONTINUED

VII 1841-1895			VIII 1841-1900			IX 1841-1905		
Zone	Papers	Journal	Papers	Journals	b_m	Papers	Journals	b_m
1	28	1	37	1	2.0	49	1	2.0
2	51	2	63	2	1.5	79	2	1.5
3	32	3	34	3	2.0	48	3	1.3
4	34	6	39	5	1.6	44	4	1.5
5	34	8	38	7	1.4	49	6	1.5
6	33	14	37	10	1.8	50	9	1.5
7	31	31	36	17	1.7	50	14	1.6
8			32	32	1.8	49	23	1.7
9						39	101	1.7
	243	65	316	77	Av.1.8	457	Av.1.6	

j=28 Z=31

j=37 Z=32

or*

X 1841-1910			XI 1841-1915		
Zone	Papers	Journal	Papers	Journals	b_m
1	69	1	77	1	2.0
2	97	2	115	2	1.5
3	70	3	80	3	1.7
4	70	5	84	5	1.2
5	74	7	78	6	1.3
6	68	10	75	8	1.4
7	69	15	74	11	1.5
8	68	30	73	17	1.8
9	57	54	72	31	2.1
10			72	65	Av.1.6
	642	127	800	149	Av.1.7

j=69 Z=51

j=77 Z=58

j=98 Z=39
 *Top journals were identical in number of articles

TABLE 5-CONTINUED

XII 1841-1920				XIII 1841-1925				XIV 1841-1930			
Zone	Papers	Journals	b_m	Papers	Journals	b_m		Papers	Journals	b_m	
1	82	1	2.0	86	1	2.0		109	1	2.0	
2	124	2	1.5	127	2	1.5		137	2	1.5	
3	106	3	1.3	123	3	1.3		161	3	1.3	
4	98	4	1.3	122	4	1.3		162	4	1.3	
5	93	6	1.5	103	66	1.5		125	6	1.5	
6	93	9	1.5	98	8	1.3		124	8	1.3	
7	90	12	1.3	92	11	1.4		116	10	1.3	
8	89	19	1.6	87	14	1.3		121	14	1.4	
9	90	39	2.1	88	22	1.6		116	18	1.3	
10	63	61	1.6	85	36	1.6		120	29	1.6	
11				85	80	2.2		112	48	1.7	
12								83	83	1.7	
	928	156	Av.1.6	1096	187	Av.1.6		1486	226	Av.1.5	
	j=82	Z=58		j=86	Z=75			j=109	Z=83		

TABLE 5-CONTINUED

XV 1841-1935			XIV 1841-1940			XVII 1841-1945		
Zone	Papers	Journals	b_m	Papers	Journals	b_m	Papers	Journals
1	138	1	2.0	179	1	2.0	221	1
2	172	2	1.5	216	2	1.5	358	2
3	202	3	1.3	276	3	1.3	303	3
4	213	4	1.3	307	4	1.3	355	4
5	155	5	1.3	263	5	1.3	298	5
6	139	6	1.2	218	6	1.2	244	6
7	138	7	1.3	193	7	1.2	236	7
8	140	8	1.3	190	8	1.3	225	8
9	135	9	1.3	190	9	1.3	221	9
10	138	10	1.4	180	10	1.3	225	10
11	135	11	1.3	166	11	1.2	223	11
12	137	12	1.6	170	12	1.2	224	12
13	122	13	1.6	173	13	1.5	222	13
14	114	14	1.9	169	14	1.4	223	14
15		15		156	15	1.5	179	15
16		16		143	16	2.0	174	16
	2078	305	Av.1.4	3192	405	Av.1.3	3931	465
	j=138	Z=114		j=179	Z=143		j=221	Z=174

TABLE 6

DISPERSION OF THE SYMBOLIC LOGIC LITERATURE
BY 10 YEAR INTERVALS

I 1861-1870				II 1871-1880				III 1881-1890			
Zone	Papers	Journals	b_m	Papers	Journals	b_m		Papers	Journals	b_m	
1	4	1		16	1			11	1		
2	4	3	3.0	17	3	3.0		15	2	2.0	
3	4	4	1.3	13	7	2.3		12	3	1.5	
4				13	13	1.9		11	4	1.3	
5								12	6	1.5	
6								19	18	3.0	
	12	8	Av.2.2	59	24	Av.2.4		80	34	Av.1.8	
	j=4	Z=6		j=16	Z=16			j=11	Z=17		

IV 1891-1900				V 1901-1910			
Zone	Papers	Journals	b_m	Papers	Journals	b_m	
1	37	1		35	1		
2	37	3	3.0	54	2	2.0	
3	36	6	2.0	42	3	1.5	
4	26	10	1.6	36	4	1.3	
5	23	18	1.8	37	5	1.3	
6				36	7	1.4	
7				36	15	2.1	
8				50	43	2.9	
	159	38	Av.2.1	326	80	Av.1.8	
	j=37	Z=13		j=35	Z=36		

TABLE 6-CONTINUED

VI 1911-1920						VII 1921-1930					
Zone	Papers	Journals	b _m	Papers	Journals	Papers	Journals	b _m	Papers	Journals	b _m
1	28	1		56	2	27	1		27	1	
2	55	2	2.0	61	3	47	2	2.0	47	2	2.0
3	45	3	1.5	56	7	59	3	1.5	59	3	1.5
4	32	4	1.3	58	17	66	4	1.3	66	4	1.3
5	32	6	1.5	55	47	53	5	1.3	53	5	1.3
6	31	9	1.5			52	6	1.2	52	6	1.2
7	30	18	2.0			47	7	1.2	47	7	1.2
8	33	33	1.8			44	8	1.1	44	8	1.1
9						39	9	1.1	39	9	1.1
10						31	10	1.1	31	10	1.1
11						30	13	1.3	30	13	1.3
12						30	21	1.6	30	21	1.6
13						33	33	1.6	33	33	1.6
	<u>286</u>	<u>76</u>	<u>Av. 1.7</u>	<u>286</u>	<u>76</u>	<u>558</u>	<u>121</u>	<u>Av. 1.4</u>	<u>558</u>	<u>121</u>	<u>Av. 1.4</u>
	j=28	Z=39		j=56	Z=39	j=27	Z=45		j=27	Z=45	

TABLE 6-CONTINUED

	VIII 1931-1940			IX 1941-1950			X 1951-1960		
Zone	Papers	Journals	b_m	Papers	Journals	b_m	Papers	Journals	b_m
1	112	1	2.0	277	1	2.0	461	1	4.0
2	152	2	1.5	256	2	1.5	502	4	1.5
3	158	3	1.3	279	3	1.7	482	6	1.3
4	159	4	1.3	264	5	2.2	475	8	1.6
5	132	5	1.2	271	11	1.6	477	13	1.3
6	117	6	1.3	274	18	1.7	468	17	1.6
7	119	8	1.1	273	31	1.9	469	28	2.0
8	114	9	1.3	273	60	3.4	468	45	2.7
9	113	12	1.3	279	202		464	90	
10	115	18	1.5				361	250	
11	115	26	1.4						
12	114	35	1.3						
13	96	47	1.3						
14	90	90	1.9						
	1706	266	Av. 1.4	2446	333	Av. 2.0	4627	462	Av. 2.0
	j=112	Z=90		j=277	Z=139		j=461	Z=166	

TABLE 7

DISPERSION OF THE SYMBOLIC LOGIC LITERATURE
BY 5 YEAR INTERVALS

I 1866-1870				II 1871-1875				III 1876-1880			
Zone	Papers	Journals	b_m	Papers	Journals	b_m	Papers	Journals	b_m		
1	2	1		2	1		16	1			
2	4	4	4.0	4	4	4.0	13	2	2.0		
3							11	4	2.0		
4							13	13	3.3		
	8	5	Av. 4.0	8	5	Av. 4.0	53	20	Av. 2.4		
	j=2 Z=4			j=2 Z=4			j=16 Z=13				
IV 1881-1885				V 1886-1890				VI 1891-1895			
Zone	Papers	Journals	b_m	Papers	Journals	b_m	Papers	Journals	b_m		
1	10	1		10	4		24	1			
2	13	2	2.0	9	8	2.0	20	2	2.0		
3	9	3	1.5	10	10	1.3	23	5	2.5		
4	10	5	1.7				19	15	3.0		
5	2	2	1.8								
	51	20	Av. 1.8	29	22	Av. 1.7	86	23	Av. 2.5		
	j=10 Z=9			j=10 Z=17			j=24 Z=11				

TABLE 7-CONTINUED

VII 1896-1900			VIII 1901-1905			IX 1906-1910		
Zone	Papers	Journals	b_m	Papers	Journals	b_m	Papers	Journals
1	13	1	2.0	15	1	2.0	20	1
2	13	2	2.0	26	2	1.5	33	2
3	15	3	1.5	21	3	1.3	22	3
4	15	6	2.0	23	4	1.3	23	4
5	17	14	2.3	16	5	1.3	20	5
6				18	9	1.3	20	8
7				22	22	2.4	20	12
8							27	27
	73	26	Av.2.0	141	46	Av.1.7	185	62
	j=13	Z=11		j=15	Z=22		j=20	Z=31
X 1911-1915			XI 1916-1920			XII 1921-1925		
Zone	Papers	Journals	b_m	Papers	Journals	b_m	Papers	Journals
1	29	2	1.5	18	1	2.0	22	2
2	25	3	2.0	31	2	1.5	23	3
3	27	6	2.0	20	3	1.3	21	4
4	30	12	2.0	18	4	1.3	21	5
5	47	42	3.5	18	6	1.5	22	7
6				23	21	3.5	28	14
7							31	31
	158	65	Av.2.3	128	37	Av.2.0	168	66
	j=18	Z=37		j=18	Z=19		j=13	Z=31

TABLE 7-CONTINUED

XIII 1926-1930				XIV 1931-1935				XV 1936-1940			
Zone	Papers	Journals	b_m	Papers	Journals	b_m		Papers	Journals	b_m	
1	23	1	2.0	60	2	1.5		112	1	2.0	
2	33	2	1.5	74	3	1.3		95	2	1.5	
3	37	3	1.3	63	4	1.3		106	3	1.3	
4	42	4	1.3	65	5	1.3		116	4	1.3	
5	43	5	1.2	59	7	1.4		116	7	1.8	
6	39	6	1.2	59	9	1.3		116	12	1.7	
7	37	7	1.2	60	13	1.4		115	18	1.5	
8	34	8	1.1	60	24	1.8		113	26	1.4	
9	27	9	1.1	92	78	3.3		112	41	1.6	
10	26	10	1.1					113	91	2.2	
11	25	18	1.8								
12	24	24	1.3								
	390	97	Av. 1.4								
				592	145	Av. 1.7		1114	205	Av. 1.7	
	j=23	Z=35		j=31	Z=64			j=112	Z=69		

XVI 1941-1945			
Zone	Papers	Journals	b_m
1	99	1	2.0
2	85	2	1.5
3	110	3	2.3
4	97	7	1.7
5	95	12	1.9
6	98	23	1.5
7	80	35	2.1
8	75	25	Av. 1.9
	739	158	
	j=99	Z=75	

TABLE 7-CONTINUED

	XVII 1946-1950			XVIII 1951-1955			XIX 1956-1960		
Zone	Papers	Journals	b_m	Papers	Journals	b_m	Papers	Journals	b_m
1	178	1	2.0	211	1	2.0	250	1	4.0
2	177	2	1.5	179	2	1.5	232	4	1.5
3	194	3	1.3	192	3	1.3	235	6	1.5
4	175	4	2.0	191	4	1.5	243	9	1.3
5	176	8	1.5	213	6	1.3	240	12	1.6
6	176	12	1.8	208	8	1.4	253	20	1.8
7	178	20	2.0	218	11	1.3	247	31	3.1
8	178	32	1.6	215	16	1.5	250	56	
9	145	57	1.8	212	21	1.3		174	
10	120	113	2.0	210	33	1.6			
11				212	71	2.2			
12				166	139	2.0			
	1707	252	Av. 1.7	2427	315	Av. 1.6	2200	313	Av. 2.1
	j=178	Z=106		j=211	Z=112		j=250	Z=115	

TABLE 7-CONTINUED

	XVII 1946-1950			XVIII 1951-1955			XIX 1956-1960		
Zone	Papers	Journals	b_m	Papers	Journals	b_m	Papers	Journals	b_m
1	178	1	2.0	211	1	2.0	250	1	4.0
2	177	2	1.5	179	2	1.5	232	4	1.5
3	194	3	1.3	192	3	1.3	235	6	1.5
4	175	4	2.0	191	4	1.3	243	9	1.3
5	176	8	1.5	213	6	1.5	240	12	1.6
6	176	12	1.8	208	8	1.3	253	20	1.6
7	178	20	1.6	218	11	1.3	247	31	1.8
8	178	32	1.8	215	16	1.5	250	56	3.1
9	145	57	2.0	212	21	1.3			
10	120	113		210	33	1.6			
11				212	71	2.2			
12				166	139	2.0			
	1707	252	Av. 1.7	2427	315	Av. 1.6	2200	313	Av. 2.1
	j=178	Z=106		j=211	Z=112		j=250	Z=115	

TABLE 8

A COMPARISON OF THE DISPERSION RATIOS OF THE
CUMULATIVE SYMBOLIC LOGIC LITERATURE

Time Period	Total Art.	Total Per.	Z*	Art. Ratio	Per. Ratio
1841-50	3	3	3	1.0	1.0
1841-55	5	5	5	1.0	1.0
1841-60	6	5	4	.66	.80
1841-65	12	7	6	.50	.86
1841-70	18	12	10	.56	.83
1841-75	24	14	10	.42	.71
1841-80	77	32	21	.27	.66
1841-85	128	42	24	.19	.57
1841-90	157	50	25	.16	.50
1841-95	243	65	31	.13	.48
1841-00	316	77	32	.10	.42
1841-05	457	101	39	.09	.39
1841-10	642	127	51	.08	.40
1841-15	800	149	58	.07	.39
1841-20	928	156	58	.06	.37
1841-25	1096	187	75	.07	.40
1841-30	1486	226	83	.06	.37
1841-35	2078	305	114	.05	.37
1841-40	3192	405	143	.04	.35
1841-45	3931	465	174	.04	.37
1841-50	5638	589	216	.04	.37
1841-55	8065	741	278	.03	.38
1841-60	10265	871	321	.03	.37

* Number of periodicals containing a single article.

TABLE 9

76

A COMPARISON OF THE DISPERSION RATIOS IN
SYMBOLIC LOGIC LITERATURE FOR EACH
FIVE YEAR PERIOD

Time Period	Total Art.	Total Per.	Z*	Art. Ratio	Per. Ratio
1846-50	3	3	3	1.0	1.0
1851-55	2	2	2	1.0	1.0
1856-60	1	1	1	1.0	1.0
1861-65	6	3	2	.33	.67
1866-70	6	5	4	.67	.80
1871-75	6	5	4	.67	.80
1876-80	53	20	13	.25	.65
1881-85	51	20	9	.18	.45
1886-90	29	22	17	.58	.77
1891-95	86	23	11	.13	.48
1896-00	73	26	11	.15	.42
1901-05	141	46	22	.16	.48
1906-10	185	62	31	.17	.50
1911-15	158	65	37	.23	.57
1916-20	128	37	19	.15	.51
1921-25	168	66	31	.18	.41
1926-30	390	97	35	.09	.36
1931-35	592	145	64	.11	.44
1936-40	1114	205	69	.06	.34
1941-45	739	158	75	.10	.47
1946-50	1707	252	106	.06	.42
1951-55	2427	315	112	.05	.36
1956-60	2200	313	115	.05	.37

* Number of periodicals containing a single article.

TABLE 10

77

A LISTING OF THE TOP 50 SERIALS
IN THE CUMULATIVE SYMBOLIC LOGIC LITERATURE

Code	1960		1955		1950	
	Rank	% Total	Rank	% Total	Rank	% Total
AJTH	49	.4	46	.4	37	.5
AMJM	37	.5	32	.6	25	.8
AMMM	28	.7	24	.8	22	.8
ANFY	7	1.8	9	1.8	14	1.5
APNN	32	.6	32	.6	21	.9
AUJP	41	.5	46	.4	60	.3
BRJP	37	.5	57	.3	-	-
BUAM	10	1.6	8	1.8	5	2.4
CASP	42	.5	43	.4	83	.2
CRHS	9	1.6	10	1.6	11	1.6
DEUL	40	.5	37	.5	31	.6
DIAL	33	.6	46	.4	78	.2
DOKA	16	1.0	29	.7	63	.3
ENSM	45	.4	35	.5	23	.8
ERKT	21	.9	17	1.1	13	1.6
FUNM	11	1.3	12	1.3	16	1.3
INDA	21	.9	23	.8	39	.5
JAFM	50	.4	41	.5	28	.7
JBDM	30	.7	20	.9	17	1.2
JPHY	3	3.2	3	3.5	3	3.8
JSBL	1	8.3	1	7.4	1	6.9
KONI	19	.9	19	.9	35	.5
MAKG	37	.5	38	.5	54	.4
MATA	14	1.1	15	1.2	15	1.4
MATZ	33	.6	28	.7	30	.7
METS	13	1.1	14	1.3	47	.4
MIND	2	4.6	2	5.1	2	5.4
MOST	20	.9	16	1.1	11	1.6
PHCR	4	2.5	4	2.5	6	2.3
PHDM	18	1.0	21	.8	87	.2
PHPH	27	.7	30	.7	29	.7
PHPR	5	1.9	5	2.1	7	2.3
PHSC	6	1.9	6	1.6	4	2.5
PRCM	42	.5	97	.2	288	*
PRDA	42	.5	39	.5	27	.7
PRZF	16	1.0	12	1.3	9	1.9
RECW	50	.4	57	.3	199	.1
REGM	35	.6	26	.7	18	1.0

* Value less than .1%.

TABLE 10

77

A LISTING OF THE TOP 50 SERIALS
IN THE CUMULATIVE SYMBOLIC LOGIC LITERATURE

Code	1960		1955		1950	
	Rank	% Total	Rank	% Total	Rank	% Total
AJTH	49	.4	46	.4	37	.5
AMJM	37	.5	32	.6	25	.8
AMMM	28	.7	24	.8	22	.8
ANFY	7	1.8	9	1.8	14	1.5
APNN	32	.6	32	.6	21	.9
AUJP	41	.5	46	.4	60	.3
BRJP	37	.5	57	.3	-	-
BUAM	10	1.6	8	1.8	5	2.4
CASP	42	.5	43	.4	83	.2
CRHS	9	1.6	10	1.6	11	1.6
DEUL	40	.5	37	.5	31	.6
DIAL	33	.6	46	.4	78	.2
DOKA	16	1.0	29	.7	63	.3
ENSM	45	.4	35	.5	23	.8
ERKT	21	.9	17	1.1	13	1.6
FUNM	11	1.3	12	1.3	16	1.3
INDA	21	.9	23	.8	39	.5
JAFM	50	.4	41	.5	28	.7
JBDM	30	.7	20	.9	17	1.2
JPHY	3	3.2	3	3.5	3	3.8
JSBL	1	8.3	1	7.4	1	6.9
KONI	19	.9	19	.9	35	.5
MAKG	37	.5	38	.5	54	.4
MATA	14	1.1	15	1.2	15	1.4
MATZ	33	.6	28	.7	30	.7
METS	13	1.1	14	1.3	47	.4
MIND	2	4.6	2	5.1	2	5.4
MOST	20	.9	16	1.1	11	1.6
PHCR	4	2.5	4	2.5	6	2.3
PHDM	18	1.0	21	.8	87	.2
PHPH	27	.7	30	.7	29	.7
PHPR	5	1.9	5	2.1	7	2.3
PHSC	6	1.9	6	1.6	4	2.5
PRCM	42	.5	97	.2	288	*
PRDA	42	.5	39	.5	27	.7
PRZF	16	1.0	12	1.3	9	1.9
RECW	50	.4	57	.3	199	.1
REGM	35	.6	26	.7	18	1.0

* Value less than .1%.

TABLE 10-CONTINUED

78

Code	1960		1955		1950	
	Rank	% Total	Rank	% Total	Rank	% Total
REMM	15	1.0	11	1.3	10	1.8
REPF	48	.4	41	.5	44	.5
REPL	35	.5	35	.6	34	.6
SCVM	31	.7	26	.7	31	.6
STUL	25	.8	61	.3	-	-
SYTS	12	1.1	18	1.1	18	1.0
THER	24	.8	22	.8	20	.9
TRAM	23	.8	31	.7	26	.8
XICM	47	.4	40	.5	31	.6
XICP	8	1.7	7	2.0	8	1.9
XIPS	45	.4	35	.6	23	.8
ZEML	26	.7	116	.2	-	-
ZETM	28	.7	25	.7	40	.5
Total %		56.6		57.1		58.7
Av. A/J	11.8		10.9		9.6	

Code	1945		1940		1935	
	Rank	% Total	Rank	% Total	Rank	% Total
AJTH	49	.4	163	.1	192	*
AMJM	21	.9	20	.9	17	1.2
AMMM	21	.9	28	.8	28	.8
ANFY	17	1.1	17	1.3	68	.3
APNN	18	1.0	20	.9	20	1.0
AUJP	78	.3	81	.3	95	.2
BRJP	-	-	-	-	-	-
BUAM	4	3.0	4	3.0	5	3.1
CASP	113	.2	94	.2	86	.3
CRHS	39	.6	54	.4	68	.3
DEUL	28	.8	25	.8	30	.7
DIAL	-	-	-	-	-	-
DOKA	291	*	262	*	-	-
ENSM	16	1.1	16	1.4	12	1.5
ERKT	8	2.3	7	2.9	10	1.8
FUNM	14	1.3	15	1.5	11	1.6
INDA	291	*	-	-	-	-
JAFM	19	1.0	18	1.2	13	1.5
JBDM	12	1.7	9	1.0	8	2.9
JPHY	3	3.7	3	3.3	4	3.6
JSBL	2	5.4	2	3.5	-	-
KONI	153	.1	130	.1	94	.2

TABLE 10-CONTINUED

79

Code	1945		1940		1935	
	Rank	% Total	Rank	% Total	Rank	% Total
MAKG	42	.5	41	.5	50	.4
MATA	11	1.8	9	2.0	9	2.8
MATZ	26	.8	24	.9	17	1.2
METS	-	-	-	-	-	-
MIND	1	5.6	1	5.6	1	6.6
MOST	6	2.3	5	2.9	2	4.4
PHCR	5	2.4	12	1.8	15	1.3
PHDM	-	-	-	-	-	-
PHPH	36	.6	44	.5	61	.3
PHPR	20	1.0	148	.4	-	-
PHSC	9	2.2	14	1.6	30	.7
PRCM	-	-	-	-	-	-
PRDA	25	.9	20	.9	42	.5
PRZF	10	2.2	8	2.7	5	3.1
RECW	-	-	-	-	-	-
REGM	13	1.5	11	1.8	9	2.7
REMM	6	2.3	5	2.9	3	3.9
REPF	53	.4	44	.5	42	.5
REPL	53	.4	57	.4	50	.4
SCVM	31	.7	36	.6	46	.5
STUL	-	-	-	-	-	-
SYTS	137	.1	113	.2	-	-
THER	21	.9	33	.7	-	-
TRAM	24	.9	30	.7	27	.8
XICM	28	.8	20	.9	15	1.3
XICP	15	1.3	13	1.6	22	.9
XIPS	31	.7	27	.8	-	-
ZEML	-	-	-	-	-	-
ZETM	52	.4	44	.5	61	.3
Total %		50.5		51.8		50.5
Av. A/J	8.5		7.9		6.8	

Code	1930		1925		1920	
	Rank	% Total	Rank	% Total	Rank	% Total
AJTH	-	-	-	-	-	-
AMJM	18	1.1	19	1.2	17	1.4
AMMM	32	.7	34	.6	41	.5
ANFY	-	-	-	-	-	-
APNN	50	.4	68	.3	69	.2
AUJP	92	.2	113	.1	-	-
BRJP	-	-	-	-	-	-

TABLE 10-CONTINUED

80

Code	1930		1925		1920	
	Rank	% Total	Rank	% Total	Rank	% Total
BUAM	9	2.6	10	2.0	11	1.8
CASP	92	.2	113	.1	98	.1
CRHS	67	.3	-	-	-	-
DEUL	44	.5	113	.1	98	.1
DIAL	-	-	-	-	-	-
DOKA	-	-	-	-	-	-
ENSM	12	1.5	11	1.8	10	2.2
ERKT	35	.6	-	-	-	-
FUNM	15	1.2	31	.7	-	-
INDA	-	-	-	-	-	-
JAFM	11	1.8	11	1.8	15	1.5
JBDM	6	3.4	6	3.4	6	3.4
JPHY	5	3.6	5	3.8	5	3.6
JSBL	-	-	-	-	-	-
KONI	75	.3	72	.2	-	-
MAKG	92	.2	-	-	-	-
MATA	8	3.0	8	3.0	8	2.6
MATZ	18	1.1	48	.5	-	-
METS	-	-	-	-	-	-
MIND	1	7.3	1	7.8	1	8.8
MOST	3	4.0	4	4.0	4	4.4
PHCR	30	.7	31	.7	31	.8
PHDM	-	-	-	-	-	-
PHPH	-	-	-	-	-	-
PHPR	-	-	-	-	-	-
PHSC	-	-	-	-	-	-
PRCM	-	-	-	-	-	-
PRDA	30	.7	25	.8	23	1.0
PRZF	7	3.2	7	3.3	9	2.5
RECW	-	-	-	-	-	-
REGM	4	3.8	3	5.2	3	6.1
REMM	2	5.2	2	6.3	2	7.
REPF	44	.5	41	.5	41	.5
REPL	35	.6	41	.5	69	.2
SCVM	-	-	-	-	-	-
STUL	-	-	-	-	-	-
SYTS	-	-	-	-	-	-
THER	-	-	-	-	-	-
TRAM	27	.9	34	.6	41	.5
XICM	15	1.2	21	1.1	20	1.1
XICP	14	1.3	18	1.3	20	1.1
XIPS	-	-	-	-	-	-
ZEML	-	-	-	-	-	-
ZETM	-	-	-	-	-	-
Total %		52.1		51.7		51.6
Av. A/J	5.9		5.9		5.9	

TABLE 10-CONTINUED

81

Code	1915		1910		1905	
	Rank	% Total	Rank	% Total	Rank	% Total
AJTH	-	-	-	-	-	-
AMJM	15	1.6	10	2.0	9	2.2
AMMM	64	.3	77	.2	63	.2
ANPY	-	-	-	-	-	-
APNN	92	.1	77	.2	63	.2
AUJP	-	-	-	-	-	-
BRJP	-	-	-	-	-	-
BUAM	13	1.8	17	1.4	16	1.3
CASP	92	.1	-	-	-	-
CRHS	-	-	-	-	-	-
DEUL	92	.1	77	.2	63	.2
DIAL	-	-	-	-	-	-
DOKA	-	-	-	-	-	-
ENSM	10	1.9	10	1.6	9	2.2
ERKT	-	-	-	-	-	-
FUNM	-	-	-	-	-	-
INDA	-	-	-	-	-	-
JAFM	21	1.1	21	1.1	22	1.1
JBDM	5	3.3	5	3.3	14	1.5
JPHY	8	2.0	31	.8	43	.4
JSBL	-	-	-	-	-	-
KONI	-	-	-	-	-	-
MAKG	-	-	-	-	-	-
MATA	7	2.8	6	2.8	6	2.8
MATZ	-	-	-	-	-	-
METS	-	-	-	-	-	-
MIND	1	9.6	1	10.7	1	10.7
MOST	6	2.9	10	2.0	16	1.3
PHCR	37	.6	52	.3	63	.2
PHDM	-	-	-	-	-	-
PHPH	-	-	-	-	-	-
PHPR	-	-	-	-	-	-
PHSC	-	-	-	-	-	-
PRCM	-	-	-	-	-	-
PRDA	26	1.0	31	.8	27	.9
PRZF	21	1.1	52	.3	-	-
RECW	-	-	-	-	-	-
RECM	3	7.1	2	8.9	1	10.7
REMM	2	7.3	3	6.2	4	4.6
REPF	37	.6	36	.6	33	.7
REPL	64	.3	52	.3	43	.4
SCVM	-	-	-	-	-	-
STUL	-	-	-	-	-	-
SYTS	-	-	-	-	-	-
THER	-	-	-	-	-	-
TRAM	54	.4	52	.3	43	.4

TABLE 10-CONTINUED

82

Code	1915		1910		1905	
	Rank	% Total	Rank	% Total	Rank	% Total
XICM	17	1.3	25	.9	33	.7
XICP	17	1.3	14	1.6	16	1.0
XIPS	-	-	-	-	-	-
ZEML	-	-	-	-	-	-
ZETM	-	-	-	-	-	-
Total %		48.6		46.5		43.7
Av. A/J	5.3		5.1		4.5	

Code	1900		1895		1890	
	Rank	% Total	Rank	% Total	Rank	% Total
AJTH	-	-	-	-	-	-
ANJM	20	1.3	15	1.6	14	1.9
AMDM	46	.3	-	-	-	-
ANFY	-	-	-	-	-	-
APNN	46	.3	35	.4	26	.6
AUJP	-	-	-	-	-	-
BRJP	-	-	-	-	-	-
BUAM	-	-	-	-	-	-
CASP	-	-	-	-	-	-
CRHS	-	-	-	-	-	-
DEUL	46	.3	35	.4	26	.6
DIAL	-	-	-	-	-	-
DOKA	-	-	-	-	-	-
ENSM	31	.6	-	-	-	-
ERKT	-	-	-	-	-	-
FUNM	-	-	-	-	-	-
INDA	-	-	-	-	-	-
JAFM	15	1.6	10	2.1	9	2.5
JBDM	-	-	-	-	-	-
JPHY	-	-	-	-	-	-
JSBL	-	-	-	-	-	-
KONI	-	-	-	-	-	-
MAKG	-	-	-	-	-	-
MATA	9	2.2	10	2.1	14	1.9
MATZ	-	-	-	-	-	-
METS	-	-	-	-	-	-
MIND	2	10.8	1	11.5	2	11.5
MOST	15	1.6	34	.4	-	-
PHCR	-	-	-	-	-	-
PHDM	-	-	-	-	-	-
PRPH	-	-	-	-	-	-

TABLE 10-CONTINUED

83

Code	1900		1895		1890	
	Rank	% Total	Rank	% Total	Rank	% Total
PHPR	-	-	-	-	-	-
PHSC	-	-	-	-	-	-
PRCM	-	-	-	-	-	-
PRDA	-	-	-	-	-	-
PRZF	-	-	-	-	-	-
RECV	-	-	-	-	-	-
REGM	1	11.7	3	9.9	-	-
REMM	9	2.2	34	.4	-	-
REPP	25	.9	21	1.2	14	1.9
REPL	-	-	-	-	-	-
SCVM	-	-	-	-	-	-
STUL	-	-	-	-	-	-
SYTS	-	-	-	-	-	-
THER	-	-	-	-	-	-
TRAM	-	-	-	-	-	-
XICM	-	-	-	-	-	-
XICP	-	-	-	-	-	-
XIPS	-	-	-	-	-	-
ZEML	-	-	-	-	-	-
ZETM	-	-	-	-	-	-
Total %		33.8		30.0		20.9
Av. A/J	4.1		3.7		3.1	

Code	1885		1880		1875	
	Rank	% Total	Rank	% Total	Rank	% Total
AJTH	-	-	-	-	-	-
AMJM	11	2.3	12	1.3	-	-
AMMM	-	-	-	-	-	-
ANFY	-	-	-	-	-	-
APNN	-	-	-	-	-	-
AUJP	-	-	-	-	-	-
BRJP	-	-	-	-	-	-
BUAM	-	-	-	-	-	-
CASP	-	-	-	-	-	-
CRHS	-	-	-	-	-	-
DEUL	19	.8	-	-	-	-
DIAL	-	-	-	-	-	-
DOKA	-	-	-	-	-	-
ENSM	-	-	-	-	-	-
ERKT	-	-	-	-	-	-
FUNM	-	-	-	-	-	-

TABLE 10-CONTINUED

84

Code	1885		1880		1875	
	Rank	% Total	Rank	% Total	Rank	% Total
INDA	-	-	-	-	-	-
JAFM	19	.8	12	1.3	-	-
JBDM	-	-	-	-	-	-
JPHY	-	-	-	-	-	-
JSBL	-	-	-	-	-	-
KONI	-	-	-	-	-	-
MAKO	-	-	-	-	-	-
MATA	19	.8	12	1.3	-	-
MATZ	-	-	-	-	-	-
METS	-	-	-	-	-	-
MIND	2	12.5	2	11.7	-	-
MOST	-	-	-	-	-	-
PHCR	-	-	-	-	-	-
PHDM	-	-	-	-	-	-
PHPH	-	-	-	-	-	-
PHPR	-	-	-	-	-	-
PHSC	-	-	-	-	-	-
PRCM	-	-	-	-	-	-
PRDA	-	-	-	-	-	-
PRZF	-	-	-	-	-	-
RECW	-	-	-	-	-	-
REGM	-	-	-	-	-	-
REMM	-	-	-	-	-	-
REPF	11	2.3	9	2.6	-	-
REPL	-	-	-	-	-	-
SCVM	-	-	-	-	-	-
STUL	-	-	-	-	-	-
SYTS	-	-	-	-	-	-
THER	-	-	-	-	-	-
TRAM	-	-	-	-	-	-
XICM	-	-	-	-	-	-
XIPS	-	-	-	-	-	-
ZEML	-	-	-	-	-	-
ZETM	-	-	-	-	-	-
Total %		19.5		18.2		-
Av. A/J	3.0		2.4		-	

TABLE 11

A TRACING OF THE TABLE 10 SERIALS
BY FIVE YEAR INTERVALS

Code	1956-60		1951-55		1946-50	
	Rank	% Total	Rank	% Total	Rank	% Total
AJTH	71	.3	106	.2	28	.8
AMJM	199	*	65	.4	55	.4
AMMM	59	.4	37	.6	35	.6
ANFY	8	1.8	6	2.5	9	2.3
APNN	71	.3	106	.2	44	.4
AUJP	32	.7	36	.7	44	.4
BRJP	15	1.1	18	1.2	-	-
BUAM	32	.7	47	.5	19	1.0
CASP	36	.6	28	.9	44	.4
CRHS	9	1.5	10	1.6	4	4.1
DEUL	79	.3	73	.3	55	.4
DIAL	15	1.1	31	.8	26	.8
DOKA	6	2.2	13	1.5	24	.9
ENSM	-	-	-	-	-	-
ERKT	-	-	-	-	-	-
FUNM	10	1.5	15	1.4	15	1.2
INDA	15	.1	12	1.6	11	1.6
JAFM	-	-	-	-	-	-
JBDM	-	-	204	*	-	-
JPHY	6	2.2	5	2.7	5	3.9
JSBL	1	11.2	1	8.7	1	10.4
KONI	19	1.1	9	1.7	11	1.6
MAKG	49	.4	26	.9	87	.2
MATA	49	.4	30	.8	39	.5
MATZ	107	.2	33	.7	55	.4
METS	64	.4	3	3.1	13	1.5
MIND	2	2.8	2	4.2	3	4.9
MOST	-	-	-	-	-	-
PHCR	4	2.6	4	2.8	9	2.3
PHDM	14	1.4	7	2.3	29	.7
PHPH	26	.9	40	.6	24	.9
PHPR	21	1.0	11	1.6	2	5.4
PHSC	15	1.1	21	1.0	7	3.2
PRCM	12	1.4	40	.6	110	.1
PRDA	79	.3	148	.1	55	.4
PRZF	-	-	-	-	16	1.1
RECW	46	.5	21	1.0	78	.2
REGM	-	-	-	-	-	-
REMM	-	-	148	.1	29	.7
REPP	157	.1	43	.5	33	.6

TABLE 11-CONTINUED

86

Code	1956-60		1951-55		1946-50	
	Rank	% Total	Rank	% Total	Rank	% Total
REPL	107	.2	32	.7	18	1.1
SCVM	49	.4	28	.9	35	.6
STUL	5	2.3	19	1.1	-	-
SYTS	19	1.1	17	1.2	8	3.0
THER	34	.7	40	.6	20	.9
TRAM	12	1.4	58	.4	44	.4
XICM	107	.2	106	.2	55	.4
XICP	64	.4	8	2.2	6	3.3
XIPS	-	-	-	-	16	1.1
ZEML	3	2.7	43	.5	-	-
ZETM	43	.5	16	1.3	29	.7
Total %		51.5		56.9		65.8
Av. A/J	7.0		7.7		6.8	

* Value less than .1%.

Code	1941-1945		1936-1940		1931-35	
	Rank	% Total	Rank	% Total	Rank	% Total
AJTH	9	1.8	102	.2	82	.2
AMJM	20	.9	38	.5	18	1.4
AMMM	11	1.6	24	.8	27	1.0
ANFY	-	-	4	3.3	27	1.0
APNN	12	1.5	21	.9	12	2.2
AUJP	59	.3	57	.4	82	.2
BRJP	-	-	-	-	-	-
BUAM	7	3.0	7	2.8	4	4.2
CASP	-	-	137	.1	54	.3
CRHS	14	1.2	32	.6	82	.2
DEUL	44	.4	18	1.1	21	1.2
DIAL	-	-	-	-	-	-
DOKA	-	-	137	.1	-	-
ENSM	-	-	16	1.2	16	1.5
ERKT	-	-	2	4.8	3	4.7
FUNM	30	.7	16	1.2	6	2.7
INDA	84	.1	-	-	-	-
JAFM	-	-	27	.7	36	.7
JBDM	44	.4	57	.4	14	1.7
JPHY	2	5.8	8	2.7	5	3.5
JSBL	1	13.4	1	10.1	-	-
KONI	-	-	-	-	-	-
MAKG	59	.3	32	.6	27	1.0

TABLE 11-CONTINUED

87

Code	1941-45		1936-40		1931-35	
	Rank	% Total	Rank	% Total	Rank	% Total
MATA	33	.5	32	.6	11	2.4
MATZ	44	.4	57	.4	18	1.4
METS	-	-	-	-	-	-
MIND	3	5.7	3	3.7	2	4.9
MOST	-	-	137	.1	1	5.2
PHCR	4	5.1	9	2.6	6	2.7
PHDM	-	-	-	-	-	-
PHPH	14	1.2	27	.7	21	1.2
PHPR	5	5.0	102	.2	-	-
PHSC	6	4.7	5	3.2	9	2.5
PRCM	-	-	-	-	-	-
PRDA	33	.5	13	1.7	-	-
PRZF	-	-	11	2.0	6	2.7
RECW	-	-	-	-	-	-
REGM	-	-	-	-	-	-
REMM	-	-	20	1.0	36	.7
REPF	-	-	57	.4	46	.5
REPL	44	.4	76	.3	-	-
SCVM	20	.9	24	.8	14	1.7
STUL	-	-	-	-	-	-
SYTS	20	.9	45	.4	-	-
THER	8	2.2	12	1.9	-	-
TRAM	9	1.8	38	.5	36	.7
XICM	-	-	76	.3	16	1.5
XICP	-	-	6	3.0	-	-
XIPS	-	-	10	2.3	-	-
ZEML	-	-	-	-	-	-
ZETM	84	.1	27	.7	21	1.2
Total %		60.8		59.3		57.0
Av. A/J	4.7		5.4		4.1	

Code	1926-30		1921-25		1916-20	
	Rank	% Total	Rank	% Total	Rank	% Total
AJTH	-	-	-	-	-	-
ANJM	37	.8	-	-	-	-
ANOM	37	.8	21	1.2	12	2.3
ANPY	-	-	-	-	-	-
APNN	31	1.0	36	.6	19	.8
AUJP	52	.5	36	.6	-	-
BRJP	-	-	-	-	-	-
BUAM	2	4.4	7	3.0	12	2.3

TABLE 11-CONTINUED

88

Code	1926-30		1921-25		1916-20	
	Rank	% Total	Rank	% Total	Rank	% Total
CASP	52	.5	-	-	-	-
CRHS	24	1.3	-	-	-	-
DEUL	15	1.8	-	-	-	-
DIAL	-	-	-	-	-	-
DOKA	-	-	-	-	-	-
ENSM	37	.8	-	-	6	3.9
ERKT	11	2.3	-	-	-	-
FUNM	9	2.6	4	4.8	-	-
INDA	-	-	-	-	-	-
JAFM	15	1.8	5	3.6	6	3.9
JBDM	4	3.6	7	3.0	5	4.7
JPHY	6	2.8	2	5.4	2	13.3
JSBL	-	-	-	-	-	-
KONI	52	.5	21	1.2	-	-
MAKQ	37	.8	-	-	-	-
MATA	6	2.8	2	5.4	16	1.6
MATZ	6	2.8	7	3.0	-	-
METS	-	-	-	-	-	-
MIND	1	5.9	11	2.4	6	3.9
MOST	3	4.1	17	1.8	1	14.1
PHCR	37	.8	36	.6	16	1.6
PHDM	-	-	-	-	-	-
PHPH	-	-	-	-	-	-
PHPR	-	-	-	-	-	-
PHSC	-	-	-	-	-	-
PRCM	-	-	-	-	-	-
PRDA	52	.5	-	-	19	.8
PRXF	5	3.1	1	7.7	3	10.9
RECW	-	-	-	-	-	-
REGM	-	-	-	-	-	-
REMM	15	1.8	17	1.8	4	7.0
REPP	52	.5	36	.6	-	-
REPL	37	.8	11	2.4	-	-
SCVM	-	-	-	-	-	-
STUL	-	-	-	-	-	-
SYTS	-	-	-	-	-	-
THER	-	-	-	-	-	-
TRAM	19	1.5	21	1.2	16	1.6
XICM	19	1.5	21	1.2	-	-
XICP	24	1.3	11	2.4	-	-
XIPS	-	-	-	-	-	-
ZEML	-	-	-	-	-	-
ZETM	-	-	-	-	-	-
Total %		53.7		53.9		72.7
Av. A/J	4.0		2.5		3.5	

TABLE 11-CONTINUED

89

Code	1911-15		1906-10		1901-05	
	Rank	% Total	Rank	% Total	Rank	% Total
AJTH	-	-	-	-	-	-
AMJM	-	-	14	1.6	6	4.3
AMMM	29	.6	-	-	-	-
ANFY	-	-	-	-	-	-
APNN	-	-	-	-	-	-
AUJP	-	-	-	-	-	-
BRJP	-	-	-	-	-	-
BUAM	6	3.2	14	1.6	6	4.3
CASP	29	.6	-	-	-	-
CRHS	-	-	-	-	-	-
DEUL	-	-	-	-	-	-
DIAL	-	-	-	-	-	-
DOKA	-	-	-	-	-	-
ENSM	18	1.3	14	1.6	4	5.7
ERKT	-	-	-	-	-	-
FUNM	-	-	-	-	-	-
INDA	-	-	-	-	-	-
JAPM	18	1.3	20	1.1	-	-
JBDM	6	3.2	3	7.6	5	5.0
JPHY	2	7.0	14	1.6	16	1.4
JSBL	-	-	-	-	-	-
KONI	-	-	-	-	-	-
MAKG	-	-	-	-	-	-
MATA	9	2.5	10	2.7	6	4.3
MATZ	-	-	-	-	-	-
METS	-	-	-	-	-	-
MIND	4	5.1	1	10.8	1	10.6
MOST	3	6.3	5	3.8	25	.7
PHCR	12	1.9	32	.5	26	.7
PHDM	-	-	-	-	-	-
PHPH	-	-	-	-	-	-
PHPR	-	-	-	-	-	-
PHSC	-	-	-	-	-	-
PRCM	-	-	-	-	-	-
PRDA	12	1.9	32	.5	11	2.8
PRZF	5	4.4	20	1.1	-	-
RECW	-	-	-	-	-	-
REGM	-	-	4	4.3	3	8.5
REMM	1	11.4	2	10.3	2	9.9
REPF	29	.6	32	.5	-	-
REPL	-	-	-	-	16	1.4
SCVM	-	-	-	-	-	-
STUL	-	-	-	-	-	-
SYTS	-	-	-	-	-	-
THER	-	-	-	-	-	-
TRAM	29	.6	-	-	16	1.4

TABLE 11-CONTINUED

90

Code	1911-15		1906-10		1901-05	
	Rank	% Total	Rank	% Total	Rank	% Total
XICM	9	2.5	14	1.6	16	1.4
XICP	-	-	13	2.2	6	4.3
XIPS	-	-	-	-	-	-
ZEML	-	-	-	-	-	-
ZETM	-	-	-	-	-	-
Total %		54.4		53.4		66.7
Av. A/J	2.4		3.0		3.1	

Code	1896-00		1891-95		1886-90	
	Rank	% Total	Rank	% Total	Rank	% Total
AJTH	-	-	-	-	-	-
AMJM	-	-	13	1.2	-	-
AMMM	16	1.4	-	-	-	-
ANFY	-	-	-	-	-	-
APNN	-	-	-	-	3	3.4
AUJP	-	-	-	-	-	-
BRJP	-	-	-	-	-	-
BUAM	-	-	-	-	-	-
CASP	-	-	-	-	-	-
CRHS	-	-	-	-	-	-
DEUL	-	-	-	-	-	-
DIAL	-	-	-	-	-	-
DOKA	-	-	-	-	-	-
ENSM	9	2.7	-	-	-	-
ERKT	-	-	-	-	-	-
FUNM	-	-	-	-	-	-
INDA	-	-	-	-	-	-
JAPM	-	-	13	1.2	1	10.3
JBDM	-	-	-	-	-	-
JPHY	-	-	-	-	-	-
JSBL	-	-	-	-	-	-
KONI	-	-	-	-	-	-
MAKG	-	-	-	-	-	-
MATA	9	2.7	9	2.3	2	6.9
MATZ	-	-	-	-	-	-
METS	-	-	-	-	-	-
MIND	3	8.2	2	11.6	2	6.9
MOST	6	5.5	13	1.2	-	-
PHCR	-	-	-	-	-	-
PHDM	-	-	-	-	-	-
PHPH	-	-	-	-	-	-
PHPR	-	-	-	-	-	-

TABLE 11-CONTINUED

91

Code	1896-00		1891-95		1886-90	
	Rank	% Total	Rank	% Total	Rank	% Total
PHDM	-	-	-	-	-	-
PHPH	-	-	-	-	-	-
PHPR	-	-	-	-	-	-
PHSC	-	-	-	-	-	-
PRCM	-	-	-	-	-	-
PRDA	-	-	-	-	-	-
PRZF	-	-	-	-	-	-
RECW	-	-	-	-	-	-
REGM	1	17.8	1	27.9	-	-
REMM	3	8.2	13	1.2	-	-
REPF	-	-	-	-	-	-
REPL	-	-	-	-	-	-
SCVM	-	-	-	-	-	-
STUL	-	-	-	-	-	-
SYTS	-	-	-	-	-	-
THER	-	-	-	-	-	-
TRAM	-	-	-	-	-	-
XICM	16	1.4	-	-	-	-
XICP	-	-	-	-	-	-
XIPS	-	-	-	-	-	-
ZEML	-	-	-	-	-	-
ZETM	-	-	-	-	-	-
Total %		47.9		46.6		27.5
Av. A/J	2.8		3.7		1.3	

Code	1881-85		1876-80	
	Rank	% Total	Rank	% Total
AJTH	-	-	-	-
AMJM	6	3.9	12	1.9
AMMM	-	-	-	-
ANFY	-	-	-	-
APNN	-	-	-	-
AUJP	-	-	-	-
BRJP	-	-	-	-
BUAM	-	-	-	-
CASP	-	-	-	-
CRHS	-	-	-	-
DEUL	7	2.0	-	-
DIAL	-	-	-	-
DOKA	-	-	-	-
ENSM	-	-	-	-

TABLE 11-CONTINUED

92

Code	1881-85		1876-80	
	Rank	% Total	Rank	% Total
ERKT	-	-	-	-
FUNM	-	-	-	-
INDA	-	-	-	-
JAFM	-	-	12	1.9
JBDM	-	-	-	-
JPHY	-	-	-	-
JSBL	-	-	-	-
KONI	-	-	-	-
MAKG	-	-	-	-
MATA	-	-	12	1.9
MATZ	-	-	-	-
METS	-	-	-	-
MIND	2	13.7	2	17.0
MOST	-	-	-	-
PHCR	-	-	-	-
PHDM	-	-	-	-
PHPH	-	-	-	-
PHPR	-	-	-	-
PHSC	-	-	-	-
PRCM	-	-	-	-
PRDA	-	-	-	-
PRZF	-	-	-	-
RECW	-	-	-	-
REGM	-	-	-	-
REMM	-	-	-	-
REPF	7	2.0	9	3.8
REPL	-	-	-	-
SCVM	-	-	-	-
STUL	-	-	-	-
SYTS	-	-	-	-
THER	-	-	-	-
TRAM	-	-	-	-
XICM	-	-	-	-
XICP	-	-	-	-
XIPS	-	-	-	-
ZEML	-	-	-	-
ZETM	-	-	-	-
Total %		21.6		26.5
Av. A/J	2.6		2.7	

VI
FIGURES

Figure 3. Cumulative Article Growth Curve.

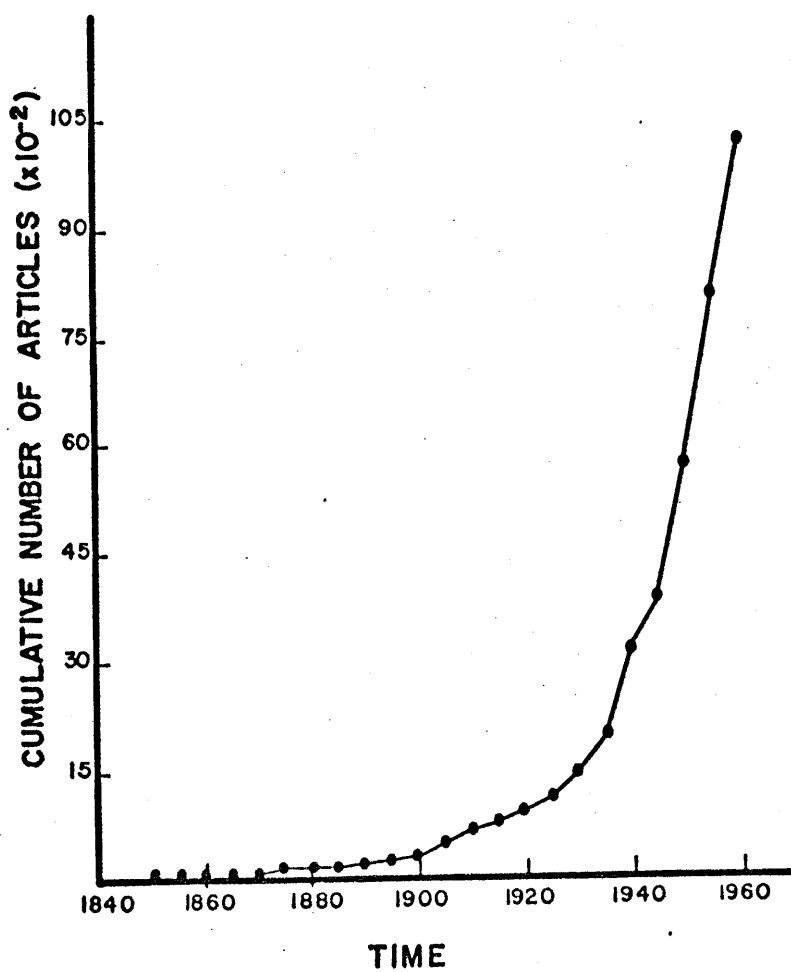


Figure 4. Cumulative Journal Growth Curve.

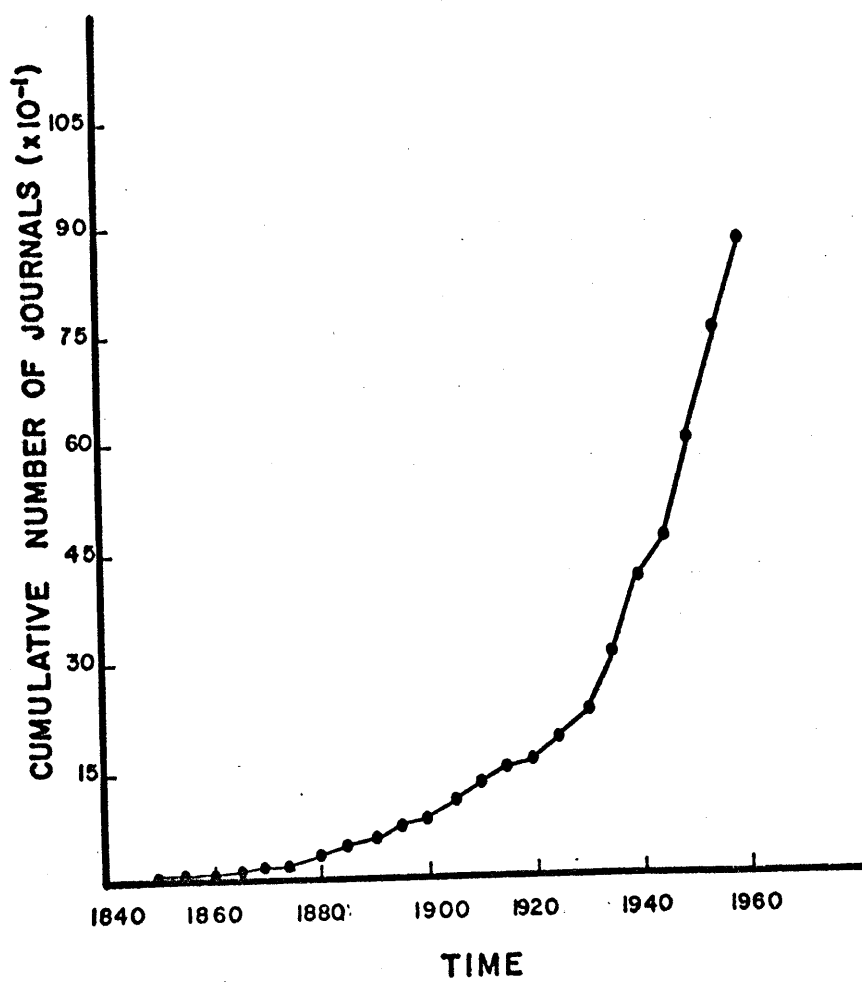


Figure 5. Change in Number of Articles.

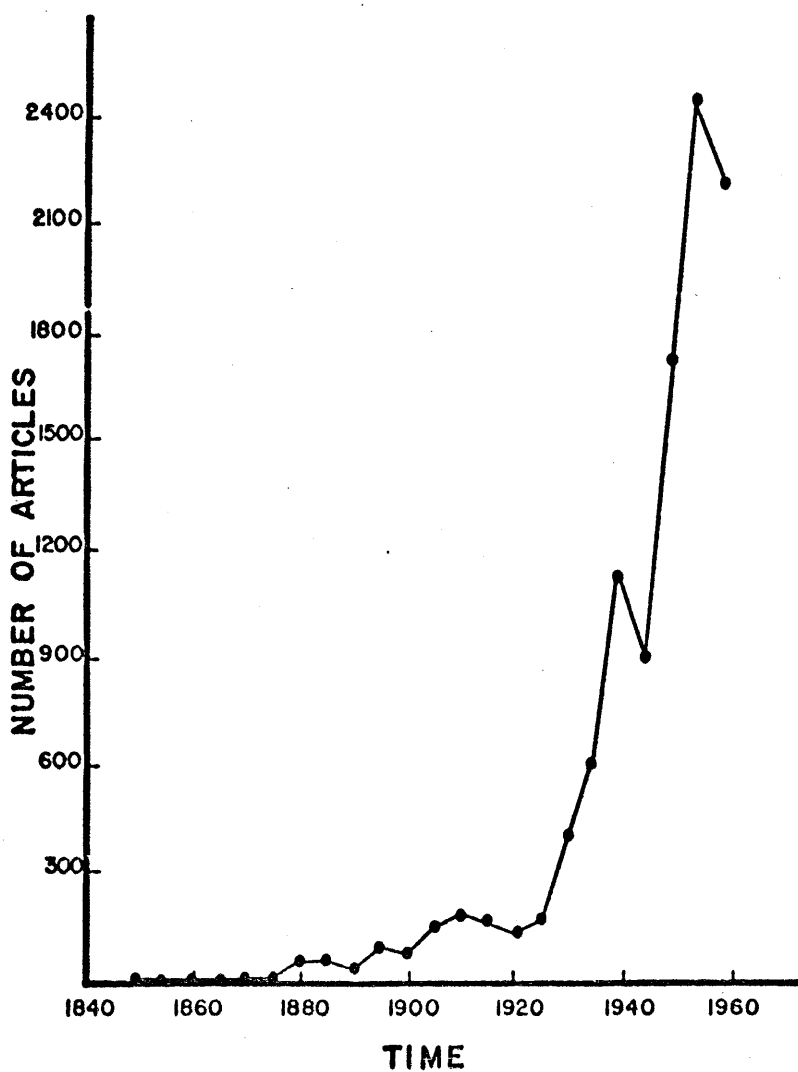


Figure 6. Change in Number of Journals.

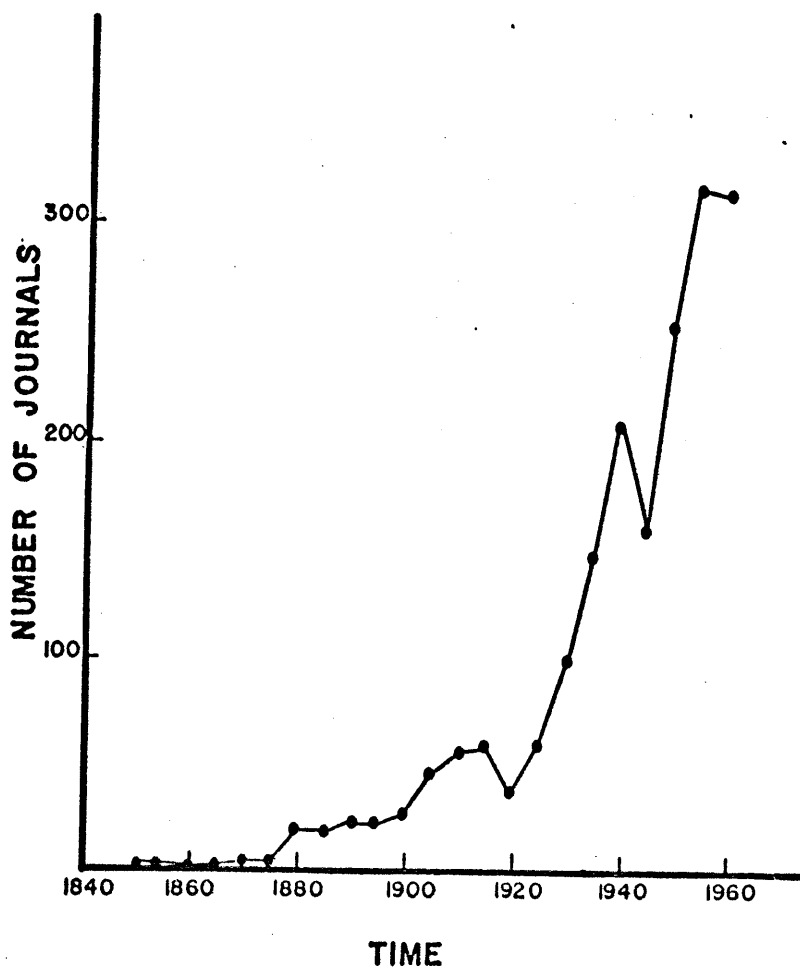


Figure 7. Epidemic Curve for Symbolic Logic Literature Based on Periodical Data.

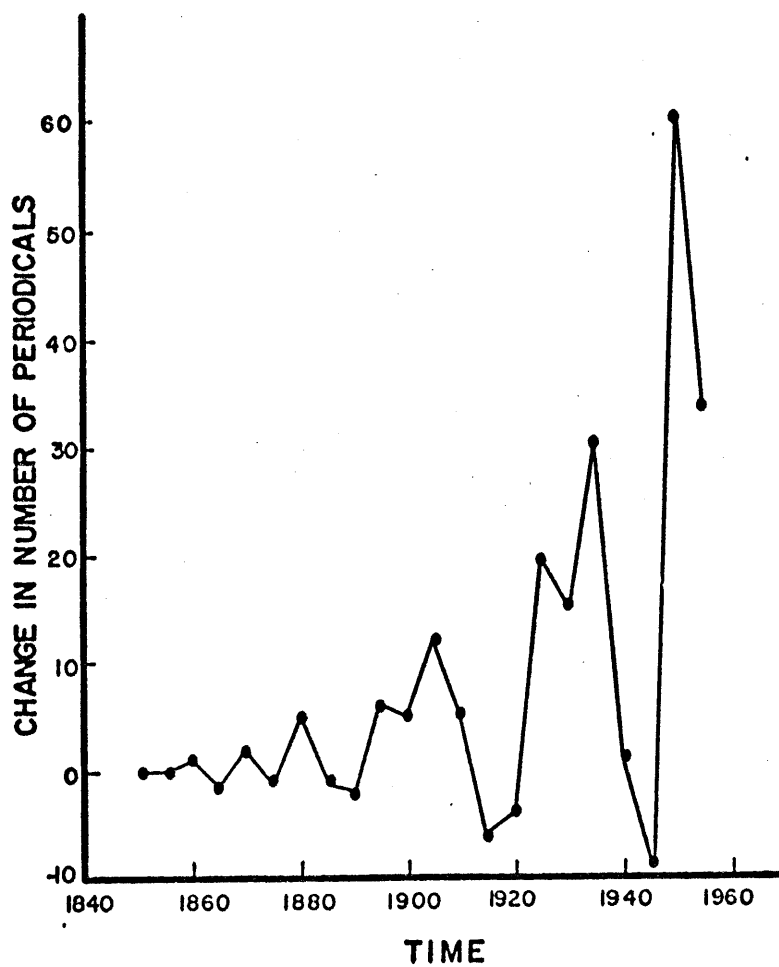


Figure 8. Author Epidemic Curve for the Symbolic Logic Literature.

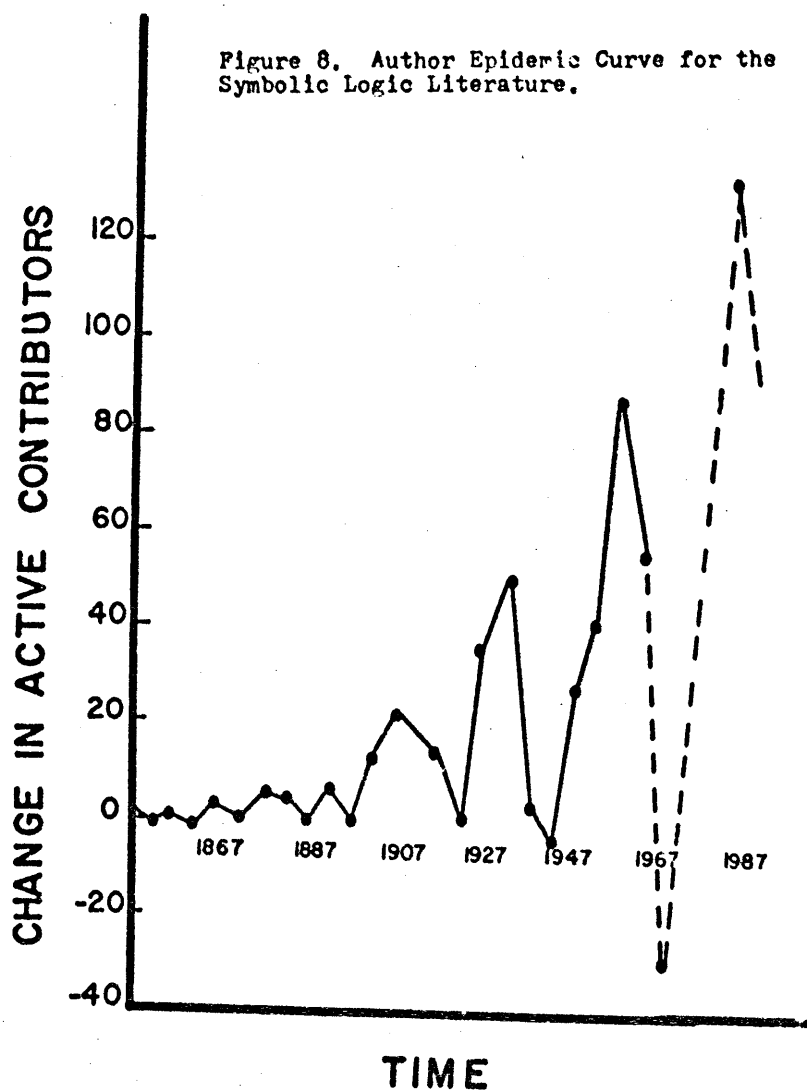


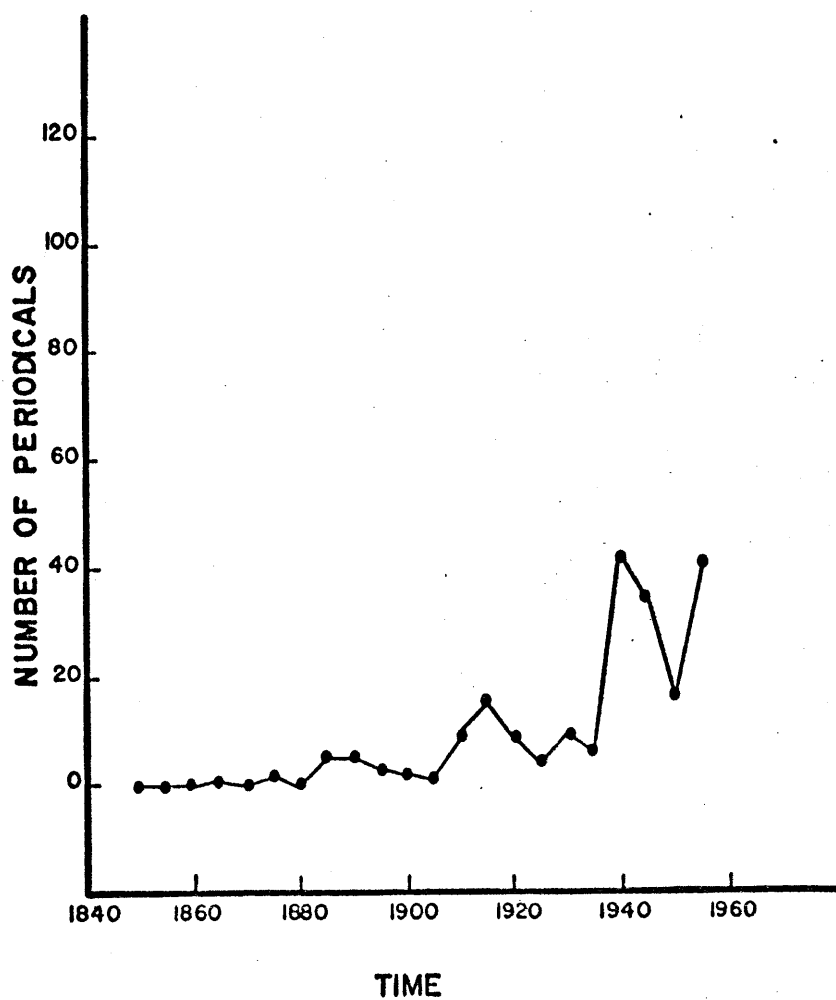
Figure 9. I_2 Periodical Curve.

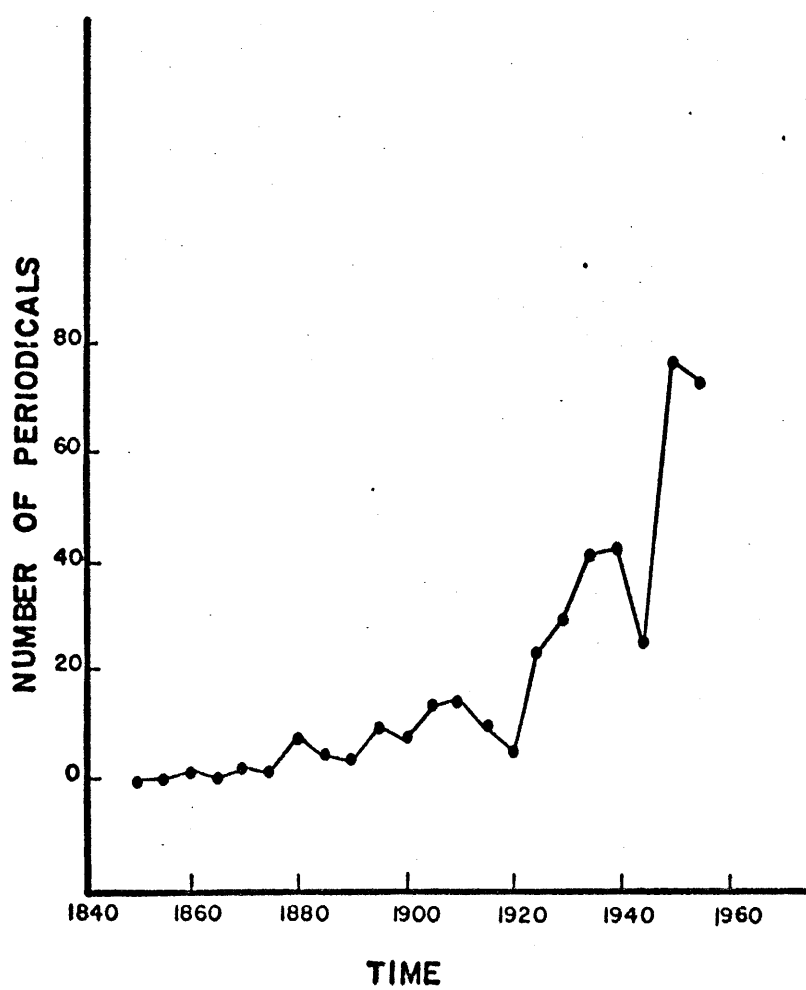
Figure 10. I_4 Periodical Curve.

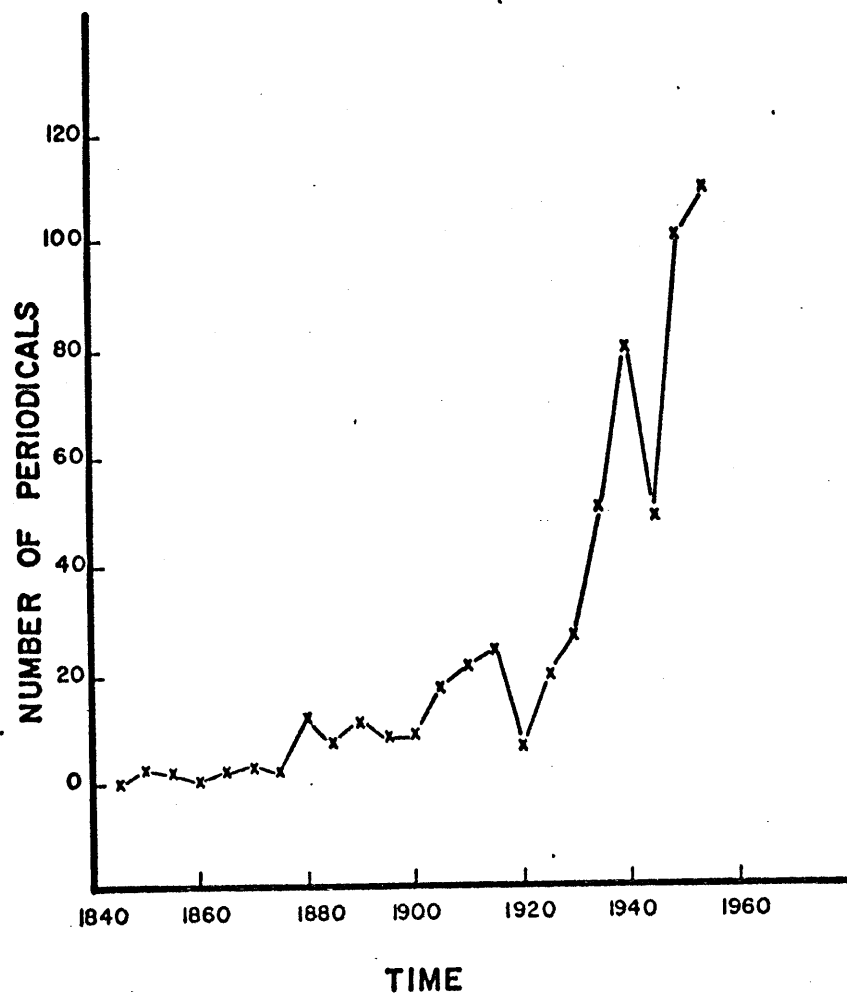
Figure 11. I_1 Periodical Curve.

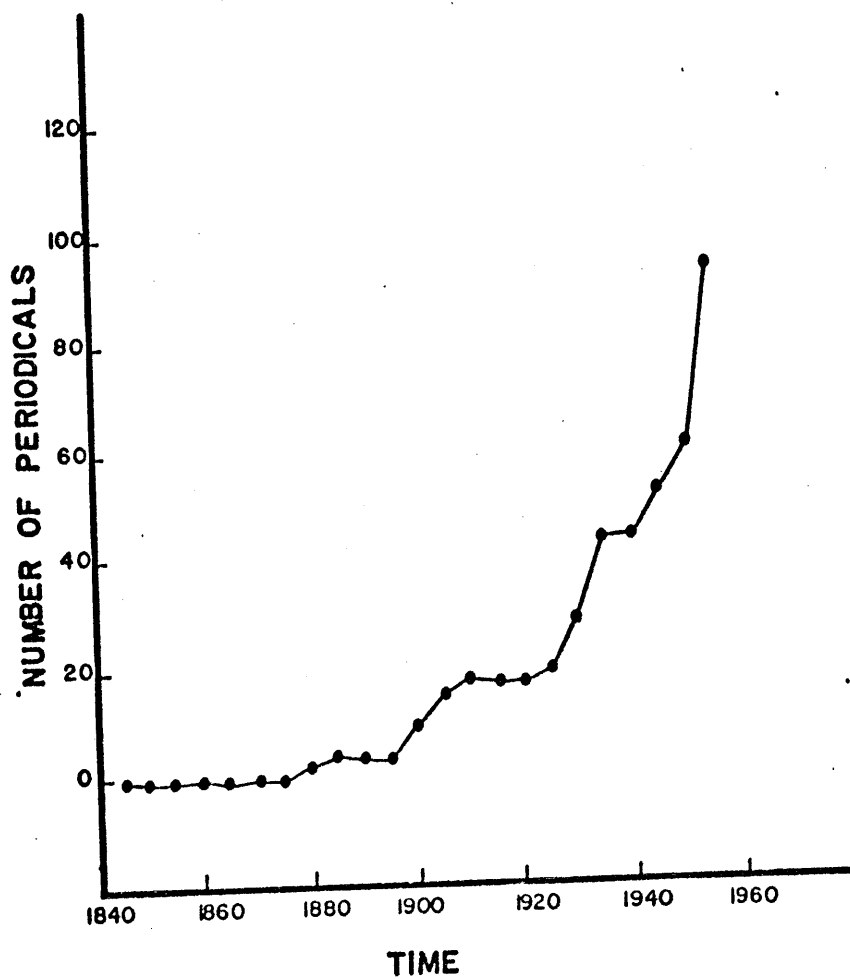
Figure 12. I_3 Periodical Curve.

Figure 13. I_1 (x) and I_3 (o) Periodical Curves. 104

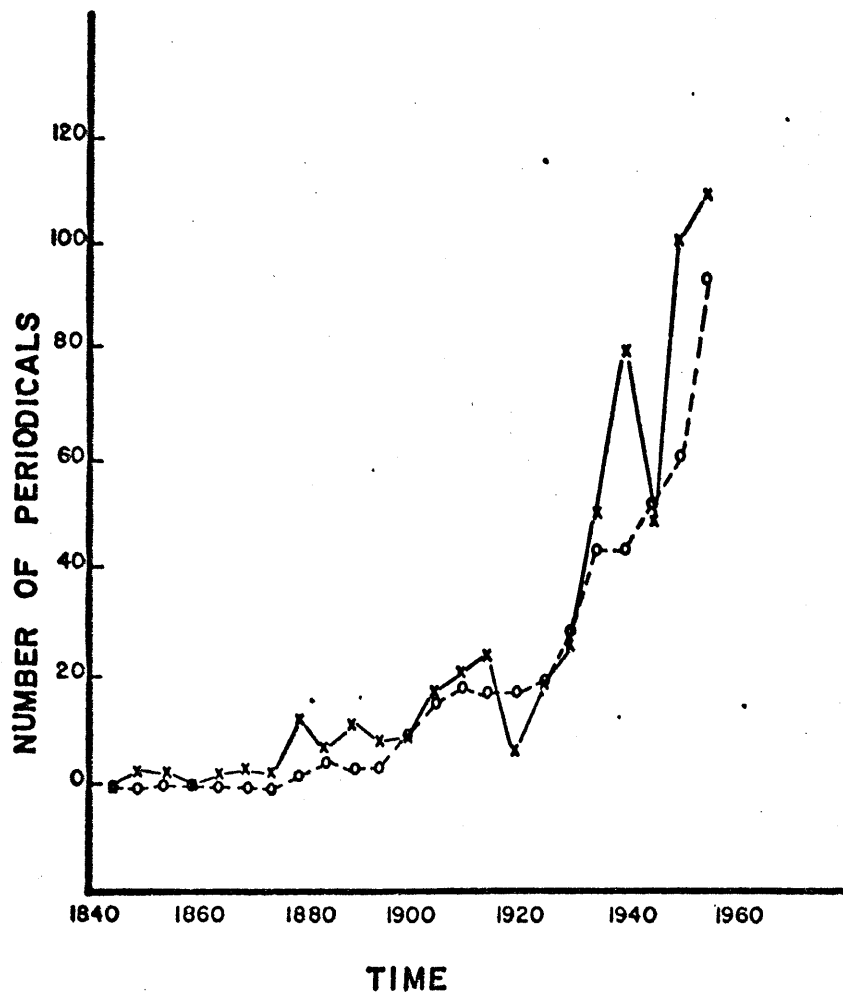


Figure 14. Bradford Curve 1841-1880.

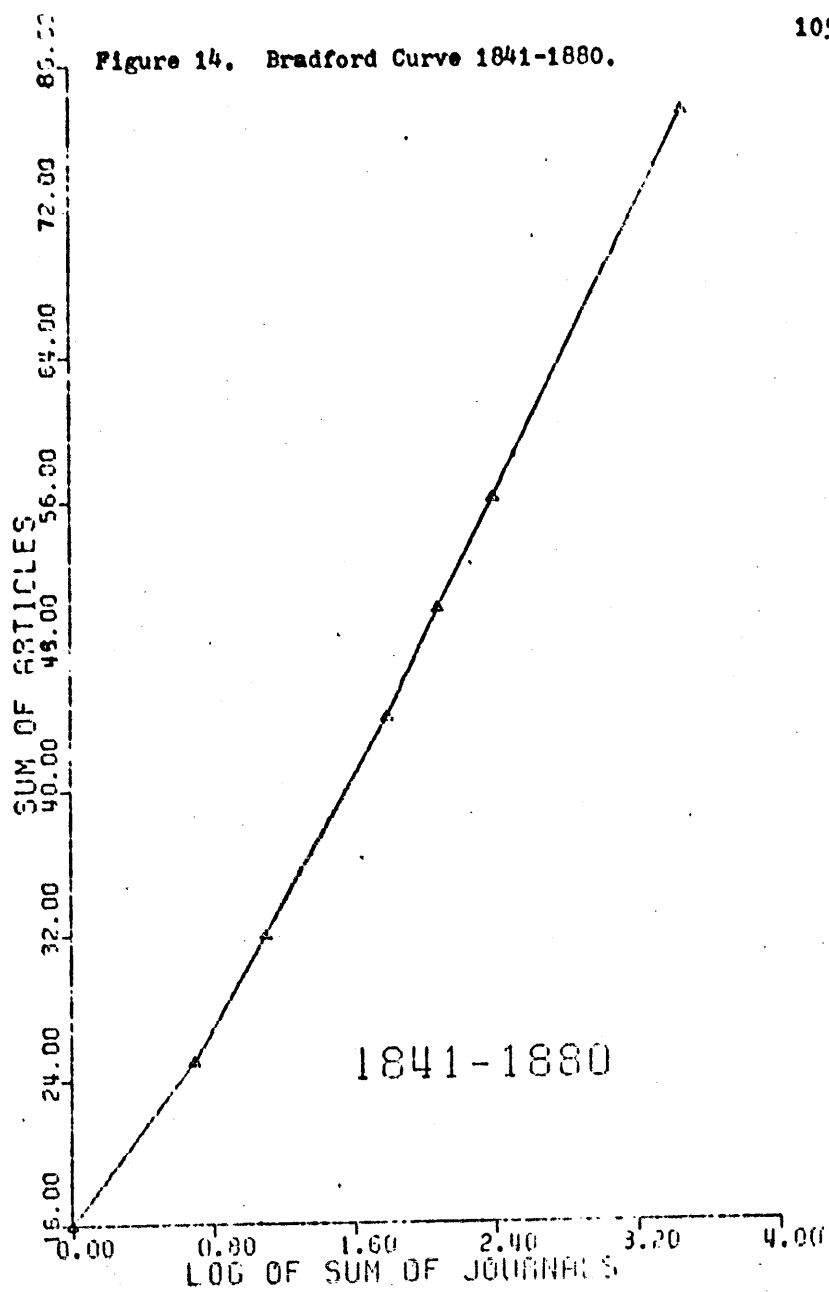


Figure 15. Bradford Curve 1841-1895.

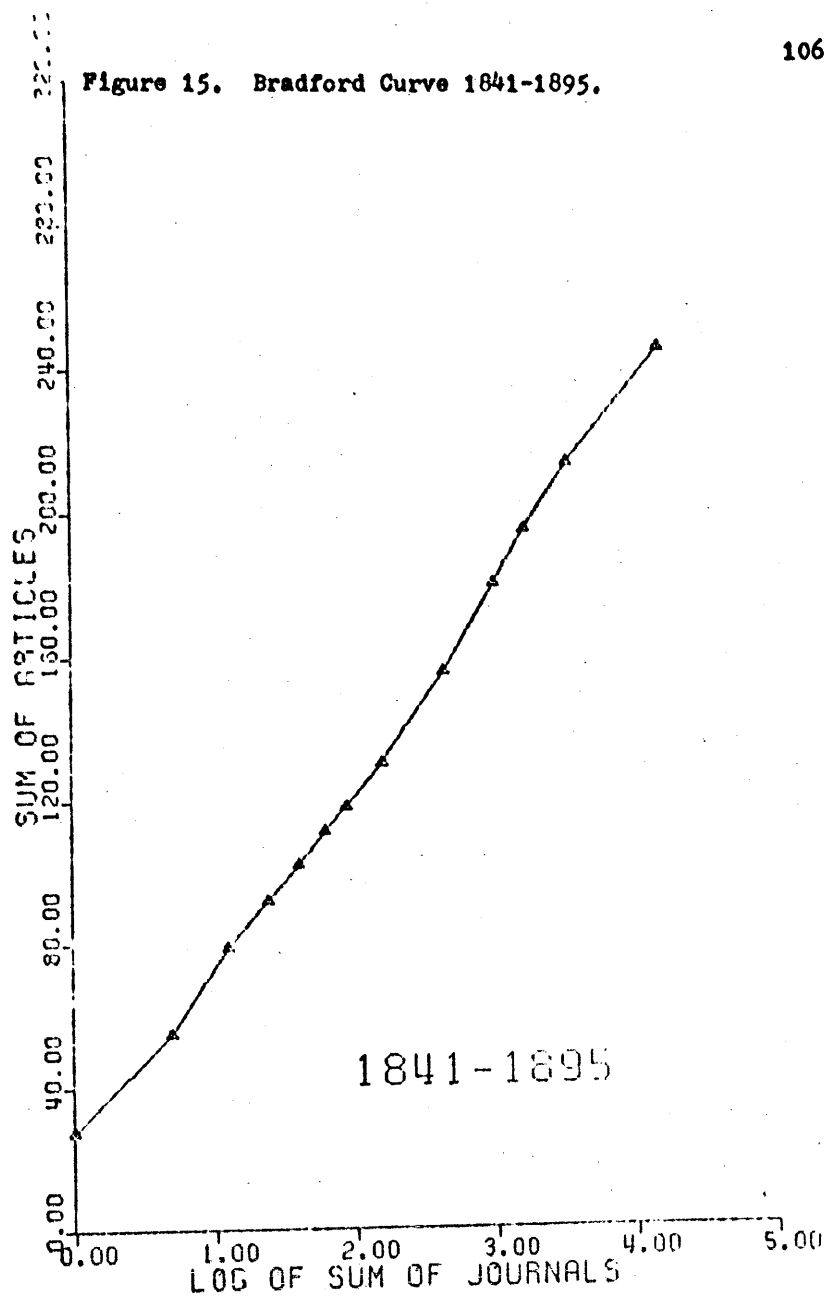
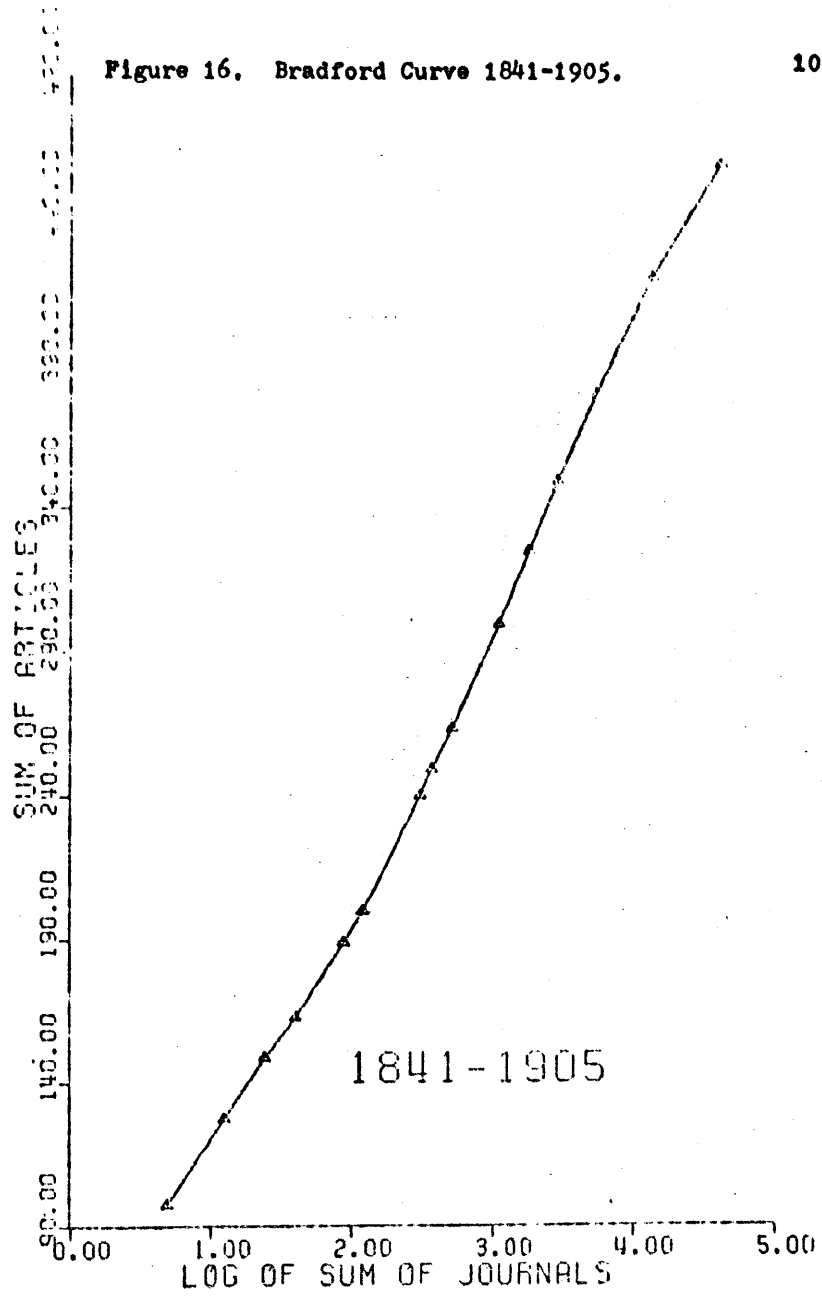


Figure 16. Bradford Curve 1841-1905.

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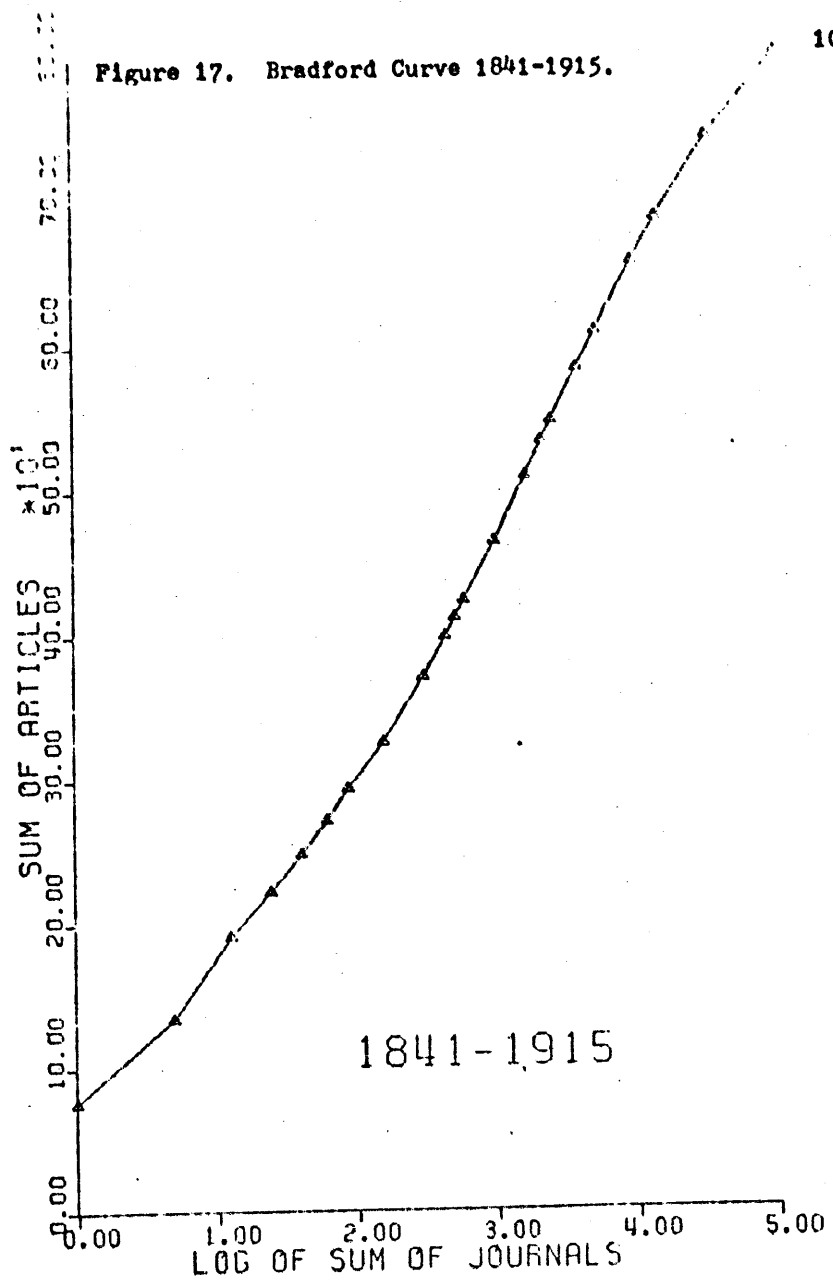


Figure 18. Bradford Curve 1841-1925.

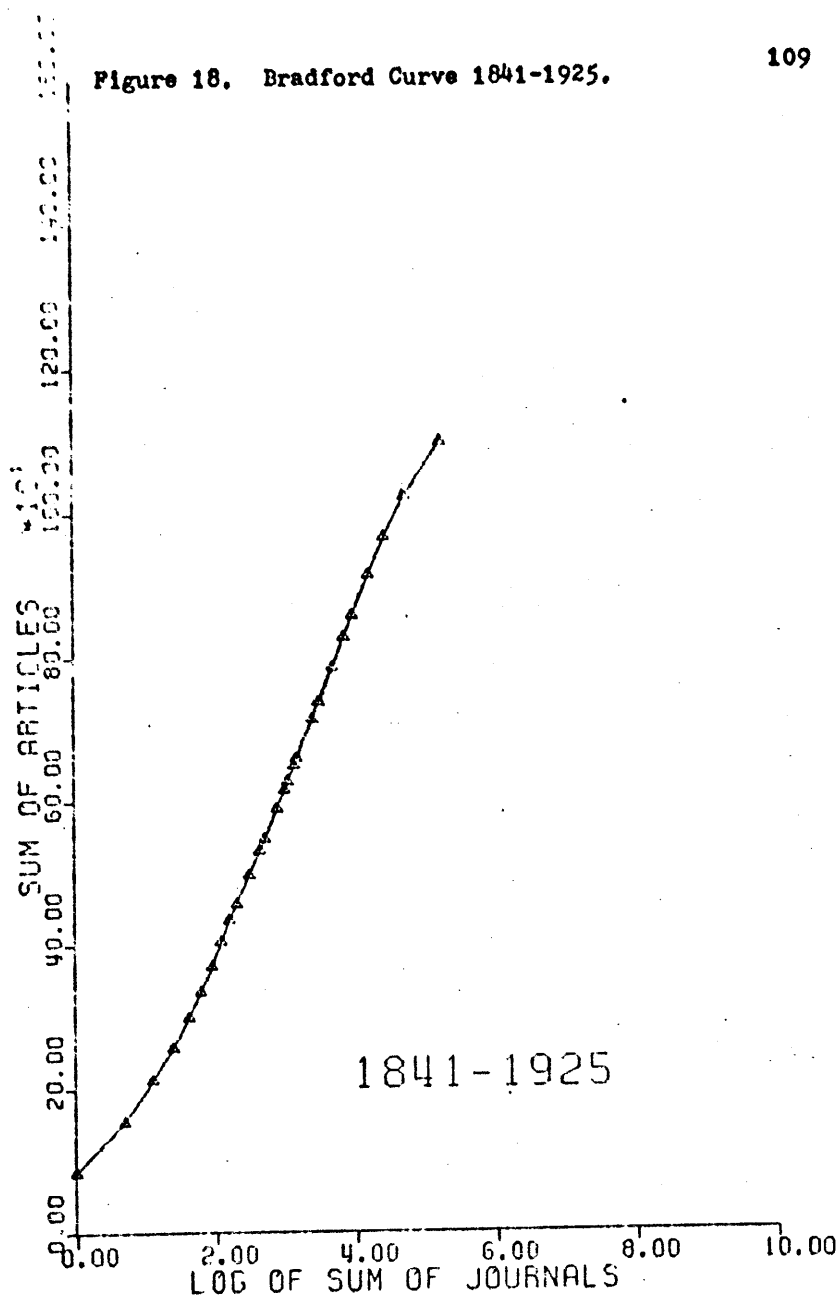


Figure 19. Bradford Curve 1841-1930.

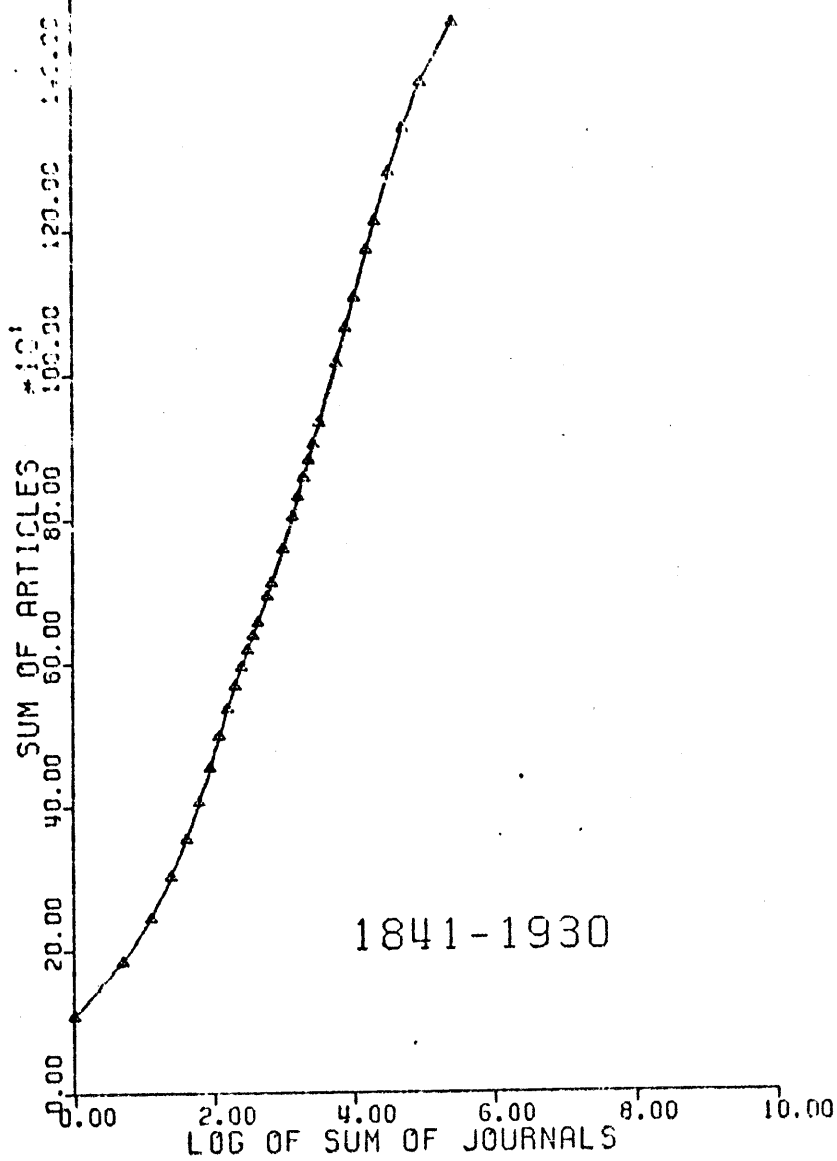
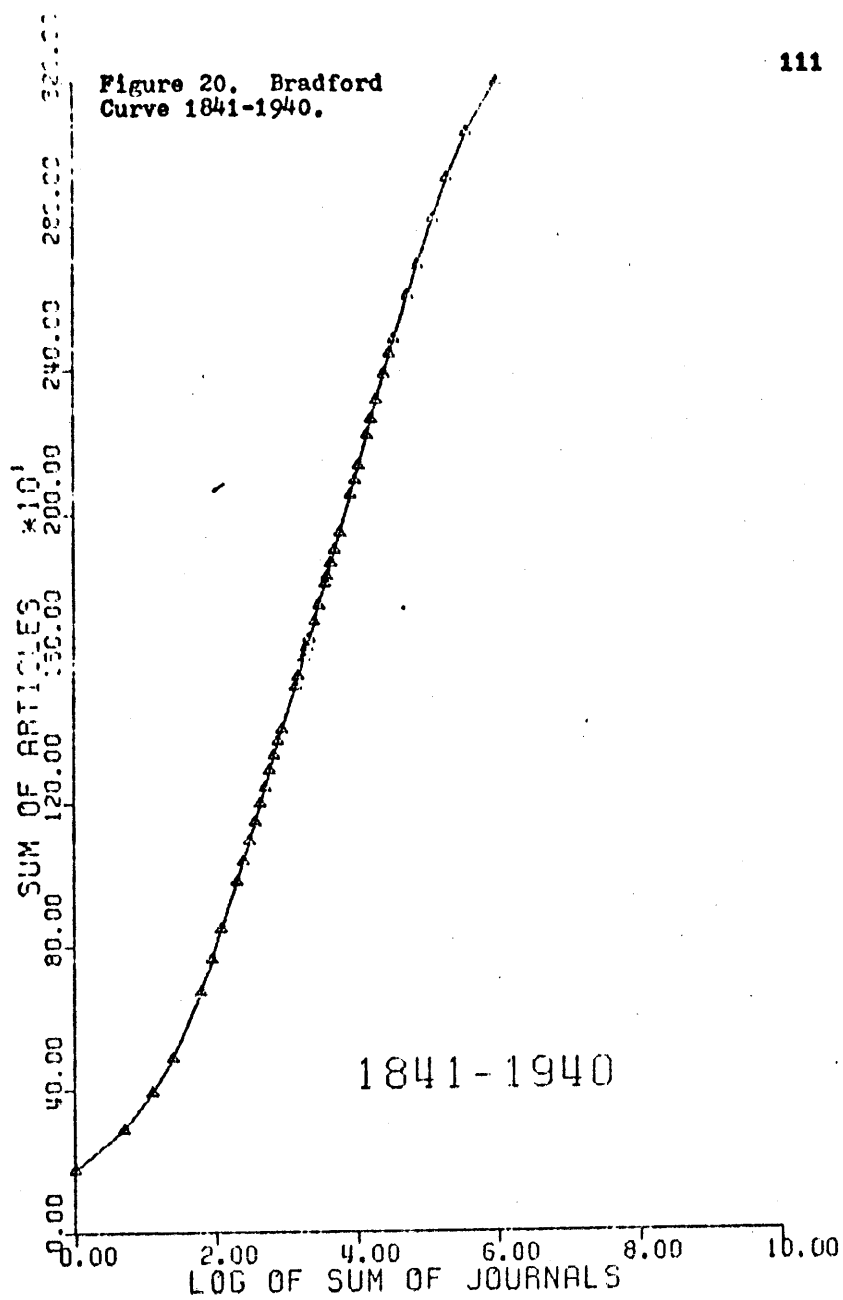


Figure 20. Bradford
Curve 1841-1940.



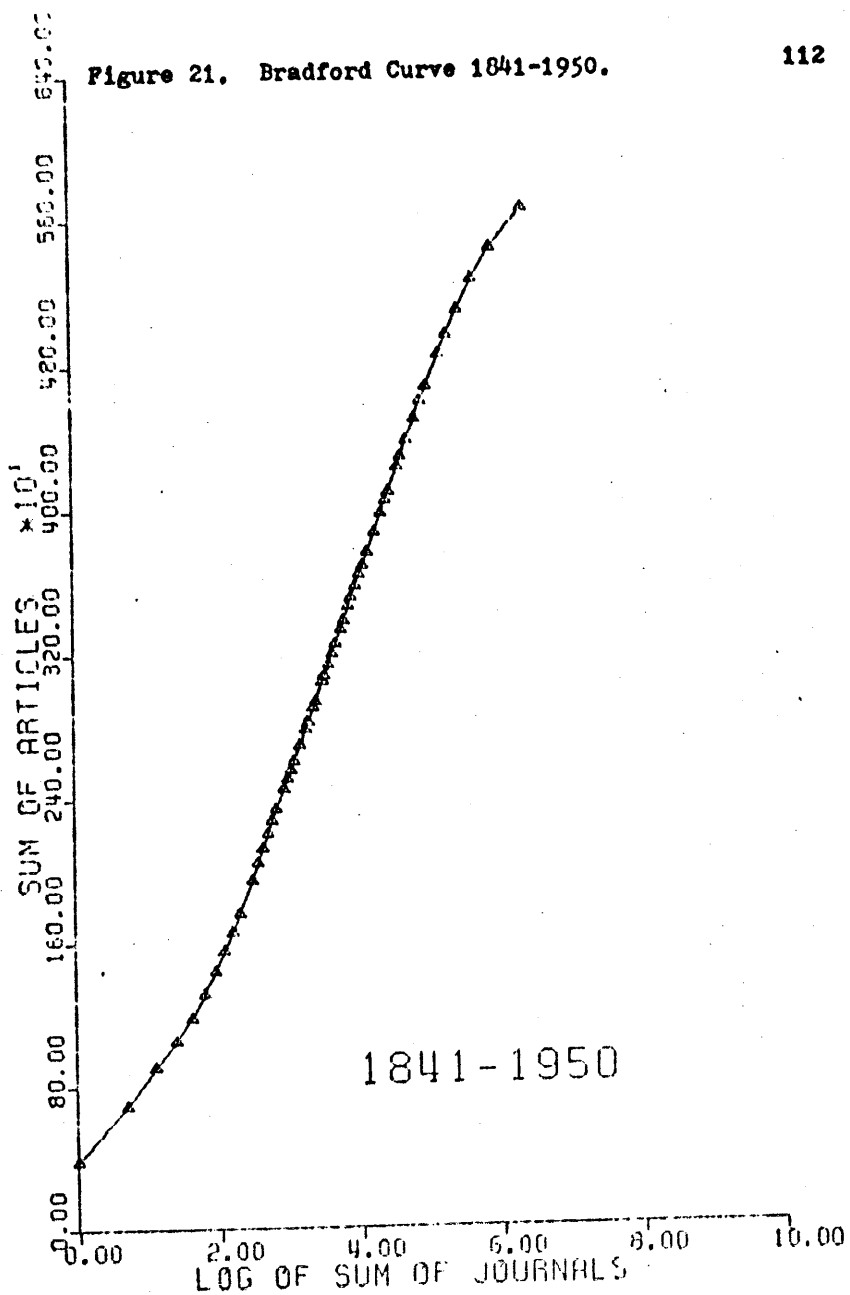


Figure 22. Bradford Curve 1841-1960.

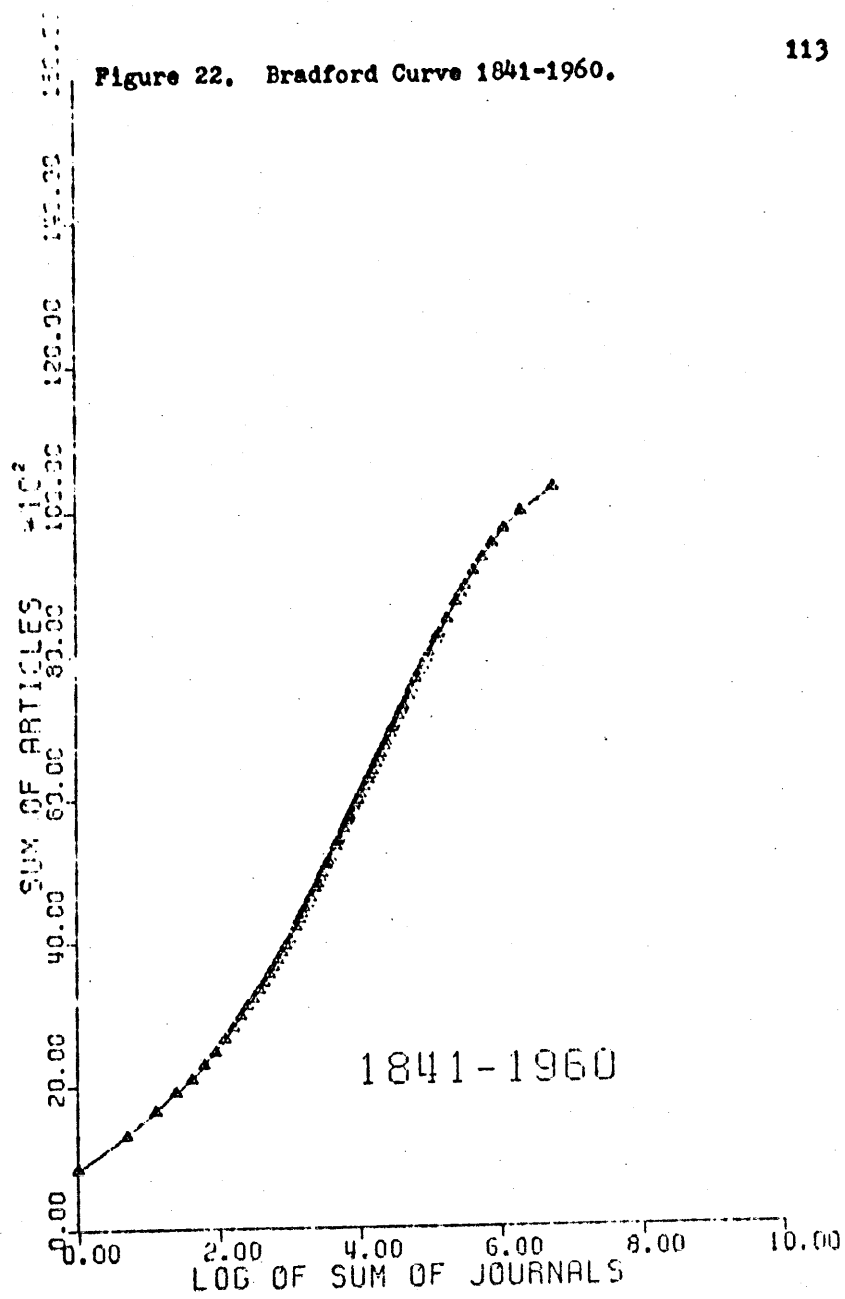
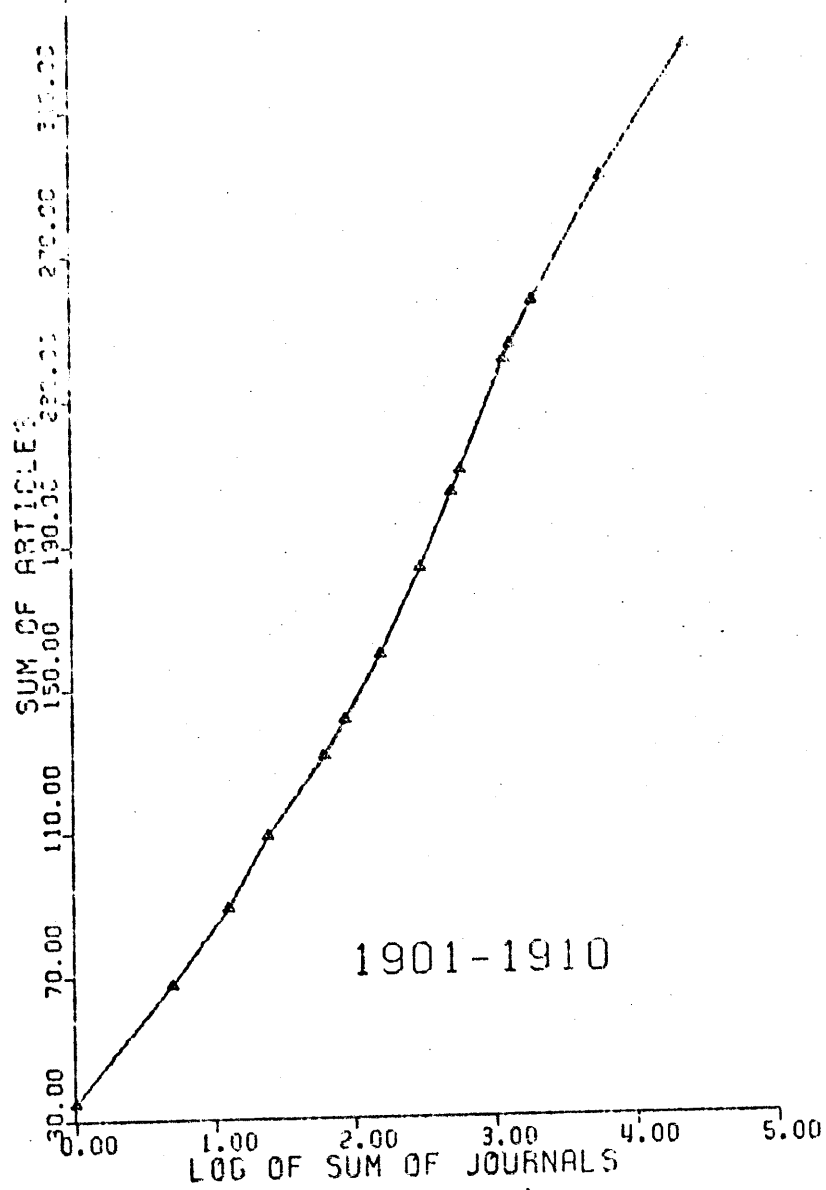


Figure 23. Bradford Curve 1901-1910.



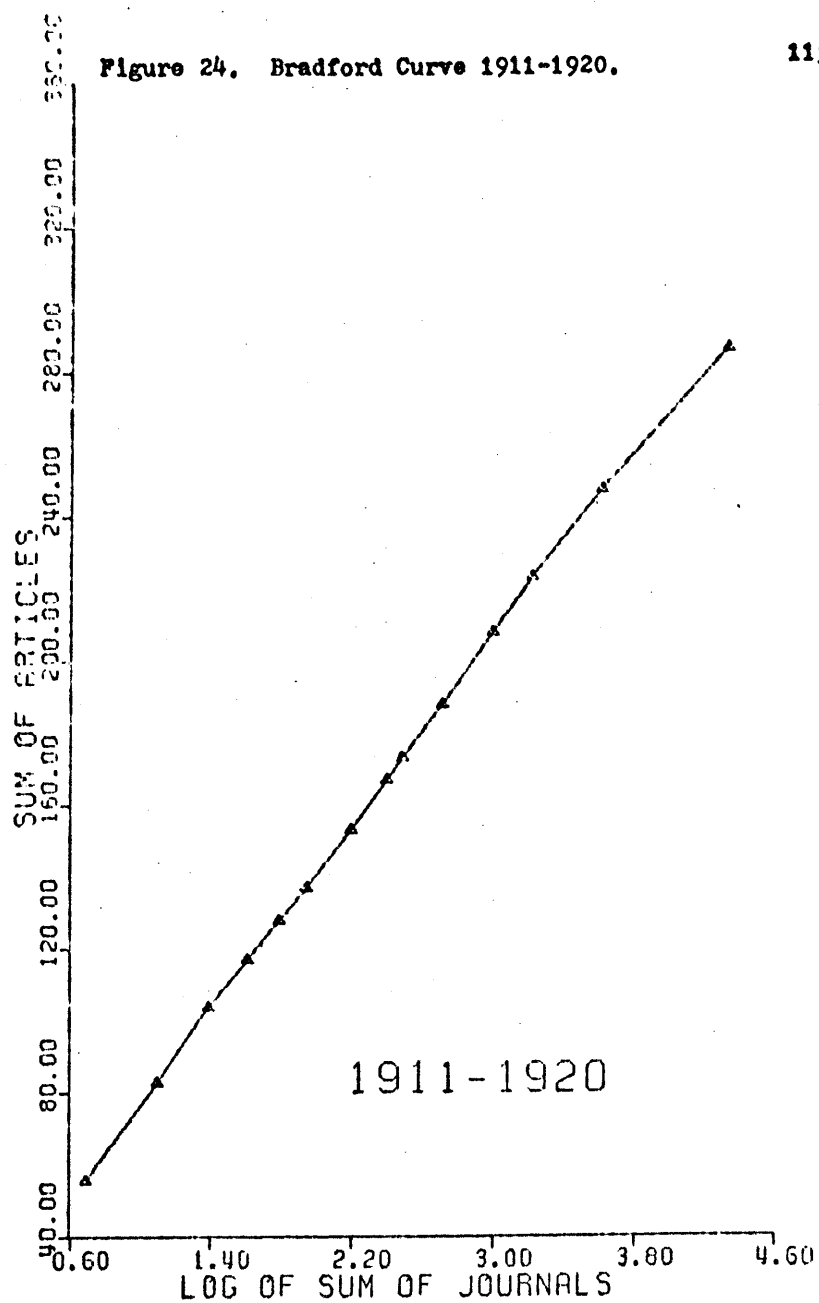


Figure 25. Bradford Curve 1921-1930.

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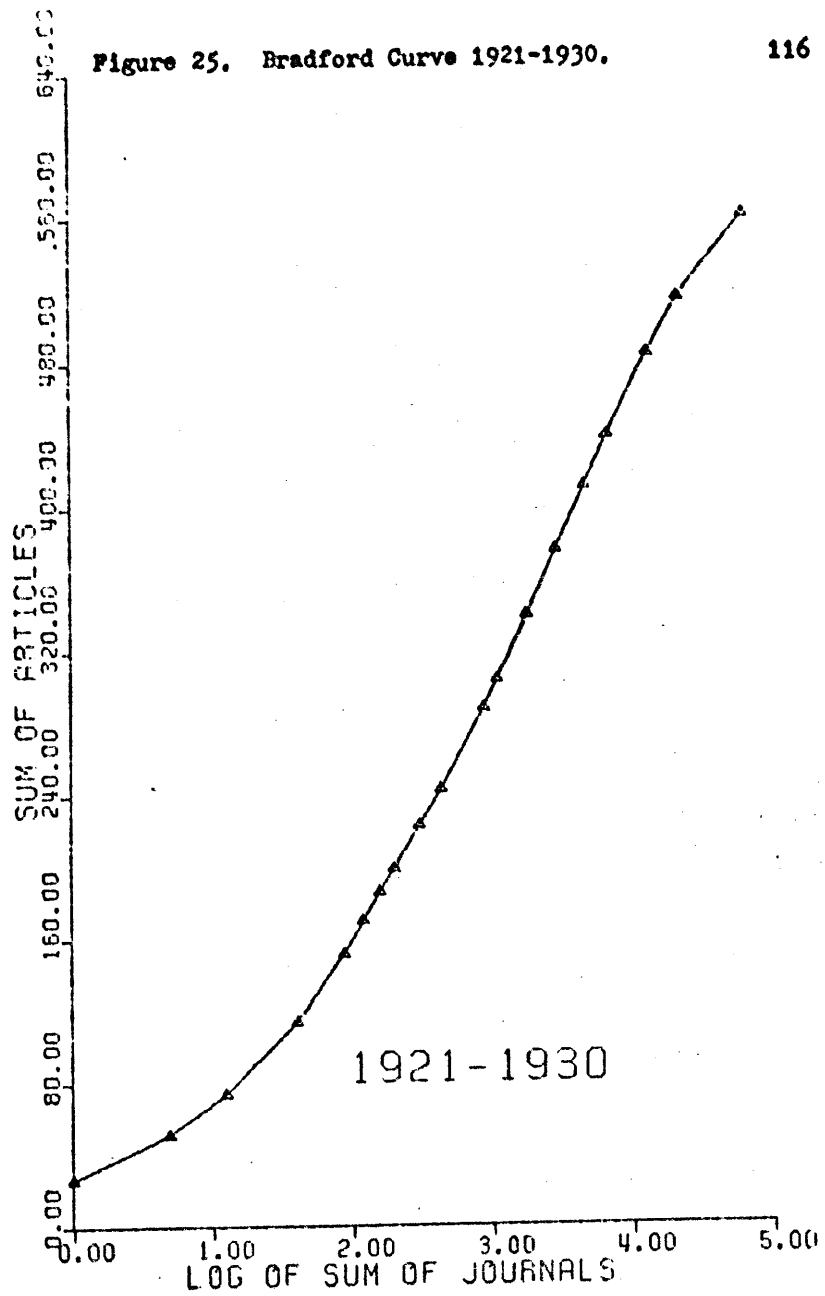
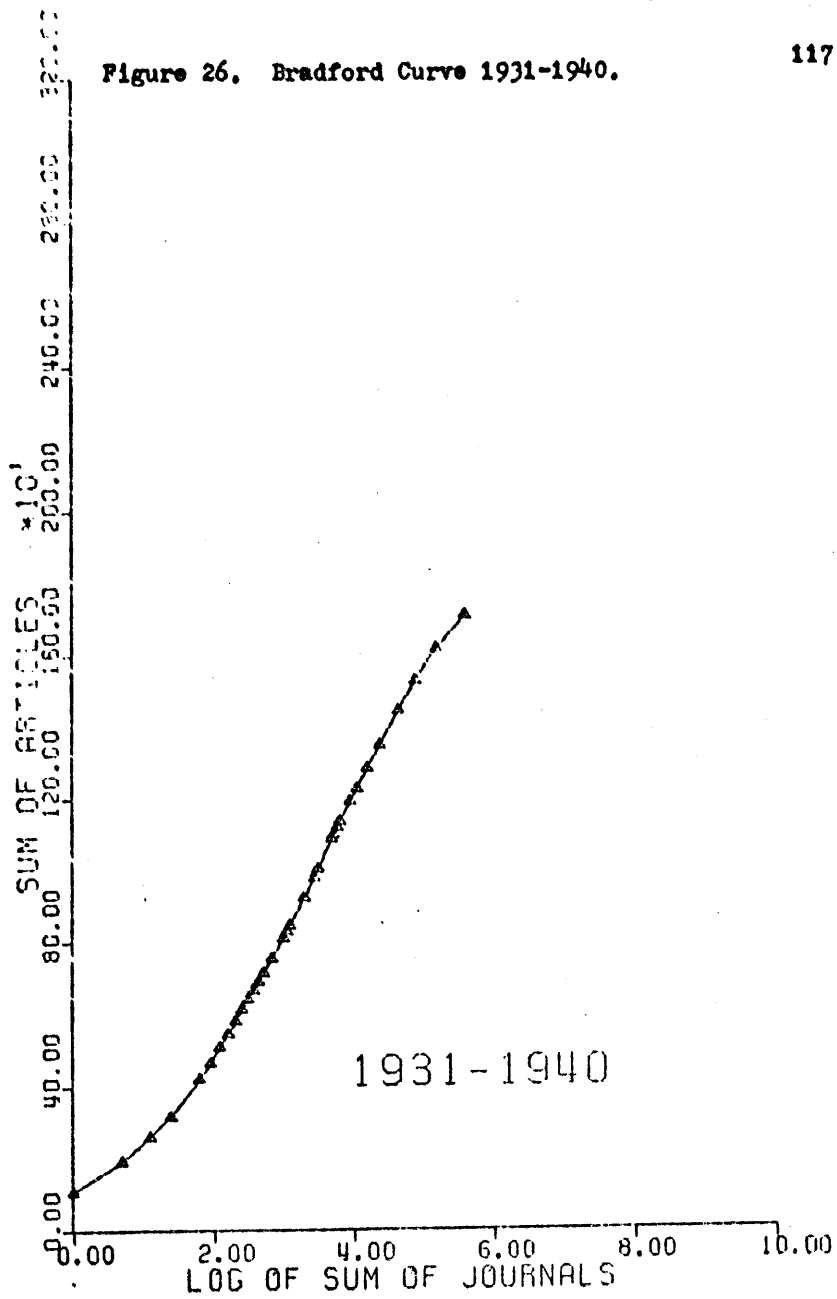


Figure 26. Bradford Curve 1931-1940.

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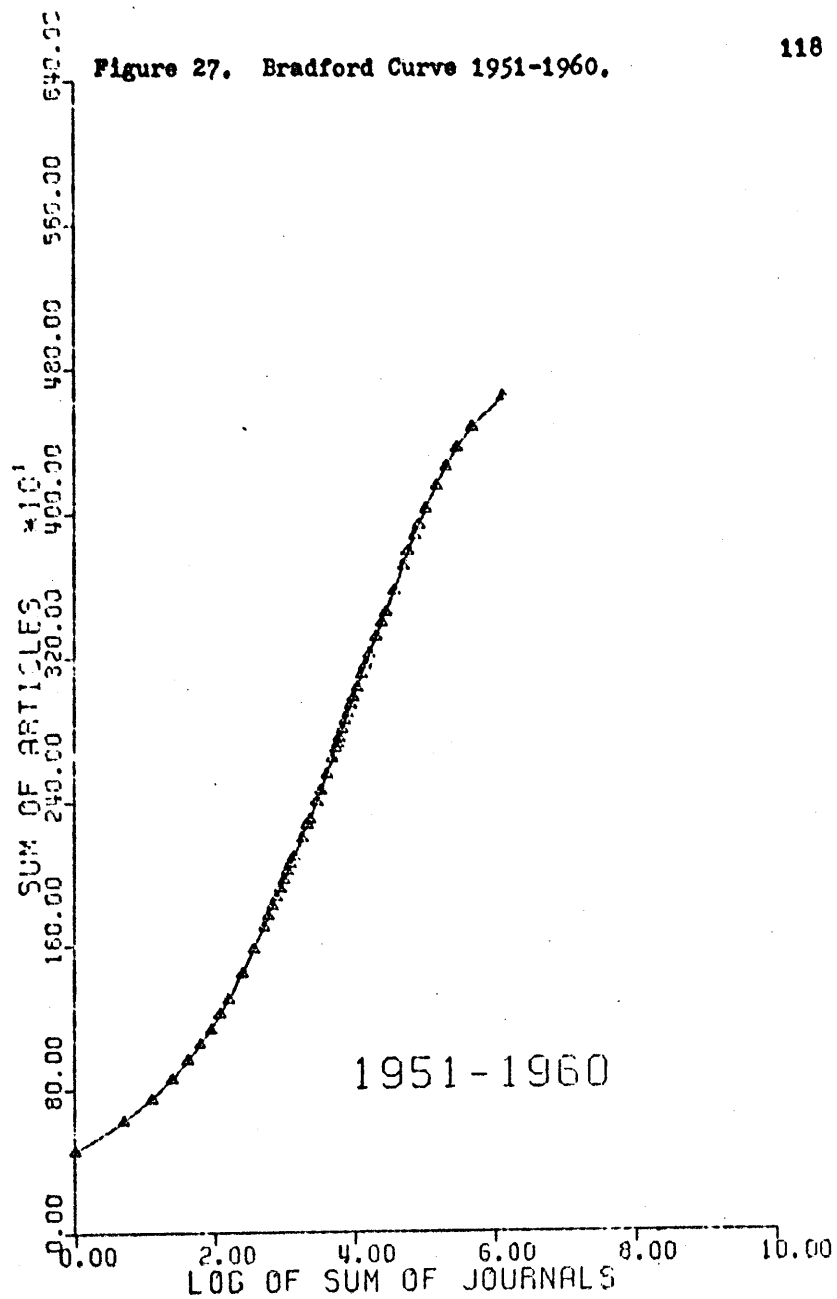


Figure 28. Bradford Curve 1876-1880.

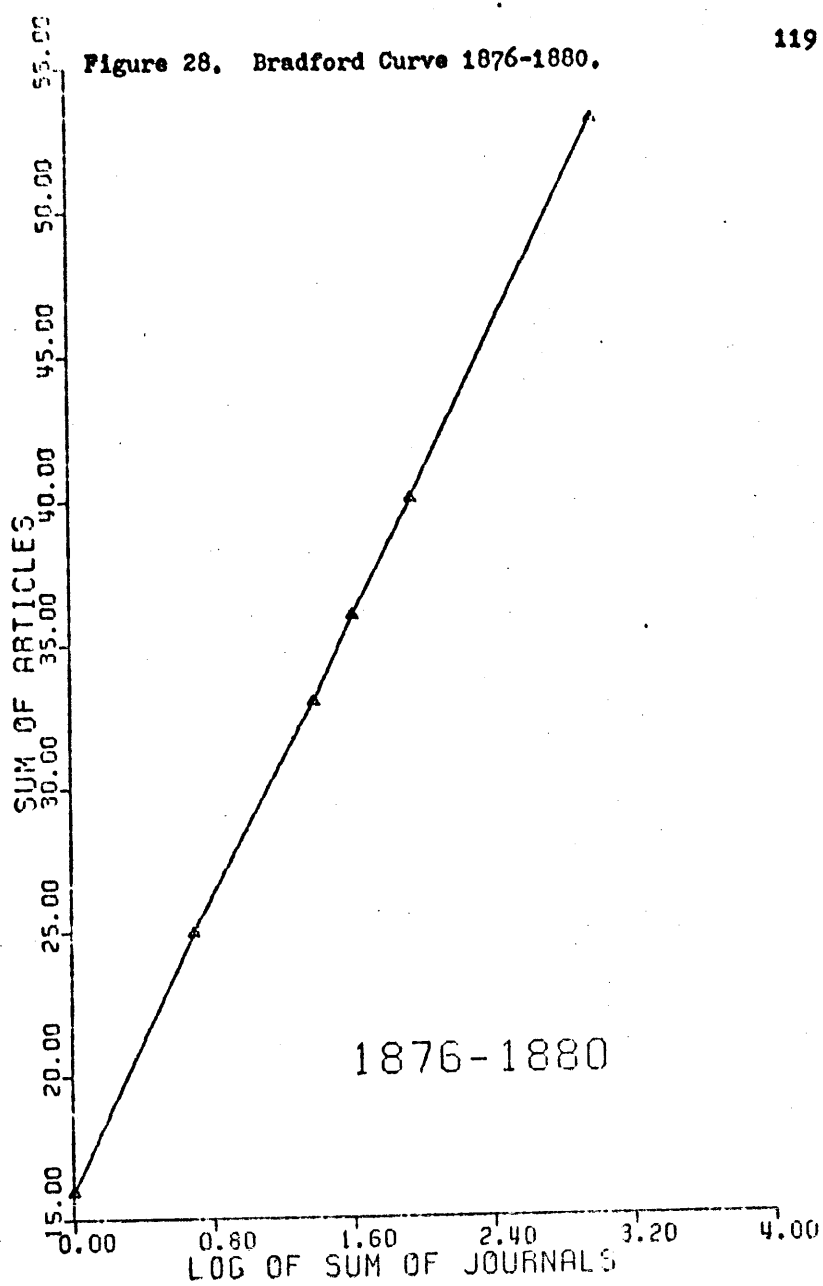


Figure 29. Bradford Curve 1881-1885.

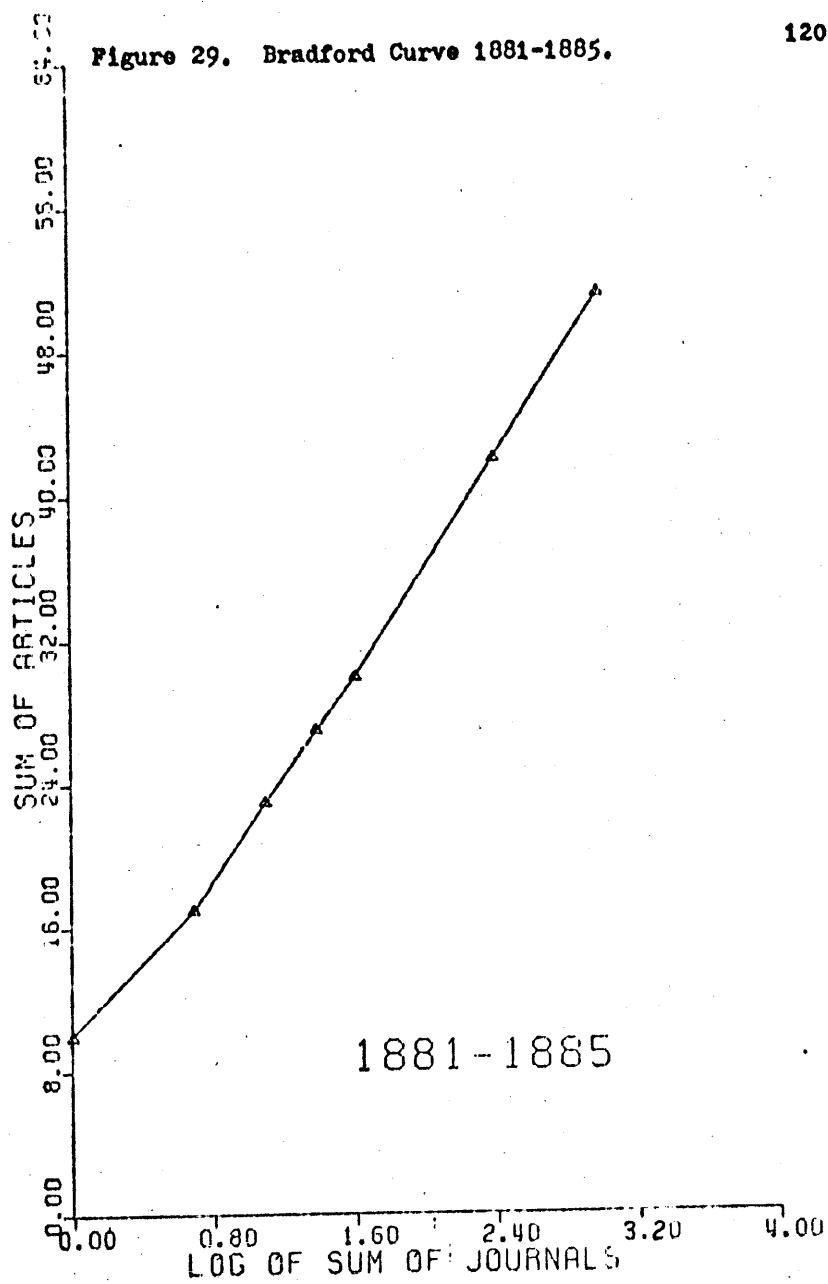


Figure 30. Bradford Curve 1896-1900.

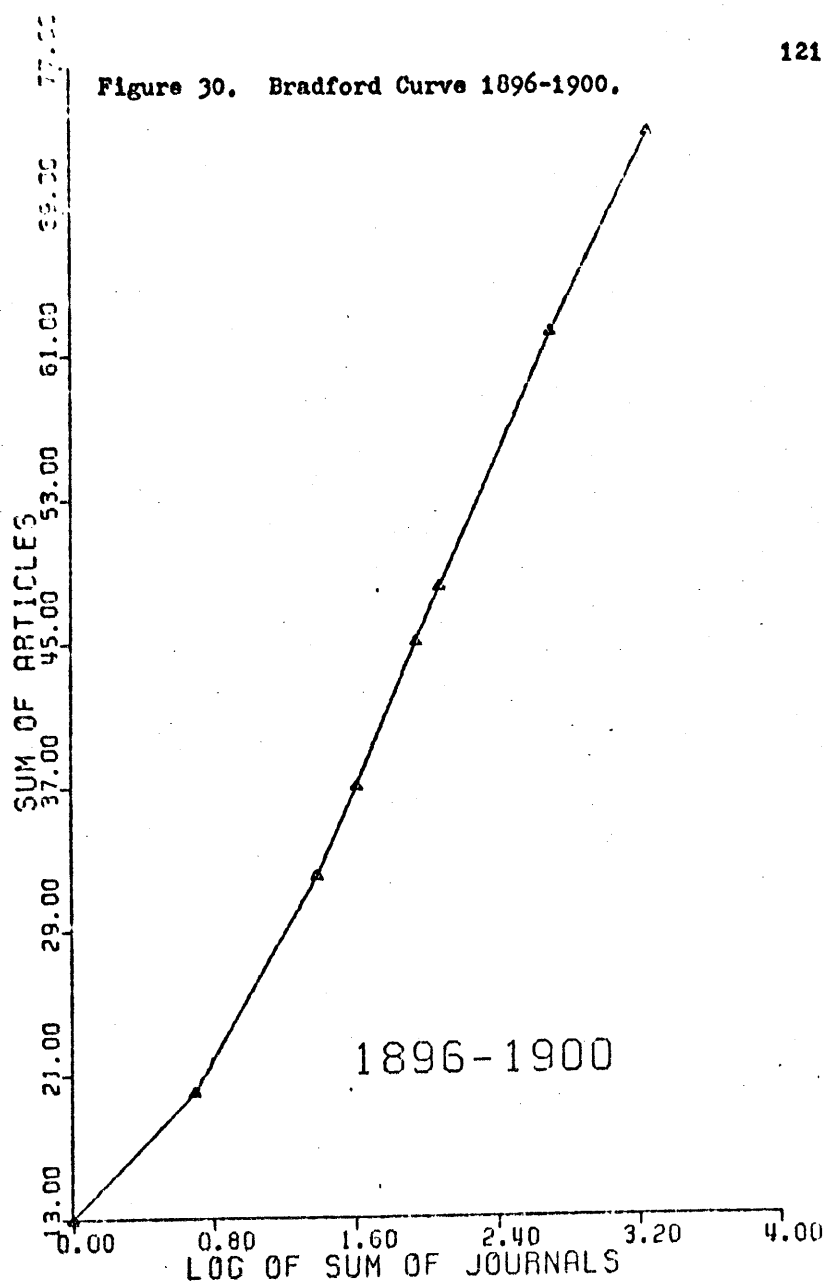
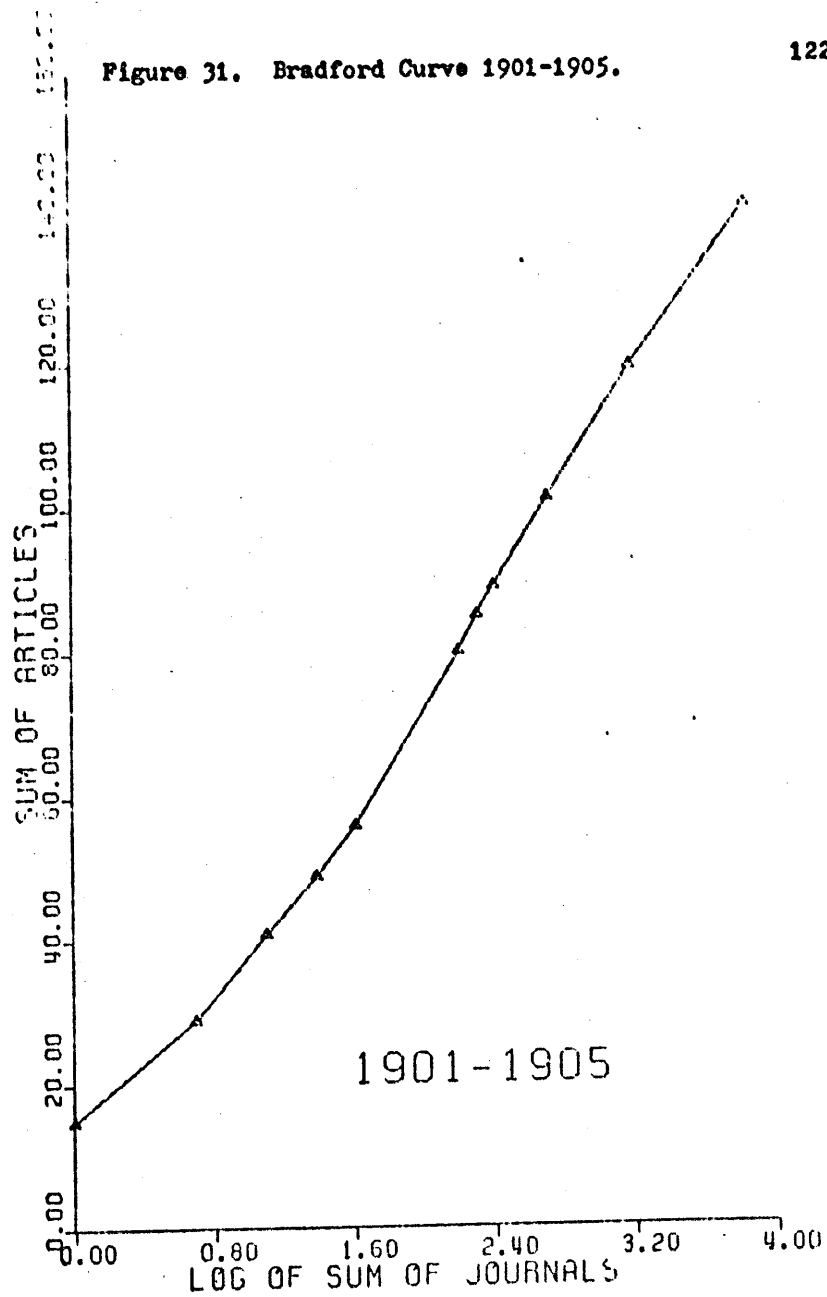


Figure 31. Bradford Curve 1901-1905.

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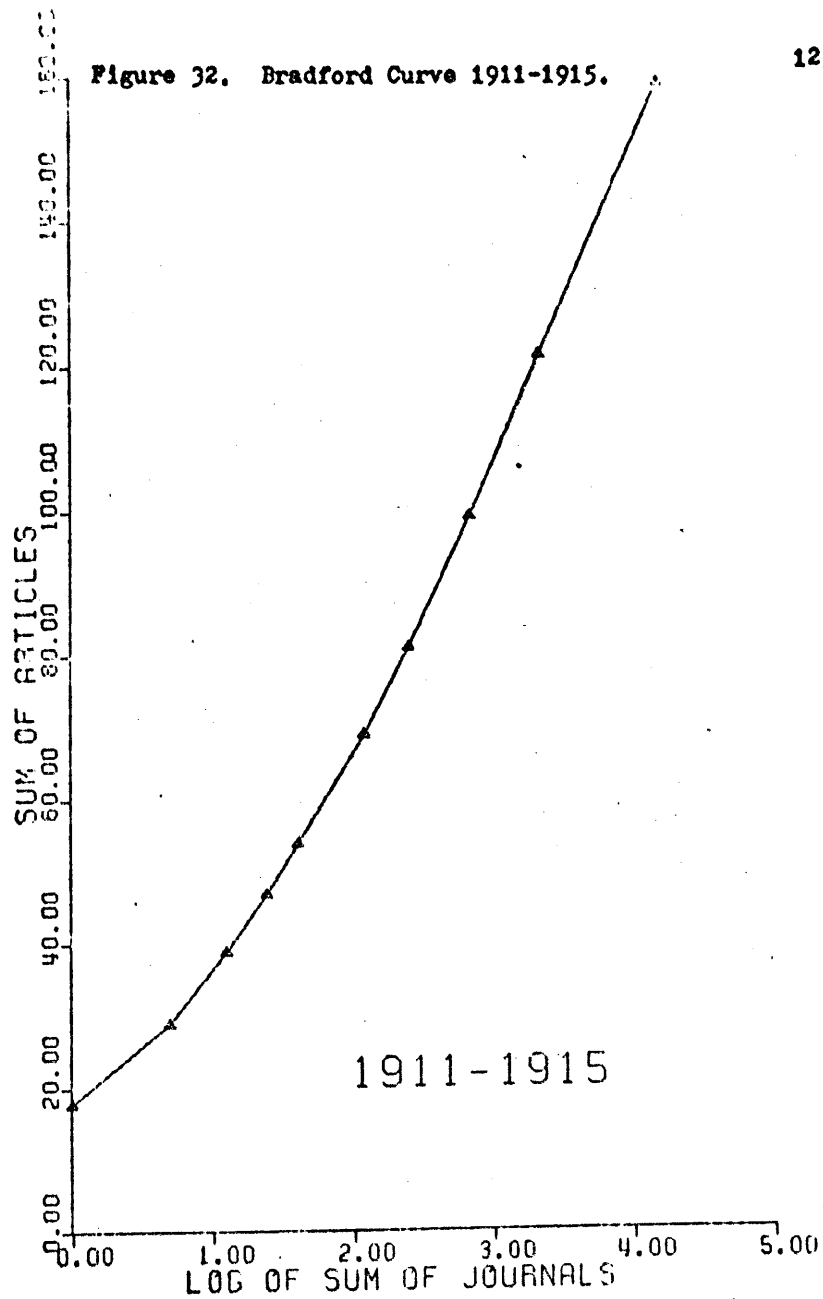
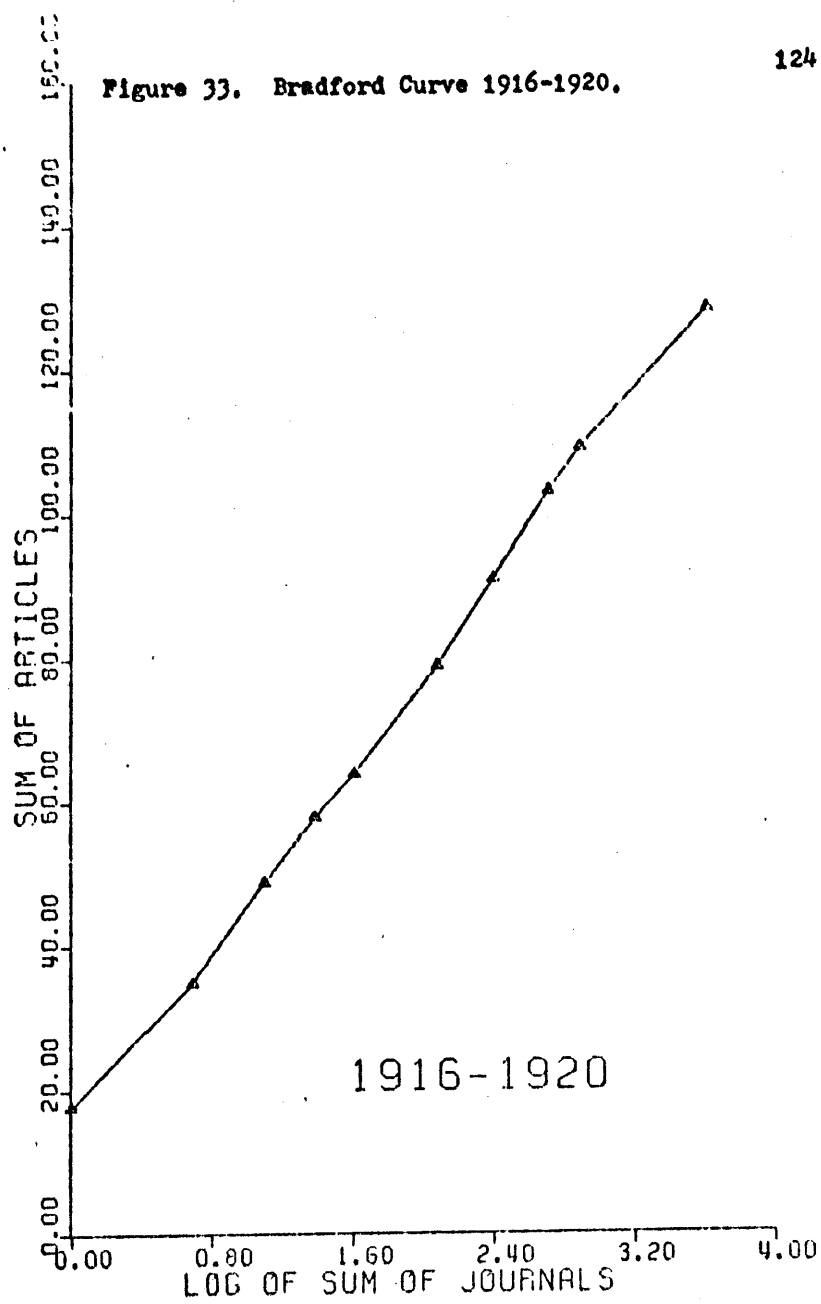
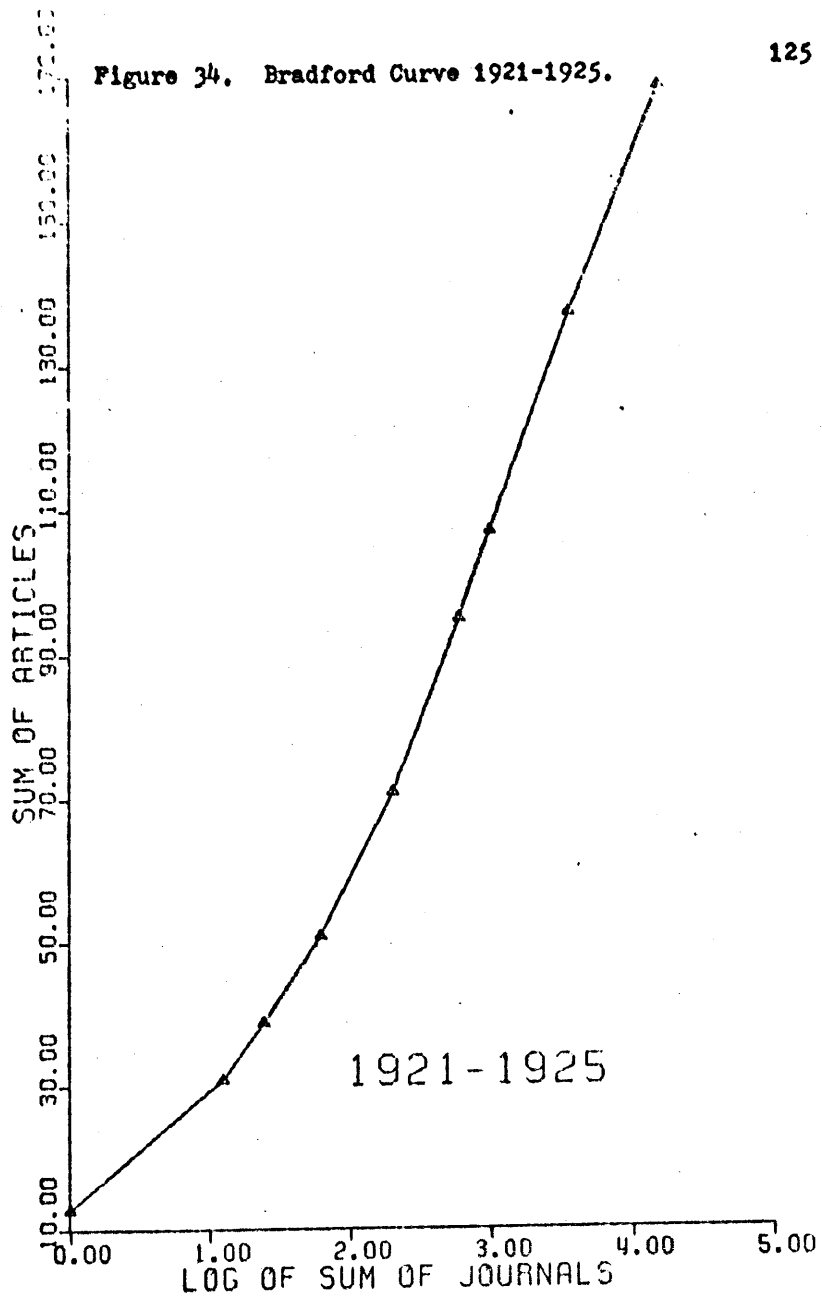


Figure 33. Bradford Curve 1916-1920.





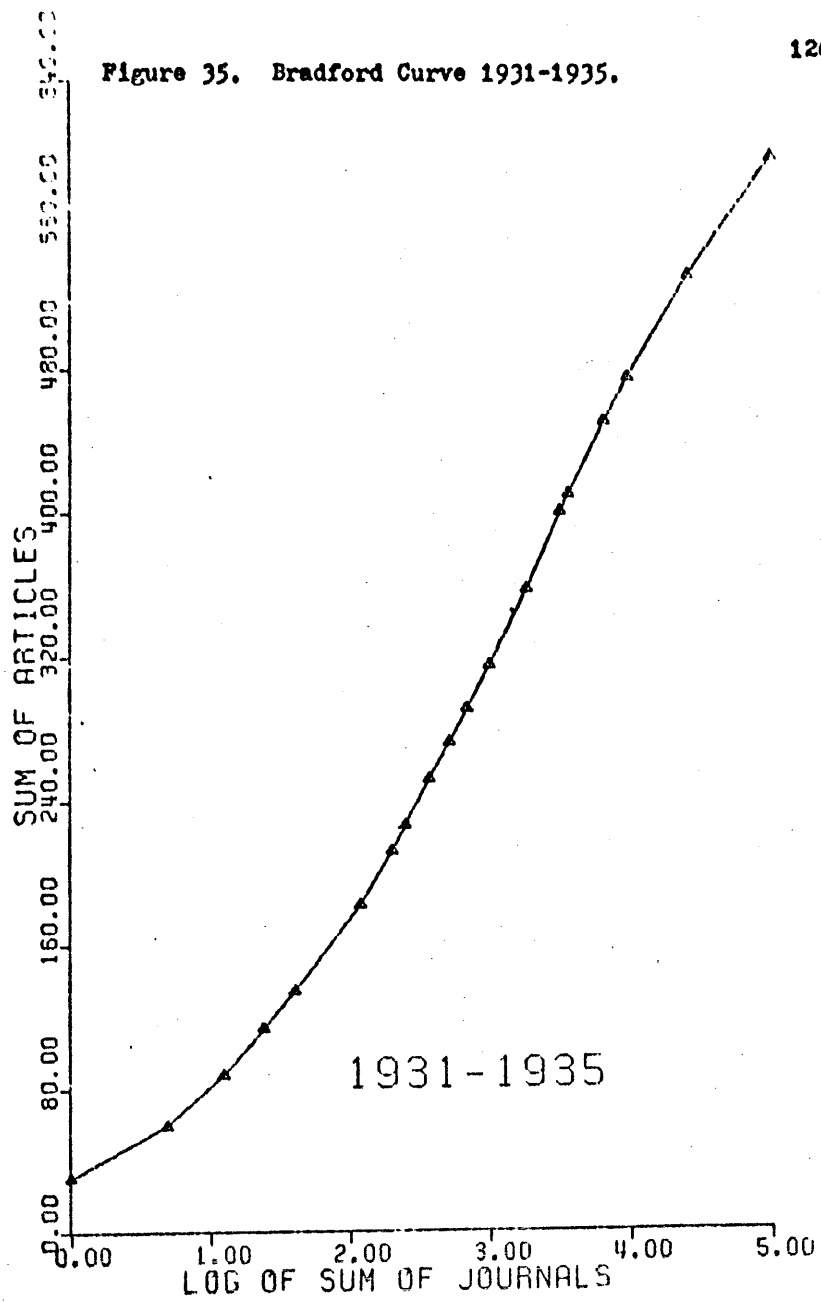


Figure 36. Bradford Curve 1941-1945.

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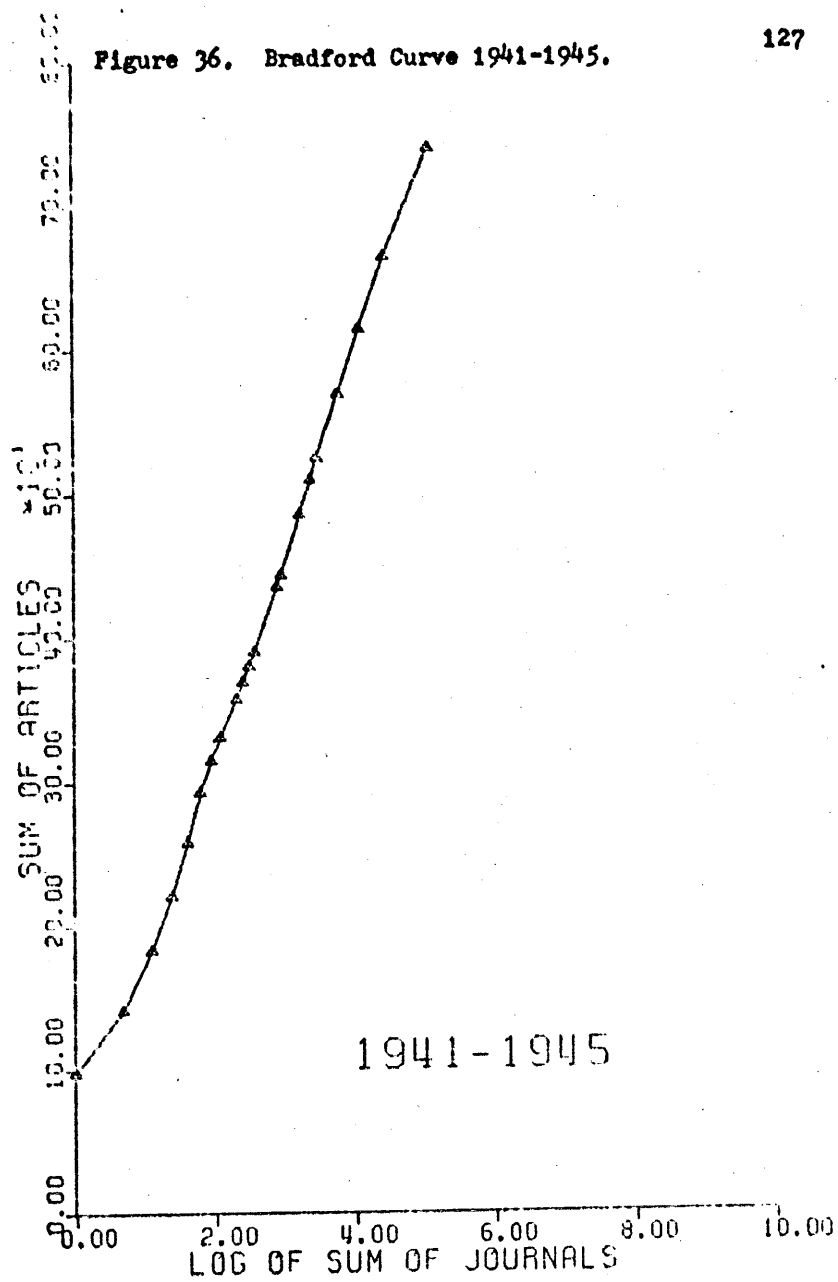


Figure 37. Bradford Curve 1946-1950.

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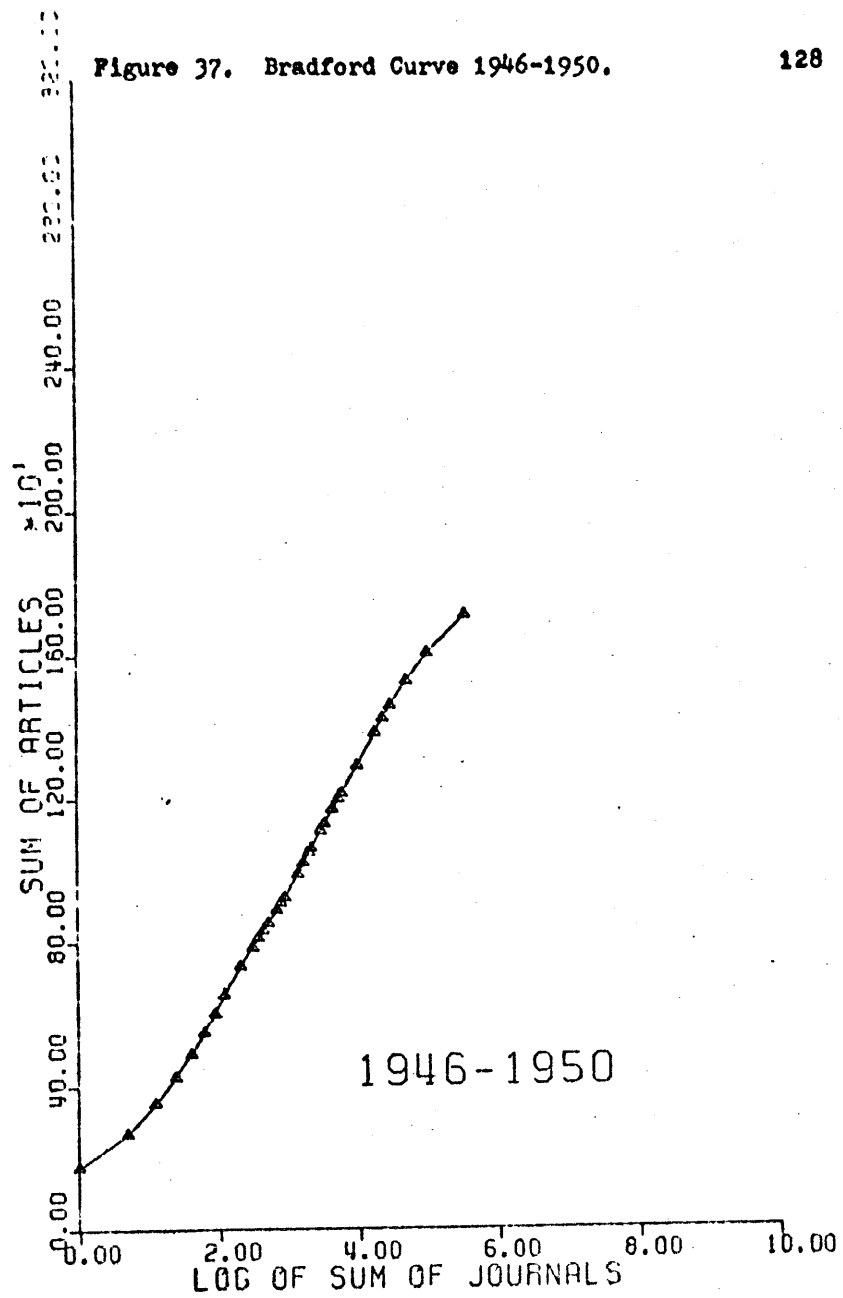


Figure 38. Bradford Curve 1951-1955.

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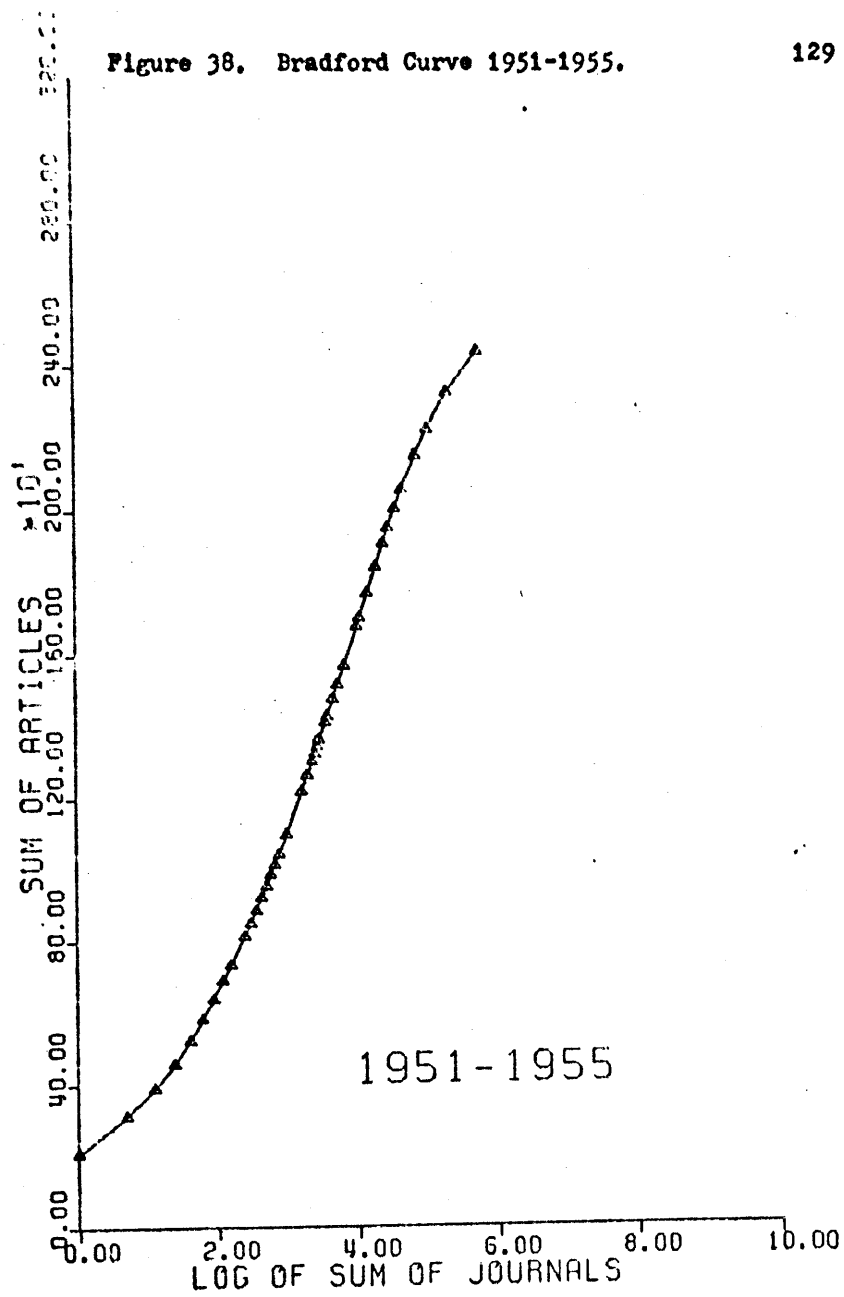
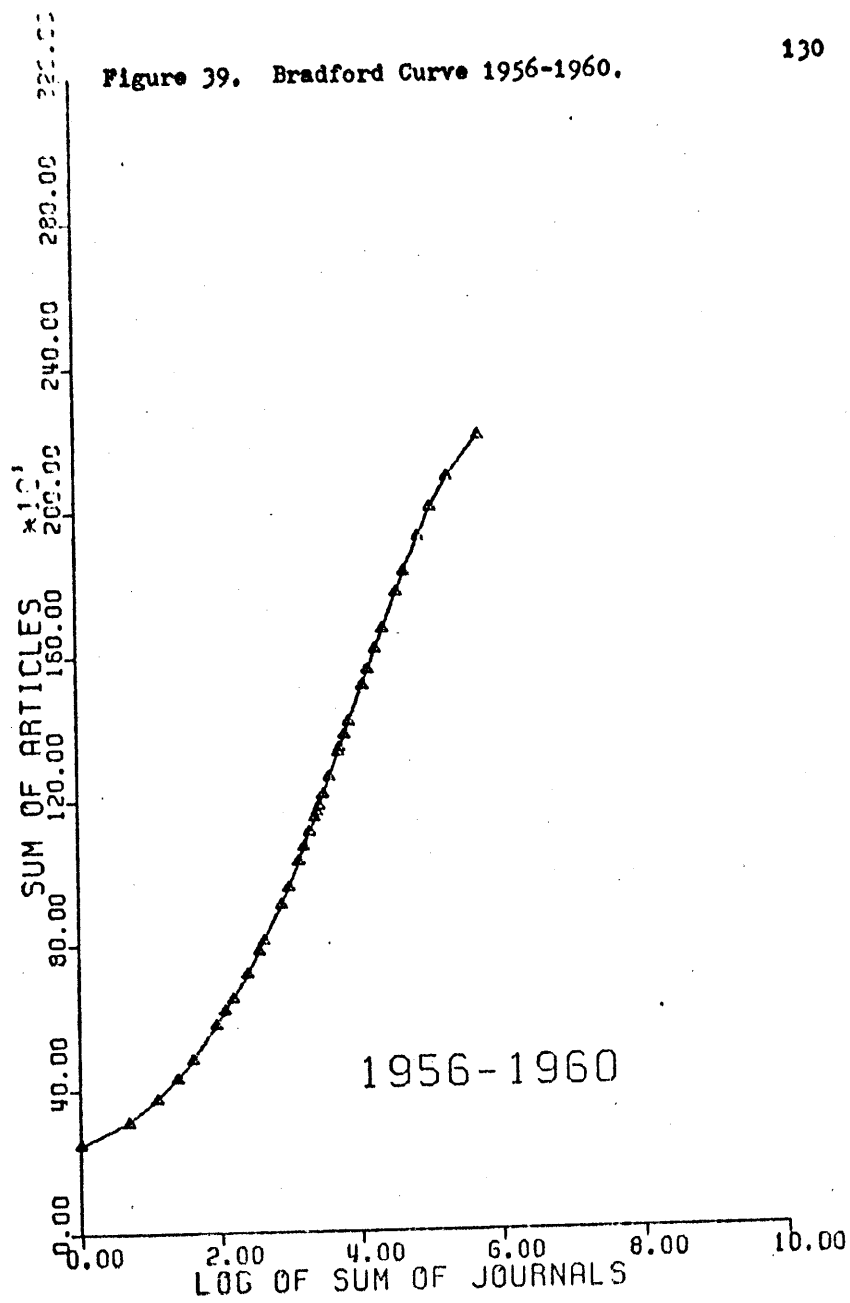


Figure 39. Bradford Curve 1956-1960.



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APPENDICES

APPENDIX A

CONSOLIDATED LISTING OF THE SYMBOLIC LOGIC LITERATURE DATA

Time Period	Number of Journals	Number of Articles	Number of Art./Jrnl.	Sum of Articles	Sum of Journals	Log _e Sum of Jnls.
1841-1850	3	3	1.0	3	3	1.10
1841-1855	5	5	1.0	5	5	1.61
1841-1860	1 4	2 4	2.0 1.0	2 6	1 5	0.0 1.61
1841-1865	1 6	6 6	6.0 1.0	6 12	1 7	0.0 1.95
1841-1870	1 1 10	6 2 10	6.0 2.0 1.0	6 8 18	1 2 12	0.0 0.69 2.48
1841-1875	1 1 2 10	7 3 4 10	7.0 3.0 2.0 1.0	7 10 14 24	1 2 4 14	0.0 0.69 1.39 2.64
1841-1880	1 1 1 3 2 3 21	16 9 7 12 6 6 21	16.0 9.0 7.0 4.0 3.0 2.0 1.0	16 25 32 44 50 56 77	1 2 3 6 8 11 32	0.0 0.69 1.10 1.79 2.08 2.40 3.47

APPENDIX A-CONTINUED

Time Period	Number of Journals	Number of Articles	Number of Art./Jrnl.	Sum of Articles	Sum of Journals	Log. Sum of Jrnls.
1841-1885	1	26	26.0	26	1	0.0
	1	16	16.0	42	2	0.69
	2	14	7.0	56	4	1.39
	2	12	6.0	68	6	1.79
	4	16	4.0	84	10	2.30
	4	12	3.0	96	14	2.64
	4	8	2.0	104	18	2.89
	24	24	1.0	128	42	3.74
	1	27	27.0	27	1	0.0
	1	18	18.0	45	2	0.69
1841-1890	1	8	8.0	53	3	1.10
	1	7	7.0	60	4	1.39
	2	12	6.0	72	6	1.79
	2	10	5.0	82	8	2.08
	5	20	4.0	102	13	2.56
	6	18	3.0	120	19	2.94
	6	12	2.0	132	25	3.22
	25	25	1.0	157	50	3.91
	1	28	28.0	28	1	0.0
	1	27	27.0	55	2	0.69
	1	24	24.0	79	3	1.10
	1	13	13.0	92	4	1.39
	1	10	10.0	102	5	1.61
1841-1895	1	9	9.0	111	6	1.79
	1	7	7.0	118	7	1.95
	2	12	6.0	130	9	2.20
	5	25	5.0	155	14	2.64
	6	24	4.0	179	20	3.0
	1	28	28.0	28	1	0.0
	1	27	27.0	55	2	0.69
	1	24	24.0	79	3	1.10
	1	13	13.0	92	4	1.39
	1	10	10.0	102	5	1.61

APPENDIX A-CONTINUED

Time Period	Number of Journals	Number of Articles	Number of Art./Jrnl.	Sum of Articles	Sum of Journals	Log. Sum of Jrnls.
1841-1895	5	15	3.0	194	25	3.22
	9	18	2.0	212	34	3.53
	31	31	1.0	243	65	4.17
1841-1900	1	37	37.0	37	1	0.0
	1	34	34.0	71	2	0.69
	1	29	29.0	100	3	1.10
	1	13	13.0	113	4	1.39
	1	11	11.0	124	5	1.61
	1	10	10.0	134	6	1.79
	2	18	9.0	152	8	2.08
	3	21	7.0	173	11	2.40
	3	18	6.0	191	14	2.64
	5	25	5.0	216	19	2.94
	5	20	4.0	236	24	3.18
	5	18	3.0	254	30	3.40
	15	30	2.0	284	45	3.81
	32	32	1.0	316	77	4.34
1841-1905	2	98	49.0	98	2	0.69
	1	30	30.0	128	3	1.10
	1	21	21.0	149	4	1.39
	1	14	14.0	163	5	1.61
	2	26	13.0	189	7	1.95
	1	11	11.0	200	8	2.08
	4	40	10.0	240	12	2.48
	1	9	9.0	249	13	2.56
	2	14	7.0	263	15	2.71
	6	36	6.0	299	21	3.04
	5	25	5.0	324	26	3.26
						138

APPENDIX A-CONTINUED

Time Period	Number of Journals	Number of Articles	Number of Art./Jrnl.	Sum of Articles	Sum of Journals	Log ₁₀ Sum of JmIs.
1841-1905	6	24	4.0	348	32	3.47
	10	30	3.0	378	42	3.74
	20	40	2.0	418	62	4.13
	39	39	1.0	457	101	4.62
1841-1910	1	69	69.0	69	1	0.0
	1	57	57.0	126	2	0.69
	1	40	40.0	166	3	1.10
	1	31	31.0	197	4	1.39
	1	21	21.0	218	5	1.61
	1	18	18.0	236	6	1.79
	1	16	16.0	252	7	1.95
	2	28	14.0	280	9	2.20
	4	52	13.0	332	13	2.56
	3	30	10.0	362	16	2.77
	2	18	9.0	380	18	2.89
	2	16	8.0	396	20	3.00
	4	28	7.0	424	24	3.18
	6	36	6.0	460	30	3.40
	5	25	5.0	485	35	3.56
	8	32	4.0	517	43	3.76
	25	24	3.0	541	51	3.93
	51	50	2.0	591	76	4.33
		51	1.0	642	127	4.84
1841-1915	1	77	77.0	77	1	0.0
	1	58	58.0	135	2	0.69
	1	57	57.0	192	3	1.10
	1	31	31.0	223	4	1.39
	1	26	26.0	249	5	1.61

APPENDIX A-CONTINUED

Time Period	Number of Journals	Number of Articles	Number of Art./Jrnl.	Sum of Articles	Sum of Journals	Log _e Sum of Jtnls.
1841-1915	1	23	23.0	272	6	1.79
	1	22	22.0	294	7	1.95
	2	32	16.0	326	9	2.20
	3	45	15.0	371	12	2.48
	2	28	14.0	399	14	2.64
	1	13	13.0	412	15	2.71
	1	12	12.0	424	16	2.77
	4	40	10.0	464	20	3.00
	5	45	9.0	509	25	3.22
	3	24	8.0	533	28	3.33
	2	14	7.0	547	30	3.40
	6	36	6.0	583	36	3.58
	5	25	5.0	608	41	3.71
	12	48	4.0	656	53	3.97
	10	30	3.0	686	63	4.14
	28	56	2.0	742	91	4.51
	58	58	1.0	800	149	5.00
1841-1920	1	82	82.0	82	1	0.0
	1	67	67.0	149	2	0.69
	1	57	57.0	206	3	1.10
	1	41	41.0	247	4	1.39
	1	33	33.0	280	5	1.61
	1	32	32.0	312	6	1.79
	1	31	31.0	343	7	1.95
	1	24	24.0	367	8	2.08
	1	23	23.0	390	9	2.20
	1	20	20.0	410	10	2.30
	2	34	17.0	444	12	2.48
	1	16	16.0	460	13	2.56

APPENDIX A-CONTINUED

Time Period	Number of Journals	Number of Articles	Number of Art./Jnl.	Sum of Articles	Sum of Journals	Log. Sum of Jnls.
1841-1920	1	15	15.0	475	14	2.64
	2	28	14.0	503	16	2.77
	1	13	13.0	516	17	2.83
	1	12	12.0	528	18	2.89
	1	11	11.0	539	19	2.94
	3	30	10.0	569	22	3.09
	7	63	9.0	632	29	3.37
	1	8	8.0	640	30	3.40
	4	28	7.0	668	34	3.53
	6	36	6.0	704	40	3.69
	7	35	5.0	739	47	3.85
	9	36	4.0	775	56	4.03
	12	36	3.0	811	68	4.22
	29	58	2.0	869	97	4.57
	59	59	1.0	928	156	5.05
	1	86	86.0	86	1	0.0
	1	70	70.0	156	2	0.69
	1	57	57.0	213	3	1.10
	1	44	44.0	257	4	1.39
	1	42	42.0	299	5	1.61
	1	37	37.0	336	6	1.79
	1	36	36.0	372	7	1.95
	1	33	33.0	405	8	2.08
	1	31	31.0	436	9	2.20
	1	22	22.0	458	10	2.30
	2	40	20.0	498	12	2.43
	2	34	17.0	532	14	2.64
	1	15	15.0	547	15	2.71
	3	42	14.0	589	18	2.89
1841-1925						
	1	86	86.0	86	1	0.0
	1	70	70.0	156	2	0.69
	1	57	57.0	213	3	1.10
	1	44	44.0	257	4	1.39
	1	42	42.0	299	5	1.61
	1	37	37.0	336	6	1.79
	1	36	36.0	372	7	1.95
	1	33	33.0	405	8	2.08
	1	31	31.0	436	9	2.20
	1	22	22.0	458	10	2.30
	2	40	20.0	498	12	2.43
	2	34	17.0	532	14	2.64
	1	15	15.0	547	15	2.71
	3	42	14.0	589	18	2.89

APPENDIX A-CONTINUED

Time Period	Number of Journals	Number of Articles	Number of Art./Jnl.	Sum of Articles	Sum of Journals	Log. Sum of Jnl.
1841-1925	2	26	13.0	615	20	3.00
	1	12	12.0	627	21	3.04
	2	22	11.0	649	23	3.14
	1	10	10.0	659	24	3.18
	6	54	9.0	713	30	3.40
	3	24	8.0	737	33	3.50
	7	49	7.0	786	40	3.69
	7	42	6.0	828	47	3.85
	6	30	5.0	858	53	3.97
	14	56	4.0	914	67	4.20
	17	51	3.0	965	84	4.43
	28	56	2.0	1021	112	4.72
	75	75	1.0	1096	187	5.23
1841-1930	1	109	109.0	109	1	0.0
	1	77	77.0	186	2	0.69
	1	60	60.0	246	3	1.10
	1	57	57.0	303	4	1.39
	1	53	53.0	356	5	1.61
	1	51	51.0	407	6	1.79
	1	48	48.0	455	7	1.95
	1	44	44.0	499	8	2.03
	1	39	39.0	538	9	2.20
	1	31	31.0	569	10	2.30
	1	27	27.0	596	11	2.40
	1	23	23.0	619	12	2.48
	1	20	20.0	639	13	2.56
	1	19	19.0	658	14	2.64
	2	36	18.0	694	16	2.77
	1	17	17.0	711	17	2.83
						142

APPENDIX A-CONTINUED

Time Period	Number of Journals	Number of Articles	Number of Art./Jrnl.	Sum of Articles	Sum of Journals	Log Sum
1841-1930	3	48	16.0	759	20	3.00
	3	45	15.0	804	23	3.14
	2	28	14.0	832	25	3.22
	2	26	13.0	858	27	3.30
	2	24	12.0	852	29	3.37
	2	22	11.0	904	31	3.43
	3	30	10.0	934	34	3.53
	9	81	9.0	1015	43	3.76
	6	48	8.0	1063	49	3.89
	6	42	7.0	1105	55	4.01
	11	66	6.0	1171	66	4.19
	8	40	5.0	1211	74	4.30
	17	68	4.0	1279	91	4.51
	20	60	3.0	1339	111	4.71
	32	64	2.0	1403	143	4.96
	83	83	1.0	1486	226	5.42
1841-1935	1	138	138.0	138	1	0.0
	1	91	91.0	229	2	0.69
	1	81	81.0	310	3	1.10
	1	74	74.0	384	4	1.39
	2	123	64.0	512	6	1.79
	1	61	61.0	573	7	1.95
	1	58	58.0	631	8	2.08
	1	57	57.0	688	9	2.20
	1	37	37.0	725	10	2.30
	1	34	34.0	759	11	2.40
	1	32	32.0	791	12	2.48
	2	62	31.0	853	14	2.64
	2	54	27.0	907	16	2.77
						143

APPENDIX A-CONTINUED

Time Period	Number of Journals	Number of Articles	Number of Art./Jrnl.	Sum of Articles	Sum of Journals	Log. Sum of Jrnls.
1841-1935	3	72	24.0	979	19	2.94
	2	40	20.0	1019	21	3.04
	1	19	19.0	1038	22	3.09
	2	36	18.0	1074	24	3.18
	3	51	17.0	1125	27	3.30
	2	32	16.0	1157	29	3.37
	5	75	15.0	1232	34	3.52
	2	28	14.0	1260	36	3.58
	1	13	13.0	1273	37	3.61
	4	48	12.0	1321	41	3.71
	4	44	11.0	1365	45	3.81
	4	40	10.0	1405	49	3.89
	8	72	9.0	1477	57	4.04
	4	32	8.0	1509	61	4.11
	7	49	7.0	1558	68	4.22
	17	102	6.0	1660	85	4.44
	9	45	5.0	1705	94	4.54
	23	92	4.0	1797	117	4.76
	19	57	3.0	1854	136	4.91
	55	110	2.0	1964	191	5.25
	114	114	1.0	2078	305	5.72
1841-1940	1	179	179.0	179	1	0.0
	1	112	112.0	291	2	0.69
	1	104	104.0	395	3	1.10
	1	95	95.0	490	4	1.39
	2	184	92.0	674	6	1.79
	1	91	91.0	765	7	1.95
	1	86	86.0	851	8	2.08
	2	130	65.0	981	10	2.30
						144

APPENDIX A-CONTINUED

Time Period	Number of Journals	Number of Articles	Number of Art./Jrnl.	Sum of Articles	Sum of Journals	Log. Sum of Jrnls.
1841-1940	1	57	57.0	1038	11	2.40
	1	56	56.0	1094	12	2.48
	1	52	52.0	1146	13	2.56
	1	51	51.0	1197	14	2.64
	1	47	47.0	1244	15	2.71
	1	45	45.0	1289	16	2.77
	1	43	43.0	1332	17	2.83
	1	39	39.0	1371	18	2.89
	1	31	31.0	1402	19	2.94
	4	120	30.0	1522	23	3.14
	1	28	28.0	1550	24	3.18
	2	54	27.0	1604	26	3.26
	1	26	26.0	1630	27	3.30
	1	25	25.0	1655	28	3.33
	2	46	23.0	1701	30	3.40
	2	44	22.0	1745	32	3.47
	3	63	21.0	1808	35	3.56
	1	19	19.0	1827	36	3.58
	2	36	18.0	1863	38	3.58
	2	34	17.0	1897	40	3.64
	3	48	16.0	1945	43	3.69
	7	105	15.0	2050	50	3.76
	3	42	14.0	2092	53	3.91
	3	39	13.0	2131	56	3.97
	7	84	12.0	2215	63	4.03
	4	44	11.0	2259	67	4.14
	5	50	10.0	2309	72	4.20
	8	72	9.0	2381	80	4.28
	2	56	8.0	2437	87	4.38
	6	42	7.0	2479	93	4.47
						4.53

APPENDIX A-CONTINUED

Time Period	Number of Journals	Number of Articles	Number of Art./Jrnl.	Sum of Articles	Sum of Journals	Log. Sum of Jrnls.
1841-1940	20	120	6.0	2599	113	4.73
	17	85	5.0	2684	130	4.87
	32	128	4.0	2812	162	5.09
	37	111	3.0	2923	199	5.29
	63	126	2.0	3049	262	5.57
	143	143	1.0	3192	405	6.00
1841-1945	1	221	221.0	221	1	0.0
	1	211	211.0	432	2	0.69
	1	147	147.0	479	3	1.10
	1	117	117.0	696	4	1.39
	1	94	94.0	790	5	1.61
	2	184	92.0	974	7	1.95
	1	91	91.0	1065	8	2.08
	2	172	86.0	1237	10	2.30
	1	69	69.0	1306	11	2.40
	1	68	68.0	1374	12	2.48
	1	57	57.0	1431	13	2.56
	2	104	52.0	1535	15	2.71
	1	45	45.0	1580	16	2.77
	1	43	43.0	1623	17	2.83
	1	41	41.0	1664	18	2.89
	2	78	39.0	1742	20	3.00
	3	111	37.0	1853	23	3.14
	1	36	36.0	1889	24	3.18
	1	34	34.0	1923	25	3.22
	2	62	31.0	1985	27	3.30
	2	60	30.0	2045	29	3.37
	1	27	27.0	2072	30	3.40
	2	52	26.0	2124	32	3.47

APPENDIX A-CONTINUED

Time Period	Number of Journals	Number of Articles	Number of Art./Jrnl.	Sum of Articles	Sum of Journals	Log. Sum of Jrnls.
1841-1945	3	72	24.0	2196	35	3.56
	3	66	22.0	2262	38	3.64
	2	42	21.0	2304	40	3.69
	1	19	19.0	2323	41	3.71
	3	54	18.0	2377	44	3.78
	4	68	17.0	2445	48	3.87
	4	64	16.0	2509	52	3.95
	9	135	15.0	2644	61	4.11
	4	56	14.0	2700	65	4.17
	2	26	13.0	2726	67	4.20
	6	72	12.0	2798	73	4.29
	4	44	11.0	2842	77	4.34
	4	40	10.0	2882	81	4.39
	16	144	9.0	3026	97	4.57
	9	72	8.0	3098	106	4.66
	6	42	7.0	3140	112	4.72
	25	150	6.0	3290	137	4.92
	18	90	5.0	3380	155	5.04
	33	132	4.0	3512	188	5.24
	39	117	3.0	3629	227	5.42
	64	128	2.0	3757	291	5.67
	174	174	1.0	3931	465	6.14
1841-1950	1	389	389.0	389	1	0.0
	1	305	305.0	694	2	0.69
	1	214	214.0	908	3	1.10
	1	141	141.0	1049	4	1.39
	1	134	134.0	1183	5	1.61
	1	133	133.0	1316	6	1.79

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APPENDIX A-CONTINUED

Time Period	Number of Journals	Number of Articles	Number of Art./Jrnl.	Sum of Articles	Sum of Journals	Log. Sum of Jrnls.
1841-1950	1	132	132.0	1448	7	1.95
	1	109	109.0	1557	8	2.08
	1	105	105.0	1662	9	2.20
	1	104	104.0	1766	10	2.30
	2	184	92.0	1950	12	2.48
	1	91	91.0	2041	13	2.56
	1	82	82.0	2123	14	2.64
	1	78	78.0	2201	15	2.71
	1	72	72.0	2273	16	2.77
	1	68	68.0	2341	17	2.83
	2	114	57.0	2455	19	2.94
	1	53	53.0	2508	20	3.00
	1	48	48.0	2556	21	3.04
	1	47	47.0	2603	22	3.09
	2	90	45.0	2693	24	3.18
	2	86	43.0	2779	26	3.26
	2	40	40.0	2819	27	3.30
	2	78	39.0	2897	29	3.37
	1	37	37.0	2934	30	3.40
	3	108	36.0	3042	33	3.50
	1	33	33.0	3075	34	3.53
	2	62	31.0	3137	36	3.58
	2	58	29.0	3195	38	3.64
	2	56	28.0	3251	40	3.69
	3	81	27.0	3322	43	3.76
	2	52	26.0	3384	45	3.81
	2	73	25.0	3459	48	3.87
	2	46	23.0	3505	50	3.91
						148

APPENDIX A-CONTINUED

Time Period	Number of Journals	Number of Articles	Number of Art./Jrn.	Sum of Articles	Sum of Journals	Log Sum
1841-1950	3	66	22.0	3571	53	3.97
	3	63	21.0	3634	56	4.03
	3	54	18.0	3688	59	4.08
	4	68	17.0	3756	63	4.14
	7	112	16.0	3868	70	4.25
	7	105	15.0	3973	77	4.34
	5	70	14.0	4043	82	4.41
	4	52	13.0	4095	86	4.45
	11	132	12.0	4227	97	4.57
	5	55	11.0	4282	102	4.63
	9	90	10.0	4372	111	4.71
	13	117	9.0	4489	124	4.82
	12	96	8.0	4585	136	4.91
	12	84	7.0	4669	148	5.00
	29	174	6.0	4843	177	5.18
	21	105	5.0	4948	198	5.29
	35	140	4.0	5088	233	5.45
	54	162	3.0	5250	287	5.66
	86	172	2.0	5422	373	5.92
	216	216	1.0	5638	589	6.38
1841-1955	1	600	600.0	600	1	0.0
	1	408	408.0	1008	2	0.69
	1	279	279.0	1287	3	1.10
	1	200	200.0	1487	4	1.39
	1	172	172.0	1659	5	1.61
	1	165	165.0	1824	6	1.79
	1	162	162.0	1986	7	1.95
	1	146	146.0	2132	8	2.08

APPENDIX A-CONTINUED

Time Period	Number of Journals	Number of Articles	Number of Art./Jrnl.	Sum of Articles	Sum of Journals	Log. Sum of Jrnls.
1841-1955	1	142	142.0	2274	9	2.20
	1	132	132.0	2406	10	2.30
	1	106	106.0	2514	11	2.40
	2	210	105.0	2722	13	2.56
	1	101	101.0	2823	14	2.64
	1	98	98.0	2921	15	2.71
	1	92	92.0	3013	16	2.77
	1	91	91.0	3104	17	2.83
	1	87	87.0	3191	18	2.89
	1	73	73.0	3284	19	2.94
	1	69	69.0	3333	20	3.00
	1	68	68.0	3401	21	3.04
	1	67	67.0	3468	22	3.09
	1	66	66.0	3534	23	3.14
	1	62	62.0	3596	24	3.18
	1	59	59.0	3655	25	3.22
	2	114	57.0	3769	27	3.30
	1	54	54.0	3823	28	3.33
	3	159	53.0	3982	31	3.43
	2	104	52.0	4086	33	3.50
	1	51	51.0	4137	34	3.53
	2	90	45.0	4227	36	3.58
	1	44	44.0	4271	37	3.61
	1	43	43.0	4314	38	3.64
	1	42	42.0	4356	39	3.66
	1	40	40.0	4396	40	3.69
	2	78	39.0	4474	42	3.74
	3	102	34.0	4576	45	3.81
	4	122	49.0	4708	49	3.89
	4	124	31.0	4832	53	3.97

APPENDIX A-CONTINUED

Time Period	Number of Journals	Number of Articles	Number of Art./Jrnl.	Sum of Articles	Sum of Journals	Log. Sum of Jrnls.
1841-1955	3	87	29.0	4919	56	4.03
	4	112	28.0	5031	60	4.09
	3	81	27.0	5112	63	4.14
	4	100	25.0	5212	67	4.20
	1	24	24.0	5236	68	4.22
	3	69	23.0	5305	71	4.26
	5	110	22.0	5415	76	4.33
	4	84	21.0	5499	80	4.38
	6	120	20.0	5619	86	4.45
	2	38	19.0	5657	88	4.48
	3	54	18.0	5711	91	4.51
	5	85	17.0	5796	96	4.56
	5	80	16.0	5876	101	4.62
	9	135	15.0	6011	110	4.70
	6	84	14.0	6095	116	4.75
	5	65	13.0	6160	121	4.80
	16	192	12.0	6352	137	4.92
	6	66	11.0	6418	143	4.96
	15	150	10.0	6568	158	5.06
	18	162	9.0	6730	176	5.17
	15	120	8.0	6850	191	5.25
	11	77	7.0	6927	202	5.31
	27	162	6.0	7089	229	5.43
	25	125	5.0	7214	254	5.54
	44	176	4.0	7390	298	5.70
	67	201	3.0	7591	365	5.90
	98	196	2.0	7787	463	6.14
	278	278	1.0	8065	741	6.61

APPENDIX A-CONTINUED

Time Period	Number of Journals	Number of Articles	Number of Art./Jrnl	Sum of Articles	Sum of Journals	Log. Sum of Jyrls.
1841-1960	1	850	850.0	850	1	0.0
	1	470	470.0	1320	2	0.69
	1	327	327.0	1647	3	1.10
	1	258	258.0	1905	4	1.39
	1	195	195.0	2100	5	1.61
	1	190	190.0	2290	6	1.79
	1	181	181.0	2471	7	1.95
	1	170	170.0	2641	8	2.08
	1	166	166.0	2807	9	2.20
	1	162	162.0	2969	10	2.30
	1	138	138.0	3107	11	2.40
	1	111	111.0	3218	12	2.48
	1	109	109.0	3327	13	2.56
	1	108	108.0	3425	14	2.64
	1	106	106.0	3511	15	2.71
	1	105	105.0	3646	16	2.77
	1	101	101.0	3747	17	2.83
	1	99	99.0	3846	18	2.89
	1	97	97.0	3943	19	2.94
	1	92	92.0	4035	20	3.00
	2	182	91.0	4217	22	3.09
	1	85	85.0	4302	23	3.14
	1	82	82.0	4384	24	3.18
	1	78	78.0	4462	25	3.22
	1	74	74.0	4536	26	3.26
	1	73	73.0	4609	27	3.30
	2	142	71.0	4751	29	3.37
	1	69	69.0	4820	30	3.40
	1	67	67.0	4887	31	3.43

APPENDIX A-CONTINUED

Time Period	Number of Journals	Number of Articles	Number of Art./Jrnl.	Sum of Articles	Sum of Journals	Log. Sum of Jtnls.
1841-1960	1	59	59.0	4946	32	3.47
	2	116	58.0	5062	34	3.53
	1	57	57.0	5119	35	3.56
	1	55	55.0	5174	36	3.58
	3	159	53.0	5333	39	3.66
	1	50	50.0	5383	40	3.69
	1	49	49.0	5432	41	3.71
	2	144	48.0	5576	44	3.78
	3	90	45.0	5666	46	3.83
	1	44	44.0	5710	47	3.85
	1	41	41.0	5751	48	3.87
	1	40	40.0	5791	49	3.89
	2	78	39.0	5869	51	3.93
	1	38	38.0	5907	52	3.95
	1	37	37.0	5944	53	3.97
	1	36	36.0	5980	54	3.99
	2	70	35.0	6050	56	4.03
	3	102	34.0	6132	59	4.08
	2	99	33.0	6251	62	4.13
	2	84	32.0	6315	64	4.16
	2	62	31.0	6377	66	4.19
	3	90	30.0	6467	69	4.23
	3	87	29.0	6554	72	4.28
	2	56	28.0	6610	74	4.30
	4	108	27.0	6718	78	4.36
	2	52	26.0	6770	80	4.38
	5	125	25.0	6895	85	4.44

APPENDIX A-CONTINUED

Time Period	Number of Journals	Number of Articles	Number of Art./Jrnl.	Sum of Articles	Sum of Journals	Log. Sum of Jrnl.
1841-1960	3	72	24.0	6967	88	4.48
	2	46	23.0	7013	90	4.50
	5	110	22.0	7123	95	4.55
	4	84	21.0	7207	99	4.60
	3	60	20.0	7267	102	4.62
	3	152	19.0	7419	110	4.70
	5	90	18.0	7509	115	4.74
	8	136	17.0	7645	123	4.81
	6	96	16.0	7741	129	4.86
	6	90	15.0	7831	135	4.91
	7	98	14.0	7929	142	4.96
	7	91	13.0	8020	149	5.00
	15	180	12.0	8200	164	5.10
	6	66	11.0	8266	170	5.14
	21	210	10.0	8476	191	5.25
	25	225	9.0	8701	216	5.38
	15	120	8.0	8821	231	5.44
	16	112	7.0	8933	247	5.50
	32	192	6.0	9125	279	5.63
	37	185	5.0	9310	316	5.76
	48	192	4.0	9502	364	5.90
	70	210	3.0	9712	434	6.07
	116	232	2.0	9944	550	6.31
	321	321	1.0	10265	871	6.77

APPENDIX A-CONTINUED

Time Period	Number of Journals	Number of Articles	Number of Art./Jrnl.	Sum of Articles	Sum of Journals	Log. Sum
1841-1850	3	3	1.0	3	3	1.10
1851-1860	3	3	1.0	3	3	1.10
1861-1870	1	4	4.0	4	1	0.0
	1	2	2.0	6	2	0.69
	6	6	1.0	12	8	2.00
1871-1880	1	16	16.0	16	1	0.0
	1	9	9.0	25	2	0.69
	2	8	4.0	33	4	1.39
	2	6	3.0	39	6	1.79
	2	4	2.0	43	8	2.08
	16	16	1.0	59	24	3.18
1881-1890	1	11	11.0	11	1	0.0
	1	11	11.0	22	2	0.69
	1	9	9.0	31	3	1.10
	1	6	6.0	37	4	1.39
	1	5	5.0	42	5	1.61
	1	4	4.0	46	6	1.79
	4	12	3.0	58	10	2.30
	8	16	2.0	74	18	2.89
	17	17	1.0	91	35	3.56
1891-1900	1	37	37.0	37	1	0.0
	1	16	16.0	53	2	0.69
	1	11	11.0	64	3	1.10
	1	10	10.0	74	4	1.39

APPENDIX A-CONTINUED

Time Period	Number of Journals	Number of Articles	Number of Art./Jrnl.	Sum of Articles	Sum of Log. Sum of Journals of Jrnl.
1891-1900	1	8	8.0	82	5
	1	7	7.0	89	6
	1	6	6.0	95	7
	3	15	5.0	110	10
	2	8	4.0	118	12
	2	6	3.0	124	14
	11	22	2.0	146	25
	13	13	1.0	159	38
					3.64
1901-1910	1	35	35.0	35	1
	1	33	33.0	68	2
	1	21	21.0	89	3
	1	20	20.0	109	4
	2	22	11.0	131	6
	1	10	10.0	141	7
	2	18	9.0	159	9
	3	24	8.0	183	12
	3	21	7.0	204	15
	1	6	6.0	210	16
	6	30	5.0	240	22
	1	4	4.0	244	23
	4	12	3.0	256	27
	17	34	2.0	290	44
	36	36	1.0	326	80
					4.38
1911-1920	2	56	28.0	56	2
	1	27	27.0	83	3
	1	21	21.0	104	4
	1	13	13.0	117	5
					1.61

APPENDIX A-CONTINUED

Time Period	Number of Journals	Number of Articles	Number of Art./Jrn.	Sum of Articles	Sum of Journals	Log. Sum
1911-1920	1	11	11.0	128	6	1.79
	1	9	9.0	137	7	1.95
	2	16	8.0	153	9	2.20
	2	14	7.0	167	11	2.40
	1	6	6.0	173	12	2.48
	3	15	5.0	188	15	2.71
	5	20	4.0	208	20	3.00
	5	15	3.0	223	25	3.22
	12	24	2.0	247	37	3.61
	39	39	1.0	286	76	4.33
1921-1930	1	27	27.0	27	1	0.0
	1	25	25.0	52	2	0.69
	1	22	22.0	74	3	1.10
	2	40	20.0	114	5	1.61
	2	38	19.0	152	7	1.95
	1	18	18.0	170	8	2.08
	1	16	16.0	186	9	2.20
	1	13	13.0	199	10	2.30
	2	24	12.0	223	12	2.48
	2	20	10.0	243	14	2.64
	5	45	9.0	288	19	2.94
	5	16	8.0	304	21	3.04
	5	35	7.0	339	26	3.26
	6	36	6.0	375	32	3.47
	7	35	5.0	410	39	3.66
	7	28	4.0	438	46	3.83
	15	45	3.0	483	61	4.11

APPENDIX A-CONTINUED

Time Period	Number of Journals	Number of Articles	Number of Art./jnl.	Sum of Articles	Sum of Journals	Leg. Sum of Jnl.
1921-1930	15	30	2.0	513	76	4.33
	45	45	1.0	558	121	4.80
1931-1940	1	112	112.0	112	1	0.0
	1	82	82.0	194	2	0.69
	1	70	70.0	264	3	1.10
	1	56	56.0	320	4	1.39
	2	102	51.0	422	6	1.79
	1	45	45.0	467	7	1.95
	1	43	43.0	510	8	2.08
	1	38	38.0	548	9	2.20
	1	33	33.0	581	10	2.30
	1	32	32.0	613	11	2.40
	1	29	29.0	642	12	2.48
	1	26	26.0	668	13	2.56
	1	23	23.0	691	14	2.64
	1	22	22.0	713	15	2.71
	2	42	21.0	755	17	2.83
	3	57	19.0	812	20	3.00
	1	18	18.0	830	21	3.04
	1	16	16.0	846	22	3.09
	5	75	15.0	921	27	3.30
	4	56	14.0	977	31	3.43
	2	26	13.0	1003	33	3.50
	7	84	12.0	1087	40	3.69
	1	11	11.0	1098	41	3.71
	2	20	10.0	1118	43	3.76
	2	18	9.0	1136	45	3.81
	7	56	8.0	1192	52	3.95

APPENDIX A-CONTINUED

Time Period	Number of Journals	Number of Articles	Number of Art./Jrnl.	Sum of Articles	Sum of Journals	Log. Sum of Jrnls.
1931-1940	5	35	7.0	1227	57	4.04
	9	54	6.0	1281	66	4.19
	13	65	5.0	1346	79	4.37
	24	96	4.0	1442	103	4.63
	28	84	3.0	1526	131	4.88
	45	90	2.0	1616	176	5.17
	90	90	1.0	1706	266	5.58
1941-1950	1	277	277.0	277	1	0.0
	1	130	130.0	407	2	0.69
	1	126	126.0	533	3	1.10
	1	110	110.0	643	4	1.39
	1	90	90.0	713	5	1.61
	1	79	79.0	812	6	1.79
	1	77	77.0	889	7	1.95
	1	57	57.0	946	8	2.08
	1	52	52.0	998	9	2.20
	2	78	39.0	1076	11	2.40
	1	32	32.0	1108	12	2.48
	1	28	28.0	1136	13	2.56
	1	27	27.0	1163	14	2.64
	1	26	26.0	1189	15	2.71
	2	50	25.0	1239	17	2.83
	1	24	24.0	1263	18	2.89
	1	22	22.0	1285	19	2.94
	2	42	21.0	1327	21	3.04
	1	20	20.0	1347	22	3.09
	2	38	19.0	1385	24	3.18
	2	36	18.0	1421	26	3.26

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Time Period	Number of Journals	Number of Articles	Number of Art./Jrnl.	Sum of Articles	Log. Sum of Jrnls.
1941-1950	1	17	17.0	1438	3.30
	4	64	16.0	1502	3.43
	1	15	15.0	1517	3.47
	2	28	14.0	1545	3.53
	4	52	13.0	1597	3.64
	5	60	12.0	1657	3.76
	2	22	11.0	1679	3.81
	5	50	10.0	1729	3.91
	6	54	9.0	1783	4.03
	6	48	8.0	1831	4.13
	13	91	7.0	1922	4.32
	12	72	6.0	1994	4.47
	14	70	5.0	2064	4.62
	13	52	4.0	2116	4.74
	31	93	3.0	2209	4.98
	49	98	2.0	2307	5.27
	139	139	1.0	2446	5.81
1951-1960	1	461	461.0	461	0.0
	1	165	165.0	626	0.69
	1	125	125.0	751	1.10
	1	113	113.0	864	1.39
	1	99	99.0	963	1.61
	1	87	87.0	1050	1.70
	1	85	85.0	1135	1.95
	1	84	84.0	1219	2.08
	1	78	78.0	1297	2.20
	2	148	74.0	1445	2.40
	2	132	66.0	1577	2.56

APPENDIX A-CONTINUED

Time Period	Number of Journals	Number of Articles	Number of Art./Jnl.	Sum of Articles	Sum of Journals	Log. Sum of Jnl.
1951-1960	2	126	63.0	1703	15	2.71
	1	61	61.0	1764	16	2.77
	1	54	54.0	1818	17	2.83
	1	53	53.0	1871	18	2.89
	1	49	49.0	1920	19	2.94
	1	46	46.0	1966	20	3.00
	1	44	44.0	2010	21	3.04
	1	43	43.0	2053	22	3.09
	1	42	42.0	2095	23	3.14
	3	105	35.0	2200	26	3.26
	2	68	34.0	2268	28	3.33
	1	33	33.0	2301	29	3.37
	1	96	31.0	2397	32	3.47
	2	62	31.0	2459	34	3.53
	3	90	30.0	2549	37	3.61
	2	87	29.0	2636	40	3.69
	2	56	28.0	2692	42	3.74
	1	27	27.0	2719	43	3.76
	1	26	26.0	2745	44	3.78
	2	50	25.0	2795	46	3.83
	2	48	24.0	2843	48	3.87
	2	44	22.0	2887	50	3.91
	2	42	21.0	2929	52	3.95
	2	40	20.0	2969	54	3.99
	2	57	19.0	3026	57	4.04
	4	72	18.0	3098	61	4.11
	3	51	17.0	3149	64	4.16
	1	16	16.0	3165	65	4.17
	3	45	15.0	3210	68	4.22

APPENDIX A-CONTINUED

Time Period	Number of Journals	Number of Articles	Number of Art./Jrnl.	Sum of Articles	Sum of Journals	Log. Sum of Journals
1951-1960	7	98	14.0	3308	75	4.32
	6	78	13.0	3386	81	4.39
	5	60	12.0	3446	86	4.45
	11	121	11.0	3567	97	4.57
	13	130	10.0	3697	110	4.70
	9	81	9.0	3778	119	4.78
	11	88	8.0	3866	130	4.87
	8	56	7.0	3922	138	4.93
	15	90	6.0	4012	153	5.03
	25	125	5.0	4137	178	5.18
	27	108	4.0	4245	205	5.32
	34	102	3.0	4347	239	5.48
	57	114	2.0	4461	296	5.69
	166	166	1.0	4627	462	6.14
1846-1850	3	3	1.0	3	3	1.10
1851-1855	2	2	1.0	2	2	0.69
1856-1860	1	1	1.0	1	1	0.0
1861-1865	1	4	4.0	4	1	0.0
	2	2	1.0	6	3	1.10
1866-1870	1	2	2.0	2	1	0.0
	4	4	1.0	6	5	1.61
1871-1875	1	2	2.0	2	1	0.0
	4	4	1.0	6	5	1.61

APPENDIX A-CONTINUED

Time Period	Number of Journals	Number of Articles	Number of Art./Jrnal.	Sum of Articles	Sum of Journals	Log. Sum of Jrnals.
1876-1880	1	16	16.0	16	1	0.0
	1	9	9.0	25	2	0.59
	2	8	4.0	33	4	1.39
	1	3	3.0	36	5	1.61
	2	4	2.0	40	7	1.95
1881-1885	13	13	1.0	53	20	3.00
	1	10	10.0	10	1	0.0
	1	7	7.0	17	2	0.69
	1	6	6.0	23	3	1.10
	1	4	4.0	27	4	1.39
1886-1890	1	3	3.0	30	5	1.61
	6	12	2.0	42	11	2.40
	9	9	1.0	51	20	3.00
	2	6	3.0	6	2	0.69
	3	6	2.0	12	5	1.61
1891-1895	17	17	1.0	29	22	3.09
	1	24	24.0	24	1	0.0
	2	20	10.0	44	3	1.10
	1	8	8.0	52	4	1.39
	1	5	5.0	57	5	1.61
1896-1900	1	4	4.0	61	6	1.79
	2	6	3.0	67	8	2.08
	4	8	2.0	75	12	2.48
	11	11	1.0	86	23	3.00
	1	1	1.0	1	1	0.0

APPENDIX A-CONTINUED

Time Period	Number of Journals	Number of Articles	Number of Art./Jrnl.	Sum of Articles	Sum of Journals	Log. Sum of Jrnls.
1896-1900	1	13	13.0	13	1	0.0
	1	7	7.0	20	2	0.69
	2	12	6.0	32	4	1.39
	1	5	5.0	37	5	1.61
	1	3	3.0	48	8	2.08
	7	14	2.0	62	15	2.72
	11	11	1.0	73	26	3.26
1901-1905	1	15	15.0	15	1	0.0
	1	14	14.0	29	2	0.69
	1	12	12.0	41	3	1.10
	1	8	8.0	49	4	1.39
	1	7	7.0	56	5	1.61
	4	24	6.0	80	9	2.20
	1	5	5.0	85	10	2.30
	1	4	4.0	89	11	2.40
	1	12	3.0	101	15	2.71
	4	18	2.0	119	24	3.18
	9	22	1.0	141	46	3.83
	22					
1906-1910	1	20	20.0	20	1	0.0
	1	19	19.0	39	2	0.69
	1	14	14.0	53	3	1.10
	1	8	8.0	61	4	1.39
	2	14	7.0	75	6	1.79
	3	18	6.0	93	9	2.20
	3	15	5.0	108	12	2.48
	1	4	4.0	112	13	2.56
						164

APPENDIX A-CONTINUED

Time Period	Number of Journals	Number of Articles	Number of Art./Jrnl.	Sum of Articles	Sum of Journals	Log. Sum of Jtals.
1906-1910	6	18	3.0	130	19	2.94
	12	24	2.0	154	31	3.43
	31	31	1.0	185	62	4.13
1911-1915	1	18	18.0	18	1	0.0
	1	11	11.0	29	2	0.69
	1	10	10.0	39	3	1.10
	1	8	8.0	47	4	1.39
	1	7	7.0	54	5	1.61
	3	15	5.0	69	8	2.08
	3	12	4.0	81	11	2.40
	3	18	3.0	99	17	2.83
	11	22	2.0	121	28	3.33
	37	37	1.0	158	65	4.17
1916-1920	1	18	18.0	18	1	0.0
	1	17	17.0	35	2	0.69
	1	14	14.0	49	3	1.10
	1	9	9.0	58	4	1.39
	1	6	6.0	64	5	1.61
	3	15	5.0	79	8	2.08
	3	12	4.0	91	11	2.40
	4	12	3.0	103	15	2.71
	3	12	2.0	109	18	2.89
	19	19	1.0	128	37	3.61
1921-1925	1	13	13.0	13	1	0.0
	2	18	9.0	31	3	1.10
	1	8	8.0	39	4	1.39
						165

APPENDIX A-CONTINUED

Time Period	Number of Journals	Number of Articles	Number of Art./Jrnl.	Sum of Articles	Sum of Journals	Log. Sum of Jrnls.
1921-1925	2	12	6.0	51	6	1.79
	4	20	5.0	71	10	2.30
	6	24	4.0	95	16	2.77
	4	12	3.0	107	20	2.00
	15	30	2.0	137	35	3.56
1926-1930	31	31	1.0	168	66	4.19
	1	23	23.0	23	1	0.0
	1	17	17.0	40	2	0.69
	1	16	16.0	56	3	1.10
	1	14	14.0	70	4	1.39
	1	12	12.0	82	5	1.61
	3	33	11.0	115	8	2.08
	2	20	10.0	135	10	2.30
	4	36	9.0	171	14	2.64
	4	28	7.0	199	18	2.89
	5	30	6.0	229	23	3.14
	7	35	5.0	264	30	3.40
	6	24	4.0	288	36	3.58
	15	45	3.0	333	51	3.93
	11	22	2.0	355	62	4.13
	35	35	1.0	390	97	4.57
1931-1935	1	31	31.0	31	1	0.0
	1	29	29.0	60	2	0.69
	1	28	28.0	88	3	1.10
	1	25	25.0	113	4	1.39
	1	21	21.0	134	5	1.61
						166

APPENDIX A-CONTINUED

Time Period	Number of Journals	Number of Articles	Number of Art./Jrnl.	Sum of Articles	Sum of Journals	Log Sum of Jrnls.
1931-1935	3	48	16.0	182	8	2.08
	2	30	15.0	212	10	2.30
	1	14	14.0	226	11	2.40
	2	26	13.0	252	13	2.56
	2	20	10.0	272	15	2.71
	2	18	9.0	290	17	2.83
	3	24	8.0	314	20	3.00
	6	42	7.0	356	26	3.26
	7	42	6.0	398	33	3.50
	2	10	5.0	408	35	3.56
	10	40	4.0	448	45	3.81
	8	24	3.0	472	53	3.97
	28	56	2.0	528	81	4.39
	64	64	1.0	592	145	4.98
	1	112	112.0	112	1	0.0
	1	54	54.0	166	2	0.69
	1	41	41.0	207	3	1.10
1936-1940	1	37	37.0	244	4	1.39
	1	36	36.0	280	5	1.61
	1	33	33.0	313	6	1.79
	1	31	31.0	344	7	1.95
	1	30	30.0	374	8	2.08
	1	29	29.0	403	9	2.20
	1	26	26.0	429	10	2.30
	1	22	22.0	451	11	2.40
	1	21	21.0	472	12	2.48
	1	19	19.0	491	13	2.56
	2	28	14.0	519	15	2.71

APPENDIX A-CONTINUED

Time Period	Number of Journals	Number of Articles	Number of Art./Jnl.	Sum of Articles	Sum of Journals	Log. Sum of Jnls.
1936-1940	2	26	13.0	545	17	2.83
	2	24	12.0	569	19	2.94
	1	11	11.0	580	20	3.00
	3	30	10.0	610	23	3.14
	3	27	9.0	637	26	3.26
	5	40	8.0	677	31	3.43
	6	42	7.0	719	37	3.61
	7	42	6.0	761	44	3.78
	12	60	5.0	821	56	4.03
	19	76	4.0	897	75	4.32
	26	78	3.0	975	101	4.62
	35	70	2.0	1045	136	4.91
	69	69	1.0	1114	205	5.32
1941-1945	1	99	99.0	99	1	0.0
	1	43	43.0	142	2	0.69
	1	42	42.0	184	3	1.10
	1	38	38.0	222	4	1.39
	1	37	37.0	259	5	1.61
	1	35	35.0	294	6	1.79
	1	22	22.0	316	7	1.95
	1	16	16.0	332	8	2.08
	2	26	13.0	358	10	2.30
	1	12	12.0	370	11	2.40
	1	11	11.0	381	12	2.48
	1	10	10.0	391	13	2.56
	5	45	9.0	436	18	2.89
	1	8	8.0	444	19	2.94
	6	42	7.0	486	25	3.22
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APPENDIX A-CONTINUED

Time Period	Number of Journals	Number of Articles	Number of Art./Jrnl.	Sum of Articles	Sum of Journals	Log. Sum of %Jrnl.
1941-1945	4	24	6.0	510	29	3.37
	3	15	5.0	525	32	3.47
	11	44	4.0	569	43	3.76
	15	45	3.0	614	58	4.06
	25	50	2.0	664	83	4.42
	75	75	1.0	739	158	5.06
1946-1950	1	178	178.0	178	1	0.0
	1	93	93.0	271	2	0.69
	1	84	84.0	355	3	1.10
	1	70	70.0	425	4	1.39
	1	67	67.0	492	5	1.61
	1	57	57.0	549	6	1.79
	1	55	55.0	604	7	1.95
	1	52	52.0	656	8	2.08
	2	78	39.0	734	10	2.30
	2	54	27.0	788	12	2.48
	1	25	25.0	813	13	2.56
	1	21	21.0	834	14	2.64
	1	20	20.0	854	15	2.71
	2	38	19.0	892	17	2.83
	1	18	18.0	910	18	2.89
	1	17	17.0	927	19	2.94
	4	64	16.0	991	23	3.14
	2	30	15.0	1021	25	3.22
	2	28	14.0	1049	27	3.30
	1	13	13.0	1062	28	3.33
	4	48	12.0	1110	32	3.47
	2	22	11.0	1132	34	3.53

APPENDIX A-CONTINUED

Time Period	Number of Journals	Number of Articles	Number of Art./Jrnl.	Sum of Articles	Sum of Journals	Log. Sum of Jrnls.
1946-1950	4	40	10.0	1172	38	3.64
	3	27	9.0	1199	41	3.71
	2	16	8.0	1215	43	3.76
	11	77	7.0	1292	54	3.99
	15	90	6.0	1382	69	4.23
	8	40	5.0	1422	77	4.34
	9	36	4.0	1458	86	4.45
	23	69	3.0	1527	109	4.69
	37	74	2.0	1601	146	4.98
	106	106	1.0	1707	252	5.53
1951-1955	1	211	211.0	211	1	0.0
	1	103	103.0	314	2	0.69
	1	76	76.0	390	3	1.10
	1	67	67.0	457	4	1.39
	1	65	65.0	522	5	1.61
	1	60	60.0	582	6	1.79
	1	56	56.0	638	7	1.95
	1	53	53.0	691	8	2.08
	1	42	42.0	733	9	2.20
	2	80	40.0	813	11	2.40
	1	38	38.0	851	12	2.48
	1	37	37.0	888	13	2.56
	1	34	34.0	922	14	2.64
	1	33	33.0	955	15	2.71
	1	31	31.0	986	16	2.77
	1	30	30.0	1016	17	2.83
	1	28	28.0	1044	18	2.89
	2	54	27.0	1098	20	3.00
	5	120	25.0	1218	25	3.22

APPENDIX A-CONTINUED

Time Period	Number of Journals	Number of Articles	Number of Art./Jrnl.	Sum of Articles	Sum of Journals	Log ₉ Sum of Jrnls.
1951-1955	2	44	22.0	1262	27	3.30
	2	42	21.0	1304	29	3.37
	1	20	20.0	1324	30	3.40
	1	19	19.0	1343	31	3.43
	1	18	18.0	1361	32	3.47
	3	51	17.0	1412	35	3.56
	1	16	16.0	1428	36	3.58
	3	45	15.0	1473	39	3.66
	3	42	14.0	1515	42	3.74
	4	52	13.0	1567	46	3.83
	9	108	12.0	1675	55	4.01
	2	22	11.0	1697	57	4.04
	7	70	10.0	1767	64	4.16
	8	72	9.0	1839	72	4.28
	8	64	8.0	1903	80	4.38
	6	42	7.0	1945	86	4.45
	9	54	6.0	1999	95	4.55
	10	50	5.0	2049	105	4.65
	23	92	4.0	2141	128	4.85
	24	72	3.0	2213	152	5.02
	51	102	2.0	2315	203	5.31
	112	112	1.0	2427	315	5.75
1956-1960	1	250	250.0	250	1	0.0
	1	62	62.0	312	2	0.69
	1	61	61.0	373	3	1.10
	1	58	58.0	431	4	1.39
	1	51	51.0	482	5	1.61
	2	96	48.0	578	7	1.95

APPENDIX A-CONTINUED

Time Period	Number of Journals	Number of Articles	Number of Art./Jrnl.	Sum of Articles	Sum of Journals	Log. Sum of Jrnls.
1956-1960	1	39	39.0	617	8	2.08
	1	34	34.0	651	9	2.20
	2	66	33.0	717	11	2.40
	2	64	32.0	781	13	2.56
	1	31	31.0	812	14	2.64
	4	100	25.0	912	18	2.89
	2	48	24.0	960	20	3.00
	3	69	23.0	1029	23	3.14
	2	42	21.0	1071	25	3.22
	2	40	20.0	1111	27	3.30
	2	38	19.0	1149	29	3.37
	1	18	18.0	1167	30	3.40
	1	17	17.0	1184	31	3.43
	2	32	16.0	1216	33	3.50
	3	45	15.0	1261	36	3.58
	5	70	14.0	1331	41	3.71
	1	13	13.0	1344	42	3.74
	3	36	12.0	1380	45	3.81
	3	33	11.0	1413	48	3.87
	10	100	10.0	1513	58	4.06
	5	45	9.0	1558	63	4.14
	7	56	8.0	1614	70	4.25
	8	56	7.0	1670	78	4.36
	17	102	6.0	1772	95	4.55
	11	55	5.0	1827	106	4.86
	24	96	4.0	1923	130	4.87
	26	78	3.0	2001	156	5.05
	42	84	2.0	2085	198	5.29
	115	115	1.0	2200	313	5.75

IDENTIFICATION OF SERIAL CODES USED
IN TABLES 10 AND 11

Code	Title And Year First Published
AJTH	Ajatus (Helsinki), 1926+
AMJM	American Journal of Mathematics, 1878+
AMMM	American Mathematical Monthly, 1894+
ANFY	Analysis (Oxford), 1933+
APNN	Annalen der Philosophie und Philosophischen Kritik, 1919-1930
AUJP	Australasian Journal of Philosophy, 1923+
BRJP	British Journal for the Philosophy of Science, 1950+
BUAM	Bulletin of the American Mathematical Society, 1891+
CASP	Ceskoslovensky Casopis pro pestovani Matematiky, 1872+
CRHS	Comptes rendus hebdomadaires des seances de l'Academie des Sciences (Paris), 1835+
DEUL	Deutsche Literaturzeitung, 1930+
DIAL	Dialectica, 1947+
DOKA	Doklady Akademii Nauk SSSR, 1933+
ENSM	Enseignement mathematique, 1899+
ERKT	Erkenntnis, 1930-1939
FUNM	Fundamenta Mathematicae, 1920+
INDA	Indagationes Mathematicae, 1939+
JAFM	Jahrbuch ueber die Fortschritte der Mathematik, 1868-1944
JBDM	Jahresbresbericht der Deutschen Mathematiker-Vereinigung, 1890+

APPENDIX B-CONTINUED

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Code	Title And Year First Published
JPHY	Journal of Philosophy, 1904+
JSBL	Journal of Symbolic Logic, 1936+
KONI	Koninklijke Nederlandse Akademie von Wetenschappen, Proceedings, 1898-1950
MAKG	Mathematical Gazette, 1894+
MATA	Mathematische Annalen, 1869+
MATZ	Mathematische Zeitschrift, 1918+
METS	Methodos, 1949+
MIND	Mind, 1876+
MOST	Monist, 1890-1936
PHCR	Philosophical Review, 1892+
PHDM	Philosophical Studies (Minneapolis), 1950+
PHPH	Philosophy, 1926+
PHPR	Philosophy and Phenomenological Research, 1940+
PHSC	Philosophy of Science, 1934+
PRCM	Proceedings of the American Mathematical Society, 1950+
PRDA	Proceedings of the Aristotelian Society, 1887-1896, 1900+
PRZF	Przegląd filozoficzny, 1897+
RECW	Review of Metaphysics, 1947+
REGM	Rivista di Matematica, 1891-1906
REMM	Revue de Metaphysique et du Morales, 1893+
REPF	Revue philosophique de la France et de l'Etranger, 1876+

Code	Title And First Year Published
REPL	Revue philosophique de Louvain, 1894+
SCVM	Scripta Mathematica, 1932+
STUL	Studia Logica, 1953+
SYTS	Synthese (Utrecht), 1936+
THER	Theoria, 1935+
TRAM	Transactions of the American Mathematical Society, 1900+
XICM	International Congress of Mathematics, Proceedings, 1896+
XICP	International Congress of Philosophy, Proceedings, 1901+
XIPS	International Congress of the Philosophy of Science, Proceedings, 1936+
ZEML	Zeitschrift fuer mathematische Logik und Grundlagen der Mathematik, 1955+
ZETM	Zentralblatt fuer Mathematik und ihre Grenzgebiete, 1931+