Synchronic study of literature obsolescence: the case of Lotka's Law

Rubén Urbizagástegui-Alvarado *

Abstract

This paper examines the obsolescence of literature produced on Lotka's law up to 2010, over which time no definitive pattern of obsolescence is discernible. Cumulative data since then, however, shows a pattern of obsolescence at an annual rate of decrease of 9%, with a duplication rate of 17.4 years. These statistics indicate a good fit with the exponential model, with an R^2 of 0.985 at asignificance level of 0.01.

Keywords: Obsolescence of literature; Lotka's law; Authors' productivity; Scientometrics; Bibliometrics; Informetrics; Scientometrics.

* University of California, Riverside, CA, US. ruben@ucr.edu

Resumen

Estudio sincrónico de la obsolescencia de la literatura: el caso de la ley de Lotka
Rubén Urbizagástegui Alvarado

Se analiza la obsolescencia de la literatura producida sobre la Ley de Lotka hasta 2010. En ese periodo no parece haber un patrón de obsolescencia definido. Sin embargo, los datos acumulados muestran una comportamiento obsolescente con una tasa de decrecimiento anual del 3.9 % y una tasa de duplicación cada 17.4 años. La estadística indica un buen ajuste al modelo exponencial, con un R^2 de 0.985 para la literatura a un nivel de significancia de 0.01.

Palabras clave: Obsolescencia de la literatura; Ley de Lotka; Productividad de autores; Cienciometría; Bibliometría; Informetría.

Introduction

The use of scientific documents decreases with time and age of literature, i.e., literature obsolesces; but what does it mean that a document becomes obsolete? It is presumed that by never using or citing a particular document, the authors, as readers, determine that the document becomes obsolete, but if authors continuously cite documents in their works, these keep alive and lasting. The citation of a document is influenced by the author's prestige, the recognition he/she has in his/her field and the new discoveries described, but the document becomes more and more obsolete if, as time passes by, less and less documents cite it. In library and information science, this phenomenon is known as "literature obsolescence." This refers to a decrease in its frequency of use or citation, but not to its definite elimination. It happens because scientific and technical documents are not always original, but based on evidence of previous researches. Such previous evidence can be represented in the reference lists published in each new contribution. Thus, the evolution of citation frequency according to time allows us to recognize the value of the published document. Certainly, past literature is reviewed and updated, facts already known about a phenomenon are incorporated and merged with new knowledge regarding this phenomenon. Therefore, these facts are rewritten and reinterpreted in terms of the new theories, as

corrections and refinements of the papers published by scientific journals, but it is uncertain when that literature will become "obsolete." Studies on publication obsolescence have become common, encouraged by the work of Price (1965: 512), who suggested that "every year about 10% of all articles 'dies' by not being cited again." Data collected to measure document aging gave rise to the general conclusion that the use of literature declines with time, according to a negative exponential distribution, although other authors postulate a log-normal distribution as the most suitable to measure literature obsolescence (Egghe & Ravichandra Rao, 1992b; Gupta, 1998).

There are two methods to study obsolescence: the synchronic method and the diachronic method. Synchronic obsolescence analyzes the use in the past of a document sample in which half-life would be the statistical median (the point in which 50% of the frequencies of citations is grouped) considering the years in reverse chronological order. Diachronic obsolescence requires the selection of a point in the past to look into the future. However, some authors argue that synchronic and diachronic studies produce the same results (Stinson, 1981; Stinson & Lancaster, 1987), suggesting a preference for the synchronic method. Both studies can also be performed retrospectively (Egghe & Rousseau, 2000).

Although it is possible to know literature's half-life, it is not yet possible to know when it really begins to age and is not cited anymore, or the reasons for this. Is access to the document what is influencing literature obsolescence? Does document language affect obsolescence? Or is the discovery of new models or methods for the discipline measurement or evaluation what is affecting?

It is not always possible to carry out the obsolescence analysis using the printed citation indexes or those available online such as Science Citation Index, Social Science Citation Index, etc. First, because these citation indexes favor Anglo-Saxon production in the document compilation process, to the detriment of the production of other regions; secondly, because these indexes emphasize the collection of documents in English, once again at the expense of other languages. For these reasons, the only option to carry out this research was to develop a database of my own to examine, analyze, evaluate and communicate the results.

Based on the above, the objective of this work is to analyze the existence or non-existence of "literature obsolescence" in a sample of documents published from 2007 to 2009 (86 citing documents) dedicated to study Lotka's law, opposite to a total of 663 citable and available documents published from 1926 until 2006. The theoretical model is explained in a separate chapter. Incidentally, the study will analyze the languages of documents included in the sample and

the most frequent languages cited by documents published in English, Portuguese and Spanish from the sample of 86 documents. Bradford's law will be used to identify cited authors in the nucleus and succeeding zone; i.e., those more frequently cited and whose articles will have increased possibilities to escape from "obsolescence."

In general, this type of studies has been performed counting all the citations included in a sample of documents published during a specific period without any type of separation and/or discrimination. In this case, the interest is on the obsolescence of documents dedicated to analyze Lotka's law, which will also cite other previous documents studying and/or applying Lotka's law.

THEORETICAL FRAMEWORK

The term "obsolescence" first appeared in Gosnell's work (1943). Later, during the International Conference on Scientific Information held at Washington, it was stated that:

> [...] Many studies show that the effective life of a piece of scientific information in the different fields of science is vastly different. The true half-life of a particular piece of information can be defined as the time after publication up to which half the uses (references) or enquiries about the piece of information was made. This is extremely difficult to evaluate, though it would be well worth doing. Instead we are obliged to use what might be called the back half-life of a group of similar pieces of information —paper in a given journal for instance. This can be defined as the time counted back from a given date within which half the requests for, or references to, information have occurred. This period is about two years for Physics and fifteen for Biology (Bernal, 1958: 86).
> (Modified from: https://books.google.com.mx/books?id=BksrAAAAYAA-J&pg=PA77&lpg=PA77&dq=Bernal,+J.+D.+(1958),+%E2%80%9CThe+-transmission+of+scientific+information%E2%80%9D,&source=bl&ots=y-Y77FavZ_&sig=kOmJ_DL7aEGYI4Jymm8034aoNu4&hl=es&sa=X-&ved=0CCYQ6AEwAWoVChMI3Pvb35CNxgIVgRiSCh1UcAge#v=one-page&q&f=false (Consulted: June 13, 2015))

Following this same idea of half-life, Burton & Kebler (1960) postulated that literature becomes obsolete instead of disintegrating and half-life means "half of the active life" or the time during which half of the literature was published. Researches seem to indicate different results, so much so that Bourne (1965) stated that most of the reported "half-lives" was valid only for the studied samples, and could not be generalized for all scientific and technical activ-

ities. Shortly after, Ewing (1966) carried out a diachronic study of papers published in a Physics journal and found that the number of citations decreased as the year of publication was closer to the current year. This aging rate was more dramatic when adjusted, based on the growing of literature published in that journal. The "intensity of citations" was seven times higher in 1955 than in 1964, and showed a half-life of 3.5 years and an obsolescence rate of 8.0 years.

The interest to understand literature obsolescence continued growing and Line (1970a) tried to specify the meaning of the term "half-life", since in his opinion, the commonly used sense was inadequate and with a limited value. If the collection growth rate is faster or lower than the growth rate of literature produced in the study area, half-life can be in some cases too big or too small. Therefore, literature half-life would be composed by the obsolescence rate and literature growth rate. However, these statements are not free from criticisms, so much so that Brookes (1970a) discusses Line's text and states that "[…] a recent theoretical analysis of the relationship between growth rate and obsolescence rate of periodic scientific literature carried out by Line is based on certain implicit assumptions that have to become explicit, to be questioned later. The theoretical problem of measuring obsolescence rates when literature is growing is more complex that the analysis suggested by Line and, thus, to clarify this issue, the concept of 'utility' in periodic literature will be introduced and applied. The practical problem of measuring an obsolescence rate, which actually depends on the sample of a geometric distribution, should be discussed also, because it can be demonstrated that the technique proposed by Line requires an accuracy that is impossible to reach in the library context."

Next year, Sandison (1971a) stated that there was no apparent reason by which older literature would always have a declining interest. Seymour (1972a, b) carried out two reviews of state-of-the-art researches on literature obsolescence publishing these in two parts, one referred to monographs and the other to periodic publications, in which she affirmed that obsolescence studies were the result of two factors: the explosion of publications and the lack of available space in libraries. In that same year, Chen (1972) observed a rapid decline in the use of journals as these were older. Sandison (1974) analyzed again Chen's data (1972) and found that most journals showed an increase in the density rate according to age. These observations were enough for Line & Sandison (1974) to define obsolescence as the decrease or fall into time of the validity or utility of information. However, studies and discussions on this matter continued with Bulick et al. (1976); Taylor (1976-1977); Longyear (1977); Bronmo (1978); Abramescu (1979); Gapen & Milner (1981); Wallace (1986); McCain (1987); Heisey (1988) and other authors.

By that time, the way to carry out studies on literature obsolescence was clear. For example, Gupta (1990) observed that, in Physics, both the number of citations and density rate decreased with age, showing a half-life of 4.9 years and both fitted to an exponential model. Literature obsolescence can also be influenced by unknown factors; thus, Ravichandra Rao & Meera (1992) investigated the influence of literature growth rate on the obsolescence rate and demonstrated that, in the synchronic case, the faster literature grows, the faster it becomes obsolete. Egghe & Ravichandra Rao (1992b) also demonstrated that the obsolescence factor defined by Brookes (1970a) as an independent constant of time is not actually a constant, but a statistical function of time, since generally, citation data is not exponentially distributed, as Brookes stated (1970a). In practice, obsolescence presents an initial growth followed by a form of exponential decline, so, no obsolescence factor is independent from time, since this factor is independent from time only in the case of an exponential distribution. Egghe & Ravichandra Rao (1992b) stated that log-normal distribution is the model that best describes both the initial growth of citations and the subsequent decline.

Egghe (1994) studied the combination of growth with obsolescence stating that both phenomena can be studied with the same mathematic techniques. In the synchronic case, obsolescence increases with literature growth; in the diachronic case, the effect is opposite. Van Raan (2000) states that, without any doubt, the aging of the oldest published literature is part of reality, but the other part of reality is that in the initial phases of any discipline much less published documents exist than in more recent years; therefore, reference distribution according to years always has a combination of aging and scientific literature growth phenomena. With this vision in mind, Van Raan (2000) carried out a synchronic study of the references of all articles published in 1998 and included in the Science Citation Index. Results revealed that citations ranged from 1500 to 1998, but the period from 1500 to 1800 was characterized by much more "noise"; i.e., citations with very low frequency in published literature, so citations from 1800 to 1998 were paid more attention, showing a literature age-dependent nonlinear growth.

Egghe & Ravichandra Rao (2002b) analyzed the age of the first references of articles published in the Journal of the American Society for Information Science (JASIS) between 1985 and 1986. These first citations can be considered as a diachronic analysis of citations, since these are important in the life of an article. If the article is first used in a specific period, its status changes from "not used" to "used", reason why this is also a measure of its use "immediacy". Results revealed that log-normal distribution describes and fits very well to the age of the first references. Burrell (2002b) did not use formal sta-

tistical methods to evaluate the goodness of fit of log-normal, Weibull and log-logistic distributions, but instead used graphical methods to carry out a retrospective study (synchronic) of citations in a document. Paraphrasing the technical reliability studies in "life time" of mechanical objects, suggested that citations' age is not a continuous variable but a discrete variable. In order to illustrate this graphic method, he used five sets of data from surveys carried out by Egghe & Ravichandra Rao (1992b) and Gupta (1998). The author concluded that the log-normal distribution model shows more success describing the fitting of the distribution of retrospective citations (synchronic) of documents, confirming previous studies such as that of Egghe & Ravichandra Rao (1992b). He emphasized this subject again in subsequent articles (Burrell, 2002b, 2003a, b), stating that it seemed reasonable to think that when citing articles, it is not always possible to cite the newest articles, because these are not very well known or they are not already incorporated into the knowledge of researchers. Thus, most citations would be of median age articles, which constitute the majority of references and have more probability to be cited. Then, older articles would be selectively cited to provide a historical perspective in performed researches.

Ahmed, Johnson, Oppenheim & Peck (2004) carried out a diachronic study of the paper on the DNA double helix structure, published in 1953 by Watson and Crick (1953). They used the printed volumes of the Science Citation Index from 1961 to 1980, and the Web of Science, for the period from 1981 to 2002. They observed 2,061 citations, with a mean of 49 citations per year. The authors concluded that this article is continuously being cited 50 years after its publication and found no explanation about why it is still cited. Glänzel (2004) offered a panoramic view of aging from the perspective of the reliability theory, representing different aspects that can be analyzed by both methods, synchronic and diachronic. If document citations are considered as a way to use information in the scientific communication process, the "technical reliability" of a scientific article expresses the realization of the intended function; i.e., to be read, to have some impact on scientific research and that its reliability can be measured by citations. As with any other technology that does not function correctly, it can be considered that an article never cited only performed its intended function satisfactorily at the time of its publication. Therefore, the concept of "technical reliability" implies a diachronic perspective (prospective).

More recently, Zafrunnisha & Reddy (2010) studied the obsolescence of Ph.D. theses in Psychology from 1963 to 2005 in four universities in India. They found the half-life for this literature is 14 years for articles and 19 years for books.

Theoretical model

Literature obsolescence is measured through the citation analysis technique. This technique presumes an association relationship between the cited document and the citing document. Authors persistently and constantly cite more current documents to the detriment of older documents, which are set aside in their frequency of use (citations), and are condemned to obsolescence, because few people or nobody uses them (cite). This idea of a relationship between citing documents and cited documents makes up the theoretical model of this research and is presented in Figure 1. This article will be based on literature published on "Lotka's law" from 1926 to 2010. Until 2010, 663 documents were published in different languages, from which only the citations of 86 documents published between 2007 and 2010 were considered.

The elaboration logic of new research documents suggests that any author having written an article in 2008 on Lotka's law had 605 documents available, produced up to the previous year (2007), to be retrieved, reviewed and cited. Likewise, any author having written in 2009 an article on Lotka's law had available the 605 documents produced until 2007 plus 27 documents published in 2008; i.e., a total of 632 publications to be retrieved, reviewed and cited. Similarly, an author having written in 2010 an article on Lotka's law had available the documents produced until 2007 (605 documents), plus those produced in 2008 (27 documents), plus those produced in 2009 (28 documents) for a total of 663 documents to be retrieved, reviewed and cited. In this potentially citable literature is where literature obsolescence is intended to be measured. It is expected that citations to previous documents, if information obsolescence exists, be exponential as those observed in other researches and listed in the literature review. The absence of this scatter plot dispersion in the observed data would indicate that obsolescence does not exist and the cause of this form of dispersion of the cited literature would have other unknown causal variables not analyzed in this work.
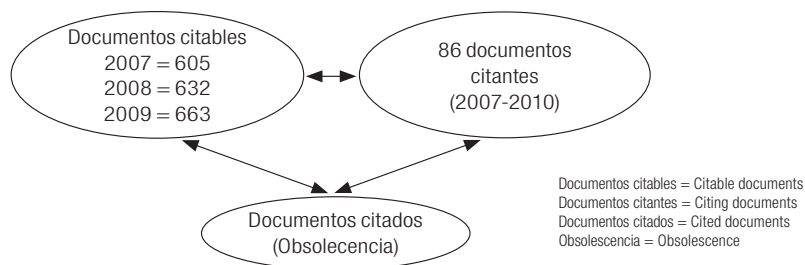

Documentos citables = Citable documents
Documentos citantes = Citing documents
Documentos citados = Cited documents
Obsolescencia = Obsolescence

Figure 1. Theoretical model of the research.

METHODOLOGY

In order to identify published documents, a search in all databases of DIA-LOG was performed with the terms Lotka?(5n)Law?. This search strategy resulted in a total of 515 records, which after depuration of duplicates and false retrievals the total was 457 bibliographic references. These 457 references were transferred to Pro-Cite 5.0 for the elaboration of a specific database for this subject. In addition, searches were performed in the Information Science Abstract (ISA), Library Literature (LL) and Library and Information Science Abstract (LISA), Web of Knowledge, Scopus and Latin-American databases such as Infobila of Mexico and LICI from the *Instituto Brasileiro de Informação em Ciência e Tecnologia* (IBICT). Likewise, Chinese databases were consulted with China Academic Journals via EastView Online Services and Japanese databases via CiNii: Citation Information by National Institute of Informatics, Japanese Scholarly & Academic Information. Thus, an analytic bibliography on Lotka's law was gathered listing a total of 691 bibliographic references, including journal articles, book chapters, papers presented in congresses, brochures and letters to editors of specialized journals in Library and Information Science, produced and published from 1926 until December 2011.[1] From these 691 documents included in the database in Pro-Cite 5.0, only documents published in 2008 (27 documents), 2009 (31 documents) and 2010 (28 documents) were used as base documents, for a total of 86 documents, from which citations refering to the 663 documents published between 1926 and 2007 were isolated.

The exponential model was considered to measure data of retrieved citations, a model that published literature suggests to better describe the observed distribution of citations. The exponential decrease represents a reduction of the population in a fixed ratio in each time unit. It also considers a constant decrease rate with an undefined decrease limit. The model not only offers a mean decrease rate, but provides a duplication rate of that decrease; i.e., a rate in which the population size is reduced to a half. According to Egghe & Ravichandra Rao (1992b: 201), only "the obsolescence factor a must be determined, since both half-life and the utility factor are simple functions of a". Mathematically, this function is represented as:

$$c(t) = \theta e^{-\theta t} \tag{1}$$

for $t \geq 0$ and when parameter $\theta > 0$.

---

1 The author keeps a bibliographic database in Pro-Cite 5.0 on this subject, which he continuously updates as years go by, adding new records permanently.

Based on this proposal, obsolescence factor a is defined as

$$a\left(t\right) = a = \frac{c\left(t+1\right)}{c\left(t\right)} \tag{2}$$

In the case of equation (2), $a(t)$ is independent from t, so

$$a\left(t\right) = \frac{\theta e^{-\theta\left(t+1\right)}}{\theta e^{-\theta t}} = e^{-\theta}$$

that Egghe & Ravichandra Rao (1992a) define as the aging factor

$$a = e^{-\theta} \tag{3}$$

However, in practice many fluctuations occur in the values of citations with zero years of obsolescence or with the first five years of obsolescence. The best way to overcome this issue was proposed by Brookes (1973). Then, presuming equations (1) and (2) are true, it can be stated that

$$c\left(t\right) = \theta a^{t} \tag{4}$$

If m indicates the total number of citations to publications with t years old,

$$m = \theta a^{t} + \theta a^{t+1} + \dots$$
$$m = a^{t}\left(\theta + \theta a + \theta a^{2}\right)$$
$$m = a^{t} T$$

where T indicates the total number of citations. Therefore,

$$a = \left(\frac{m}{T}\right)^{1/t} \tag{5}$$

However, in general, data of citations do not fit to equation (1) and show a different outline. Outlines of data most frequently found in researches show an initial growth of citations followed by an exponential decrease. Then, "there is no way to find an aging factor a independent from t: a is only independent from t in the case of exponential distribution" (Egghe & Ravichandra Rao, 1992b: 203). For this reason, these authors recommend the use of the half-life and state that total utility factor U is directly related to the aging factor through the formula:

$$U = \frac{1}{1-a} \qquad (6)$$

for $t \geq 0$.

Certainly, frequency of citations in literature published in any knowledge area decreases in time, so the older the document, the lower its possibilities to be cited, but how this decrease happens is unknown. Therefore, by studying literature obsolescence, a relationship is suggested between the age of literature (independent variable), measured in years, and the number of citations (dependent variable), measured in volume of produced citations. This relationship can be statistically modelable, in such a way that a dispersion graph (scatter plot) is built to evaluate the fit of the model based on the observed data. This allows us to evaluate if certain regularity exists in the distribution of the observed frequencies, and when that regularity is similar to the curve shown in the scatter plot, this curve is fitted through a nonlinear regression. The exponential distribution will evaluate if the frequency of citations in documents according to the years *(t)* derives from a nonlinear distribution. That is, the probability that the frequency of citations in the sample is equally probable for all citations in the same situation. As a high correlation between dependent and independent variables is expected, that correlation will be explored through Pearson's correlation coefficient. The analysis of variance and the calculation of the slope and the intercept of the exponential distribution were carried out using the estimation method of nonlinear regression curve with the statistical software SPSS 17.0 and Mathematica 5.0 for Windows.

Results

In spite of those affirming that researches in this area "have been exhaustively analyzed and demonstrated since 1926, so currently it can be considered these conform part of the bibliometrics knowledge and little new information can be contributed [...] and these are no longer beneficial or no more works are published on this subject" (Referee of the *Revista Española de Documentación Científica*, 2011), the interest to investigate this field still is in permanent growth, so much so that in these three years (2008-2010) 15% of the total documents existing until 2007 were incorporated into this subject. Not for nothing Urbizagástegui (2009: 120) affirms that this area grows with an annual rate of 7% and duplicates its volume every 10.2 years. However,

obsolescence of this published literature, languages in which it is written, or citations of these documents have not been studied. Naturally, the language of the published document and the language of citations referenced in publications have obvious implications in literature obsolescence. Table 1 depicts the languages of the 86 documents studied by year of publication.

Table 1. Languages of documents published by years.

Years	English	Portuguese	Chinese	Spanish	Turkish	German	Total
2008	16	5	3	2	1	-	27
	(59.3)	*(18.2)*	*(11.1)*	*(7.4)*	*(3.7)*	-	*(100.0)*
2009	21	4	3	2	-	1	31
	(67.7)	*(12.9)*	*(9.7)*	*(6.5)*	-	*(3.2)*	*(100.0)*
2010	26	1	-	1	-	-	28
	(92.9)	*(3.4)*	-	*(3.4)*	-	-	*(100.0)*
Total	63	10	6	5	1	1	86
	(73.3)	(11.6)	(7.0)	(5.8)	(1.2)	(1.2)	(100.0)

* Numbers in parenthesis indicate percentages.

English language (73%) dominates the production of documents, followed by publications in Portuguese (12%), Chinese (7%) and Spanish (6%). Publications in Turkish and German are less significant and represent just 1% of the total documents published in the studied period. Consistently over the years, three times more documents are published in English than in the other languages about Lotka's law.

Table 2 shows the languages cited by the 63 documents published in English in the study period (2008-2010). Consistently over the years, those publishing in English only cite documents in English. For example, 16 documents were published in English in 2008 and these documents cited 358 times other documents also published in English, representing 98% of the total number of documents cited that year. Likewise, in 2009, documents written and published in English were cited 662 times, representing 94.4% of the total number of documents cited that year. From the 26 documents published in English in 2010, all (100%) only cited other documents published also in English. In general, in the 3-year period analyzed, 97% of citations are from documents published in English.

Table 2. Citations of documents published in English.

Years	No. docs.	Citations in English	Citations in French	Citations in German	Citations in Dutch	Citations in Spanish	Citations in Portuguese	Citations in Catalan	Total citations

2008	16	358	3	1	1	1	1	-	365
		(98.0)	(0.82)	(0.3)	(0.3)	(0.3)	(0.3)	-	(100.0)
2009	21	625	1	-	-	30	3	3	662
		(94.4)	(0.15)	-	-	(4.5)	(0.45)	(0.45)	(100.0)
2010	26	491	-	-	-	-	-	-	491
		(100.0)	-	-	-	-	-	-	(100.0)
Total	63	1474	4	1	1	31	4	3	1518
		(97.0)	(0.3)	(0.07)	(0.07)	(2.0)	(0.3)	(0.2)	(100.0)

* Numbers between parenthesis are percentages.

Table 2 also shows an anomalous behavior in 2009. In that year, 30 citations were generated in Spanish, but these citations derived from a single document published in English whose author lives and work in a Spanish-speaking region, but is forced to publish in English because it seems this way the document will be more visible and ensure a broad international dissemination; in other words, the author is seeking the way "to reach a fairer visibility of our scientific production in information sciences" (Miranda, 1981; 1982).

Three variables could be involved here: one can be the endogamy of those publishing in English claiming that "the language of science is English" (Price, 1971; Baldauf, 1986) and are not concerned in consulting documents in languages other than English because they underestimate documents published in other languages. Another variable can be the lack of familiarity or ignorance of foreign languages, it would seem that those whose native language is English do not know other language and this reinforces the endogamic behavior. The last variable can be the accessibility to documents produced in languages other than English, but since this subject is mostly published by specialists in Library and Information Science, who know all mechanisms to retrieve required information, there is no apparent reason to explain this variable of document access. It is hard to believe that accessibility may be one of the factors driving the lack of concern to cite documents published in languages other than English. Maybe it could be argued cost is involved, but that variable does not seem feasible either. Therefore, the thesis of endogamy is reinforced.

This does not seem to occur with those publishing documents in other languages. *Table 3* shows the documents published in Portuguese. The 10 documents published in the study period included a total of 353 citations to other documents published from 1926 to 2007. From these 353 citations, 44% were to documents published in Portuguese and 52% to documents published in English. Only in 2010, a high concentration of citations to documents in Por-

tuguese (86%) was observed. Citation to publications in English seems to be permanent, consistent and similar to publications in Portuguese. Citation of publications in other languages is less significant, i.e., the follow-up of publications in Spanish, French and German is almost nonexistent. Clearly, authors publishing in Portuguese cite the production of those publishing in English, along with that published in their domestic cultural context.

Table 3. Citations of documents published in Portuguese.

Years	No. docs.	Citations in Portuguese	Citations in English	Citations in Spanish	Citations in French	Citations in German	Total cita-tions
2008	5	85	62	4	-	-	151
		(56.3)	*(41.0)*	*(2.6)*	-	-	*(100.0)*
2009	4	39	118	7	2	-	166
		(23.5)	*(71.0)*	*(4.2)*	*(1.2)*	-	*(100.0)*
2010	1	31	3	-	-	2	36
		(86.1)	*(8.3)*	-	-	*(5.5)*	*(100.0)*
Total	10	155	183	11	2	2	353
		(44.0)	*(51.9)*	*(3.1)*	*(0.56)*	*(0.56)*	*(100.0)*

* Numbers between parenthesis are percentages.

This behavior is similar among those publishing in Spanish. From the five documents published in this language in the study period (see *Table 4*), 37% are citations to documents of the same language; 58% to documents published in English; 3% to documents in French and 2% to documents in Portuguese. In this case, endogamic behavior does not seem to have a predominant role. With the exception of 2009, one fifth of citations is directed to documents published in English. Therefore, those publishing in Spanish are also aware of documents published in their own language and documents published in English.

Table 4. . Citations of documents published in Spanish.

Years	No. docs.	Citations in Spanish	Citations in English	Citations in French	Citations in Portuguese	Total citations
2008	2	18	6	4	-	28
		(64.3)	*(21.4)*	*(14.3)*	-	*(100.0)*
2009	2	9	59	-	2	70
		(13.0)	*(84.0)*	-	*(3.0)*	*(100.0)*
2010	1	18	5	-	-	23

		(78.3)	(21.7)	-	-	(100.0)
Total	5	45	70	4	2	121
		(37.2)	(57.9)	(3.3)	(1.7)	(100.0)

* Numbers between parenthesis indicate percentages.

This confirmation brings disastrous consequences for authors publishing in languages other than English. Since literature obsolescence is measured through citations of documents, who publishes in English only cites documents published in English, and documents published in English are more numerous (73%), the documents published in other languages come to life with no possibility of being read by that "international community" to which a "fairer visibility" is demanded (Miranda, 1981; 1982). That is, those not publishing in English write for a public that is not going to read or cite these documents because they do not cite documents in languages other than English, either because they are not familiarized with other languages, or due to the endogamy that characterizes them. So, if obsolescence exists, it will only occur among documents published in English, since documents published in other languages come to life obsolete even before being written. Therefore, the consumption of information produced in languages other than English will be restricted to the region where it is produced, that is, to a local consumption among those who know the author's language.

The 86 documents of the sample were produced by 95 authors, who in the study period received a total of 416 citations. Bradford's law was used to identify the most cited authors resulting in three consistent zones.[2] The zonal division is included in *Table 5*. The central nucleus is formed by 6 authors cited on average 24 times; the succeeding zone includes 16 authors, cited on average 8.5 times, and a dispersion zone formed by 73 authors cited on average 2 times in the three

2   One of the reviewers of this article states that "There are serious doubts about the use of Bradford's law to qualify the distribution of citations of the authors in this area: it is not demonstrated in the text or supported in the compared literature, that citations follow a similar model to that of literature distribution in the sources in which these are published. The fact that the law can be applied does not imply it makes sense to apply it. Alternative methods to describe such distributions exist, such as the use of quartiles, deciles or graphical representations like Box-plot diagrams" (Reviewer No. 1). Without engaging in any unnecessary controversy, is common sense not to use "quartiles, deciles or graphical representations like Box-plot diagrams" to identify the most cited authors. And since this reviewer demands "hired literature" I only mention Hubert (1978) and Yablonsky (1980), who discussed the equivalence of Bradford's law, Lotka's law and Zipf's law. However, Chen & Leimhkuler (1986) derived a functional relationship common between these three bibliometric laws. Therefore, it is legitimate to apply one law or another to citations, it only requires creativity. This same assessor demands the inclusion of citations data, but since these cover from 1926 to 2010 they require three pages, making this article longer than the extension allowed by the journal, which is already requesting a smaller extension. Thus, those interested in these data can request them directly from the author, who will gladly provide them.

years studied. Until 2010, a total of 728 authors had participated in the publication of at least one article, but only 13% of the authors active in this discipline were cited. In other words, 87% of the authors producing literature on this subject are not read or cited. This means that barely 0.8% of the authors active in this field has been cited 19 times or more in the studied period and most of these authors write and publish in English.

Table 5. Authors according to Bradford's zonal division.

Zones	No. of authors	No. of citations	Citation average
1	6	144	24.0
	(6.3)	(34.6)	
2	16	136	8.5
	(16.8)	(32.6)	
3	73	136	1.9
	(76.8)	(32.6)	
Total	95	416	4.4

* Numbers between parenthesis indicate percentages.

If authors who have been cited one or more times are considered, hardly 6% of them are cited continuously in one third of the documents, and two thirds of the documents cite only 23% of the observed authors. That is, in this discipline, barely 23% of the observed authors have possibilities to survive, escape from obsolescence and be visible to a community called "international". From the 728 authors active in this subject only 95 of them were cited one or more times between 2007 and 2010. Additionally, only 22 of them were cited more than 4 times. These 22 authors are the ones who have the greatest possibilities of establishing in the discipline, survive and escape of obsolescence. *Figure 2* shows the outline in semilogarithmic scale of the observed data. The outline clearly shows a Bradfordian behavior with an initial concave portion subsequently transforming into a straight line indicating the authors' dispersion. The nucleus is formed by the 6 first authors listed in *Table 6*.

No. de autores = No. of authors
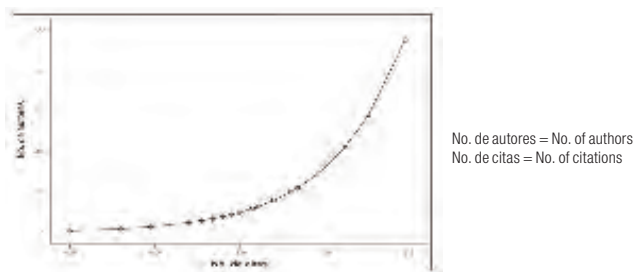No. de citas = No. of citations

Figure 2. Outline of authors according to citations.

Although it was already demonstrated that the inverse square model proposed by Lotka (1926) does not support a statistical test and that other alternative models have been proposed to better predict authors' productivity, like the generalized inverse power model, generalized inverse Gaussian-Poisson model, and Poisson log-normal, among others, this author is still very cited. The mechanism of obliteration by incorporation seems to be inapplicable in the case of Alfred J. Lotka. The same can be said about Price's text, since the chapter "Galton revisited" in his book Little Science, Big Science (Price, 1963) is the third most cited (17 times) followed by Price's article (1976), which is cited 5 times.

Table 6. Most cited authors.

Authors in the nucleus	No. of citations
Lotka, Alfred J	39
Pao, Miranda Lee	24
Price, John Derek de Solla	22
Rousseau, Ronald	20
Nicholls, Paul Travis	20
Egghe, Leo	19
Authors in the succeeding zone	No. of citations
Potter, William Gray	16
Vlachý, Jan	14
Urbizagástegui Alvarado, Rubén	12
Chung, Kee H.	11
Patra, Swapan Kumar	10
Kretschmer, Hildrum	10
Bookstein, Abraham	8
Newby, Gregory B.	7
Rowlands, Ian	6
Gupta, B. M.	6
Schorr, Alan Edward	5
Nath, Ravinder	5
Sen, B. K., Che	4
Radhakrishnan, T.	4
Kuperman, Victor	4
Huber, John C.	4

The second most cited is Miranda Lee Pao, but citations to this author include 4 different documents. The most cited document is Pao (1985) which

is cited 14 times followed by Pao (1986) which is cited 8 times and other two documents with one citation each. From Ronald Rousseau 5 different documents are cited, being the Rousseau & Rousseau document (2000) the most cited (13 times), Rousseau (1992) 2 times, Rousseau (1993) 2 times and other two documents with one citation each. From Paul Travis Nicholls 4 different articles are cited, Nicholls (1989) 9 times, Nicholls (1986) 9 times and Nicholls (1987, 1988) 2 times each one. From Leo Egghe 14 different documents are cited, one 4 times (Egghe, 2005a), another 2 times (Egghe, 2005b) and the remaining one citation each. In general, authors in the nucleus have diverse amounts of publications with different frequencies of citation. This same behavior pattern is repeated with authors in zone 2 located in the succeeding zone. In other words, the more published documents, the more possibilities of being cited.

Figure 3 shows the distribution of citations ordered from the newest to the oldest. Although a growth in citations can be observed for the first 5 years, no defined obsolescence pattern is observed, since the oscillation of citations represented in the bar graph is notorious. For example, the most elevated bars represent, respectively, the most cited publications of authors like Alfred Lotka, Miranda Lee Pao, John Derek de Solla Price, Ronald Rousseau, Paul Travis Nicholls and Leo Egghe. If it had not been for these authors, citations would be grouped in four well-differentiated sections, three of these groups very integrated and the last very dispersed.
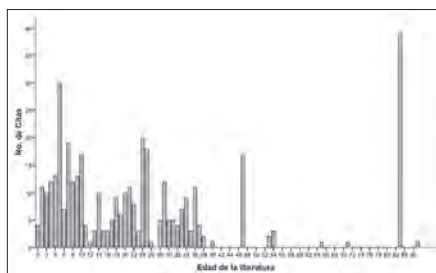

Figure 3. Distribution of citations according to the age of the literature.

No defined obsolescence pattern exists. An exponential pattern of obsolescence would show a decrease from the initial point constantly descending up to the end of the distribution. This decrease is not clearly observed in the bar graph in *Figure 3*. That decrease should be very similar to the outline in *Figure 4*.
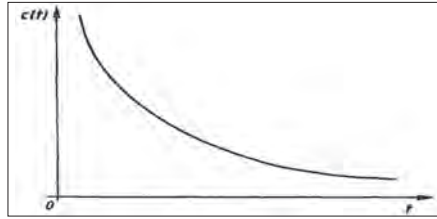
Figure 4. Exponential model of obsolescence.

A log-normal pattern of obsolescence would show a very slow initial increase, reaching a maximum level in the first four or five years. From that maximum inflection point, it would begin to descend up to the end of the distribution. That initial growth, despite it seems to appear in the first five years, is very irregular and does not represent an actual and consistent log-normal process of obsolescence (*Figure 3*). A log-normal decrease model is shown in *Figure 5.*
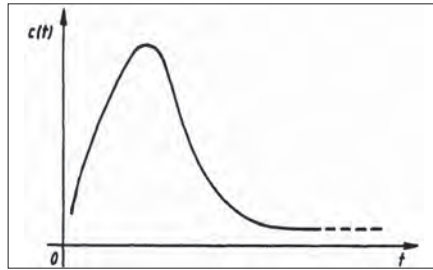

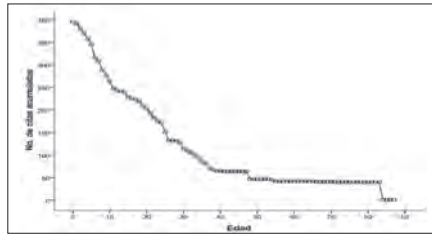Figure 5. Log-normal model of obsolescence.

Figure 6. Distribution of observed accumulated citations according to age.

The distribution of accumulated citations by age seems to produce an exponential distribution of obsolescence (*Figure 6*). An exponential decrease can be seen as cited literature ages; also, a trend is evident, high values of frequencies of citations are associated with the age of most recent literature. Lower values of frequencies of references are associated with older literature cited.

The nonlinear exponential function proposed by Egghe & Ravichandra Rao (1992b) was estimated using the statistical software SPSS 17.0 for Windows. A nonlinear regression resulted in an adjusted r2 estimate of 0.985, which indicates that more or less 98% of variations in the frequency of citations are due or dependent on variations from the age of literature. The estimated value of C was equal to 407.069 and the value of g was equal to -0.961. These values produced an asymptotic standard error of 5.098 for g and 0.001 for C. The obsolescence equation estimated with the nonlinear maximum likelihood method with 86 degrees of freedom is

$$C(t) = 407.069 \, (-0.961)^t$$

indicating that literature declines at a rate of 3.9% per year and reaches a mean aging rate at the age of 17.4 years.

Figure 7 shows the observed and estimated values of accumulated frequency versus age of citations. This figure provides a visual indication of the way in which frequency of citations and age of literature covaries negatively with a vertical decrease in the first 40 years. An exponential decrease can be observed as cited literature ages; also, a trend is evident, high values of frequencies of citations are associated with the age of most recent literature, and lower values of frequencies of references are associated with older literature cited.

Figure 7. Observed and calculated values of citations according to age.

Edad de las citas = Age of citations
No. de citas = No. of citations
Observado = Observed
Estimado = Estimated
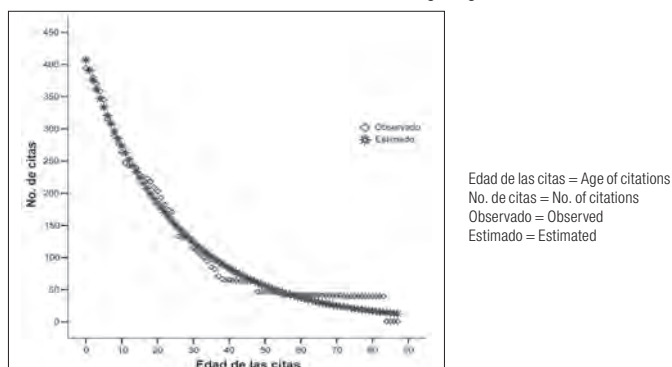
CONCLUSIONS

Reviewed literature establishes that a document is obsolete when it is no longer cited, i.e., when it is no longer used by an academic community as a source of information to justify, argue or contradict the statements or findings reported by other authors. The results of this study show that other variables can be influencing obsolescence and that, in general, these variables are not mentioned in the literature dedicated to analyze the phenomenon known as "literature obsolescence". In the case of literature on Lotka's law, one of these factors is the mother tongue of the document's author. Language of publication is a factor with a high impact on a document's obsolescence. In the literature published on Lotka's law, a high percentage of documents is published in English, but these documents only cite other documents also published in English, showing an endogamic behavior, if not ethnocentric, of authors publishing in English. This confirmation is extremely unfavorable for those publishing in other languages since their publications will not be cited by that community called "international". An "international" community should be capable to read, understand and cite research production in at least two or three languages other than the language of the author's cultural context. Not doing it implies an endogamic and ethnocentric behavior. That endogamic behavior is not produced among authors publishing in languages other than English. These authors attentively follow not only what is being produced in their own languages, but also what is being produced in English. The cases of authors publishing in Portuguese and Spanish illustrate this type of behavior.

The outline of the scatter plot distribution of nonaccumulated literature on Lotka's law published from 1926 until 2010 does not show a defined obsolescence pattern, but a group of data in three random groups, indicating the absence of the "obsolescence" phenomenon. However, the distribution of synchronically accumulated citations according to the age of cited literature produces an exponential decrease. This exponential form shows an aging rate of 3.9% per year, relating a mean aging rate to an age of 17.4 years. But these results seem to be more an artifice of data accumulation than actual literature obsolescence. This is demonstrated by nongrouped data which do not show an obsolescent decrease according to the age of cited literature.

References

Abramescu, A. (1979), "Actuality and obsolescence of scientific literature", in *Journal of the American Society for Information Science*, vol. 30, no. 5, September, pp. 296-303.

Ahmed, Tanzila; Johnson, Ben; Oppenheim, Charles & Peck, Catherine (2004), "Highly cited old papers and the reasons why they continue to be cited: Part II. The 1953 Watson and Crick article on the structure of DNA", en *Scientometrics*, vol. 61, No. 2, pp. 147-156.

Baldauf, R. B. (1986), "Linguistic constrains on participation in psychology", in *The Psychologist*, vol. 41, pp. 220-240.

Bernal, J. D. (1958), "The transmission of scientific information", in *Proceedings of the International Conference on Scientific Information*, Washington, D.C.: NAS, NRC, vol. 1, pp. 77-96.

Bourne, Charles P. (1962), "The world's journal literature: an estimate of volume, origin, language, field, indexing and abstracting", in *American Documentation*, vol. 13, No. 2, April, pp. 59-168.

—— (1965), "Some user requirements stated qualitatively in terms of the 90 per cent library", in Allen Kent & Orrin E. Taubee (eds.), *Eletronic Information Handling*, Washington, D.C.: Spartan Books, pp. 389-401.

Brookes, Bertram C. (1970a), "Obsolescence of special library periodicals: sampling errors and utility contours", in *Journal of the American Society for Information Science*, vol. 21, September, pp. 320-329.

—— (1970b), "The growth, utility and obsolescence of scientific periodical literature", in *Journal of Documentation*, vol. 26, No. 4, December, pp. 83-294.

—— (1972), "The aging of scientific literature", in *Problems of Information Science: collection of papers,* A. I Cherny (ed.), Moscow: International Federation of Documentation, Study Committee "Research on Theoretical Basis of Information", pp. 66-90.

—— (1973), "Numerical methods of bibliographical análisis", in *Library Trends*, vol. 22, No. 1, July, pp. 18-43.

Bronmo, Ole A (1978), "On the influence of availability on the use of Monographs in library criticism", in *Tidskrift for Dokumentation*, No. 34, pp. 81-83.

Bulick, Stepehen *et al.* (1976), "Use of library materials in terms of age", in *Journal of the American Society for Information Science*, No. 27, May/June, pp. 75-178.

Burrell, Quentin L. (2002a), "Will this paper ever be cited?", in *Journal of the American Society for Information Science*, vol. 53, No. 3, pp. 232-235.

—— (2002b), "The nth-citation distribution and obsolescence", in *Scientometrics*, vol. 53, No. 3, pp. 309-323.

—— (2003a), "Age-specific rates and the Egghe-Rao function", *Information Processing and Management,* vol. 39, No. 5, September, pp. 761-770.

—— (2003b), "Predicting future citation behavior", in *Journal of the American Society for Information Science*, vol. 54, No. 5, pp. 372-378.

Burton, R. E. & Kebler, R. W. (1960), "The half-life of some scientific and technical literatures", in *American Documentation*, vol. 11, No. 2, January, pp. 18-22.

Chen, C. C. (1972), "The use patterns of Physics Journals in a Large Academic Research Library", in *Journal of de American Society for Information Science*, No. 23, pp. 154-270.

Chen, Ye-Sho & Leimkuhler, Ferdinand F. (1986), "A relationship between Lotka's law, Bradford's law and Zipf's law", in *Journal of the American Society for Information Science*, vol. 37, No. 5, September, pp. 307-314.

Egghe, Leo (1994), "A theory of continuous rates and applications to the theory of growth and obsolescence rates", in *Information Processing and Management*, vol. 30, No. 2, pp. 279-292.

—— (2005a), "The power of power laws and an interpretation of Lotkaian Informetric Systems as self-similar fractals", in *Journal of the American Society for Information Science and Technology*, vol. 56, No. 7, pp. 669-675.

—— (2005b), "Relations Between the Continuous and the Discrete Lotka Power Function", in *Journal of the American Society for Information Science and Technology*, vol. 56, No. 7, pp. 664-668.

—— & Ravichandra Rao I. K. (1992a), "Classification of growth models base on growth rates and its applications", in *Scientometrics*, vol. 25, No. 1, pp. 5-46.

—— & —— (1992b), "Citation age data and the obsolescence function: fits and explanations", in *Information Processing & Management*, vol. 28, No. 2, pp. 201-217.

—— & —— (2002), "Theory and experimentation on the most-recent-reference distribution", en *Scientometrics*, vol. 53, No. 3, pp. 371-387.

—— & Rousseau, Ronald (2000), "The influence of publication delays on the observed aging distribution of scientific literature", in *Journal of the American Society for Information Science*, vol. 51, No. 2, enero, pp.158-165.

Ewing, Gordon J. (1966), "Citation of articles from volume 58 of the Journal of Physical Chemistry", in *Journal of Chemical Documentation*, vol. 6, No. 4, November, pp. 247-250.

Gapen, D. Kaye & Milner, Sigrid P. (1981), "Obsolescence", in *Library Trends*, vol. 30, No. 1, Summer, pp. 107-124.

Glänzel, Wolfgang (2004), "Towards a model for diachronous and synchronous citation analyses", in *Scientometrics*, vol. 60, No. 3, pp. 511-522.

Gosnell, Charles F. (1943), *The rate of obsolescence in college library book collections as determined by the analysis of three selected list of books for college libraries*, Ph. D. Dissertation, New York: University of New York.

Gupta, B. M. (1998), "Growth and obsolescence of literature in theoretical population genetics", in *Scientometrics*, vol. 42, No. 3, pp. 335-347.

Gupta, Usha (1990), "Obsolescence of physics literature: exponential decrease of the density of citations to Physical Review articles with age", in *Journal of the American Society for Information Science*, vol. 41, No. 4, June, pp. 282-287.

Heisey, T. M. (1988), "Paradigm agreement and literature obsolescence: a comparative study in the literature of Dead Sea Scrolls", in *Journal of Documentation*, vol. 44, pp. 285-301.

Hubert, J. J. (1978), "A relationship between two forms of Bradford's law", in *Journal of the American Society for Information Science*, vol. 29, No. 2, pp. 159-161.

Line, M. B. (1993), "Changes in the use of literature with time: obsolescence revisited", in *Library Trends*, vol. 41, No. 4, Spring, pp. 665-678.

—— (1970a), "The 'half-line' of periodical literature: apparent and real obsolescente", in *Journal of Documentation*, vol. 26, No. 1, marzo, pp. 46-54.

—— (1970b), "Does physics literature obsolesce? A study of variation of citation frequency with time for individual journal articles in physics", in *British Lending Library Review*, vol. 2, pp. 84-91.

—— & Sandison, A. (1974), "Obsolescences and changes in the use of literature with time", in *Journal of Documentation*, No. 30, pp. 284-350.

Longyear, R. M. (1977), "Article citations and 'obsolescence' in musicological journals", in *Quarterly Journal of the Music Library Association,* vol. 33, pp. 563-571.

Lotka, Alfred (1926), "The frequency distribution of scientific productivity", in *Journal of the Washington Academy of Sciences*, vol. 16, No. 12, junio, pp. 317-323.

McCain, Katherine W. (1987), "Citation patterns in the history of technology", in *Library and Information Science Research*, vol. 9, pp. 41-59.

Miranda, Antonio Lisboa Carvalho de (1982), "Latin american periodicals in the field of library science: an analysis", in IFLA Conferencia Gral. (48: 1982: Montreal), Rio de Janeiro.

—— (1981), "Revistas especializadas brasileiras em biblioteconomia e ciencia da informação: com enfase na experiencia da ABDF", in *Boletim ABDF: Nova Serie*, Brasilia, octubre-diciembre, vol. 4, No. 4, pp. 30-42.

Nicholls, Paul Travis (1986), "Empirical validation of Lotka's Law", in *Information Processing and Management*, vol. 22, No. 5, pp. 417-419.

—— (1987), "Estimation of Zipf parameters", en *Journal of the American Society for Information Science*, vol. 38, No. 6, pp. 443-445. Notes: Errata (1988): *Journal of the American Society for Information Science*, vol. 39, No. 4, p. 287.

—— (1988), "Price's square root law: empirical validity and relation to Lotka's Law", in *Information Processing and Management*, vol. 24, No. 4, pp. 469-477.

—— (1989), "Bibliometric modeling processes and the empirical validity of Lotka's Law", in *Journal of the American Society for Information Science*, vol. 40, No. 6, pp. 379-385.

Pao, Miranda Lee (1986), "An empirical examination of Lotka's law", in *Journal of the American Society for Information Science*, vol. 37, No. 1, enero, pp. 26-33.

—— (1985), "Lotka's Law: a testing procedure", in *Information Processing and Management*, vol. 21, No. 4, pp. 305-320.

Price, John Derek de Solla (1965), "Networks of scientific papers", in *Science*, vol.149, No. 3683, pp. 510-515.

—— (1963), "Galton revisited", in *Litle Science, Big Science*, New York, N.Y.: Columbia University Press, pp. 33-61.

—— (1971), "The expansion of scientific knowledge", in *Annals of the New York Academy of Sciences*, New York, vol. 184, pp. 257-259.

—— (1976), "A general theory of bibliometric and other cumulative advantage processes", in *Journal of the American Society for Information Science*, vol. 27, núm. 5/6, pp. 292-306.

Ravichandra Rao, I. K. & Meera, B. M. (1992), "Growth and obsolescence of literature: an empirical study", International Conference on Bibliometrics, Scientometrics, and Informetrics (1991, Bangalore, India), in *Informetrics 91: selected papers from the third International Conference on Informetrics*, 9-12 de agosto, Bangalore: Sarada Ranganathan Endowment for Library Science, pp. 377-394.

Referee of REDC (Revista Española de Documentación Científica), communication sent to Rubén Urbizagástegui on Friday June 24, 2011.

Rousseau, Ronald (1992), "Breakdown of the robustness property of Lotka's Law: the case of adjusted counts for multiauthorship attribution", in *Journal of the American Society for Information Science*, vol. 43, No. 10, pp. 645-647.

—— (1993), "A table for estimating the exponent in Lotka's law", in *Journal of Documentation*, vol. 49, núm. 4, pp. 409-412.

Rousseau, Brendan & Rousseau, Ronald (2000), "LOTKA: A program to fit a power law distribution to observed frequency data", in *Cybermetrics*, vol. 4, No. 1, pp. 1-6.

Sandison, A. (1971a), "The use of older literature and its obsolescence", en *Journal of Documentation*, vol. 27, No. 3, pp. 184-199.

—— (1971b), "Library optimum", in *Nature*, núm. 234, pp. 368-379.

—— (1974), "Densities of use, and absence of obsolescence in Physic journal at MIT", in *Journal of the American Society for Information Science*, vol. 25, No. 3, May-June, pp. 172-182.

—— (1975), "Patterns of citation densities by date of publication in Physical Review", in *Journal of the American Society for Information Science*, vol. 26, No. 6, pp. 349-351.

Stinson, Eddie Ray (1981), *Diachronous vs. synchronous study of obsolescence*, Thesis (Ph. D.), University of Illinois at Urbana-Champaign.

—— & Lancaster, F. W. (1987), "Diachronous vs. synchronous methods in the measurement of obsolescence by citation Studies", in *Journal of Information Science*, vol. 13, No. 2, pp. 65-74.

Seymour, Carol A. (1972a), "Weeding the collection: a review of research on identifying obsolete stock: monographs (part 1)", in *Libri*, No. 22, pp. 137-148.

—— (1972b), "Weeding the collection: a review of research on identifying obsolete stock: serials (part 2)", in *Libri*, No. 22, pp. 183-189.

Taylor, Colin R. (1976-1977), "A practical solution to weedding University Library collections", in *Collection Management*, No. 1, Autumn-Winter, pp. 27-45.

Urbizagástegui Alvarado, Rubén (2009), "Crescimento da literatura e dos autores sobre a Lei de Lotka", in *Ciencia da Informação*, Brasilia, vol. 38, No. 3, September-December, pp. 111-129.

Van Raan, Anthony F. J. (2000), "On growth, ageing, and fractal differentiation of science", in *Scientometrics*, vol. 47, No. 2, pp. 347-362.

Wallace, Danny P. (1986), "The relationship between journal productivity and obsolescence", in *Journal of the American Society for Information Science*, vol. 37, No. 3, May, pp. 136-145.

Watson, James D. & Crick, Francis (1953), *Molecular structure of nucleic acids: a structure for deoxyribonucleic acid*, St. Albans: Fisher, Knight, 1953.

Yablonsky, A. I. (1980), "On fundamental regularities of the distribution of scientific productivity", en *Scientometrics*, vol. 2, No. 1, pp. 3-34.

Zafrunnisha, N. & Reedy, V. Pulla (2010), "Citations in Psychology PhD Theses: An Obsolescence Study", in *Library Philosophy and Practice*, vol. 7, No. 27, julio, pp. 1-8.

❧