A bibliometric study of taxonomic botany

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Abstract

Purpose – The aims of this paper are to: investigate the citation-patterns of monograph books in taxonomic botany (looking mainly at publications and publishers, and the age of current literature); and make recommendations for collections management and reference services in libraries that hold botany materials.

Design/methodology/approach – In total, 454 citations were collected at random from 47 botanical monographs published in 2009; a Bradford distribution of cited journals was produced; age-distributions of citations were devised; and other bibliographical characteristics were tabulated.

Findings – A small Bradfordian core of highly-cited journals and important publishers of monograph books were identified; monographs are cited more often than journal articles; older materials are more important than in other sciences; monographs are used by botanists for current awareness purposes; coverage of botanical journals by citation indexes is poor.

Research limitations/implications – The small size of the sample means that results were indicative. Further studies could: take larger samples; look at citations in journal articles, theses, conference proceeding; look at citations made over several years.

Practical implications – Librarians should: note the core botanical journals identified here; continue to acquire botanical monographs and to retain older materials; display new botanical monographs prominently and include them in current awareness services.

Originality/value – The bibliometrics of taxonomic botany have previously been little studied; likewise citations from monographs. This paper fills some of the gaps. Some of the bibliometric methods of J. M. Cullars were applied to botanical literature.

Keywords Bibliometrics, Citation studies, Monographs, Botany, Biology, Libraries, Research work, Serials

Paper type Research paper

Introduction

Citation studies of whole disciplines have tended to concentrate on the mathematical sciences, engineering and medicine; social sciences and humanities disciplines have also been studied; botany, however, has been relatively neglected. This study investigates the bibliometrics of taxonomic botany as a discipline and makes recommendations for managing botany collections and dealing with botanical

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reference queries in research and academic libraries. "Taxonomic botany" is taken to mean that branch of botany which distinguishes and describes species and other groupings ("taxa") of plants, and which names them and classifies them in relation to each other; it is also known as "systematic botany" or "plant systematics". It is the basis of plant sciences generally.

It may be thought that any given species of plant need only be identified, distinguished, named and classified once, and that the taxonomy of that plant is then permanently established. However, another, new species may be discovered in a remote corner of the world; or there may be a new discovery in physiological or genetic research – such discoveries may show that the present taxonomical view of the first type of plant is wrong, and needs to be changed. In this case a botanist must carry out a "revision" of the plant, which means carefully working over previous research to make sure that any rearranging that has to be done takes this research into account. The naming and renaming of species, in particular, follows an elaborate and conservative set of rules (International Code of Botanical Nomenclature, 2011). All progress in taxonomic botany is therefore accompanied by research into previous results, sometimes decades or even centuries old. This sets it apart from the physical sciences, where all but the most important research quickly ceases to be used. This is the first thing that makes taxonomic botany interesting from a bibliometric point-of-view.

The second thing is the greater importance which taxonomic botany attaches to the publication of work in monograph books. The "revisions" mentioned above, if they are of particularly large or complicated taxa, are often published as books; the other distinctive genre of botanical book is the "flora". A flora is effectively a hand-list of all the species of plant found in a particular geographical region, each presented with a taxonomic description, and entered according to its taxonomic classification. Compiling a flora requires a great deal of investigative field work, but again prior research must also be consulted, for a number of reasons: it may be that what the field-worker has taken to be a newly-discovered species has in fact already been discovered but has somehow not been recorded properly (e.g. mis-named or mis-classified); or that a species that had been recorded before is now more or less common than it used to be (or indeed is now extinct); or simply that previous floras dealing with the region are useful guides for new field work. Floras and revisions embody much of the most valuable and significant botanical research, and therefore both are of bibliometric interest.

Background

The use of bibliometrics to assess and to manage information services has been dealt with in some detail by information scientists. For example, Bradford originally developed his well-known theory of scattering of subject-relevant journal articles, in order to improve indexing and abstracting services (Bradford, 1971, pp. 144-159) and Garfield has long advocated the use of citation-data – especially of his impact factor (IF) – in the selection and de-selection of library stock (Garfield, 1972, 1977a, b). Not all researchers have been in favour of the use of bibliometrics. De Bellis (2009, pp. 95-105) and Wallace (1987), for instance, argue that it is wrong to manage a library for the use of, for example, undergraduates at a particular university, on the basis of the citation habits of scientists from all over the world (De Bellis, 2009, pp. 95-105; also Wallace, 1987); and Line and his colleagues have stated that it is after all "highly improbable

that citations reflect closely uses in any individual library" (Line, 1979a, p. 2; see also Line, 1977; Line and Sandison, 1974). Latterly, however, there has been a move away from this scepticism. Bensman (2001) and Corby (2003) both point out the usefulness of bibliometrics for library reference work and McDonald (2007) has even shown that the citing behaviour of authors is affected by the holdings of the libraries that they use, *i.e.* that there is a positive connection between citation and library use. New indices have also been developed, such as Hirsch's *h*-index (Hirsch, 2005), which was devised to assess research impact – this has also been adapted to assess journals (Braun *et al.*, 2006); Norris and Oppenheim (2010) give a comprehensive review of these developments. Consequently, it is not surprising that bibliometrics have ultimately found a place in standard modern textbooks on information needs-assessments and on collection management (Nicholas and Herman, 2009, pp. 150-152; Johnson, 2009, pp. 247-248; also Glänzel and Moed, 2002). In libraries, the most important *caveat* is that bibliometric data should be used alongside other data, such as circulation statistics and user surveys.

Different kinds of specialist information are often published in different kinds of document, for example, monographs. Bibliometric studies should take this into account – according to Line, any study of social science documents based solely on citations from "core" journals is likely to be "unrepresentative" (Line, 1979b). Several studies of citations from monographs have been successfully carried out: the DISISS project (Line, 1979a; Nicholas *et al.*, 1978) and Cronin's study (Cronin *et al.*, 1997) are good examples. Others have studied citations made *of* monographs, apparently taking their data from *ISI* Web *of Science* (Lindholm-Romantschuk and Warner, 1996; Tang, 2008). On a smaller scale, Cullars has studied citations taken from monographs in a number of humanities subjects. His two most recent studies are of particular interest here, because they deal with disciplines that appear to inhabit a border region between the humanities and other fields: analytic philosophy and linguistics (Cullars, 1998; Georgas and Cullars, 2005). He suggests that the comparative neglect of analytic philosophy by bibliometricians may be precisely as a result of its intermediate character as a discipline (Cullars, 1998) – here is a clear analogy with taxonomic botany, a science which is not quite like many other sciences.

de Solla Price explicitly identified taxonomic botany as a "strongly classic" discipline, placing it closer to social sciences and humanities than to the physical sciences, at least in terms of its citation-habits (de Solla Price, 1965, p. 514); Line and Sandison (1974, p. 317) made a similar assertion. Bibliometric studies have been carried out on the literature of botany, but they are few in number and often deal with isolated problems. The following are typical: a comparison of bibliometrics and peer-review methods in assessing biological (including botanical) research (Lovegrove and Johnson, 2008); studies of citations in issues of botanical journals in particular sub-disciplines (Biswas *et al.*, 2007; MacRoberts and MacRoberts, 1997); a survey of research on the marine botany of the Indian Ocean (Erftemeijer *et al.*, 2001); a survey of research on pomegranates (Al-Qallaf, 2009). These studies (and others like them) are disparate and so not easily comparable; they do not, taken together, provide a coherent picture of the literature of botany as a whole, or of taxonomic botany in particular.

Garfield published many short papers on botanical journals in the *SCI* (see Garfield, 1972, 1977a, b, c, d, e, 1979, 1980a, b, c, d, 1981a, b, c, 1990). He noticed that individual botanists were not among the 250 most frequently cited scientists whose articles

appeared in the *SCI*; that the majority of the articles most often cited in botany journals were not themselves published in botany journals; that (by contrast) non-botanical articles very rarely cited botanical ones; and that botanical journals had relatively low IFs. Two particular studies have set out to deal with the overall characteristics of botanical literature. The first, by Nordstrom (1987), analysed references in the 1985 numbers of two botanical journals. The second study, by Delendick (1990), analysed references in the 1986 numbers of three journals. He took into account references to monographs as well as to other journals. He criticised Garfield's assessment of botanical literature on the grounds that the *SCI* did not (in 1990) index articles from a number of the most important taxonomical journals, but tended to concentrate on physiological, biochemical and genetic botany.

From the foregoing review it is clear that there is work to be done on the bibliometrics of taxonomic botany: it is a discipline whose documents have bibliometric characteristics that set it apart from other scientific disciplines. It is also clear that bibliometric data have a place alongside other kinds of data in helping collections management and subject specialist librarians to do their jobs. These two considerations have determined the aims of this study.

Aims and objectives

This study has sought to clarify and quantify, by bibliometric means, notable characteristics of botanical documents: that they may remain useful for a long time after publication; and that monographs are more important to botanists than they are to scientists in other disciplines.

The main objectives were:

- To identify the "core" journals in taxonomic botany.
- To identify the most important publishers of monographs in taxonomic botany.
- To determine the importance of monographs compared to that of journals.
- To determine the age of current literature, and whether and to what extent its use changes over time.

The findings should be of use to librarians who may not be very familiar with botany, but who are responsible for managing collections which include specialist botany materials, or for dealing with reference queries on the subject in, say, a general university library. This study should provide librarians with evidence which supplements other, local, evidence, such as the results of user-profiling or user surveys, and of course local circulation statistics. The attention which this study devotes to monographs may also be of broader interest to librarians who work in collections management in fields other than botany, where monographs are still relatively important, such as the humanities and the social sciences.

Method

This research involved collecting and analysing citations taken from botanical monograph books. Taking citations from books has the advantage of enabling a better assessment to be made of the precise significance of books as opposed to journals within the field (which is one of the objectives of this study). It was intended that this citation-data should be collected in such a way as to make it comparable with data

from *ISI*, to further test this significance. The holdings of relevant monographs in the Library of the Royal Botanic Gardens, Kew, were taken as the sampling frame. This Library is widely acknowledged to be one of the most important botanical libraries in the world, and its holdings have been designated a national reference collection by Act of Parliament (National Heritage Act, 1983; Griffiths, 2011). It was therefore thought to provide as good a population of botanical books to work from as could be practically obtained.

The method and the scale of sampling followed the example of J. M. Cullars (Cullars, 1985, 1988, 1989, 1990, 1992,1996,1998). It was intended that at least 50 monographs would be used as source-documents. A total of 60 monographs were therefore selected, since it was thought unlikely that references could be obtained from all of them. Selection was semi-structured: 30 floras were selected, and 30 revisions and other monographs, in order to give equal representation to each type. It may be thought that this decision was arbitrary. However, it was stated at the outset that floras and revisions are of equal interest to the present study; and it was not part of this study to determine their relative importance, so intentionally to have given them equal representation in sampling has not, in fact, prejudged any results. The monographs were selected at random using the OPAC of the Library at Kew; from each monograph ten citations were then selected at random, giving approximately 500 in total. At both stages, random numbers were obtained using a web site intended for this purpose (Random.org, 2011). Citations were only taken from formal lists of references. Delendick decided to include so-called "internal citations" in his study where it was possible to identify them (Delendick, 1990, pp. 538-539). To do this with a large number of monographs would have been excessively time-consuming and so it was not attempted here (for some of the complications of traditional biological citations, see Williams (2011)).

When dealing with journal articles, bibliometricians tend to study citations made in a single year, on the grounds that journal articles are published relatively promptly according to an annual pattern; by contrast, it is arguable that the "slow, irregular and bulky transmission of knowledge" characteristic of book publishing ought not to be treated in the same way. Nicholas and Ritchie argue that one year's monographic publication within a field is unrepresentative of the literature of that field (Nicholas and Ritchie, 1978, p. 35, p. 40); yet one study of theirs dealt with monographs published only in 1971 (Nicholas *et al.*, 1978, p. 8). Some monograph citation-studies by Cullars also deal with citations from monographs published in a single year, so it was decided to follow this practice here (Cullars, 1989; Cullars, 1992; Cullars, 1998). Only monographs published in 2009 were selected, so that data from *ISI* could be compared with data from the present study (at the time of writing, data from 2009 were the latest which *ISI* had released).

Data were recorded both for source documents and for documents cited. First, basic bibliographical data were collected, i.e. author, title, journal title (where applicable, and with number, issue and page numbers), place of publication (including country), publisher, and date. The type of document cited was noted (book, article, conference proceedings, thesis, or grey literature). The language of the citing and cited documents was also recorded. In dealing with works by several authors, the first three authors only were recorded: this was intended to be a compromise, to avoid collecting too little

or too much data (Persson, 2001). Once citation-data were gathered, they were analysed using SPSS/PASW and MS Office Excel software.

- Citations to journals were tabulated by frequency and the journals ranked; it was then determined whether cited articles were distributed in a Bradfordian pattern among the journals (Garfield, 1981a; Hirst, 1978).
- Publishers of monographs were tabulated and ranked according to the number of citations made of their publications.
- Different types of document (including journal articles and monograph books) were tabulated and compared according to frequency of citation.
- Cited documents were distributed by age. The median age of citations (i.e. the "citing half-life" of the monographs) was calculated; but it was more meaningful to look at the distribution in terms of the "updating" and "normal" use of the documents (Line and Sandison, 1974). Two further age-distributions were produced, one of cited books and one of cited journals, in order to supplement the comparison of these two types of document.

Results

It was possible to obtain only 454 citations from 47 monographs – partly because some monographs were temporarily unavailable at Kew, and partly because some of them had fewer than ten bibliographical references. The number of citations was therefore smaller than was intended, but it should be noted that Cullars, whose sampling methods the present study imitates, has relied on samples that varied in size from as many as 581 citations (1992) to as few as 390 (1996).

"Core" journals

Table I shows the Bradford-type distribution of the frequency with which journals were cited. Traditionally, Bradford distributions are made by ranking journals in terms of the number of subject-relevant articles that they contain; here they were ranked by the number of citations that their articles had received instead. (This innovation was first made by Garfield, which is not surprising, since the assumption that citations can be treated as surrogates for subject-descriptors lies at the root of his citation-indexes.)

Table I.
Journal productivity of cited articles

Journal rank	Number of journals	Number of articles cited	Cumulative number of journals	Cumulative number of articles cited	Cumulative per cent of articles cited
1	1	10	1	10	4.5
2	1	9	2	19	8.6
3	1	8	3	27	12.2
4	1	7	4	34	15.4
5	1	6	5	40	18.1
6	2	5	7	50	22.6
7	4	4	11	66	29.9
8	13	3	24	105	47.5
9	12	2	36	129	58.4
10	92	1	128	221	100.0

The distribution was divided into three "zones" of a Bradfordian type – this seemed a reasonable number of zones considering the relatively small number of journals cited. In a Bradford distribution each zone produces the same number of cited articles, but the number of journals in each zone increases as the number of cited articles per journal decreases. The first zone is known as the "core". Of the 128 journals cited in the monographs, the 11 most highly cited journals (ranks 1-7) accounted for almost a third of all citations, while the 24 most highly-cited (ranks 1-8) accounted for nearly half. The boundary of the "core" group of journals was therefore observed to fall somewhere in rank 8 (i.e. somewhere between the 11th and the 24th most highly-cited journal). There is an established mathematical formula which shows whether citation-distributions are of a Bradfordian kind, and can show more precisely which journals fall into what parts of the distribution (Andrés, 2009, pp. 34-37). The numbers of journals in each zone are related to each other in the ratio:

$$1 : n : n^2 : n^3 \ldots \text{ and so on, for any number of zones.}$$

n is calculated as follows:

$$n = (e^{\gamma} \times Y_m)^{1/p} = 2.6115$$

where:

E = 2.7182 (Euler's Number).

Γ = 0.5772 (the Euler-Mascheroni Constant).

Y_m = maximum journal output (i.e. no. of articles cited from each journal in rank 1) = 10.

P = number of zones = 3

To determine which journals belong to the first zone, or core, of most highly-cited journals, the following formula is used:

$$r_0 \frac{T(n-1)}{(n^p - 1)}$$

where: r_0 = number of journals in the core group. T = total number of cited journals. So here:

$$r_0 = \frac{128(2.6115 - 1)}{(2.6115^3 - 1)} = 12.2706 \approx 12.$$

So the first 12 journals are the core journals here. How many journals fall into the second and third zones can be determined by applying the ratio 1: n: n^2:

$$r_1 = nr_0 = 2.6115 \times 12.2706 = 32.0447 \approx 32$$

and:

$$r_2 = n^2 r_0 = 2.6115^2 \times 12.2706 = 83.6847 \approx 84.$$

That the figures for each of these zones add up to 128, and that they correspond to the percentage distribution of articles *as observed* (see Table I), show that the

present figures really do fall into a Bradford curve. The 12 "core" journals are the following:

(1) *Kew Bulletin* (ten citations).
(2) *Bulletin de la Société Botanique de France* (nine).
(3) *Botanical Journal of the Linnean Society* (eight).
(4) *American Journal of Botany* (seven).
(5) *Systematic Botany* (six).
(6) *Canadian Journal of Plant Science* (five).
(7) *Watsonia* (five).
(8) *New Phytologist* (four).
(9) *Novosti sistematiki nizshikh rastenii* (four).
(10) *Taxon* (four).
(11) *Ukrainskii botanichnii zhurnal* (four).
(12) *Botaniska notiser* (three).

Most of these are well-known to botanists and are regarded as authoritative. (The presence of *Ukrainskii botanichnii zhurnal* and *Novosti sistematiki nizshikh rastenii* in this core group was an anomaly.) Seven of these core journals are indexed by *ISI Web of Science*:

(1) *New Phytologist* (I.F. for 2009 = 6.033).
(2) *Taxon* (2.747).
(3) *American Journal of Botany* (2.604).
(4) *Systematic Botany* (1.697).
(5) *Botanical Journal of the Linnean Society* (0.984).
(6) *Botaniska notiser* (0.868).
(7) *Canadian Journal of Plant Science* (0.609).

According to *ISI*, the aggregated (i.e. the mean) I.F. of all journals in the discipline "Plant sciences" in 2009 was 2.458; the median I.F. of these journals in 2009 was 1.218. Four of the "core" journals identified here had I.F.s exceeding the median I.F. for the discipline; three had I.F.s exceeding the mean.

Major publishers

Table II shows all the publishers of monographs whose publications were cited more than twice. The total number of monographs cited is 224; the total number of monograph publishers is 160. The nine publishers in Table II – 5.6 per cent of the total – account for 24.2 per cent of the cited monographs, and constitute a quasi-Bradfordian "core" of monograph publishers.

Monographs and journals compared

Table III shows the relative frequencies of citation of different types of document.

It is interesting that citations of monographs and of journal articles were so evenly balanced.

Number	Publisher	Citations	Per cent	Cumulative per cent
1	Cambridge University Press	8	3.6	9.9
2	Timber Press	7	3.1	13.0
3	[author]	4	1.8	14.8
4	Botanical Survey of India	4	1.8	16.6
5	Royal Botanic Gardens, Kew	4	1.8	18.4
6	Springer	4	1.8	20.2
7	Reeve	3	1.3	21.5
8	Science Press	3	1.3	22.9
9	Succulent Plant Trust	3	1.3	24.2

Table II. Publishers of monographs cited

	Citations	Per cent
Monograph books	224	49.3
Journal articles	221	48.6
Grey literature	4	0.9
Theses	4	0.9
Conference proceedings	1	0.2
Total	454	100.0

Table III. Cited document type

Current literature and changes in its use over time

The citation-frequency of all documents was found to be in approximately inverse proportion to their age. The nature of this inverse relation is shown by Tables IV and V. The sample-monographs cited documents between six and ten years old more than the

Age/years	Citations	Per cent	Cumulative per cent
0-5	61	13.4	13.4
6-10	77	17.0	30.4
11-15	51	11.2	41.6
16-20	34	7.5	49.1
21-25	39	8.6	57.7
26-30	23	5.1	62.8
31-35	22	4.8	67.6
36-40	23	5.1	72.7
41-45	20	4.4	77.1
46-50	9	2.0	79.1
51-60	19	4.2	83.3
61-70	6	1.3	84.6
71-80	6	1.3	85.9
81-90	8	1.8	87.7
91-100	5	1.1	88.8
101-150	34	7.5	96.3
151-200	10	2.2	98.5
201-300	6	1.3	99.8
301 or older	1	0.2	100.0
Total	454	100.0	

Table IV. Age of all documents cited

very newest documents – this is probably just because of the slowness with which the monographs were published. It is perhaps more significant that a majority of documents cited were over 20 years old.

The difference between the mean and the median age of the documents cited gives an idea of how "skewed" away from a normal distribution the present data are. Price's Index for the citing monographs – i.e. the per cent. of their references to documents not greater than five years old – is 13.4 per cent. In his own brief study, de Solla Price (1970, p. 15) remarked that "the taxonomic sciences" would probably rank somewhere near the humanities, i.e. around 10 per cent. The present data would prove him right, but for the fact that they are drawn from monographs, whereas de Solla Price was dealing with references in journal articles. In fact, botany journals had Price's Indices ranging from 21 per cent to 40 per cent (de Solla Price, 1970, pp. 16-21). Given the comparative slowness of book publishing, it is not surprising that the present figure is somewhat lower.

Figure 1 compares the frequency of citation of monographs and of journal articles of different ages up to 100 years old.

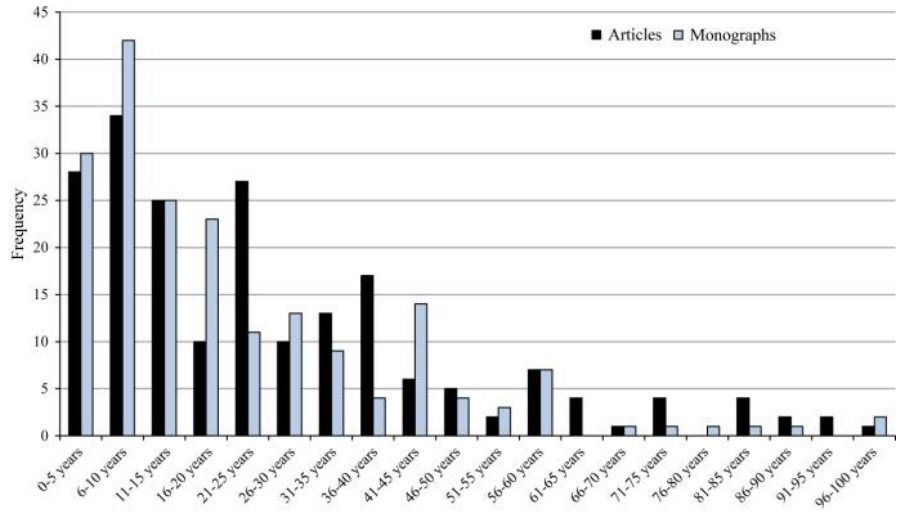
Table V gives the average ages of the different kinds of documents cited:

It is curious that the median age of articles cited was greater than that of monographs cited, and that Price's Index for references to journals (12.6 per cent) was

	Median/years	Mean/years	Standard deviation/years
All documents	21[a]	38	46
Journal articles	24	36	39
Monograph books	17	40	53

Note: [a] or "citing half-life" of source-monographs

Table V.
Average age of cited documents



Note: Up to 100 years old

Figure 1.
Age of cited articles and of cited monographs (up to 100 years old)

less than that for references to monographs (13.5 per cent). Since the point of academic journals is to foster current awareness of new research, Price's Index based solely on citation of them ought to have been greater than one calculated for books. Monographs were cited slightly more intensively than journal articles in what Line and Sandison (1974) called the "updating" (i.e. current awareness) phase of their useful lives as documents; but the patterns of "updating" and "normal" use of articles and of monographs were broadly similar – this is seen most clearly in Figure 1. It must be emphasised that this Linean view has only been indicated by the results, and not demonstrated, since this study was synchronous (based on citations made all at the same time) rather than diachronous (based on citations made over several years).

The mean age and standard deviation of cited journal articles were less than the mean and standard deviation of the ages of cited monographs. This greater chronological spread of cited monographs seems to reflect the fact that publishing in journals is a relatively new phenomenon, and that taxonomic botanists continue to cite monographs from a time when botanical journals hardly existed.

Citation indexes and taxonomic botany

It has emerged incidentally that taxonomic botany as a discipline is not served as well as it might be by citation indexes of journal articles. Of the 128 cited journals, only 41 were indexed on the *ISI Web of Science*, whereas *Scopus* indexed current material in fifty of them, and had more or less substantial back-files for another eight titles (ISI Web of Science, 2011; Scopus, 2011). Also, five out of the 12 "core" journals identified by this study were not indexed by *ISI*:

(1) *Bulletin de la Société Botanique de France*.

(2) *Kew Bulletin*.

(3) *Novosti sistematiki nizshikh rastenii*.

(4) *Ukrainskii botanichnii zhurnal*.

(5) *Watsonia* (i.e. *New Journal of Botany*, published by the Botanical Society of the British Isles).

Conclusions

There are several conclusions to be drawn from this study. The attempt to create a Bradford-type distribution of the bare frequencies with which journals were cited, was successful. A "core" of 12 most highly-cited journals has been identified. Most of these are already viewed as authoritative in the field, and this is confirmed by the present study.

This Bradford distribution could be improved, however. Its first problem is that there were 12 more journals that, like *Botaniska Notiser*, had three citations each, but they were cut out of the "core" group simply because of the alphabetical filing of their titles. This is misleading, and is really a consequence of the small size of the sample used for this study. Second, it is quite clear that *Novosti sistematiki nizshikh rastenii* (*Non-vascular Plant Systematics News*) and *Ukrainskii botanichni zhurnal* (*Ukrainian Botanical Journal*) are not really "core" journals, and have only appeared here because they were heavily cited by (respectively) the one Russian monograph and the one Ukrainian monograph that fell into the sample of citing monographs. Again, the small size of this sample is the cause. A third (apparent) problem is that *Kew Bulletin*

appeared at the top of the Bradford ranking. The Library at the Royal Botanic Gardens has the policy of acquiring copies of all books published by the Gardens; Kew books are perhaps more likely to cite *Kew Bulletin*; and so (it may be argued) *Kew Bulletin* was over-represented. However, only three of the ten citations of *Kew Bulletin* were made in books published by the Royal Botanic Gardens, and, if these are discounted, *Kew Bulletin* is still comfortably inside the top twelve most-cited journals. It is therefore recommended that library collections managers and subject specialists should be aware of the following journals:

- *American Journal of Botany*.
- *Botanical Journal of the Linnean Society*.
- *Bulletin de la Société Botanique de France*.
- *Canadian Journal of Plant Science*.
- *Kew Bulletin*.
- *New Phytologist*.
- *Systematic Botany*.
- *Taxon*.
- *Watsonia (now the New Journal of Botany)*.

Finding out which are the most important book-publishers in a given field should be of particular interest to acquisitions librarians. Again, the value of the present study is mainly that it confirms what experienced selectors of botanical monographs already know, that publishers like CUP, Timber Press, Springer, Science Press (Beijing) and the Royal Botanic Gardens, Kew, are among the most important publishers. (Incidentally, in the present sample no monographs published at Kew were cited by other monographs published at Kew.) Also notable is the importance of monographs published by their authors – the difficulty of getting hold of copies of such books is apparently one which acquisitions librarians must still grapple with from time to time when building up good botany collections.

This study has confirmed and underlined two unsurprising facts about botanical publications:

(1) that books are relatively more important than in other sciences; and

(2) that older materials are relatively more important than in other sciences.

The discipline places a great deal of value on the oldest work: and it appears that monographs continue to be cited for longer than journal articles (the very oldest book referred to in the present study is over three hundred years old). The present study at least provides some quantitative evidence to justify collections managers in continuing to place emphasis on monographs and on older materials in botany collections. What is unexpected is that monographs are also referred to slightly more intensively than journal articles when they are still very new. In other words, it appears that botanists use monograph books (as well as journal articles) for current awareness purposes. It is recommended that librarians should take this into account: the acquisition of new books must be particularly prompt where the authors have the same interests as local researchers; such books must be processed and catalogued quickly, and displayed

prominently; and any current awareness services which subject librarians provide must include new books as well as new journal articles.

Finally, it appears that taxonomic botany journals are not adequately covered in citation indexes. *Scopus* seems to have slightly broader coverage than *ISI Web of Science*, but there are still several journals that are authoritative in the field which neither index includes. Garfield (1990) and Thompson Reuters (2011a, b) have stated the criteria by which journals are selected or rejected by *ISI Web of Science*, but it is not quite clear from these statements why journals like *New Journal of Botany* or *Kew Bulletin* should be omitted. Some indication is given in the selection criteria for *BIOSIS*: "the journal's editorial roster must … display diversity of institutional affiliation and geographic base" (Thompson Reuters, 2011a). It may be that the publications of the Royal Botanic Gardens at Kew and at Edinburgh, and those of the BSBI, fail to meet this criterion, since the editorial staff are presumably mostly from the publishing institutions themselves. It is interesting that the *Botanical Journal of the Linnean Society* is indexed by *ISI Web of Science* and by *Scopus*, and that it has been published by Blackwell on behalf of the Society since 2001. At any rate, taxonomic botanists who wish to use *ISI* or *Scopus* to assess the impact of their own research should beware of the error that could result – as should librarians who assist researchers with bibliometric assessment.

This study is a first step towards a better understanding of the bibliometrics of taxonomic botany, and it could be built on by further research. First, a larger study could be undertaken to corroborate the results found here.

Second, a systematic comparison of citations from journal articles could be made with those from monographs: in other words, an orthodox citation-study based on existing citation indexes could also be carried out. It appears from the present study that monographs and journal articles are about as important as each other in the publication of botanical research, so this should be reflected in future work. Other forms of publication, though comparatively minor, should not be neglected: doctoral theses often contain revisions of particular taxa, and what role they play in the literature of botany requires further investigation.

Third, a diachronous study could be carried out of the citation of botanical monographs. Careful investigation could be made of those monographs that are indexed by *ISI Web of Science*, to see whether a sample representative of the literature as a whole could be obtained. This, alongside a diachronous study of citations of journal articles, would allow a better understanding of the overall shape of taxonomic botany as a discipline and how it develops over time, as expressed in the pattern of its publications.

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