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Analysis of the distribution of cited journals according to their positions in the h-core of citing journal listed in Journal Citation Reports

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ABSTRACT

The aim of this study is to analyze some properties of the distribution of journals that are cited in the h-core of citing journals listed in the Journal Citation Reports. Data were obtained from the 2011 edition of JCR available for universities in Spain. The citing journal matrix available in JCR was used to identify the cited journals that appear most frequently in the h-core. The results show that about 70% of citing journals occupy positions other than the first one in the set of journals cited by them. Some properties of the distribution of cited journals that appear in the h-core are also studied, such as the cost, in terms of citations, of occupying a given position, and the spectrum of positions (distribution of frequencies with which a given cited journal appears in different positions). The measures calculated here could be used to define new scientometric indicators.

1. Introduction

The creation of citation indexes has made it possible to rank journals using citation-based indicators (Garfield, 1972). Identifying the most highly cited journals is an interesting research goal because, in scientometrics, extreme values represent the high end of research performance and therefore merit special attention (Glanzel, 2013). Scientists, research administrators and others are involved in decisions about where to publish manuscripts or how to evaluate research. Total citations or the rank of a given journal within a set of cited sources can be used to study a journal's influence. As Leydesdorff notes, "total citations can be considered as reflecting the prestige of a journal, while impact factors highlight a journal's current value on one or more research fronts" (Leydesdorff, 2008: 278–279).

Indicators such as the impact factor are so widely used that they have almost become the standard way to rank journals. Citation counts have also been used to rank journals. Many years ago, in a series of 53 essays on journal citation studies, Eugene Garfield explored the core journals in some areas. He often ranked journals by the number of citations they received (see, for example, Garfield, 1983, 1984, 1990). Other authors have carried out similar research in other fields (Nagy, 1994).

As an example of this kind of study, Kim performed a citation analysis of Library and Information Science journals by looking for correlations between some prestige rankings and nine citation measures, including total citation count (Kim, 1991). Similarly, Bensman computed correlation coefficients for the journal impact factor (JIF) and total citations, as recorded in the Science Citation Index, for Chemistry journals in 1993. He also obtained other measures of journal importance, and

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Box 1

Example of how cited journals included in the h-core of cited journals are identified. The numbers in the second column are the Impact Factors as listed by Thomson-Reuters in the citing journal matrix. The rest of data are the cited journal's title and the position of journals according the number of times articles published in journals that appear in each row (cited journals) were cited in AATCC REV (citing journal) in 2011 (column "All Yrs"). Thus, cited journals are ranked according to the total number of citations (column "All Yrs"). In this example, the h-index of this citing journal is 9 (there are 9 cited journals that received 9 or more citations). However, there are two cited journals with 9 citations (FIBRES TEXT EAST EUR and SPECTROCHIM ACTA B). Both cited journals are included in the h-core. Thus, the h-core of the citing journal AATCC REV would have 10 journals cited 9 or more times each one. The data corresponding to the citing journal, when it appears as a cited journal, are in bold.

Citing	*JIF*	*Cited*	*Position*	*All Yrs*	*2011*	*2010*	*2009*	*2008*	*2007*	*2006*	*2005*	*2004*	*2003*	*2002*	*Rest*	*h-core*
AATCC REV	1.122	TEXT RES J	1	35	0	0	4	0	2	2	2	3	2	1	19	Yes
AATCC REV	1.289	J APPL POLYM SCI	2	33	1	1	0	1	10	2	1	2	1	0	14	Yes
AATCC REV	**0.139**	**AATCC REV**	**3**	**20**	**1**	**0**	**1**	**5**	**2**	**1**	**0**	**2**	**1**	**3**	**4**	**Yes**
AATCC REV		TEXT CHEM COLOR	4	18	0	0	0	0	0	0	0	0	0	0	18	Yes
AATCC REV	3.628	CARBOHYD POLYM	5	16	0	1	9	4	1	0	0	0	1	0	0	Yes
AATCC REV	3.126	DYES PIGMENTS	6	11	0	0	0	0	5	2	2	0	0	0	2	Yes
AATCC REV	0.959	COLOR TECHNOL	7	10	0	2	1	0	1	0	2	1	1	1	1	Yes
AATCC REV		J SOC DYERS COLOUR	8	10	0	0	0	0	0	0	0	0	0	0	10	Yes
AATCC REV	0.532	FIBRES TEXT EAST EUR	9	9	0	0	0	0	2	1	2	2	1	1	0	Yes
AATCC REV	2.876	SPECTROCHIM ACTA B	10	9	0	0	0	0	0	0	0	2	0	3	4	Yes
AATCC REV		AATCC TECH MANU	11	7	0	4	1	1	1	0	0	0	0	0	0	
AATCC REV	4.951	J POWER SOURCES	12	7	0	2	0	2	1	1	0	1	0	0	0	
AATCC REV	4.555	ANAL CHIM ACTA	13	6	0	0	0	0	0	0	0	0	1	0	5	
AATCC REV		ANN BOOK ASTM STAND	14	6	0	0	1	0	1	1	0	0	1	0	2	
AATCC REV	3.600	CELLULOSE	15	6	0	3	2	0	0	0	0	0	0	0	1	
AATCC REV	5.167	MACROMOLECULES	16	6	0	0	1	0	0	0	0	0	0	1	4	
AATCC REV		AM DYEST REP	17	5	0	0	0	0	0	0	0	0	0	0	5	
AATCC REV		ANN BOOK ASTM STANDA	18	5	0	0	2	0	0	0	0	0	0	2	1	
AATCC REV	3.794	TALANTA	19	5	0	0	0	0	0	0	0	0	1	1	3	

Shading: The positions with ranks equal or minor than the number of citations.
Highlight: The number of citations equal to the h-index of citing journal.

concluded that "total citations are a better holistic measure of journal importance than the impact factor" (Bensman, 2007b: 62), a view that Garfield also suggested in his seminal paper on JIFs (Garfield, 1972). In a recent study, Finardi studied how the correlation between the JIF and the (time-weighed) article mean received citations (intended as a measure of journal performance) evolved with time. He used a sample of hard science and social science journals from the period between 1999 and 2010, and found that in most cases JIF and their yearly variations did not show a strong correlation with citedness (Finardi, 2013).

Other authors have used total citations as data in studies of journal rank in different fields (Beckmann & Persson, 1998; Bensman & Leydesdorff, 2009; Campanario, 2010; Didegah, Thelwall & Gazni, 2012; Di Vaio & Weisdorf, 2010; DuBois & Reeb, 2000; Franceschini & Maisano, 2011; Halkos & Tzeremes, 2011; Leydesdorff, 2009; Leydesdorff, Moya-Anegón, & Guerrero-Bote, 2010; Linton & Thongpapanl, 2004; Malesios & Arabatzis, 2012; Rethlefsen & Aldrich, 2013; Sangwal, 2013). Some authors, however, argue that using journal rank as an assessment tool is bad scientific practice (Brembs, Button, & Munafo, 2013). According to this view, any journal rank would have a negative impact.

Recently, Schubert used data from the 2006 Science Citation Index to study an indicator to measure similarity between the cited and citing journal list. For each journal, the journal-by-journal distribution of references (Citing Journal Package) and citations (Cited Journal Package) were determined. He found that the similarity (or dissimilarity) between cited and citing journals is a structural indicator that conveys information about the journal's place and role in the information network (Schubert, 2013).

It is clear, from the above, that the absolute number of citations is a well known indicator that has been used by researchers. However, it appears that nobody has attempted a large-scale citation study based on the number of times that journals tend to appear in the top positions in the set of journals cited by the citing journal. In this case the relevant information is not the absolute number of citations that a given journal receives, but the position that the journal occupies among all journals cited by the citing journal (see Box 1). This position is naturally a consequence of the number of citations, but represents a more qualitative indicator of intellectual influence.

To study the positions that journals occupy, I will use the concept of h-core. By analogy to the h-index and the h-core for a scientist, a citing journal's h-index is h if the first h journals it cites each receive at least h citations, while the cited journal ranked h + 1 always received less than h + 1 citations. The first h journals in this ranked list thus comprise the h-core (see Box 1) (Rousseau, 2008).

In the light of these considerations, the goals of the present study are:

(a) to identify journals that are cited most frequently (i.e., in the h-core) by citing journals listed in the Journal Citation Reports (JCR).

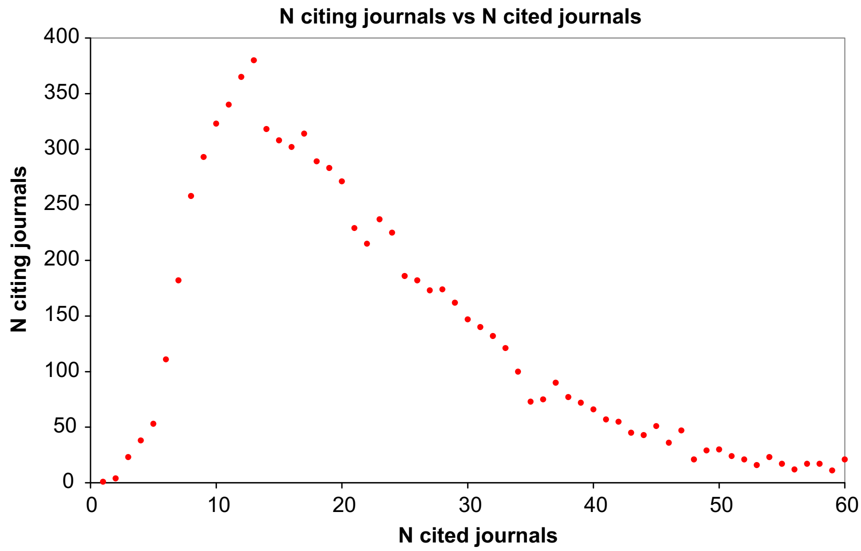

Fig. 1. Distribution of citing journals according to the number of cited journals that appear in the h-core. Only citing journals with 60 cited journals or less are plotted ($N = 7925$, 97.6%).

(b) to determine some of the properties of the distribution of journals that occupy the h-core in the rank order of citation frequency.

2. Method

Data were obtained from the 2011 edition of JCR available for universities in Spain. Most methods used to study the relative influence of different journals are based on journal-to-journal citation transaction frequencies (Tijssen & van Raan, 1990). These citations can help to understand the flow of information among journals (Fernando & Minton, 2011). Thus, for each journal, I used the Citing Journal Matrix (see Box 1). This matrix is available on each journal's page in JCR and records the number of times articles published in other journals (cited journals) were cited in a given journal (citing journal) in 2011.

In the example shown in Box 1, the h-core for the journals cited most frequently in 2011 by the citing journal AAOHN JOURNAL comprises 10 different journals. The row corresponding to the citing journal (when it appears as the cited journal) is marked in bold. In this case the citing journal occupies the third position among the cited journals.[1]

To avoid spurious results, I excluded citing journals in which the sum of citations given to all cited journals was 5 or less. Thus, these citing journals were not studied.

The primary variable was the number of times that a given cited journal appears in the h-core. In addition, I calculated the number of times that the cited journals appears in position 1, 2, 3, ... 10. The total number of citations received by cited journals was also used as a variable. Next, other variables and distributions were calculated. The statistics were mostly descriptive, and computations were straightforward. To facilitate data reporting and analysis, the calculations carried out will be explained below in the Results section.

3. Results

A total of 8116 citing journals met the above criteria. The journal PLOS ONE, with 329 cited journals, was the citing journal with the largest number of cited journals in the h-core. Fig. 1 shows the distribution of these citing journals. Only a few citing journals had a large number of cited journals in their h-core.

Of the 183,456 cited records included in all h-cores, 171,405 (93.4%) had an associated Impact Factor, and 12,051 cited records (6.6%) had no Impact Factor. However, many of these records correspond to overlap in the journals that are cited in different citing journals. When duplicates are removed, a total of 11,315 different cited journals occupy the h-core: 7237 with an Impact Factor (64.0%) and 4078 without an Impact Factor (36.0%).

An interesting initial observation is the position occupied by the citing journal itself within the set of cited journals. For example, as explained in Box 1, the citing journal AATCC REV occupies the third position in the set of cited journals. The group of cited journals that occupy positions in the h-core comprises a total of 7016 citing journals (86.4%). The distribution

[1] Use of the h-core as a selection criterion was suggested by two anonymous referees. In a previous version of the manuscript the criterion was different: cited journals occupying the 10 first places in each citing journal.

Table 1
Distribution of citing journals according to the position they occupy among cited journals. For example, 1232 citing journals (15.2%) appear in the second position in the set of journals cited by them. Only the first 20 positions are shown. Percentages are calculated based on the total number of citing journals studied (N = 8116).

Position	*N* citing	%
1	2509	30.9
2	1232	15.2
3	777	9.6
4	559	6.9
5	449	5.5
6	297	3.7
7	248	3.1
8	185	2.3
9	152	1.9
10	107	1.3
11	92	1.1
12	71	0.9
13	67	0.8
14	44	0.5
15	37	0.5
16	23	0.3
17	25	0.3
18	28	0.3
19	21	0.3
20	20	0.2

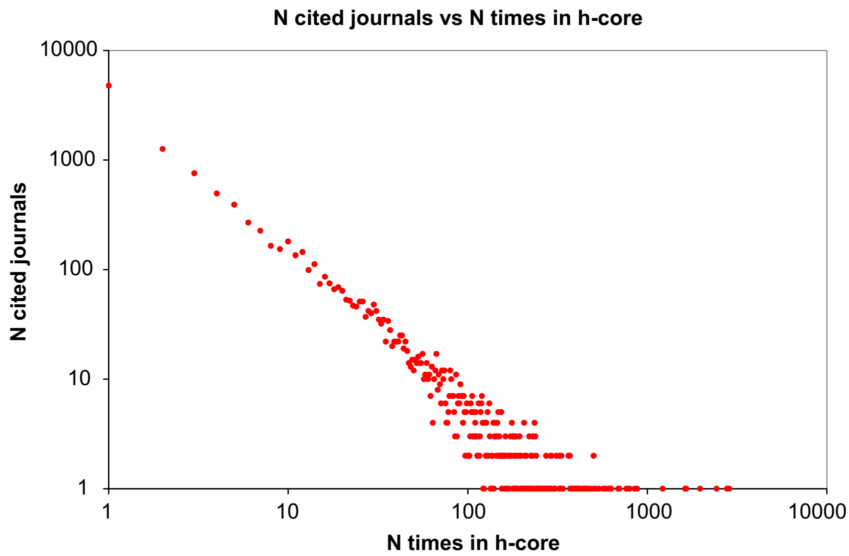

Fig. 2. Distribution of cited journals according to the number of times they appear in the h-core of citing journals. Note that logarithmic scales are used in both axes.

of these citing journals is shown in Table 1. As seen, about 70% of citing journals occupy positions other than the first one in the rank order of cited journals. It thus appears that in these instances, the citing journal itself is not the main source of information. This result contrasts with the widespread perception that journals tend mainly to self-cite rather than to cite other sources.

Next, the cited journals that appear most often in the h-core of citing journals were identified. Table 2 shows the 50 cited journals that appear most often in the h-core. These are mostly well known journals that tend to be leading sources in their respective fields. For example, as seen in Table 2, the cited journal NATURE leads the ranking and appears a total of 2862 times in the h-core. To use the term suggested by Franceschet, journals that appear many times in the first positions and are cited by a large number of other journals can be considered *authorities* (Franceschet, 2012).

Also of interest is the distribution of all cited journals according to the number of times they appear in the h-core. Fig. 2 illustrates this information; note that logarithmic scales are used in both axes. As often happens in scientometric studies, many of the cited journals appear only a few times, whereas a few cited journals appear many times. For example, 4761 cited journals appear only once in the h-core; in contrast, only 64 cited journals appear 20 times in the h-core and only 361 journals appear 100 or more times. Garfield noted a similar pattern in citations as early as 1972 (Bensman, 2007a; Garfield,

Table 2

The 50 cited journals that appear most frequently in the h-core of citing journals. The table shows the number of times that each cited journal appears in position 1, 2, 3, . . . 20 and others. The last column is the total number of times that the cited journal appears in the h-core of citing journals.

Cited journal	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Other	Total
NATURE	57	101	172	195	175	194	187	178	143	152	133	117	108	110	116	95	81	73	47	58	376	**2868**
SCIENCE	20	57	105	126	168	190	191	185	167	174	152	157	143	119	89	88	80	74	75	67	358	**2785**
P NATL ACAD SCI USA	81	230	209	232	168	148	141	109	120	108	90	76	70	73	68	63	59	37	37	26	285	**2430**
NEW ENGL J MED	79	110	130	139	183	164	147	123	120	110	78	80	68	48	40	41	38	26	24	18	202	**1968**
J BIOL CHEM	208	114	109	111	103	86	89	80	66	59	64	61	53	41	45	38	28	25	29	39	201	**1649**
LANCET	22	47	63	82	77	87	97	122	105	100	90	108	98	67	42	58	50	39	31	32	208	**1625**
JAMA-J AM MED ASSOC	7	41	51	74	79	83	93	90	67	62	68	56	45	49	45	33	32	34	27	24	158	**1218**
CELL	10	14	19	42	56	48	44	47	44	47	49	30	30	28	30	32	32	22	22	19	212	**877**
CIRCULATION	109	51	46	52	41	41	42	42	47	43	26	34	39	22	32	27	21	10	19	19	90	**853**
CANCER RES	58	42	38	41	38	27	50	28	47	38	31	34	28	28	25	24	17	16	15	19	153	**797**
J AM CHEM SOC	89	93	66	37	50	51	33	32	24	31	23	24	13	13	21	14	16	17	12	5	105	**769**
BRIT MED J	13	31	33	40	27	37	35	48	35	32	28	34	34	40	29	24	27	23	20	21	155	**766**
BLOOD	53	38	31	31	26	29	31	35	25	28	23	26	22	27	28	21	22	20	18	17	148	**699**
J CLIN INVEST		2	3	4	9	21	25	33	22	29	41	44	31	37	37	37	20	29	28	23	214	**689**
PHYS REV LETT	42	77	57	43	47	45	27	18	22	22	15	19	18	15	12	14	13	11	8	8	98	**631**
J IMMUNOL	62	21	21	23	18	20	17	29	21	23	22	27	23	20	22	15	14	17	23	16	167	**621**
J CLIN ONCOL	77	54	43	32	32	30	26	30	29	18	18	16	19	22	14	15	20	10	12	6	83	**606**
BIOCHEM BIOPH RES CO		1	2	4	6	8	10	14	20	22	14	26	31	34	25	22	20	20	25	18	261	**583**
NUCLEIC ACIDS RES	15	22	8	14	12	30	25	27	20	27	24	24	28	26	16	17	21	22	15	18	158	**569**
J NEUROSCI	66	42	29	22	24	24	21	24	20	19	18	16	16	17	16	14	10	19	10	9	102	**538**
PHYS REV B	46	53	34	31	36	25	35	23	19	14	22	17	12	12	7	10	11	8	11	10	81	**517**
APPL PHYS LETT	67	37	34	39	33	34	28	17	22	21	17	8	16	14	6	8	6	4	6	8	79	**504**
CANCER-AM CANCER SOC	1	30	24	38	28	30	35	30	19	15	20	21	24	17	19	17	20	15	10	7	82	**502**
NAT GENET	5	11	5	10	15	7	12	22	14	17	13	13	27	16	14	21	16	23	23	17	201	**502**
J APPL PHYS	1	30	42	51	40	32	21	19	25	20	26	11	18	16	18	14	11	10	7	6	66	**484**
PLOS ONE			1		3	2	1	2	1	4	6	10	9	14	22	17	15	22	21	25	290	**465**
J CHEM PHYS	31	18	19	23	16	7	23	18	12	20	13	16	19	27	19	7	8	13	9	3	143	**464**
J GEOPHYS RES	54	54	47	36	38	27	25	21	13	14	20	5	12	16	13	4	4	6	3	7	39	**458**
APPL ENVIRON MICROB	48	29	19	23	29	23	21	26	24	24	20	12	9	12	14	13	10	5	5	4	83	**453**
J PHYS CHEM B	2	3	9	21	21	19	23	21	14	24	22	14	20	17	13	20	18	13	14	18	117	**443**
ANN INTERN MED	1	2	2	4	6	7	11	21	17	24	19	32	29	26	26	18	20	17	19	13	121	**435**
EMBO J					3	2	12	16	17	18	18	17	24	22	17	17	18	17	15	16	170	**419**
J AGR FOOD CHEM	38	31	39	23	20	18	19	21	13	8	15	23	9	4	15	6	4	6	14	7	85	**418**
J CLIN ENDOCR METAB	33	11	17	20	24	20	23	12	22	20	19	19	14	11	12	11	13	14	5	13	82	**415**
NEUROLOGY	59	39	26	12	13	21	14	19	16	12	18	15	13	17	8	12	7	14	7	3	64	**409**
ANGEW CHEM INT EDIT	15	21	22	21	18	27	23	12	17	20	9	20	10	11	14	9	10	9	13	10	97	**408**
CLIN CANCER RES		6	34	17	25	19	18	25	18	13	19	11	16	18	12	10	18	11	8	11	93	**402**
LECT NOTES COMPUT SC	107	57	43	28	27	18	15	22	13	7	9	6	5	8	6	3	1	2	1	5	14	**397**
PEDIATRICS	46	21	14	15	16	13	17	18	21	18	24	18	15	15	17	16	11	8	8	5	60	**396**
BIOCHEMISTRY-US	5	8	11	11	17	18	8	10	18	9	15	9	18	21	6	13	6	10	12	10	153	**388**
LANGMUIR	13	8	7	5	11	13	19	15	14	18	12	24	13	14	12	15	10	15	10	11	122	**381**
ECOLOGY	34	24	33	24	27	28	26	18	23	17	15	17	12	7	6	4	7	6	5	4	38	**375**
CHEM REV		1	1	4	8	20	28	23	23	13	16	13	10	16	9	19	10	12	15	11	120	**372**
J CELL BIOL	8	10	6	5	11	8	6	9	8	15	11	25	12	9	4	15	15	16	10	6	161	**370**
ONCOGENE			9	9	13	13	17	16	15	9	12	18	7	12	15	12	7	14	16	8	148	**370**
J AM COLL CARDIOL	7	54	29	19	22	13	17	16	15	17	8	15	9	13	11	17	7	8	11	9	48	**365**
MOL CELL BIOL		1	3	1	6	6	8	14	15	14	19	13	20	18	16	12	11	17	17	14	140	**365**
ANAL CHEM	18	22	18	10	8	8	11	10	7	11	12	9	13	6	6	9	5	6	9	10	131	**339**
ARCH INTERN MED	2	1	3	2	8	14	16	12	21	13	17	27	19	19	15	19	10	10	16	9	80	**333**
NAT MED		1		3	1	1		2	1	5	4	7	14	10	17	13	14	10	13	13	204	**333**

Table 3
Number of cited journals that appear at least once in positions 1, 2, 3, . . . 20 of the h-core. For example, 2701 different cited journals (23.9%) appear in position 2. Note that this table counts only once each cited journal that appear at least once in each position regardless of the number of times it appears in each position. For example, although the cited journal NATURE appears 57 times in the first position (see Table 2), it is counted only once in this table. The goal is to illustrate the variety of different cited journals that appear at least once in each position. Percentages are computed using the total number of cited journals (11,315). Note also that, given that cited journals can appear in more than one position, the percentages add to more than 100.

Positions	*N* cited	%
1	2825	25.0
2	2701	23.9
3	2741	24.2
4	2824	25.0
5	2909	25.7
6	2901	25.6
7	2861	25.3
8	2856	25.2
9	2713	24.0
10	2591	22.9
11	2528	22.3
12	2389	21.1
13	2289	20.2
14	2193	19.4
15	2121	18.8
16	2065	18.3
17	1947	17.2
18	1839	16.3
19	1765	15.6
20	1671	14.8

1972). Other authors have also observed similar patterns: most journals are cited by a relatively small number of other journals (Franceschet, 2012).

This finding, however, bears closer analysis because two cited journals may appear the same number of times in the h-core, although they may have different rank positions. For example, as seen in Table 2, the cited journal J CHEM PHYS

Table 4
Number of cited journals that appear at least once in a total of 1, 2, 3, . . . 30 and other different positions. As in Table 3, note that this table counts only once each cited journal that appear at least once in each position regardless of the number of times it appears in each position.

N different positions	*N* cited journals	%
1	4810	42.5
2	1317	11.6
3	772	6.8
4	551	4.9
5	389	3.4
6	322	2.8
7	248	2.2
8	228	2.0
9	214	1.9
10	197	1.7
11	147	1.3
12	155	1.4
13	143	1.3
14	130	1.1
15	143	1.3
16	110	1.0
17	107	0.9
18	102	0.9
19	97	0.9
20	89	0.8
21	86	0.8
22	73	0.6
23	66	0.6
24	59	0.5
25	53	0.5
26	46	0.4
27	44	0.4
28	44	0.4
29	39	0.3
30	47	0.4
Other	487	4.3
Total	11,315	100.0

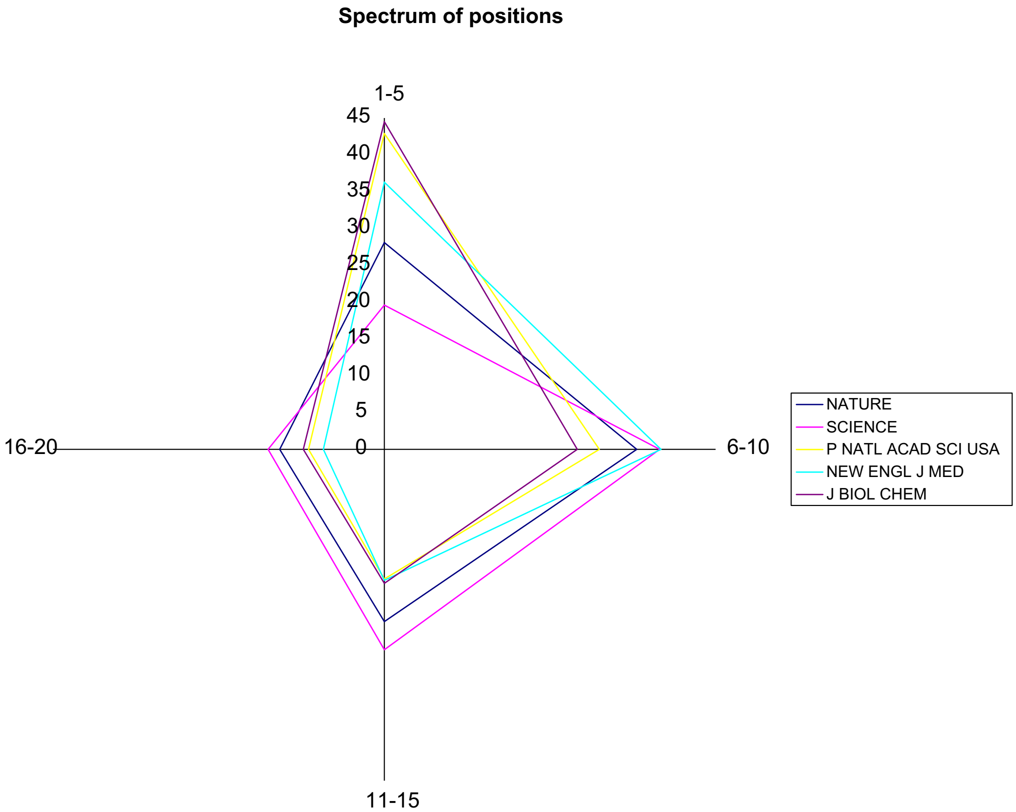

Fig. 3. Spectrum of positions corresponding to the top five cited journals listed in Tables 2 and 5. For each cited journal, the values of the first (positions 1–5), second (positions 6–10), third (positions 11–15) and fourth category are plotted. For example, it is clear that the cited journal SCIENCE tends to be a second- and third-category journal.

appears 464 times in the h-core and appears in each of the first 20 positions (1, 2, 3, . . . 20). The cited journal PLOS ONE appears 465 times in the h-core, but never appears in positions 1 or 2. It is therefore of interest to count the number of cited journals that appear, for example, in each of the first 20 positions of h-core. This more detailed analysis, as shown in Table 3, distinguishes between the numbers of cited journals that appear in positions 1, 2, 3, . . . 20. Note that this table counts each appearance of a cited journal in each position only once, and does not reflect the number of times it appears in each position. For example, the cited journal NATURE appears 57 times in the first position (Table 2), but is counted only once in Table 3. The aim is to determine how many different cited journals appear at least once in each position. Given that cited journals can appear in different positions (1, 2, etc.), the percentages add to more than 100.

The results in Table 3 show that 2825 different cited journals (25% of the total) are the most frequent source of information and influence for all citing journals. These cited journals are likely to be among the most influential in their respective fields. However, this number of journals is far greater than the number of JCR groups.

Table 4 shows the number of cited journals that appear at least once in a total of 1, 2, 3, etc. different positions. As in Table 3, this table counts multiple values only once. Thus, each cited journal is counted only once regardless of the number of times it appears in a given position. For example, the cited journal NATURE appears in 49 different positions whereas the cited journal J CLIN INVEST appears in 56 different positions. In this case the percentages add to 100 (with 11,315 as the total number of cited journals included in the h-core). Note that there is a decreasing trend. It is clear that many cited journals appear in only a few different positions, and a few cited journals appear in many different positions. This type of distribution tends to be a common trend in scientometric studies of citations (Seglen, 1992).

The results above lead us to introduce the notion of spectrum of positions for a given cited journal. For example, if we consider only the first 20 positions, Tables 2 and 5 show that the cited journal P NATL ACAD SCI USA appears more frequently in positions 1 to 5 (42.9% of all times) than in positions 6 to 10 (29.2%). However, the cited journal LANCET appears more frequently in positions 6 to 10 (36.1%) than in positions 1 to 5 (20.5%). The former journal may thus be a more relevant source of information and influence for citing journals than the latter. Table 5 shows the spectrum of positions for the cited journals listed in Table 2. To avoid too many categories, the 20 first positions were collapsed into four categories: first (1–5), second (6–10), third (11–15) and fourth (16–20).

The spectrum of positions of a given cited journal reflects the nature of this journal's participation in the JCR. For example, J BIOL CHEM is a cited journal that appears more frequently in the first category (44.5%) than in other categories. The cited

Table 5
Spectrum of positions of cited journals listed in Table 2. The spectrum is restricted to four categories with 5 positions each. Each category is computed based on the percentage of times that the cited journal appears in positions 1–5 (first category), 6–10 (second category), 11–15 (third category) and 16–20 (fourth category). Percentages are computed from the total number of times that cited journals appear in the first 20 positions.

Cited journal	1–5	6–10	11–15	16–20
NATURE	28.1	34.3	23.4	14.2
SCIENCE	19.6	37.4	27.2	15.8
P NATL ACAD SCI USA	42.9	29.2	17.6	10.3
NEW ENGL J MED	36.3	37.6	17.8	8.3
J BIOL CHEM	44.5	26.2	18.2	11.0
LANCET	20.5	36.1	28.6	14.8
JAMA-J AM MED ASSOC	23.8	37.3	24.8	14.2
CELL	21.2	34.6	25.1	19.1
CIRCULATION	39.2	28.2	20.1	12.6
CANCER RES	33.7	29.5	22.7	14.1
J AM CHEM SOC	50.5	25.8	14.2	9.6
BRIT MED J	23.6	30.6	27.0	18.8
BLOOD	32.5	26.9	22.9	17.8
J CLIN INVEST	3.8	27.4	40.0	28.8
PHYS REV LETT	49.9	25.1	14.8	10.1
J IMMUNOL	31.9	24.2	25.1	18.7
J CLIN ONCOL	45.5	25.4	17.0	12.0
BIOCHEM BIOPH RES CO	4.0	23.0	40.4	32.6
NUCLEIC ACIDS RES	17.3	31.4	28.7	22.6
J NEUROSCI	42.0	24.8	19.0	14.2
PHYS REV B	45.9	26.6	16.1	11.5
APPL PHYS LETT	49.4	28.7	14.4	7.5
CANCER-AM CANCER SOC	28.8	30.7	24.0	16.4
NAT GENET	15.3	23.9	27.6	33.2
J APPL PHYS	39.2	28.0	21.3	11.5
PLOS ONE	2.3	5.7	34.9	57.1
J CHEM PHYS	33.3	24.9	29.3	12.5
J GEOPHYS RES	54.7	23.9	15.8	5.7
APPL ENVIRON MICROB	40.0	31.9	18.1	10.0
J PHYS CHEM B	17.2	31.0	26.4	25.5
ANN INTERN MED	4.8	25.5	42.0	27.7
EMBO J	1.2	26.1	39.4	33.3
J AGR FOOD CHEM	45.3	23.7	19.8	11.1
J CLIN ENDOCR METAB	31.5	29.1	22.5	16.8
NEUROLOGY	43.2	23.8	20.6	12.5
ANGEW CHEM INT EDIT	31.2	31.8	20.6	16.4
CLIN CANCER RES	26.5	30.1	24.6	18.8
LECT NOTES COMPUT SC	68.4	19.6	8.9	3.1
PEDIATRICS	33.3	25.9	26.5	14.3
BIOCHEMISTRY-US	22.1	26.8	29.4	21.7
LANGMUIR	17.0	30.5	29.0	23.6
ECOLOGY	42.1	33.2	16.9	7.7
CHEM REV	5.6	42.5	25.4	26.6
J CELL BIOL	19.1	22.0	29.2	29.7
ONCOGENE	14.0	31.5	28.8	25.7
J AM COLL CARDIOL	41.3	24.6	17.7	16.4
MOL CELL BIOL	4.9	25.3	38.2	31.6
ANAL CHEM	36.5	22.6	22.1	18.8
ARCH INTERN MED	6.3	30.0	38.3	25.3
NAT MED	3.9	7.0	40.3	48.8

journal SCIENCE tends to be a second- and third-category journal (19.6% for the first category versus 37.4% for the second, 27.2% for the third and 15.8% for the fourth). Thus, each cited journal can be classified according its spectrum of positions. For example, Fig. 3 shows the spectrum of positions corresponding to the top five cited journals listed in Tables 2 and 5. As seen in the figure, there are clear differences among these cited journals.

Another indicator of interest is the weight of the most frequently cited journal in the set of citations from the citing journal. For example, the citing journal PAK J MED SCI records a total of 5363 citations to all cited journals. However, its most frequently cited journal (NEW ENGL J MED) received only 67 citations (1.25%). In contrast, the citing journal NUMER HEAT TR A-APPL records a total of 6219 citations to all cited journals, and its most frequently cited journal (INT J HEAT MASS TRAN) received 2224 of them (35.8%). It is clear that NUMER HEAT TR A-APPL is more "dependent" on its top-cited journal than PAK J MED SCI is on its own top-cited source journal. Similar calculations can be done for all citing journals. When more than one cited journal occupies the first position, I consider only one, because the aim of this calculation is to determine the weight of individual cited journals in the citing journal (i.e., the percentage of citations they receive).

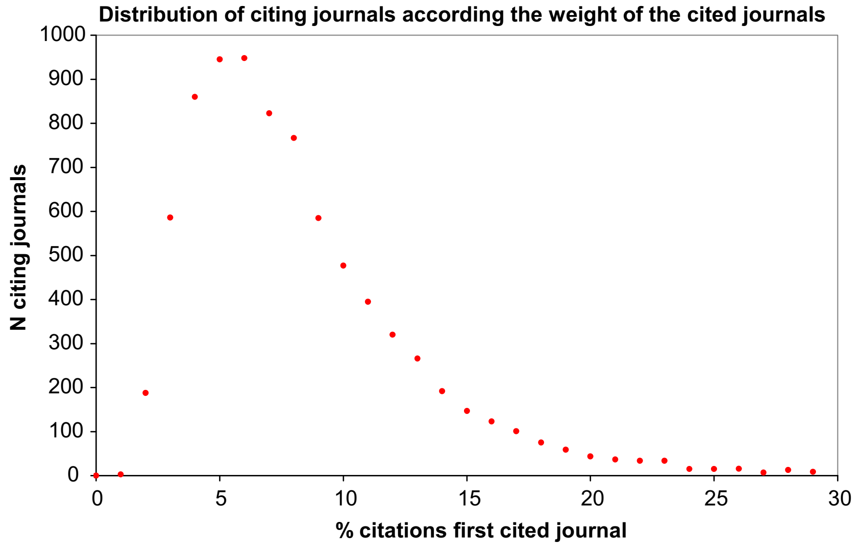

Fig. 4. Distribution of citing journals according to the weight of the first cited journal in the set of citations in the citing journals. The weight is the percentage of citations from the citing journal to the first cited journal. Only citing journals in which this figure is equal to or less than 30% are plotted (8084 journals, 99.6% of the whole set of citing journals studied).

Fig. 4 shows the distribution of citing journals according to the weight of the most cited journal in the set of citations. The values range from 0.76% (citing journal ASIA LIFE SCI) to 53.9% (citing journal CIVIL ENG). A peak is clearly evident at 4–8% of citations: about 54% of citing journals are located in this range. The implication of this distribution is clear: for these citing journals the most frequently cited journals are not the preponderant source of information and influence.

Occupying the first position among cited journals may have different "costs" for different cited journals–a cost that can be measured as citations received. For example, it costs the cited journal PHYS REV B 63,215 citations to occupy the first rank position among the journals it cites itself. In contrast, it costs the cited journal IEEE T ANTENN PROPAG only 10 citations to occupy the first position among journals cited by the citing journal RES NONDESTRUCT EVAL. Therefore, for IEEE T ANTENN PROPAG it is cheaper (measured in received citations) to reach the first position than for PHYS REV B. The same calculations can be done for the remaining rank positions: some cited journals need more citations than others to occupy the same position. For example, for 5435 cited journals (48.0% of all cited journals that occupy the first position) it costs less than 300 citations to be ranked in the top position. For 6459 cited journals (57.1%) this position costs less than 500 citations, and for 7414 cited journals (65.5%) it comes at a cost of less than 1000 citations. In these calculations I count the cited journals each time they appear. For example, the journal NATURE is counted as a different cited journal each time it appears in the

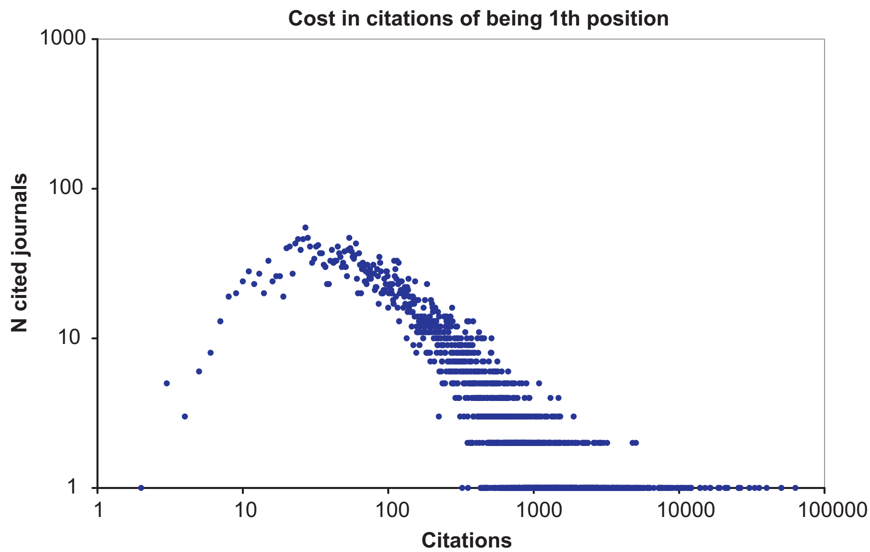

Fig. 5. Distribution of cited journals according to the cost in citations needed to occupy the first position. Note that logarithmic scales are used in both axes.

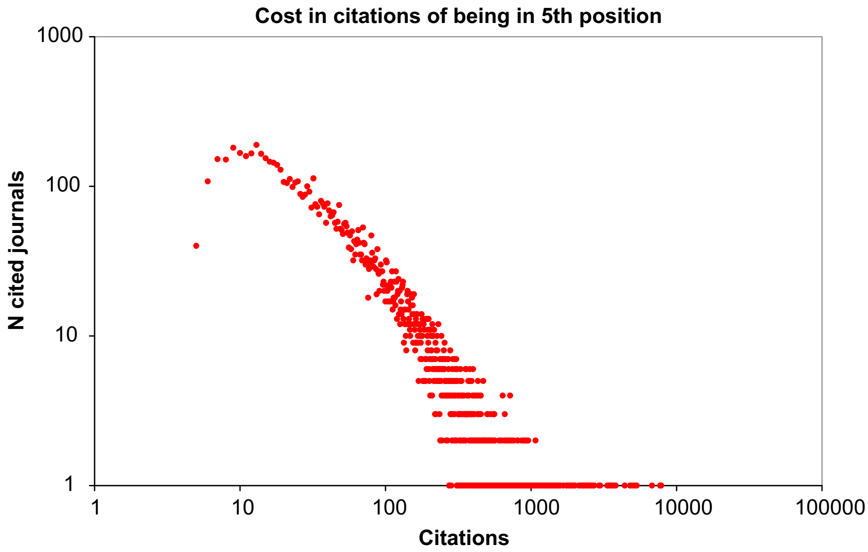

Fig. 6. Distribution of cited journals according to the cost in citations needed to occupy the fifth position. Note that logarithmic scales are used in both axes.

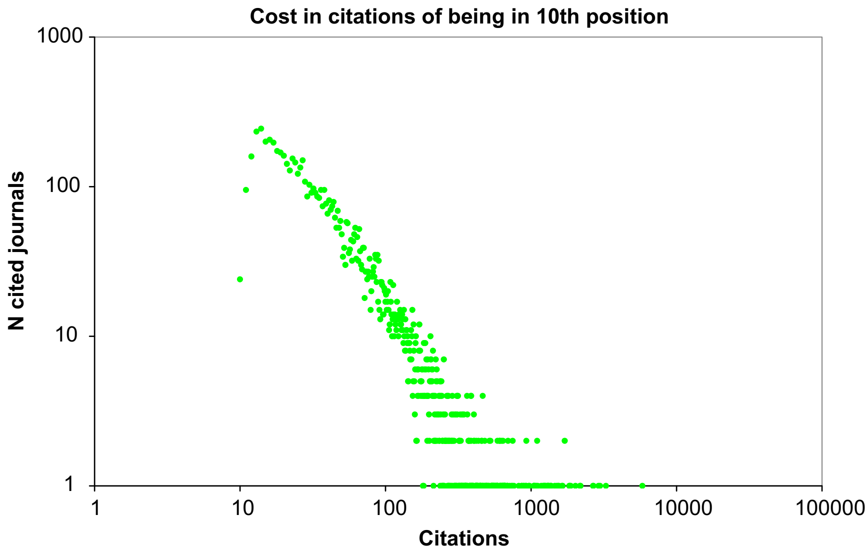

Fig. 7. Distribution of cited journals according to the cost in citations needed to occupy the tenth position. Note that logarithmic scales are used in both axes.

first position, because different numbers of citations (i.e. different costs to the cited journal) can result in the top position in different citing journals.

Figs. 5–7 show the distribution of cited journals according to the cost in terms of the number citations they need to occupy the first, fifth and tenth positions. Note that logarithmic scales are used in both axes. As expected, the number of cited journals that bear a high cost in citations for occupying a given position tends to decrease as the number of required citations increases. However, the relationship for position 1 is more curvilinear, reflecting the fact that for a small set of cited journals, the cost of occupying the first position is not very high. This curvilinear trend tends to weaken as rank position becomes lower (1–5–10).

4. Conclusions

I identified the cited journals that appear most often in the h-core of citing journals in the rank order of citation frequency. These journals are usually leading sources in their respective fields.

The distribution of all cited journals according to the number of times they appear in the h-core of citing journals showed a double logarithmic trend. This distribution reflects the fact that many cited journals tend to appear infrequently in the h-core, whereas a few cited journals tend to appear many times. In the early days of citation analysis, Garfield used total citations to identify the small core of journals that dominated a given scientific field (Bensman, 2007c; Garfield, 1972). Similarly, as a consequence of the Law of Concentration, a small number of journals tend to appear more often in the h-core of citing journals. This may represent another kind of Law of Concentration.

Analysis of the number of cited journals that top the citation frequency ranking (i.e., that appear in the first position) shows that 25% of all cited journals are the main source of information and main reference for all citing journals. This number is far greater than the number of JCR groups. In addition, many cited journals occupy only a few different positions (1, 2 or 3, for example) and a few cited journals appear in many different positions. This pattern of distribution is not unusual in scientometric studies when citations are used as the variable.

The spectrum of positions is a measure that can be used to classify cited journals according to the position they tend to occupy in the rank order. For example, if we restrict ourselves to the first 20 positions, some cited journals tend to appear more often in the top positions (1–5), whereas others tend to appear in lowest positions (11–15 and 16–20).

Another indicator studied here was the weight of the most frequently cited journal in terms of their percentage of citations in the citing journal. The distribution of citing journals according to this indicator peaked between 4% and 8% of all citations. In fact, about half of all citing journals were included in this range. The implication is clear: in these citing journals, the journal that is cited most frequently is not a very influential source of information or references.

The cost, in terms of citations, of occupying the first, second, third and other positions can be also computed and plotted on a logarithmic scale in both axes. The distribution of cited journals according to this parameter shows a curvilinear relationship for position 1, but the curve tends to straighten out at positions 5 and 10.

Many bibliometric indicators are available to evaluate research and researchers (Durieux & Gevenois, 2010; Pendlebury, 2009). Bensman insisted on the use of "total cites" as an indicator for journal evaluation (Bensman, 1996; Bensman & Wilder, 1998). Is it possible to use and systematize scientometric indicators based in the number of times that cited journals appear in the h-core or in the first 10, or 20, or 30 positions (h-core index, 10P-Index, 20P-Index, 30P-Index and so)? A potential advantage of this kind of indicator is that it covers all cited years. Other indicators such as the 2-year and 5- year impact factor refer only to a subset of cited years. According to Leydesdorff, total citations are more stable over time than impact factors (Leydesdorff, 2008), because total citations accumulate over time. In addition, the impact maturity period varies widely across different fields (Dorta-Gonzalez & Dorta-Gonzalez, 2013), so there is no standard or optimal period that could be used across disciplines.

A possible extension of this work would be to study the distribution of journals in JCR groups. Such a study might have a more applied orientation, and might potentially be focused on evaluative scientometrics.

Of course, new indicators based in the number of times that cited journals appear in different positions could be explored and correlated with existing indicators. However, the main problem with new indicators based on rank position is that the number of citations by each citing journal is ignored once the cited journal occupies the first, second, third (or any) position. Thus, two cited journals that appear the same number of times in the first position may have received different numbers of citations. It would not be surprising if the cost, in terms of citations, of occupying the top citation frequency rank position at a given citing journal were higher for large, multidisciplinary journals than for smaller, more specialized journals. An additional consideration is that differences in citation practices among scientific fields make comparisons problematic.

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