Current Comments

Journal Citation Studies. 33. Botany Journals, Part 1: What They Cite and What Cites Them

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In our study of the 300 most-cited scientists,[1] very few botanists appeared on the list. I suggested one reason for this is that botany is a heavily descriptive field. For this reason, I also suggested basic science researchers would find little of interest to cite in the botany literature. However, I may have done an injustice to many botanists who are indeed engaged in very basic research.

Jacob Levitt, Carnegie Institution of Washington, Stanford, California, suggested a different reason why few botanists appeared on that list. He pointed out that botanists cite basic physics and chemistry heavily but the reverse is not true. Using imagery that comes naturally to a plant physiologist, Levitt said, "It is simply a fact that information flows up the tree of scientific knowledge in the sap stream, from the most fundamental physical and chemical knowledge in the roots, to biophysical and biochemical knowledge in the stems, to organelle and cell knowledge in the leaves, and to the final flowering—knowledge of the whole organism."[2]

In this hierarchy of scientific knowledge, the more specialized life sciences—botany and cell biology, for example—make heavy use of information from physics and chemistry, but the reverse is much less frequent. Does this mean that botany is less "basic" than physics or chemistry? Oftentimes, botanists or plant scientists address problems with a narrow focus. But this does not mean their work is less basic or potentially rewarding in terms of pure knowledge.

Brent Heath, associate professor of botany, York University, Ontario, Canada, suggests another reason why botanists are relatively less-cited by their colleagues in biophysics and biochemistry. He says most people, including scientists, think plant studies are less important than human or animal studies. The "second-class citizen" status of botanical research doesn't encourage animal cell researchers to refer to plant cell work. "As a general principle, people working on plants tend to be more broad in their outlook and consider relevant data from the animal and microbial worlds, but the reverse is less true, even though in many cases plant cell data is very good and highly relevant."[3]

Levitt points out that many fundamental discoveries in basic biological science were made by botanists. "The botanist Brown discovered Brownian movement, the botanist Tswett discovered chromatography, the botanists Garner and Allard discovered photoperiodism. Even when they are cited, they are usually not considered to be botanists."[4]

My correspondence with Levitt and Heath reminded me that it was time to update our data on the plant sciences.

It's been only about five years since we last examined the field of botany, but the study was based on 1969 data.[5] The present study is based on data compiled from the 1978 *Science Citation Index®* (*SCI®*) *Journal Citation Reports®* (*JCR™*). For those of you who have not seen *SCI* lately, *JCR* is the last of 13 volumes in the 1978 *Science Citation Index* annual.

As we've done in past journal citation studies,[6,7] we will treat the botany journals included in this study as a single entity. In that way, we can determine what journals frequently cite the "core" botany journals, and what journals are most frequently cited by the core group. The number of journals listed in Table 1 is limited to 69 only as a matter of convenience. Obviously, these journals don't represent the entire universe of botanical research. Botanical research includes studies in genetics, ecology, cell biology—any study involving plants, really, that may be published in journals not having "botany" in their titles. But these "non-botany" journals will still be identified when we examine what the core cites and what cites them.

The 69 journals listed in Table 1 published 6,658 articles in 1978. This represents 1.44% of the 463,824 source items included in the 1978 *JCR* data base. This is slightly less than the 500,702 source items in the *SCI* data base. The *JCR* omits *SCI* items such as abstracts, letters, and editorials. It does include "letters" in *Nature*.

Table 1: Botany core journals indexed by the *Science Citation Index®* in 1978 and covered in *Current Contents®/Agriculture, Biology & Environmental Sciences.*

Acta Biol. Cracov. Ser. Bot.
Acta Bot. Neer.
Adv. Agron.
Agri. Hort. Genet. Landskrona
Amer. J. Bot.
Angew. Bot.
Ann. A. Plant.
Ann. Bot.
Ann. Mo. Bot. Gard.
Annu. Rev. Phytopathol.
Annu. Rev. Plant Physiol.
Aust. J. Bot.
Aust. J. Plant Physiol.
Ber. Deut. Bot. Ges.
Biochem. Physiol. Pflanz.
Biol. Plant.
Bot. Bull. Acad. Sinica
Bot. Gaz.
Bot. J. Lin. Soc.
Bot. Mag.—Tokyo
Bot. Notis.
Bot. Rev.
Bot. Tidsskr.
Brittonia
Bryologist
Bull. Torrey Bot. Club
Can. J. Bot.
Can. J. Plant Sci.
Commun. Soil Sci. Plant Anal.
Dan. Bot. Ark.
Econ. Bot.
Environ. Exp. Bot.
Euphytica
Flora
Isr. J. Bot.
J. Arnold Arboretum
J. Brit. Grassland Soc.
*J. Bryol.
J. Exp. Bot.
J. Phycol.
Lloydia—J. Nat. Prod.
New Phytol.
Oecol. Plant.
Photosynthetica
Physiol. Plant.
Physiol. Plant Pathol.
Physiol. Veget.
Phytochemistry
Phyton—Ann. Rei Bot. Austria
Phytopathol. Z.
Phytopathology
Plant Cell Physiol.
Plant Dis. Rep.
Plant Pathol.
Plant Physiol.
Plant Sci. Lett.
Plant Soil
Plant Syst. Evol.
Planta
*Planta Med.
Qual. Plan.
Rev. Palaeobot. Palynol.
Sov. Plant. Physiol.—Engl. Tr.
Taxon
Vegetatio
Weed Res.
Weed Sci.
Z. Pflanzenphysiol.
Z. Pflanzenzucht.

*Journal is covered in *Current Contents/Life Sciences*, not *CC®/AB&ES*

The 1978 *JCR* also included 6,208,187 reference citations. Of these, 136,792 or 2.2% were contained as references in source articles published in botany core journals in 1978. Botany journals averaged 20.5 references per source article in 1978, while the average for all articles in the *JCR* file that year was 17.6.

Lastly, articles published in botany core journals *received* 73,986 citations, which account for 1.2% of the 6,208,187 citations included in the 1978 *JCR*. More than half (53%) of all citations received by botany core journals in 1978 were to just seven journals—*American Journal of Botany*, *Canadian Journal of Botany*, *Physiologia Plantarum*, *Phytochemistry*, *Phytopathology*, *Plant Physiology*, and *Planta*. Five of these seven journals are covered in *Current Contents®/Life Sciences* (*CC®/LS*). All but two of the 69 core journals are covered in *Current Contents/Agriculture, Biology & Environmental Sciences* (*CC/AB&ES*). Although *Journal of Bryology* and *Planta Medica* are not covered in *CC/AB&ES*, they are covered in *CC/LS*. *Advances in Agronomy* is covered in the *Current Book Contents®* section (*CBC™*) of *CC/AB&ES*. In short, *CC/AB&ES* is comprehensive for botany and other biological sciences.

Table 2 lists the 50 journals most cited *by* the botany core journals, in order of the number of citations received from the core group. These journals account for 42.5% of all citations appearing in the core group. A Bradford-type journal distribution would show that the remaining 57.5% involve *thousands* of small publications, both living and dead. I discussed Bradford's law in detail in a recent essay.[8]

In our last study of botany literature, based on 1969 data, we also listed 50 journals most-cited by botany journals.[5] The first ten journals on that list are almost identical to the first ten listed here in Table 2. Table 2 lists *Phytochemistry* in the top ten, while it appeared as number 12 in the old list. The old list had *Science* in the top ten, but *Science* appears as number 16 in Table 2. This indicates that plant scientists generally cite the same journals now as they did in 1969.

In fact, the two lists contain 37 journals in common. Of the 13 journals listed in Table 2 that didn't appear on the old list, five are biochemistry journals—*Analytical Biochemistry*, *European Journal of Biochemistry*, and *Methods in Enzymology*, for example. This may indicate that plant scientists now cite a larger proportion of biochemistry studies than they did in 1969.

Table 3 lists 50 journals that most frequently cited the botany core journals, ranked in order of the number of references to them. In 1978, 939 out of 2,572 journals covered in the *SCI* that year cited the botany core journals, so the top 50 account for 5.3%. These 50 journals account for 64.4% of the citations received by the botany core group in 1978.

Six of the top ten journals in Table 3 are also in the top ten of the journal list published in our earlier study based on 1969 data.[5] The four journals in the top ten of Table 3 that didn't appear in the old list are: *American Journal of Botany*, *Annals of Botany*, *Physiologia Plantarum*, and *Zeitschrift fur Planzenphysiologie*. Only 26 journals are common to both lists of journals most frequently citing botany journals!

About half of the journals in Table 3 that weren't on the old list are devoted to the physiology, pathology, and chemistry of plants. Of the 24 journals on the old list that don't appear in Table 3, six were foreign language publications—four published in German and one each in Russian and Dutch.

When we compare Tables 1 and 3, we find that 36 of the 50 journals that most

Table 2: The 50 journals most-cited by botany core journals. A = citations received from botany journals. B = total citations received. C = self-citations. D = % of total citations which are botany citations (A/B). E = % of total citations which are self-citations (self-cited rate, C/B). F = % of botany citations which are self-citations (C/A). An asterisk in the list below indicates that the journal also appears on the list in Table 3.

Journal	A	B	C	D	E	F
*Plant Physiol.	7213	11638	1924	62.0	16.5	26.7
*Planta	3578	5332	738	67.1	13.7	20.5
*Phytochemistry	3241	6523	1511	49.7	23.2	46.6
*Phytopathology	3130	5059	1079	61.9	21.3	34.5
*Biochim. Biophys. Acta	2421	65311	—	3.7	—	—
*Can. J. Bot.	2209	3590	680	61.5	18.9	30.8
*Amer. J. Bot.	2200	3678	458	59.8	12.5	20.8
*Physiol. Plant.	2173	3377	499	64.3	14.8	23.0
J. Biol. Chem.	2046	102670	—	2.0	—	—
Nature	1875	80854	—	2.3	—	—
*J. Exp. Bot.	1410	2048	201	68.8	9.8	14.3
*New Phytol.	1343	2216	338	60.6	15.3	25.2
*Annu. Rev. Plant Physiol.	1339	2465	59	54.3	2.4	4.4
*Ann. Bot.	1273	2093	313	60.8	15.0	24.6
*Plant Cell Physiol.	1201	1805	345	66.5	19.1	28.7
Science	1178	59057	—	2.0	—	—
Plant Dis. Rep.	1126	1569	533	71.8	34.0	47.3
*Z. Pflanzenphysiol.	1079	1572	356	68.6	22.6	33.0
Proc. Nat. Acad. Sci. US	1037	75894	—	1.4	—	—
Biochem. J.	1020	35305	—	2.9	—	—
*Crop Sci.	1012	2854	—	35.4	—	—
*Arch. Biochem. Biophys.	881	18770	—	4.7	—	—
*Agron. J.	737	2771	—	26.6	—	—
Bioch. Biop. Res. Comm.	705	30254	—	2.3	—	—
*Plant Sci. Lett.	680	1062	138	64.0	13.0	20.3
*Weed Sci.	629	950	464	66.2	48.8	73.8
Aust. J. Biol. Sci.	623	1903	—	32.7	—	—
*Protoplasma	601	1607	—	37.4	—	—
*Bot. Gaz.	555	1007	60	55.1	5.9	10.8
J. Cell Biol.	547	24156	—	2.3	—	—
Method. Enzymol.	526	11780	—	4.5	—	—
*Plant Soil	526	1414	170	37.2	12.0	32.3
Soil Sci. Soc. Am. J.	499	3288	—	15.2	—	—
Tetrahedron Lett.	494	20636	—	2.4	—	—
J. Am. Chem. Soc.	480	105213	—	0.4	—	—
*Can. J. Plant Sci.	470	937	235	50.2	25.1	50.0
J. Bacteriol.	469	21373	—	2.2	—	—
Biochemistry—US	459	38027	—	1.2	—	—
Ecology	458	4894	—	9.3	—	—
J. Ecology	442	1544	—	28.6	—	—
*C.R. Acad. Sci. Ser. D	438	4326	—	10.1	—	—
Eur. J. Biochem.	435	20452	—	2.1	—	—
Arch. Microbiol.	431	3429	—	12.6	—	—
Analyt. Biochem.	430	15131	—	2.8	—	—
Virology	430	14107	—	3.0	—	—
*Aust. J. Plant Physiol.	422	599	135	70.5	22.5	32.0
*Phytopathol. Z.	421	650	164	64.8	25.2	38.9
*Physiol. Plant Pathol.	419	665	104	63.0	15.6	24.8
*J. Phycol.	415	1029	250	40.3	24.3	60.2
*Ann. Appl. Biol.	407	1625	—	25.0	—	—

frequently cited the core in 1978 are themselves core journals. Of the 14 *non*-core journals, eight publish in areas related to botany—horticulture, agronomy, mycology, and ecology, for example. One is a general science jour-

Table 3: The 50 journals which most frequently cited botany core journals. A = citations to botany core journals. B = citations to all journals. C = self-citations. D = % of citations to all journals which are to botany core journals (A/B). E = % of total citations which are self-citations (self-citing rate, C/B). F = % of botany citations which are self-citations (C/A). An asterisk in the list below indicates that the journal also appears on the list in Table 2.

Journal	A	B	C	D	E	F
*Plant Physiol.	4027	9509	1924	42.3	20.2	47.8
*Planta	2723	6458	738	42.2	11.4	27.1
*Phytochemistry	2693	10243	1511	26.3	14.7	56.1
*Can. J. Bot.	2604	8398	680	31.0	8.1	26.1
*Z. Pflanzenphysiol.	2442	5493	356	44.4	6.5	14.6
*Physiol. Plant.	2325	4997	499	46.5	10.0	21.5
*Phytopathology	1930	4326	1079	44.6	24.9	55.9
*Plant Cell Physiol.	1536	3530	345	43.5	9.8	22.5
*Ann. Bot.	1391	3431	313	40.5	9.1	22.5
*Amer. J. Bot.	1280	3898	458	32.8	11.7	35.8
*Plant Dis. Rep.	1230	3067	533	40.1	17.4	43.3
*J. Exp. Bot.	1190	2704	201	44.0	7.4	16.9
*New Phytol.	1127	3478	338	32.4	9.7	30.0
*Plant Sci. Lett.	983	2650	138	37.1	5.2	14.0
Biochem. Physiol. Pfl.	963	2868	77	33.6	2.7	8.0
*Physiol. Plant Pathol.	816	1765	104	46.2	5.9	12.7
*Annu. Rev. Plant Physiol.	800	2868	59	27.9	2.0	7.4
*Phytopathol. Z.	771	2013	164	38.3	8.1	21.3
*Aust. J. Plant Physiol.	744	1730	135	43.0	7.8	18.1
Bot. Mag.—Tokyo	734	1436	49	51.1	3.4	6.7
*Crop Sci.	727	4097	—	17.7	—	—
*Protoplasma	725	3146	—	23.0	—	—
*Biochem. Biophys. Acta	713	64606	—	1.1	—	—
*Weed Sci.	713	2098	464	34.0	22.1	65.1
Physiol. Veget.	708	2127	89	33.3	4.2	12.6
Annu. Rev. Phytopathol.	700	2092	62	33.5	3.0	8.8
*Ann. Appl. Biol.	682	2939	—	23.2	—	—
J. Am. Hortic. Sci.	681	3516	—	19.4	—	—
*Bot. Gaz.	628	1549	60	40.5	3.9	9.6
*Can. J. Plant Sci.	605	2366	235	25.6	9.9	38.8
*Plant Soil	579	2424	170	23.9	7.0	29.4
Photochem. Photobiol.	553	8472	—	6.5	—	—
*J. Phycol.	523	2378	250	22.0	10.5	47.8
Bryologist	519	1639	242	31.7	14.8	46.6
Biol. Plant.	489	1125	86	43.5	7.6	17.6
*Agron. J.	481	3640	—	13.2	—	—
Oecologia	466	5629	—	8.3	—	—
T. Brit. Mycol. Soc.	453	2293	—	19.8	—	—
Hortscience	446	2482	—	18.0	—	—
Aust. J. Bot.	407	1446	133	28.1	9.2	32.7
Euphytica	395	1685	128	23.4	7.6	32.4
Sov. Plant Physiol.	371	2123	—	17.5	—	—
*C.R. Acad. Sci. Ser. D	370	8995	—	4.1	—	—
Indian J. Exp. Biol.	363	8578	—	4.2	—	—
Bot. Rev.	359	1523	10	23.6	0.7	2.8
Curr. Sci. India	350	3808	—	9.2	—	—
*Arch. Biochem. Biophys.	345	15524	—	2.2	—	—
Planta Med.	344	1933	119	17.8	6.2	34.6
Photosynthetica	337	1269	67	26.5	5.3	19.9
Lloydia—J. Nat. Prod.	335	2142	116	15.6	5.4	34.6

nal—*Current Science* (India). Only five citing journals deal with topics in biochemistry, biophysics, or biology.

Turning to Tables 1 and 2, we find a different situation: the majority of the journals cited *by* the botany core jour-

nals (27 of 50) are *not* included in the core group. Only five of these 27 non-core journals are devoted to research related to botany. Four journals are multidisciplinary—*Nature* and *Science*, for example. The remaining 18 non-core journals most-cited by botanists publish research in biochemistry, biophysics, microbiology, biology, and chemistry.

Tables 2 and 3 list quite a few journals that are not included in the core group. The 6,658 articles published in the core *SCI* journals alone obviously do not represent the *total* botany literature published in 1978. The number of botany articles appearing in non-core journals is estimated by analyzing the frequency of citation to core journals by non-core journals. This indicates that about 4,500 additional botany articles were published in non-core journals in 1978. But this is a rough projection and not a precise calculation. Thus, about 11,000 botany articles were published in core and non-core *SCI* journals in 1978.

The citation data presented here confirm that botanists use research published in thousands of different journals from various basic and applied science fields not directly related to botany. At the same time, botanical research is cited by fewer journals (939), and most often by fields closely related to botany. This supports Levitt's suggestion that information flows up the tree of scientific knowledge: the more specialized branch sciences make use of research published in the more fundamental root sciences, but the reverse is less frequent.

Table 4 lists the 26 botany core journals with impact factors greater than or equal to .75. Impact tells us the number of times an average article published in a particular journal is cited. In the 1978 *JCR* it is calculated for each journal by dividing the number of 1978 citations (R) to articles published in 1976 and 1977 by the number of source items (S) it published in 1976 and 1977: R/S. Impact compensates for the differences in the number of articles published by each journal. A journal of lower quality may publish many lowly-cited articles but still receive a large number of citations. While rankings by total citations are important, they can be deceptive as indicators of quality.

Review articles generally receive more citations than the average research article. It's not surprising, then, that *Annual Review of Plant Physiology* and *Advances in Agronomy* appear at the top of Table 4.

Impact also proves to be an indicator of quality as perceived by the scientific community. The next two journals in Table 4, *Plant Physiology* and *Planta*, also rank highest in terms of citations from botany journals (Table 2) and references to botany core journals (Table 3). Thus, there can be little doubt that these two journals are among the most significant in modern botany.

Taken together, the core group of botany journals had an average impact of .91 and a median impact of .59—that is, half the core group had impact factors higher than .59 and half lower. The median impact factor for *all* journals processed for the 1978 *JCR* is .48.

At this point I should like to explain our recent turnabout concerning the *Canadian Journal of Botany*. It was the data in Table 4 which led us to the decision to drop this journal from coverage in *CC/LS*. Of course, we continued to list it in *CC/AB&ES*. As a consequence of this decision, we received a storm of protest. The journal's defenders would argue that the data in Table 2 would be enough to justify considering the *Canadian Journal of Botany* one of the few select plant sciences journals to be covered in *CC/LS*. (Remember that botany is not a field that we claim to cover comprehensively in *CC/LS*.) The

Table 4: Botany core journals with impact factor of .75 or greater (1978 *JCR*™)

Journal	Impact
Annu. Rev. Plant Physiol.	9.98
Adv. Agron.	3.06
Plant Physiol.	3.03
Planta	2.23
Plant Sci. Lett.	1.67
Annu. Rev. Phytopathol.	1.62
Physiol. Plant Pathol.	1.59
Physiol. Plant.	1.51
Plant Cell Physiol.	1.50
J. Phycol.	1.47
Aust. J. Plant Physiol.	1.44
Bot. Rev.	1.43
Phytochemistry	1.38
New Phytol.	1.32
J. Exp. Bot.	1.24
Z. Pflanzenphysiol.	1.12
Photosynthetica	1.11
Amer. J. Bot.	1.06
Ann. Bot.	1.04
Can. J. Bot.	.99
Phytopathology	.90
Physiol. Veget.	.89
Aust. J. Bot.	.82
Weed Sci.	.82
Lloydia—J. Nat. Prod.	.80
Bot. Gaz.	.75

arguments provided by most readers had little to do with the proved or unproved quality or impact of this journal. Rather, the *CC* readers who published in this journal want the readers of *CC/LS* to know what they are doing. Since they, too, view botany as a basic science it makes no difference to them whether the average reader of *CC/LS* is doing research in botany. While we have reinstated the *Canadian Journal of Botany* in *CC/LS*, the reason for doing so was the more cogent argument that there were many other journals we cover in other fields with lower impact.

Many readers argued that the *Canadian Journal of Botany* published many theoretical and basic papers. The data in Table 3 show that almost 70% of all references included in this journal in 1978 were to journals outside the core group. You can find out what individual journals were cited by the *Canadian Journal of Botany* in the Citing Journal Package of the 1978 *JCR*. Many of these journals publish basic science papers. This gives us some idea of what Levitt is talking about when he points out that botanists draw heavily on the other basic sciences. But I believe we'll get an even better idea of the importance of this journal when we examine the list of superstar papers for botany, which will be presented in part 2 of this study.

Table 5 lists botany core journals with immediacy factors greater than .15. Immediacy tells us how often an average article in a particular journal is cited in the *same* year that it was published. It is calculated by dividing the number of citations the journal's 1978 articles received in 1978 by the number of articles it published that year. As a group, the botany core journals had a median immediacy of .146, almost identical to

Table 5: Botany core journals with immediacy factor greater than .150 (1978 *JCR*™)

Journal	Immediacy
Aust. J. Plant Physiol.	.766
Annu. Rev. Plant Physiol.	.632
Plant Physiol.	.484
Planta	.476
Phytochemistry	.395
New Phytol.	.340
Ann. Bot.	.304
J. Phycol.	.290
Physiol. Plant.	.282
Phytopathology	.278
Aust. J. Bot.	.276
J. Exp. Bot.	.270
Can. J. Bot.	.268
Bot. Rev.	.250
Z. Pflanzenphysiol.	.239
Euphytica	.228
Plant Cell Physiol.	.222
Amer. J. Bot.	.206
Rev. Palaeobot. Palynol.	.194
Physiol. Veget.	.192
Bot. Mag.—Tokyo	.178
Vegetatio	.170
Planta Med.	.169
Plant Sci. Lett.	.169
Can. J. Plant Sci.	.160
Weed Res.	.156
Plant and Soil	.153
Bot. J. Lin. Soc.	.152

the .142 median immediacy for all journals covered in the 1978 *JCR*.

The data presented in this study indicate that the five most significant botany journals are *Physiologia Plantarum*, *Phytochemistry*, *Phytopathology*, *Plant Physiology*, and *Planta*. Each of these journals ranked high in terms of total number of citations from botany core journals (Table 2), total number of citations to the core (Table 3), impact (Table 4), and/or immediacy (Table 5).

In part 2 of this study, we will discuss "growth indicators" of the botanical literature. Data indicating the number of papers published and the number of references per article for each year from 1968 to 1977 will be presented. Also, two lists of highly-cited botany articles will be presented. The first indicates the single most-cited botany article from each core journal that was cited 30 or more times from 1961-78. If the most-cited paper from any core journal has less than 30 citations, it will not be included. The second list shows those articles most cited by the core journals in 1978.

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