

BIBLIOMETRIC ANALYSIS OF PUBLISHED SCIENTIFIC KNOWLEDGE WITH SPECIAL REFERENCE TO “PLANT PHYSIOLOGY”

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Abstract

In the present study “Plant Physiology”, an international journal in the field of plant science is taken as a model to bibliometrically analyse any openly accessible published scientific knowledge. The different parameters like year wise growth rate of literature, pagination pattern, degree of collaboration and top productive authors, countries, etc. are measured. The results indicate that approximately 401 articles are published per year. More than half of the articles have a page length of 11 to 15 pages. Authorship pattern shows joint authorship in the journal and degree of collaboration indicates the predominance of multiple author contribution. Country wise USA tops the lists and Max Plank Institute of Molecular Plant Physiology from Germany holds the first position among the most productive institution. Further, the study also examines the subject wise contribution of articles in the journal Plant Physiology during the study period.

Keywords: Bibliometric study, plant physiology, authorship pattern, open access scholarly communication.

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1 Introduction

Research in all fields of knowledge is getting higher momentum year by year. Hence, the scholarly community is in need of information by all means. The sharing of information among the scholars is a prime concern. One of the best ways to serve the purpose is through scholarly publications most especially journals. But the authors had to face with multiple challenge of unaffordability of cost of publishing as well as subscribing the same and hence the problems of visibility to greater number of audiences. For most libraries and researchers it was not possible to buy all the necessary journals due to their high cost of subscription. Besides all these there appeared questions of free accessibility of scholarly output of publically funded researches to the taxpaying public. In such a circumstance the idea of Open Access of research content got prominence. It refers to the free access of research output, i.e., without any restrictions of access (eg. access tolls) and use (eg. copyright issues).

After 1991 a boom of open access publications started and is going through greater development in the present times. Open Access journals in all fields are available which enabled higher range of visibility of one's research output enabling a globally shared between the scholars.

To know the impact of openly accessible published scientific knowledge in the academic and research circle a bibliometric analysis of one the most prominent open access journals with higher impact factor is done. This study reveals how effectively an open access publication works in the sharing of research output among scholars and the vast visibility an author or scholar receives via publishing his research result in an open access publication.

The open access journal selected for study is "Plant Physiology" which holds a prominent position with higher grade of impact factor in the scholarly circle. The impact factor of the journals is 6.456 with an h-index of 252.

2 OBJECTIVES

1. To map the year wise distribution of articles.
2. To find the average length of article based on pages.
3. To examine the authorship pattern and author productivity.
4. To determine the degree of collaboration
5. To find out the most prolific author.
6. To identify the highly prolific organisation.
7. To identify the country wise contribution.
8. To identify subject wise contribution of articles.

3 METHODOLOGY

The methodology used relevant bibliometrics techniques to analyse the scholarly communications of 'Plant Physiology' from 2012-2016. The data for the study was downloaded from the respective website of the journal <http://www.plantphysiol.org> which facilitates full text access to the journal. Keeping in view the aforesaid objectives a total of 60 issues/15 volumes is thoroughly scanned to collect necessary data. Relevant bibliometric measures of 2007 articles, viz., year of publication, contributor(s) name, affiliated institution, country, page length etc. are recorded in MS Excel spreadsheet and tabulated and analysed the data by using various mathematical and statistical techniques.

4 SCOPE AND LIMITATION

The scope of the study encompasses the international journal 'Plant Physiology' research outcomes available open access online. Articles during the period 2012-2016, are analysed. The present study considered 15 volumes (60 issues) covering a period of 5 years. All journal issues during the 5 years are examined page wise. The present study tries to find out the literature growth, authorship pattern, collaboration pattern, average length of articles, institution wise collaboration of articles, most prolific author, most productive country, subject wise

distribution of articles and degree of collaboration etc. published during the period 2012-2016 in the journal *Plant Physiology*.

5 LITERATURE REVIEW

K G Pillai, S., and Priyalakshmi[1] conducted a study on the bibliographic details of 1076 research articles from the Annual Reports of Central Tuber Crops Research Institute (CTCRI) during 2000 to 2010. The authors found that from the total number of 1076 research articles published during the study period the highest number of article published in the year 2006, i.e., 169 papers. The average number of publications per year was about 98%. Most of the contributions were co-authored (87.68%). The highest number of articles 125 (39.30%) are from the Journal of Root Crops published by Indian Society of Root Crops.

Maharana, Rabindra[2] focuses on the bibliometric analysis of Orissa University of Agricultural Technology's Research Output as Indexed in Scopus in 2008-2012. This study shows that most researchers prefer the Agricultural and Biological Sciences at the Orissa University of Agricultural Technology. A total of 168 journal articles have been produced by authors affiliated with the institution. Out of 86 journals where the 168 contributions have been made, Indian Journal of Agricultural Research and Indian Veterinary Journal appear to be their favourite journals. Out of 168 articles 42 articles (25%) have four authors and 40 articles (23.86%) are with three authors. The findings also reveals that the researchers have more affiliation with authors form United States, Australia and Canada.

Thavamani, K.[3] explores the publication trends of scholarly papers in *Pearl: A Journal of Library and Information Science* published from New Delhi. The bibliometric analysis has been conducted with 273 contributions published in the journal during the year 2007-2013. The highest number of contributions, i.e., 47 (17.216%) were published in the year 2009. Most of the contributions are contributed by multiple authors, i.e., 166 (60.806%). The highest number of author productivity, i.e., 89 (1.894) was published in the year 2009. The highest number of contributors, i.e., 119 (23.705%) are from Andhra Pradesh. Maximum studies were conducted in the area of user studies, i.e., 51 (18.681%). The degree of collaboration is determined as 0.608 during the study period.

6 Selection of Source

The present study tries to find out the literature growth, authorship and collaboration pattern, average length of articles, most prolific organisation etc., in the '*Plant Physiology*'. *Plant Physiology* is an international journal devoted to physiology, biochemistry, cellular and molecular biology, genetics, biophysics, and environmental biology of plant. In January 1926, *Plant Physiology* began publication and is one of the world's oldest and most well-respected plant science journals published by American Society of Plant Biologist (ASPB), one of the leading publishers in Plant Science. 15 volumes (Vol. No. 158 to 172) of *Plant Physiology*, published during 2012 to 2016 containing 60 issues have been taken into consideration for the present study. The source data was downloaded from <http://www.plantphysiology.org>. The resultant data was further refined by year 2012 to 2016. The final data consisted of 2007 articles in *Plant Physiology* during 5 years from 2012 to 2016. All the details such as authors, titles, year of publication, pagination, institutional affiliation etc. of all articles published in 60 issues during the period of 2012 to 2016 were recorded for the analysis. The data was processed on MS Excel sheets. Data was analysed to meet the objectives of the study. Complete count method has been followed for the analysis of the data. Percentage of all the places has been drawn maximum up to two decimal places and has also been rounded off to next higher value at second percentile value where third percentile value emerged above .005.

7 Analysis

Average Number of Articles Published Per Year and Per Issue

Table 1 represents average number of articles published per year and per issue in *Plant Physiology* during 2012-2016.

Table 1: Average Number of Articles Published per Year and per Issue

Sl. No.	Year	Total No. Of Issues	Issues/Year	Total No. Of Articles	Average No. Of Articles/Year	Average No. Of Articles/Issue
1	2012-2016	60	12	2007	401.4	33.45

There were 2007 articles published in Plant Physiology during 2012-2016. Table 1 shows on an average 33.45 (approximately 33) articles were published per issue and 401.4 (approximately 401) articles per year.

Year - Wise Distribution of Articles Per Issue

Table 2 represents year-wise distribution of articles and average number of articles per issue published in the 'Plant Physiology' during the period given below.

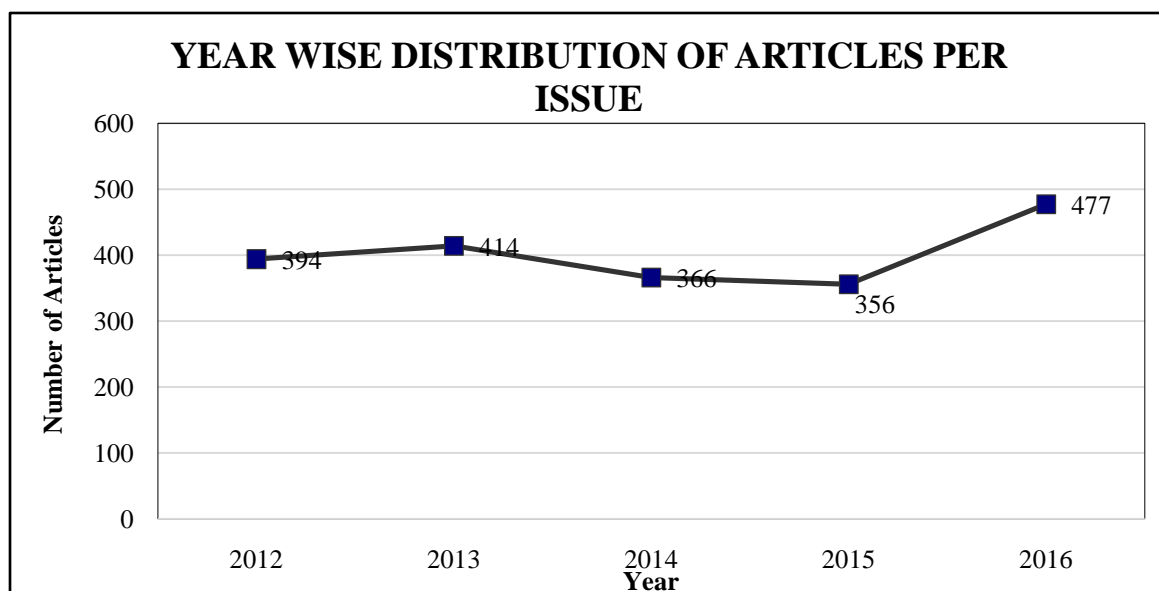
Table 2: Year - Wise Distribution of Articles per issue

Year	Volume	No. of issues	Total No. of Articles/Year	Percentage	Avg. No. Of Articles per Issue
2012	158-160	12	394	19.63	32.83
2013	161-163	12	414	20.63	34.5
2014	164-166	12	366	18.24	30.5
2015	167-169	12	356	17.74	29.67
2016	170-172	12	477	23.77	39.75
Total	15	60	2007	100	33.45

The total number of contributions in 15 volumes of the journal with 60 issues published in five years (2012- 2016) is 2007 as given chronologically in Table 2. On an average 134 (6.68%) papers were published per volume. The maximum number of articles i.e. 477 (23.77%) was published in 2016 followed by 414 (20.63%) in 2013 and minimum number i.e. 356 (17.74%) in the year 2015. It is observed that the number of articles published during the year 2012, 2014 and 2015 were less than the cumulative average number of articles. On an average the lowest number of articles per issue published in the year 2015 (29.67) and the highest is in the year 2016 (39.75). It is also visible that there was a decline in the number of articles published after the year 2013 and a sudden increase in number in the year 2016.

Fig. 1: Line Chart showing year wise distribution of article

Figure 1 shows the pattern of publication of articles over the period of study. The number of articles is



increased from 394 in 2012 into 414 in the year 2013 which is the second highest number of articles during the study period. The following two years shows continuous decline in the number of articles i.e. 366 in the year 2014, 356 in 2015. In the year 2016 it shows an upward movement and reached to 477 articles.

Length Wise Distribution of Articles

Table 3 deals with the length of articles published in 'Plant Physiology' during the period 2012-2016.

Table 3: Length wise distribution of Articles

Year	1 to 5	6 to 10	11 to 15	16 to 20	>20	Total No. of articles	Total no. of pages	Average no. of pages
2012	-	65	241	76	12	394	5274	13.36
2013	-	55	273	77	9	414	5587	13.5
2014	-	46	226	86	8	366	5046	13.79
2015		41	205	102	5	356	5041	14.16
2016	-	54	292	116	15	477	6672	13.99
Total		261	1237	457	49	2007	27620	13.76
Percentage		13	61.63	22.77	2.44	100		

The table shows that majority of the articles are having 11-15 pages each constitute more than ½ (61.63%) of the total articles published during the study period. 22.77% (457) articles comprises of 16-20 pages followed by 13% (261) consists of 6-10 pages. Only 49 articles (2.44%) are of length more than 20 papers. Table also shows that there are no articles comprising of page length less than 6. Further analysis reveals that Plant Physiology accommodated on an average 13.46 (approximately 13) pages per article.

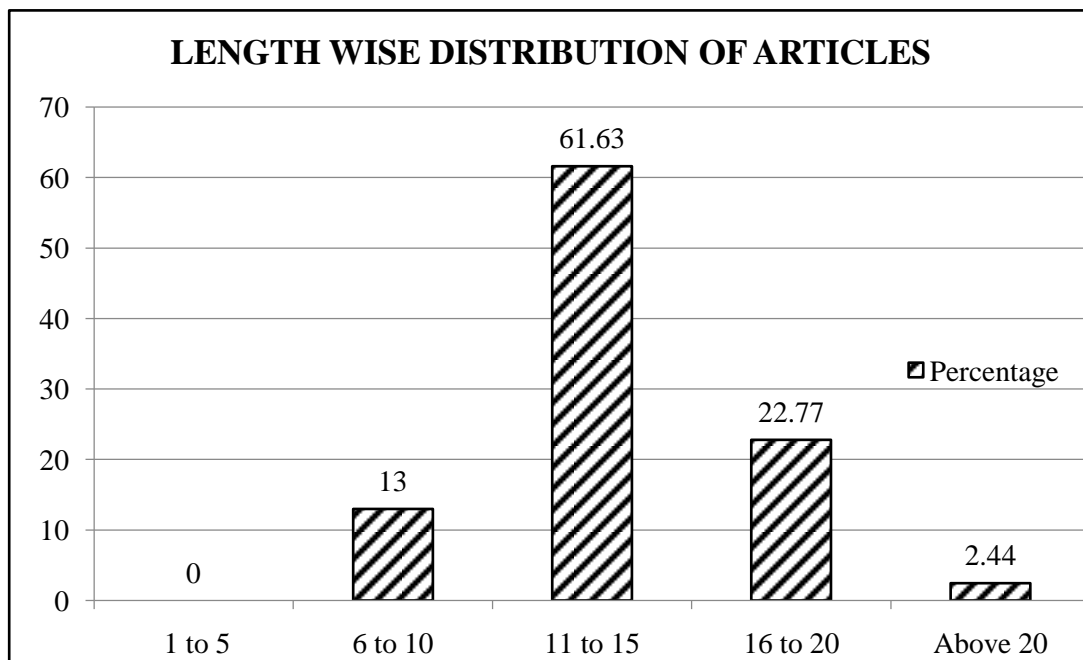
**Fig.2: Column diagram showing Length wise distribution of articles**

Figure 2 portrays the length wise distribution of articles published in the journal Plant Physiology during the study period. It is observed that more than 50% of articles consists of a page length of 11 – 15 while the lengths 6-10 and 16 -20 comprises less number of articles. Articles having a length of more than 20 pages are only 2.44%. Articles with page length 1-5 categories in the figure shows the value of zero which indicates that the journal hasn't accommodated articles with page length less than 6 during the study period

Authorship Pattern

Table4 shows the authorship pattern of the articles published during the period of study.

Table 4: Authorship Pattern

Year	Number of authors						Total no. Of authors	Total no. Of articles
	Single	Two	Three	Four	Five	> five		
2012	3	38	96	188	200	2204	2729	394
2013	1	32	120	196	230	2403	2982	414
2014	-	28	81	172	235	2153	2669	366
2015	-	24	60	148	190	2366	2788	356
2016	-	38	114	192	255	2923	3522	477
	4	160	471	896	1110	12049	14690	2007
(%)	0.03	1.09	3.21	6.10	7.56	82.02		

Analysis of table 5 shows a total number of 14690 occurrences of authors in different authorship positions during the period. It was observed that more than five authored contributions 12049 (82.02%) were found to be most predominant in collaboration ranging from 6 to 34, five authored 1110 (7.56%), four authored 896 (6.10%), three authored 471(3.21%) followed by two authored 160 (1.09%) and only four articles were contributed by single author. It is seen that the multi-authored papers highly out number single authored papers

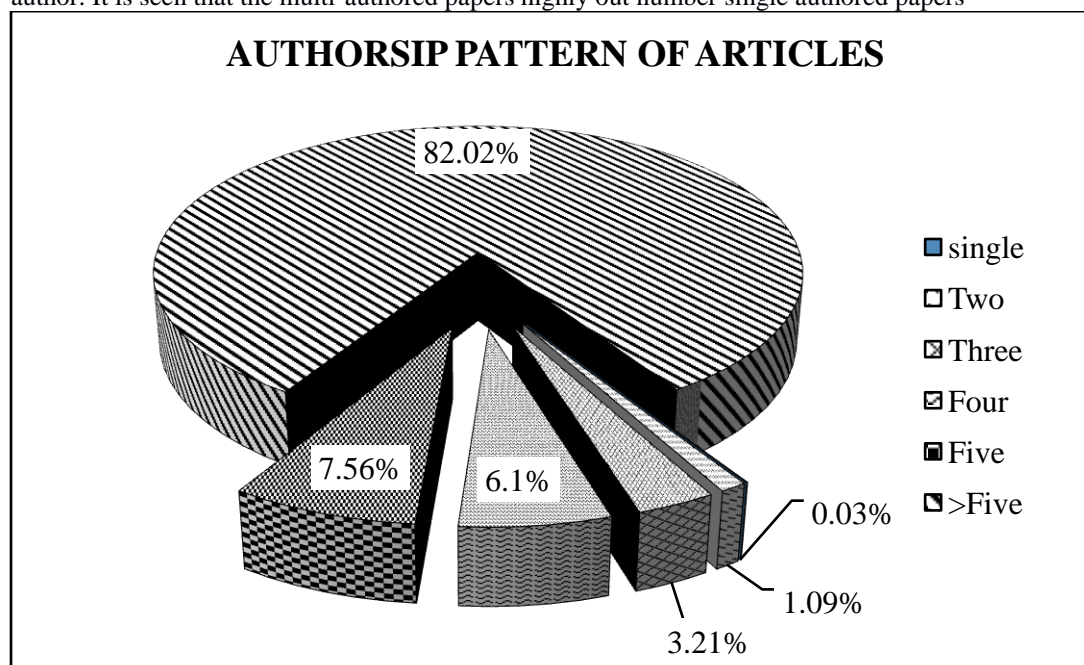


Fig. 3 Authorship Pattern of Articles

Fig 3 shows that the authorship pattern of the journal Plant Physiology during the study period. It is seen that majority 12049 (82.02%) of papers have been written in joint authorship. The lowest number of contribution is

4 (0.03%) contributed by single authors. Only 160 (1.09%) are two authored papers and three authored, four authored and five authored papers are 471(3.21%), 896 (6.01%), 1110 (7.56%) respectively.

Author Productivity

Table 5 shows the author productivity during the period of study. Productivity has been calculated with the following formula.¹

*Average authors per paper = No. Of authors/ No. Of publications

**Productivity per author = No. Of publications/No. Of authors

Table 5: Author Productivity

Year	No. of Papers	No. of Authors	Avg. Authors/Paper	Productivity/Author
2012	394	2530	6.42	0.16
2013	414	2782	6.72	0.15
2014	366	2438	6.66	0.15
2015	356	2611	7.33	0.14
2016	477	3228	6.77	0.15
	2007	13589	6.78	0.15

Table 5 represents the author productivity of 'Plant Physiology 'during the period 2012-2016. It is observed that a total of 13589 authors have contributed 2007 articles with an average of 6.78 publications per author. The year 2015 has the highest average number of authors per publications. The rest of the years have relatively equal average number of authors per publications when compared to the total average number of authors per publications. The average productivity per author is 0.15. All the years except for 2015 have the equal productivity per author when compared to the total average productivity per author.

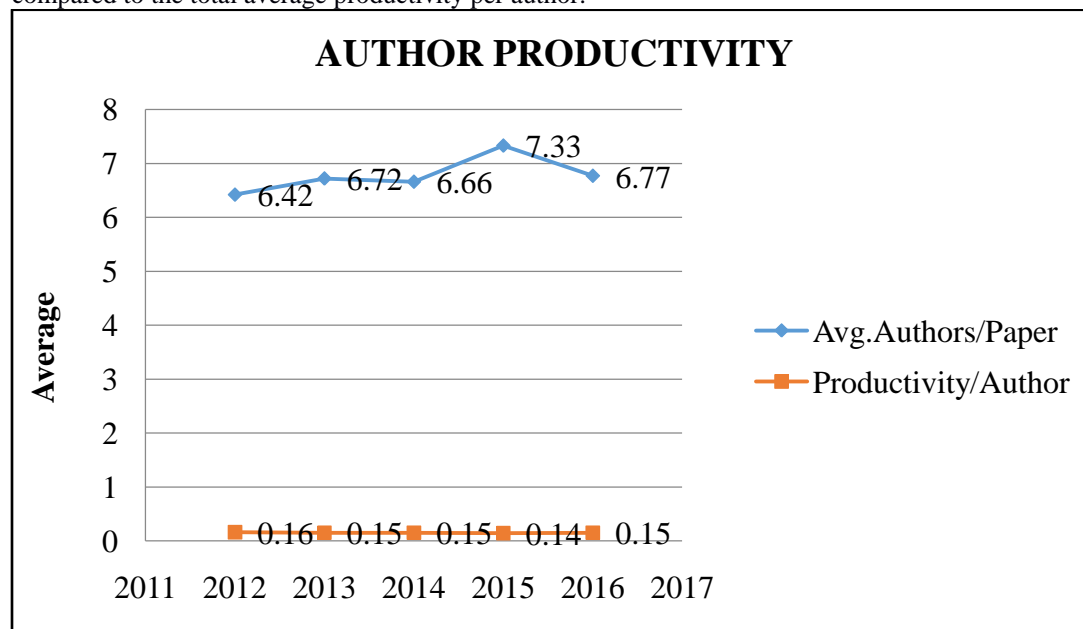


Fig 4: Line chart Author Productivity

Figure 4 shows the Average Authors per Paper and Productivity per Author. Figure displays that in the year 2015 an average of 7.33 authors were contributed for each paper which is the highest of study period. When considering rest of the years almost all years are having approximately same number of authors per publication except 2012 in which the lowest number of authors (6.42) per paper. Figure also shows that productivity per author i.e., the average number of publication per author is almost consistent during the study period (15 papers per author).

Degree of Collaboration by Year

Degree of collaboration (DC) was derived by using Subramaniyam formula, as the ratio of the number of collaborative contributions to the total number of research contributors published in the discipline during a certain period of time. Mathematically it can be expressed as

$$DC = \frac{NM}{NM+NS} \quad \text{or, } (DC)_{PP} = \frac{2003}{4+2003} = 0.99$$

where NM refers to the collaborative communications and NS denote the number of single authored communications published during certain period of time. Table 6 reveals the collaboration scenario of the contributors of 'Plant Physiology' during the period 2012-2016.

Table 6: Distribution of Degree of Collaboration by Year

Year	Vol. No	Single authored Articles (Ns)	Multi authored articles (Nm)	Total No. of Articles (Ns+Nm)	Degree of Collaboration
2012	158-160	3	391	394	0.99
2013	161-163	1	413	414	1
2014	164-166	-	366	366	1
2015	167-169		356	356	1
2016	170-172	-	477	477	1
Total		4	2003	2007	0.99

Table 6 shows that out of 2007 articles about 2003 were contributed by multiple authors and only 4 were non-collaborative. It is an indication of predominance of group research in the field. During the study period only 2 years have single authored papers. Average degree of collaboration is highly impressive (0.99) which indicates relevance of group or team research in the field. These are also shown graphically in figure 5.5 that there has been a great strength of multi authored papers which is a result of teamwork for research among the contributors. The figure shows a consistent pattern of degree of collaboration which clearly indicates dominance upon multiple author contribution.

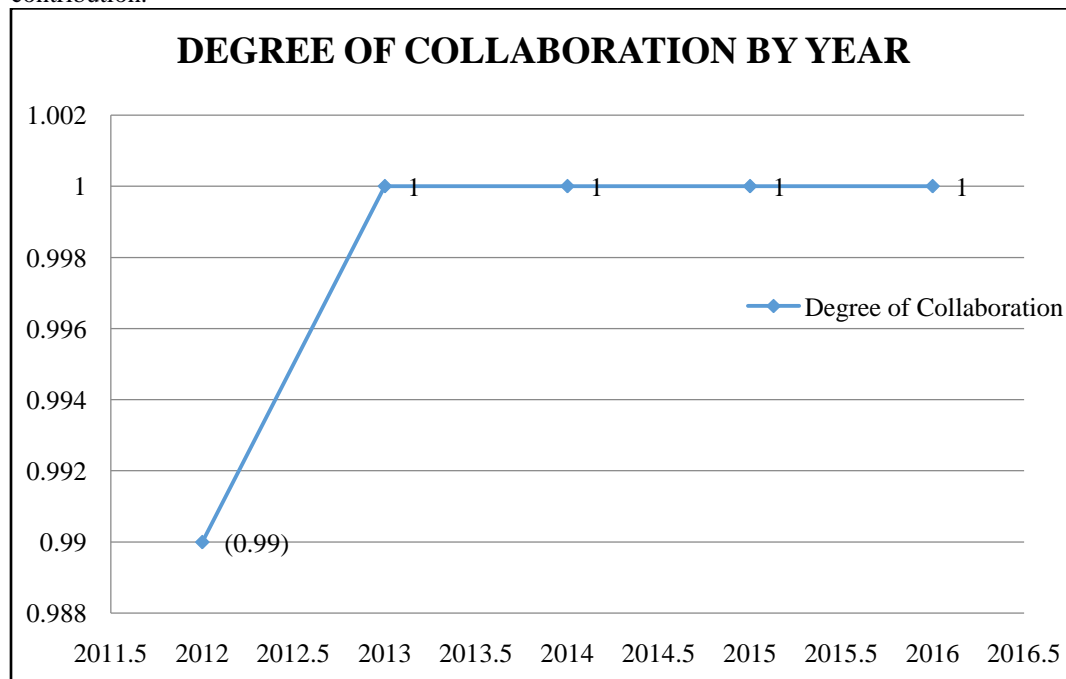


Fig. 5 Line chart showing Degree of collaboration by year

Ranking of Most Productive Author

Table 7 shows the most prolific authors who occupied in the top 10 ranks according to the number of contributions in the Plant Physiology

Table 7: Ranking of Most prolific Author

Sl. No	Name of Author	No. of Contributions	Country	Rank
1	Alisdair R. Fernie	35	Germany	1
2	Jonathan Gershenzon	14	Australia	2
3	James Whelan	13	Germany	3
4	Ian T. Baldwin	11	Germany	4
5	Regina Feil	10	Germany	5
6	Bernhard Grimm	10	Germany	6
7	John E. Lunn	9	Germany	6
8	John Ralph	9	USA	6
9	Mark Stitt	9	Germany	6
10	Sonia Osorio	9	Spain	6
11	Takayuki Tohge	9	Germany	6
12	Tom Beeckman	9	Belgium	6
13	WoutBoerjan	9	Belgium	6
14	Zoran Nikoloski	9	Germany	6
15	Dirk Inzé	8	Belgium	7
16	Jian Feng Ma	8	Japan	7
17	Jinghua Xiao	8	China	7
18	Reena Narsai	8	Australia	7
19	Ronan Sulpice	8	Germany	7
20	Shao Jian Zheng	8	China	7
21	Xianghua Li	8	China	7
22	A. Harvey Millar	7	Australia	8
23	Antony Bacic	7	Australia	8
24	Arthur R. Grossman	7	USA	8
25	Christine A. Beveridge	7	Australia	8
26	Dabing Zhang	7	China	8
27	Kazuki Saito	7	Japan	8
28	Michael K. Udvardi	7	USA	8
29	Naoki Yamaji	7	Japan	8
30	Simon R. Law	7	Australia	8
31	Bernd Mueller-Roeber	6	Germany	9
32	Daniel J. Cosgrove	6	USA	9
33	Dario Leister	6	Germany	9
34	Edgar B. Cahoon	6	Nebraska	9

Sl. No	Name of Author	No. of Contributions	Country	Rank
35	Enrico Martinoia	6	Switzerland	9
36	Eva-Mari Aro	6	Japan	9
37	Frank Van Breusegem	6	Belgium	9
38	G. Eric Schaller	6	Hanover,New Hampshire	9
39	Gilles Peltier	6	France	9
40	Herbert J. Kronzucker	6	Canada	9
41	Hitoshi Sakakibara	6	Japan	9
42	Inhwan Hwang	6	Korea	9
43	Ivo Feussner	6	Germany	9
44	Jiangqi Wen	6	USA	9
45	JianruZuo	6	China	9
46	John Browse	6	USA	9
47	JörgBohlmann	6	Canada	9
48	Julin N. Maloof	6	USA	9
49	Kirankumar S. Mysore	6	USA	9
50	Klaas J. Van Wijk	6	USA	9
51	Kris Morreel	6	Belgium	9
52	Michael R. Blatt	6	UK	9
53	Mikiko Kojima	6	Japan	9
54	Nicolaus Von Wirén	6	Germany	9
55	Paul Dupree	6	UK	9
56	Ralph Bock	6	Germany	9
57	Robert T. Mullen	6	Canada	9
58	Ruben Vanholme	6	Belgium	9
59	Salma Balazadeh	6	Germany	9
60	StaffanPersson	6	Australia	9
61	Adriano Nunes-Nesi	5	Brasil	10
62	Alison G. Smith	5	UK	10
63	AlmuthHammerbacher	5	Germany	10
64	Andrea Ghirardo	5	Germany	10
65	Asaph B. Cousins	5	USA	10
66	Bettina Hause	5	Germany	10
67	Byung Kook Hwang	5	Korea	10
68	Catherine Rameau	5	France	10
69	Cecilia Gotor	5	Spain	10
70	Christoph Benning	5	USA	10
71	Cyril Zipfel	5	USA	10
72	Dae-Jin Yun	5	Korea	10
73	Daniel H. Chitwood	5	USA	10
74	Donald R. Mccarty	5	Florida	10

Sl. No	Name of Author	No. of Contributions	Country	Rank
75	Federica Brandizzi	5	USA	10
76	Frank Hochholdinger	5	Germany	10
77	FrédéricDomergue	5	France	10
78	Gaston A. Pizzio	5	USA	10
79	Geert Goeminne	5	Belgium	10
80	Gerhard Leubner-Metzger	5	UK	10
81	Giles E.D. Oldroyd	5	UK	10
82	Gynheung An	5	Korea	10
83	HarroBouwmeester	5	Netherlands	10
84	Ikuko Hara-Nishimura	5	Japan	10
85	James J. Giovannoni	5	USA	10
86	JérômeJoubès	5	France	10
87	Jian-Kang Zhu	5	China	10
88	Jing Li	5	China	10
89	John B. Ohlrogge	5	USA	10
90	Jörg-Peter Schnitzler	5	Germany	10
91	Joseph J. Kieber	5	USA	10
92	Julian I. Schroeder	5	USA	10
93	Julio Paez-Valencia	5	USA	10
94	Jun Liu	5	China	10
95	Karin Ljung	5	Swedan	10
96	Langtao Xiao	5	China	10
97	Lixin Zhang	5	China	10
98	Louwrance P. Wright	5	Germany	10
99	Markus Pauly	5	USA	10
100	Masatomo Kobayashi	5	Japan	10
101	Michael Hippler	5	Germany	10
102	Ming Chen	5	USA	10
103	Nak Hyun Kim	5	Korea	10
104	Nam-Hai Chua	5	USA	10
105	Neelima R. Sinha	5	USA	10
106	Paul E. Verslues	5	Taiwan	10
107	Peng Wang	5	Germany	10
108	Philip B. Brewer	5	Australia	10
109	Qi Xie	5	China	10
110	Ralph Hückelhoven	5	Germany	10
111	Ray A. Bressan	5	Saudi Arabia	10
112	Robbie Waugh	5	UK	10
113	Robert Fluhr	5	Israel	10
114	Roger W. Innes	5	USA	10

Sl. No	Name of Author	No. of Contributions	Country	Rank
115	Sharyn E. Perry	5	USA	10
116	Shawn D. Mansfield	5	Canada	10
117	Sheng Yang He	5	USA	10
118	Toshihiro Obata	5	Germany	10
119	Toshinori Kinoshita	5	Japan	10
120	UeliGrossniklaus	5	Switzerland	10
121	Wanqi Liang	5	China	10
122	Wei Zhang	5	China	10
123	Xianlong Zhang	5	China	10
124	Xiao Fang Zhu	5	China	10
125	Yang Li	5	China	10
126	YoichiroFukao	5	Japan	10
127	Yuji Kamiya	5	Japan	10
128	Yusuke Jikumaru	5	Japan	10
129	Yves Gibon	5	France	10

Table 7 shows rank list of top 20 authors who contributed maximum number of articles out of the total of 2007 articles published during 2012-2016 in the Plant Physiology. The most prolific contributor Alisdair R. Fernie (Germany) stood in the first position; he contributed the highest number (35) of articles. This is followed by Jonathan Gershenzon (Germany) who occupied the second rank with 14 publications. James Whelan (Australia) with 13 publications; Ian T. Baldwin (Germany) with 11 publications and Bernhard Grimm (Germany) and Regina Feil (Germany) with 10 publications each covered the top 5 ranks.

Most Prolific Institutions

Table 8 shows rank list of highly prolific organisation in the journal during the study period

Table 8: Most Prolific Institution

Sl. No.	Name of Institution	No. of Contribution	Rank
1	Max Planck Institute of Molecular Plant Physiology, Potsdam, Germany	45	1
2	Department of Plant Biotechnology and Bioinformatics, Ghent University, Ghent, Belgium	30	2
3	RIKEN Center for Sustainable Resource Science, Suehirocho, Tsurumiku, Yokohama, Kanagawa, Japan	28	3
4	Department of Plant Systems Biology, Ghent University, Gent, Belgium	24	4
5	National Key Laboratory of Crop Genetic Improvement, Huazhong Agricultural University, Wuhan, China	24	4
6	National Key Laboratory of Plant Molecular Genetics, Shanghai, China	20	5
7	Donald Danforth Plant Science Center, St. Louis, Missouri	17	6
8	Institute of Plant Science and Resources, Okayama University, Kurashiki, Japan	17	6
9	Department of Plant Biology, Carnegie Institution for Science, Stanford, California	16	7
10	Institute of Plant and Microbial Biology, Academia Sinica, Taipei, Taiwan	16	7
11	Chinese Academy of Sciences, Shanghai, China	14	8

Sl. No.	Name of Institution	No. of Contribution	Rank
12	Shanghai Institutes for Biological Sciences, Shanghai, China	14	8
13	Department of Plant Sciences, University of California, Davis, California	13	9
14	Institute of Biological Chemistry, Washington State University, Pullman, Washington	13	9
15	Plant Biology Division, Samuel Roberts Noble Foundation, Ardmore, Oklahoma	13	9
16	Umea Plant Science Center, Swedish University of Agricultural Sciences, Umea, Sweden	13	9
17	University of Chinese Academy of Sciences, Beijing, China	13	9
18	Department of Botany, University of British Columbia, Vancouver, British Columbia, Canada	12	10
19	Department of Horticulture and Landscape Architecture, Purdue University, West Lafayette	12	10
20	Department of Plant Sciences, University of Cambridge, Cambridge CB EA, United Kingdom	12	10

Table 8 displays the top 20 institutions which come in the first 10 ranks of institutions who have given maximum contributions in the Plant Physiology during 2012-2016. It is found that 3525 Institutions from 62 countries have collaborated for 2007 articles during the study period. Among the 3525 organisations Max Planck Institute of Molecular Plant Physiology, Potsdam, Germany with 45 contributions tops the list. Department of Plant Biotechnology and Bioinformatics, Ghent University, Belgium accounts for the second position with 30 contributions. RIKEN Centre for Sustainable Resource Science, Suehirocho, Tsurumiku, Yokohama, Kanagawa, Japan with 28 contributions is in third position and Department of Plant Systems Biology, Ghent University, Belgium along with National Key Laboratory of Crop Genetic Improvement, Huazhong Agricultural University, Wuhan, China shares the 4th rank.

Geographical Distribution of Articles

Table 9 shows the geographical distribution of articles during the study period.

Table 9: Geographical Distribution of articles

Sl. No.	Name of country	No. of Contribution	Rank
1	USA	655	1
2	China	407	2
3	Germany	331	3
4	United Kingdom	193	4
5	France	192	5
6	Japan	164	6
7	Australia	122	7
8	Canada	105	8
9	Spain	104	9
10	Belgium	73	10
11	Korea	64	11
12	Switzerland	63	12
13	Netherlands	62	13
14	Italy	59	14
15	Sweden	48	15
16	Taiwan	46	16
17	Israel	44	17
18	India	34	18
19	Denmark	33	19

Sl. No.	Name of country	No. of Contribution	Rank
20	Argentina	31	20
21	Czech Republic	28	21
22	Brazil	22	22
23	Austria	21	23
24	Finland	20	24
25	Mexico	17	25
26	Poland	16	26
27	Singapore	14	27
28	New Zealand	13	28
29	Hungary	11	29
30	Saudi Arabia	11	29
31	Hong Kong	10	30
32	Portugal	9	31
33	Norway	8	32
34	Chile	7	33
35	Russia	7	33
36	Estonia	6	34
37	South Africa	6	34
38	Pakistan	5	35
39	Philippines	5	35
40	Egypt	4	36
41	Greece	4	36
42	Bulgaria	3	37
43	Iran	3	37
44	Ireland	3	37
45	Malaysia	3	37
46	Thailand	3	37
47	Sri Lanka	2	38
48	Turkey	2	38
49	Bangladesh	1	39
50	Benin	1	39
51	Fiji	1	39
52	Morocco	1	39
53	Nepal	1	39
54	Palestine	1	39
55	Panama	1	39
56	Romania	1	39
57	Senegal	1	39
58	Slovakia	1	39
59	Slovenia	1	39
60	United Arab Emirates	1	39
61	Uruguay	1	39
62	Vietnam	1	39

Table 9 shows a total of 62 countries, contributed 2007 articles. The highest number of articles i.e., 655 contributions were from USA. The second most contributions were from China i.e., 407. This is followed Germany by 331 contributions; UK by 193 contributions. The lowest number of contributions i.e. one each from 14 different countries. It can found that majority of the contributions are from European countries and only two Asian countries i.e., China and Japan come among the first ten positions. It is also inspiring that India comes in the 18th position with 34 contributions among the 62 countries.

Subject Wise Distribution of Articles

Table 10 shows the subject wise distribution of articles during the years 2012 – 2016 in the journal ‘Plant Physiology’.

Table.10: Subject-wise Distribution of Articles

Sl. No.	Subject	Total	Percentage	Rank
1	Genes, Development and Evolution	437	21.77	1
2	Signaling and Response	434	21.62	2
3	Biochemistry and Metabolism	405	20.18	3
4	Cell Biology	226	11.26	4
5	Ecophysiology and sustainability	211	10.51	5
6	Membranes, Transport and Bioenergetics	186	9.27	6
7	Systems and Synthetic biology	108	5.38	7
	Total	2007	100	

Table 10 depicts the subject classification in the journal Plant Physiology during 2012-2016. Over the 7 distinct fields covered by the journal, Genes, Development and Evolution dominates other subject fields with 437 articles (21.77%) during the study period. 21.62% (434 articles) in the field Signaling and Response immediately follows in the second position. Biochemistry and metabolism with 405 (20.18%) is in third position followed by Cell Biology with 226 (11.26%) articles and Ecophysiology and Sustainability with 211 (10.51%) articles in fourth and fifth positions respectively. Membranes and Transport (9.27%) and Systems and Synthetic Biology (5.38%) are the lowest positions compared to other subject fields in the journal.

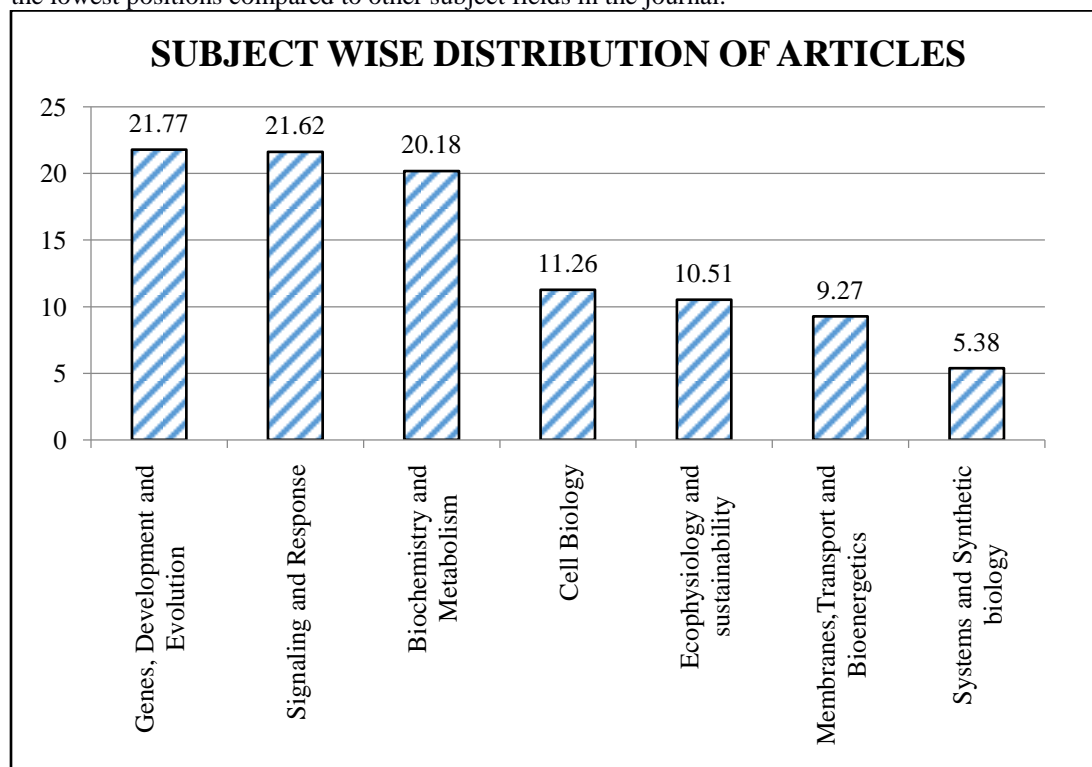
**Fig. 6: Column diagram showing Subject wise distribution of Articles**

Figure 6 displays the subject distribution of the articles in Plant Physiology. The subject area with the highest number of publications is Genes, Development and Evolution with 437 (21.77%) articles followed by the area Signaling and Response with 21.62% (434) out of total articles published. The figure also shows that the subject area Biochemistry and Metabolism (20.18%), Signaling and Response (21.62%) and Genes, Development and Evolution (21.77%) are the three dominating subject area in the Journal Plant Physiology during the study period. Cell Biology (11.26%) and Ecophysiology (10.51%) occupy the fourth and fifth position compared to the other subject areas. The subject area Membranes, Transport and Bioenergetics is having the least contribution to the journal with 9.27% of total articles published during the study period. From the figure, it is clear that more research takes place in the field Genetics and the comparatively newly emerged subject fields like Biochemistry and Signaling and Response in plant studies.

8 Findings of the Study

Average Number of Articles published per issue and per year

There were 2007 articles published in Plant Physiology during 2012-2016. On an average 33.45 (approximately 33) articles were published per issue and 401.4 (approximately 401) articles per year.

Year - Wise Distribution of Articles

The study shows that 2007 articles were published in 60 issues of 15 volumes in the Plant Physiology during 2012-2016. The highest number of articles i.e. 477 (23.77%) was published in 2016 and minimum number i.e. 356 (17.74%) in the year 2015. There is no constant growth or decline during the study period.

Length wise distribution of articles

The number of pages of an article indicates the exhaustive and intricate effort of the researchers on the research topic though it cannot be often counted for the quality of the article. The articles published in the journal have different page length. It is found that majority of the articles are having 11-15 pages which constitute 61.63% of the total articles published during the study period. Further analysis reveals that Plant Physiology accommodated on an average 13.46 (approximately 13) pages per articles. Total number of pages used during the study period is 27620. The article "Nucleoid – Enriched Proteomes in Developing Plastids and Chloroplast from Maize Leaves: A New Conceptual Framework for Nucleoid Functions." by Wojciech Majeran et al. from US is the lengthy article with 34 pages in the Plant Physiology published in 2012 (Vol.158.No.1). It is also found that there are no articles comprising less than 6 pages.

Authorship pattern

The study shows that a total number of 14690 authors in different authorship positions contributed 2007 articles during the period. It was observed that more than five authored contributions 12049 (82.02%) were found to be most predominant which indicates the co-authorship pattern in the Plant Physiology and only four articles were contributed by single author. It is seen that the multi-authored papers highly outnumbered the single authored papers.

Author Productivity

Author productivity of 'Plant Physiology' during the period 2012-2016 shows that 13589 authors have contributed 2007 articles with an average of 6.78 publications per author. The average productivity per author is 0.15.

Degree of Collaboration by Year

The study reveals that out of 2007 articles about 2003 were contributed by multiple authors and only 4 were non-collaborative. During the study period only 2 years have single authored papers. Average degree of collaboration is 0.99. The study shows a consistent pattern of degree of collaboration which clearly indicates dominance upon multiple author contribution.

Most prolific Author

A total of 11303 authors contributed 14690 times to produce 2007 articles during the study period. It is observed that a total of 14690 authors contributed 2007 articles published during 2012-2016 in the Plant Physiology. The most prolific contributor Alisdair R. Fernie (Germany) stood in the first position; he contributed the highest number (35) of articles. This is followed by Jonathan Gershenzon (Germany) who stood in second highest position with 14 publications. James Whelan (Australia) with 13 publications; Ian T. Baldwin (Germany) with 11 publications and Bernhard Grimm (Germany) and Regina Feil (Germany) with 10 publications each covered the top 5 ranks. It could be observed that among the top 5 authors 4 of them from Germany.

Prolific Institution

The study shows that 3525 Institutions from 62 countries had contributed alone and with other institutions for 2007 articles during the study period. Among the 3525 organisations Max Planck Institute of Molecular Plant

Physiology, Potsdam, Germany with 45 contributions tops the list. Department of Plant Biotechnology and Bioinformatics, Ghent University, Belgium accounts for the second position with 30 contributions. RIKEN Centre for Sustainable Resource Science, Suehirocho, Tsurumiku, Yokohama, Kanagawa, Japan with 28 contributions is in third position and Department of Plant Systems Biology, Ghent University, Belgium along with National Key Laboratory of Crop Genetic Improvement, Huazhong Agricultural University, Wuhan, China shares the 4th rank.

Geographical distribution of articles

Country wise distribution reveals the world wide popularity of the journal. It is found that total 62 countries, contributed 2007 articles during 2012 to 2016. USA contributed the highest number of articles i.e., 655. The second most contributions were from China i.e., 407. This is followed Germany by 331 contributions; UK by 193 contributions. The lowest number of contributions i.e., one each from 14 different countries. Among the 62 countries the largest contributions are mainly from European countries along the USA and Australia. The number of Asian countries is less compared to the European countries still China and Japan sustained in the second and sixth positions respectively. It is also found that India could secure a notable position i.e., 18th rank among the 62 countries with a contribution of 34 articles during the study period.

Subject-wise distribution of articles

The subject wise distribution of articles reveals that over the 7 distinct fields covered by the journal, 'Genes, Development and Evolution' contributed more with 437 articles (21.77%) during the study period. 21.62% (434 articles) in the field Signaling and Response immediately follows in the second position. Biochemistry and metabolism with 405 (20.18%) is in third position followed by Cell Biology with 226 (11.26%) articles and Ecophysiology and Sustainability with 211 (10.51%) articles in fourth and fifth positions respectively. Membranes and Transport (9.27%) and Systems and Synthetic Biology (5.38%) are the lowest positions compared to other subject fields in the journal. Among the 7 subjects fields 'Genes, Development and Evolution' accounts for largest output.

8 Conclusion

The study covers 15 volumes (Vol.158-172) consisting 60 issues of Plant Physiology during 2012 to 2016. Based on the study it can be inferred that the Journal is having an increasing growth rate in the last year. Contribution of articles from authors across the globe gives the impression of the Journal's International reputation. Multi authored contribution dominates in this journal. It can be noticed that most of the contributions are from research organisations. Analysis of contribution of 15 volumes proves that it covers contribution related to almost all aspects of Plant Science and all articles are appended with a fair amount of citations.

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