

INDIAN JOURNAL OF PURE & APPLIED MATHEMATICS : A BIBLIOMETRIC STUDY

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Bibliometric analysis of 8396 citations appended to 737 articles published in the Indian Journal of Pure & Applied Mathematics, volumes 29 to 33 during the years 1998-2002 and 470 citations appended to 70 articles published in the maiden volume 1 published in 1970 has been carried out to observe the distribution of contributions, authorship pattern, citation analysis, geographical distribution of contributions and number of pages used in each volume. A comparative study of articles published in five volumes vis-a-vis those in volume 1 has been made. Results indicate that the number of contributions is increasing in successive volumes. Highest number of papers have been written by joint authors. The most cited documents are articles from the research journals. The contributions in this journal from India and other countries are almost equal. Among the Indian states, Uttar Pradesh is the top contributor whereas among the Indian universities/institutes, University of Delhi is at the top. At the International level, India is the top contributor followed by China. The growth and popularity of this journal is found to be showing an upward trend.

INTRODUCTION

Bibliometrics is an emerging thrust area of research in the field of library and information science. British Librarian A. Pritchard first introduced the term bibliometrics as the "application of mathematics and statistical methods to books and other media of communication." A more elaborate definition has been put forward by L. Egghe who defined it as "the development and application of mathematical models and techniques to all aspects of communication."

Bibliometric studies are used to identify the pattern of publication, authorship and citation analysis with the hope that such regularities can give an insight into the dynamics of the area under consideration. This consequently sheds more light on our knowledge of the structure of subject literature and better organization of information resources which can ultimately be effectively used.

SOURCE JOURNAL

Indian Journal of Pure & Applied Mathematics (IJPAM), has been selected as the source journal for the present study. It is one of the leading journals of mathematics and started publication in 1970 with four issues in an year, and within two years it became bimonthly in 1972 and monthly the very next year i.e., 1973. From the very beginning it attracted the attention of the world mathematics community and started getting covered by international abstracting and indexing services including the *Science Citation Index*. *IJPAM* is a monthly published by the Indian National Science Academy, New Delhi. It has been publishing original research papers in pure and applied mathematics, statistics and related areas of mathematical sciences such as operations research, game theory, mathematical economics, computer science, stochastic modelling, numerical analysis, pattern recognition, mathematical systems etc., involving new developments and/or applications of mathematics or statistics. In contrast to many other journals, *IJPAM* mentions the date of receipt, the date of revision and date of acceptance of each research paper. This helps in checking duplication of research results.

OBJECTIVES

The following objectives were formulated for the present study :

- to examine the authorship pattern of the contributions,
- to sketch the volumewise distribution of contributions and to find out the average number of contributions per volume,
- to analyse the type and number of citations,

- to find out the relative use of various types of documents by the authors,
- to indicate volumewise geographical distribution of contributors,
- to find the research productivity count of the contributions on the basis of geographical distribution both at national and international level,
- to observe the number of pages used in different issues of various volumes,
- to compare the study of the five volumes of *IJPAM* (vols. 29-33; 1998-2002) vis-a-vis the maiden volume 1 published in 1970.

SCOPE

An attempt has been made to analyse the contributions in 60 issues of 5 volumes of *IJPAM* (vols. 29-33; 1998-2002) and with the 4 issues of volume 1 (1970).

METHODOLOGY

Data pertaining to each of the 737 contributions in volumes 29-33 and 70 contributions in volume 1 in terms of authorship, citations, addresses, number of pages in each issue and volume was noted on cards. All the cards were subsequently examined, observed, analysed and tabulated for making observations.

ANALYSIS

Contribution Distribution

As indicated in Table 1 the total number of contributions in 60 issues of 5 volumes of the

source journal is 737 of which the highest number of contributions are in the vol. 32; i.e. 174 (23.61%) followed by vol. 33; 172 (23.34%), vol. 31; 149 (20.22%), vol. 30; 124 (16.82%) and vol 29: 118 (16.01%).

Table 2 presents the distribution of contributions issuewise. It is observed that the number of contributions is increasing in successive issues.

Authorship Pattern

Tables 3 and 4 reveals that the two authored papers numbering 352 (47.76%) top the list in five years, followed by single authored papers 259 (35.14%), three authored papers 113 (15.33%) and four authored papers 13 (1.77%).

The predominance of two authored contributions is observed during all the years i.e. from 1998 to 2002. It is almost 50% every year which provides a definite pointer that team work is more important and that authors collaborate to produce and deduce new research results. However, the team size is small unlike the other science subjects and is mostly restricted to two or three rarely going beyond four.

Looking at the contributors parent organisation, it is observed that the research is being vigorously carried out in universities both at national and international level.

Table 5 shows that out of a total of 372 Indian contributions, 215 contributions are from universities followed by 91 by colleges.

Table 1 — Distribution of Contributions (Volumewise)

Year	Vol. No.	No. of issues	No. of contributions	%
1998	29	12	118	16.01
1999	30	12	124	16.82
2000	31	12	149	20.22
2001	32	12	174	23.61
2002	33	12	172	23.34
5 years	5 Volumes	60	737	100

Table 2 — Distribution of Contributions (Issuewise)

Month	Volume Number				
	29	30	31	32	33
January	9	10	9	15	13
February	10	10	11	14	13
March	12	10	10	14	13
April	10	10	10	14	14
May	10	10	11	13	15
June	10	10	15	14	14
July	7	10	15	14	17
August	9	10	15	13	16
September	10	12	11	17	14
October	11	11	15	18	14
November	10	11	12	13	10
December	10	10	15	15	19
Total	118	124	149	174	172

Table 3 — Authorship Pattern of Contributions

No. of authors	No. of contributions	%
One	259	35.14
Two	352	47.76
Three	113	15.33
Four	13	1.77
Total	737	100

Table 4 — Authorship pattern of Contributions (Volumewise)

Vol. No.	One Author	%	Two authors	%	Three authors	%	Four Authors	%
29	52	44.07	39	33.05	24	20.34	3	2.54
30	49	39.51	59	47.58	14	11.30	2	1.61
31	50	33.56	67	44.97	30	20.13	2	1.34
32	54	31.03	89	51.15	30	17.24	1	0.58
33	54	31.40	98	56.98	15	8.72	5	2.90
5 Vols.	259	35.14	352	47.76	113	15.33	13	1.77

Table 5 — Indian Contributors (Institutionwise)

Vol. No.	Year	University	College	Institute	Miscellaneous	Total
1	1970	31	11	22	1	65
29	1998	36	11	9	2	58
30	1999	37	13	10	5	65
31	2000	40	27	10	1	78
32	2001	52	20	12	3	87
33	2002	50	20	12	2	84
		215	91	53	13	372

Table 6 shows that out of a total of 365 foreign contributors, 305 are from the universities followed by 34 by the Institutes.

CITATION ANALYSIS

Generally, authors cite different kinds of documents in their articles according to their needs. The citations comprise of articles from journals, books/monographs, theses and dissertations, symposia and conference proceedings, personal notes etc.

Table 7 shows that there are in all 8396 citations in 5 volumes of the source journal. Volume 33 has the maximum number of citations 2047 (24.47%), next on the list is vol. 32 with 2016 (23.99%), vol. 31 with 1703 (20.26%), vol. 30 with 1346 (16.01%) and vol. 29 with 1284 (15.27%). This reveals the fact that authors are consulting more and more journals and books for presenting their results.

Table 8 reveals that highest average number of citations per contribution is 11.88 in vol. 33.

Average number of citations per contribution in 5 volumes = $8396 \div 737 = 11.34$ i.e. almost 11 citations per contribution.

Types of Documents Cited (Volumewise)

Table 9 shows that sixty issues of five volumes of IJPAM contained a total of 8396 citations.

On the basis of analysis, it was found that mathematicians make use of journal articles the most, that is 6255 (74.50%) citations. This is due to the fact that journals are the premier vehicle of nascent information transfer/dissemination. This is followed by books 1676 (20%) citation. The remaining 465 (5.50%) citations are from other sources which include conference proceedings, theses and dissertations, personal notes etc.

Table 6 — Foreign Contributors (Institutionwise)

Vol. No.	Year	University	College	Institute	Miscellaneous	Total
1	1970	4	1	—	—	5
29	1998	53	1	3	3	60
30	1999	45	4	8	2	59
31	2000	64	2	4	1	71
32	2001	68	9	8	2	87
33	2002	75	2	11	—	88
		305	18	34	8	365

Table 7— Distribution of Citations (Volumewise)

Vol. No.	No. of citations	%
29	1284	15.27
30	1346	16.01
31	1703	20.26
32	2016	23.99
33	2047	24.47
5 Vols.	8396	100

Table 8 — Average Citations per Contribution in Each Volume

Vol. No.	No. of contributions	No. of citations	Average
29	118	1284	10.88
30	124	1346	10.85
31	149	1703	11.42
32	174	2016	11.58
33	172	2047	11.88
5 Vols.	737	8396	56.61

Table 9 — Types of Publications Cited (Volumewise)

Vol. No	Books	Journals	Others	Total
29	271	938	75	1284
30	240	1031	75	1346
31	355	1268	80	1703
32	429	1467	120	2016
33	381	1551	115	2047
Total	1676	6255	465	8396
%	20	74.5	5.5	100

Table 10 — Geographical Distribution of Contributions (National)

GEOGRAPHICAL DISTRIBUTION

Geographical Distribution of Contributions

The geographical distribution of the Indian contributions to the journal is presented in Table 10. Table 11 gives the volumewise distribution of the Indian contributions. Out of the total 737 contributions in the five volumes of the journal under study, 372 contributions have been made by Indian states. Uttar Pradesh has contributed maximum with 51 (13.70%) contributions followed by Tamil Nadu, Delhi and West Bengal.

Ranking (Contributionwise)

From the contributors addresses it is observed that the researchers belonging to universities, colleges and institutes are contributing regularly in *IJPAM*.

Table 12 shows that University of Delhi is the top ranking university as regards the

S.No.	Name of state	No. of contributions	%
1.	Uttar Pradesh	51	13.70
2.	Tamil Nadu	46	12.37
3.	Delhi	45	12.10
4.	West Bengal	43	11.56
5.	Himachal Pradesh	26	6.70
6.	Maharashtra	23	6.19
7.	Andhra Pradesh	18	4.84
8.	Assam	17	4.57
9.	Haryana	16	4.30
10.	Karnataka	16	4.30
11.	Madhya Pradesh	14	3.76
12.	Punjab	13	3.50
13.	Orissa	10	2.68
14.	Bihar	6	1.61
15.	Jammu	6	1.61
16.	Pondicherry	5	1.35
17.	Rajasthan	4	1.07
18.	Uttaranchal	4	1.07
19.	Tripura	3	0.81
20.	Gujarat	2	0.61
21.	Chattisgarh	1	0.27
22.	Jharkhand	1	0.27
23.	Meghalaya	1	0.27
24.	Mizoram	1	0.27

Table 11— Geographical Distribution of Contributions (National) Volumewise

S.No.	Name of state	Vol. 29	%	Vol. 30	%	Vol. 31	%	Vol. 32	%	Vol. 33	%
1.	Uttar Pradesh	10	17.24	11	16.92	5	6.41	13	14.94	12	14.28
2.	Tamil Nadu	9	15.51	5	7.70	8	10.25	14	16.09	10	11.90
3.	Delhi	6	10.34	7	10.77	9	11.53	14	16.09	9	10.71
4.	West Bengal	6	10.34	12	18.46	11	14.10	6	6.89	8	9.52
5.	Himachal Pradesh	4	6.90	5	7.70	7	8.97	7	8.05	3	3.57
6.	Maharashtra	4	6.90	4	6.15	4	5.13	5	5.74	6	7.14
7.	Andhra Pradesh	5	8.62	2	3.08	1	1.29	3	3.45	7	8.34
8.	Assam	2	3.44	2	3.08	5	6.41	4	4.60	4	4.76
9.	Haryana	1	1.72	2	3.08	4	5.13	7	8.05	2	2.39
10.	Karnataka	3	5.17	4	6.15	5	6.41	2	2.30	2	2.39
11.	Madhya Pradesh	2	3.44	3	4.61	2	2.56	—	—	7	8.34
12.	Punjab	2	3.44	2	3.08	4	5.13	3	3.45	2	2.39
13.	Orissa	—	—	2	3.08	4	5.13	—	—	4	4.76
14.	Bihar	—	—	1	1.53	2	2.56	2	2.30	1	1.20
15.	Jammu	1	1.72	1	1.53	1	1.29	2	2.30	1	1.20
16.	Pondicherry	2	3.44	2	3.08	—	—	—	—	1	1.20
17.	Rajasthan	—	—	—	—	1	1.29	2	2.30	1	1.20
18.	Uttaranchal	—	—	—	—	—	—	2	2.30	2	2.38
19.	Tripura	1	1.72	—	—	1	1.29	—	—	1	1.20
20.	Gujarat	—	—	—	—	1	1.29	1	1.15	—	—
21.	Chattisgarh	—	—	—	—	—	—	1	1.24	—	—
22.	Jharkhand	—	—	—	—	—	—	—	—	1	1.20
23.	Meghalaya	—	—	—	—	1	1.29	—	—	—	—
24.	Mizoram	—	—	—	—	1	1.29	—	—	—	—

Table 12 — First Five Indian Universities/Institutes (Contributionwise)

Rank	Name of the University/Institute	No. of Contributions
1	University of Delhi	31
2	Himachal Pradesh University	25
3	Banaras Hindu University	13
4	University of Calcutta	10
5	IIT Kharagpur	8
5	University of Gorakhpur	8

Table 13 — Geographical Distribution of Contributions International

S.No.	Name of Country	No. of Contributions	%
1.	India	372	50.48
2.	China	95	12.90
3.	Korea	48	6.51
4.	Turkey	40	5.43
5.	Egypt	26	3.53
6.	USA	17	2.30
7.	Spain	16	2.18
8.	Saudi Arabia	12	1.63
9.	Yugoslavia	12	1.63
10.	Japan	9	1.22
11.	Russia	8	1.09
12.	Taiwan	6	0.81
13.	Italy	6	0.81
14.	Nigeria	6	0.81
15.	Bangladesh	6	0.81
16.	Iran	6	0.81
17.	Bulgaria	5	0.68
18.	France	4	0.55
19.	UK	4	0.55
20.	Australia	4	0.55
21.	Canada	3	0.41
22.	Greece	3	0.41
23.	Tunisia	3	0.41
24.	Pakistan	3	0.41
25.	Philippines	3	0.41
26.	Mexico	2	0.27
27.	Romania	2	0.27
28.	Poland	2	0.27
29.	Hong Kong	2	0.27
30.	Syria	2	0.27
31.	Finland	2	0.27
32.	Argentina	2	0.27
33.	South Africa	1	0.13
34.	Denmark	1	0.13
35.	Brazil	1	0.13
36.	Lebanon	1	0.13
37.	Hungry	1	0.13
38.	Ireland	1	0.13

contribution to *IJPAM* (31/372) followed by Himachal Pradesh University.

Tables 13 and 14 give the geographical distribution of contributions of various countries. Out of 737 contribution, Indian contribution is 372 (50.47%) and the contribution of the other countries is 365 (49.52%) which is almost half as is seen from Table 15. Apart from India, China tops the list of contributors i.e. by contributing 95 out of the total of 365 articles followed by Korea (48) and Turkey (40).

PAGE DISTRIBUTION

Tables 16 and 17 present the number of pages contained in five volumes (60 issues). It can be observed that the number of pages is increasing from vol. 30 to vol. 33 indicating that the journal is growing steadily.

Table 18 reveals the average pages per volume per contribution.

Average pages per volume = $8272 \div 5 = 1654$

Average pages per issue = $8272 \div 60 = 138$

Average pages per contribution = $8272 \div 737 = 11.22$

Number of pages in each volume is increasing as is the number of contributions and also number of citations. These factors clearly point out that the journal is becoming popular day by day as more and more researchers round the globe are contributing in this journal.

MAIDEN VOLUME 1

IJPAM came into existence in 1970 with quarterly publication. It had 70 contributions from India and abroad in the four issues published during the year.

Table 19 shows the distribution of contributions (issuewise), authorship pattern, distribution of citations, types of publications cited, geographical distribution of contributions and page distribution (issuewise).

Table 14 — Geographical Distribution of Contributions (Volumewise) International

S.No.	Name of the country	Vol.29	%	Vol.30	%	Vol.31	%	Vol.32	%	Vol.33	%
1.	India	58	49.15	65	52.41	78	52.34	87	50	84	48.83
2.	China	8	6.77	11	8.87	20	13.42	29	16.67	27	15.70
3.	Korea	9	7.62	4	3.22	11	7.38	8	4.60	16	9.30
4.	Turkey	9	7.62	10	8.06	4	2.68	4	2.30	13	7.55
5.	Egypt	2	1.70	2	1.61	6	4.02	11	6.32	5	2.90
6.	USA	6	5.08	2	1.61	3	2.01	2	1.14	4	2.32
7.	Spain	4	3.38	1	0.80	6	4.02	2	1.14	3	1.74
8.	Saudi Arabia	—	—	3	2.41	2	1.34	6	3.44	1	0.58
9.	Yugoslavia	2	1.70	5	4.03	1	0.67	2	1.14	2	1.16
10.	Japan	2	1.70	3	2.41	1	0.67	3	1.72	—	—
11.	Russia	2	1.70	2	1.61	1	0.67	—	—	3	1.74
12.	Taiwan	—	—	1	0.80	—	—	3	1.72	2	1.16
13.	Italy	—	—	1	0.80	2	1.34	3	1.72	—	—
14.	Nigeria	1	0.85	1	0.80	2	1.34	1	0.57	1	0.58
15.	Bangladesh	—	—	—	—	—	—	3	1.72	3	1.74
16.	Iran	5	4.23	—	—	—	—	—	—	1	0.58
17.	Bulgaria	—	—	2	1.61	1	0.67	2	1.14	—	—
18.	UK	2	1.70	2	1.61	—	—	—	—	—	—
19.	Australia	1	0.85	1	0.80	2	1.34	—	—	—	—
20.	France	—	—	1	0.80	1	0.67	1	0.357	1	0.58
21.	Canada	—	—	2	1.61	—	—	1	0.57	—	—
22.	Greece	—	—	1	0.80	1	0.67	1	0.57	—	—
23.	Tunisia	—	—	1	0.80	—	—	2	1.14	—	—
24.	Pakistan	—	—	—	—	1	0.67	2	1.14	—	—
25.	Philippines	—	—	—	—	1	0.67	1	0.57	1	0.58
26.	Mexico	—	—	1	0.80	1	0.67	—	—	—	—
27.	Romania	—	—	—	—	1	0.67	—	—	1	0.58
28.	Poland	2	1.70	—	—	—	—	—	—	—	—
29.	Hong Kong	—	—	—	—	1	0.67	—	—	1	0.58
30.	Syria	2	1.70	—	—	—	—	—	—	—	—
31.	Finland	—	—	—	—	—	—	—	—	2	1.16
32.	Hungry	—	—	—	—	1	0.67	—	—	—	—
33.	Argentina	1	0.85	—	—	1	0.67	—	—	—	—
34.	South Africa	—	—	1	0.80	—	—	—	—	—	—
35.	Denmark	1	0.85	—	—	—	—	—	—	—	—
36.	Brazil	—	—	1	0.80	—	—	—	—	—	—
37.	Lebanon	1	0.85	—	—	—	—	—	—	—	—
38.	Ireland	—	—	—	—	—	—	—	—	1	0.58

Table 15 — National and International Contributions

Contributions	Vol. 29	Vol. 30	Vol. 31	Vol. 32	Vol. 33	Total
National	58	65	78	87	84	372
International	60	59	71	87	88	365
Total	118	124	149	174	172	737

Table 16 — Distribution of Pages (Volumewise)

Month	Volume Number				
	29	30	31	32	33
January	1-104	1-128	1-110	1-178	1-148
February	105-220	129-220	111-226	179-300	149-302
March	221-344	221-328	227-352	301-482	303-434
April	345-460	329-434	353-460	483-630	435-606
May	461-574	435-524	461-572	631-774	607-786
June	575-670	525-648	573-746	775-972	787-952
July	671-800	649-744	747-920	973-1124	953-1156
August	801-878	749-838	921-1080	1125-1256	1157-1314
September	879-982	839-950	1081-1208	1257-1430	1315-1466
October	983-1110	951-1072	1209-1388	1431-1612	1467-1622
November	1111-1216	1073-1204	1389-1528	1613-1762	1623-1724
December	1217-1310	1205-1310	1529-1726	1763-1954	1725-1972

Table 17— Number of Pages in Each Issues

Month	Vol. 29	Vol. 30	Vol. 31	Vol. 32	Vol. 33
January	104	128	110	178	148
February	116	92	116	122	154
March	124	108	126	182	132
April	116	106	108	148	172
May	114	90	112	144	180
June	96	124	174	198	166
July	130	96	174	152	204
August	78	94	160	132	158
September	104	112	128	174	152
October	128	122	180	182	156
November	106	132	140	150	102
December	94	106	198	192	248
Total	1310	1310	1726	1954	1972

Table 18 — Average Pages: Per Volume Per Contribution

Volume No.	Total Pages	No. of contributions	Average
29	1310	118	11.10
30	1310	124	10.56
31	1726	149	11.58
32	1954	174	11.22
33	1972	172	11.46

Table 19 — Maiden Volume I (1970)

Total Contributions - 70					
1.	Distribution of Contributions (Issuewise)	No. of Issues = 4; January-March : 13; April-June : 16; July-September : 16; October-December : 21			
2.	Authorship pattern of contributions	One Author	Two Authors		
		48	22		
3.	Distribution of citations	No. of Contributions	No. of Citations		
		70	470		
Average Citations per Contribution : 6.71					
4.	Types of Publications Cited	Books	Journals	Others	Total
		142	305	23	470
5.	Geographical Distribution of Contributions	National		International	
		State	Contribution	Country	Contribution
		Uttar Pradesh	19	India	65
		Delhi	10	USA	3
		Madhya Pradesh	9	UK	2
				Total	70
		West Bengal	7		
		Rajasthan	6		
		Maharashtra	4		
		Gujrat	3		
		Tamil Nadu	2		
		Karnataka	2		
		Andhra Pradesh	1		
		Assam	1		
		Punjab	1		
		Total	65		
6.	Distribution of Pages Issuewise	I	II	III	IV
		1-106	107-275	276-432	433-639
Total Pages = 639, Average pages per contribution = 9.12					

COMPARISON OF THE FIVE VOLUMES WITH THE MAIDEN VOLUME

Data analysis has revealed the following:

1. At the time of inception (1970) of *IJPAM*, it was quarterly and became bimonthly in 1972 and finally monthly in 1973.
2. Only 70 articles appeared in vol. 1 which rose to 172 in 2002.
3. There was clear predominance of single authored contributions in vol.1 (92.86%) as compared to those in the five volumes (35.14%).
4. The average citations per contribution in vol.1 is 6.71 whereas it is 11.52 in the five volumes.
5. Citations of the articles from the research journals dominate in the five volumes as in vol.1.
6. The national geographical distribution of contributions shows that Tamil Nadu which was ranking 8th in vol.1 jumped to rank 2nd after Uttar Pradesh in the five volumes. International geographical distribution of contributions shows a very sharp increase in the contributions from abroad i.e. from 7.14% in vol.1 to 49.52% in the five volumes.
7. Average pages per contribution which was 9.12 in vol. 1, rose to 11.22 in the five volumes. Moreover, vol.1 had 639 pages which steadily increased to 1972 pages in 2002.

FINDINGS

From the observations made in this study, it can be concluded that:

- Majority of the contributions in the journal are by two authors presumably one being a research scholar and the other his/her guide. However, in the maiden vol.1 single authored papers dominated i.e. 48 out of 70.
- Number of contributions in each volume is increasing in successive volumes indicating that more and more researchers are contributing in this journal.

- The national and international contributions in the journal are almost fifty-fifty. However in vol.1 the national contribution is maximum i.e., 65 out of 70. Among the Indian states, Uttar Pradesh tops the list of contributors and among other nations Chinese are the top runner researchers in the present day scenario.
- Among the contributors, the maximum contributors are from the universities both at the national as well as at the international level. University of Delhi is at the top followed by Himachal Pradesh University.
- All the contributions are with citations. It is observed that the journals are the most cited documents 74.50%. This is due to the fact that the nascent research is being vigorously reported in journals. Also, most of the authors now a days are generalizing, extending or unifying the earlier known results in the more general framework.
- The popularity of the journal is showing an upward trend as more and more authors round the globe are contributing in this journal. The popularity graph of the journal is negotiating higher peaks as revealed by the volumewise increase in the number of contributions, number of citations and number of pages.
- There are not many Indian journals publishing mathematical literature by foreign authors as the *IJPAM* and this fact makes our source journal truly international.

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