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RESEARCH ARTICLE

AUTHORSHIP PATTERN OF MARINE CANOBACTERIA RESEARCH IN INDIA: A SCIENTOMETRIC ANALYSIS

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ABSTRACT

The study examines Marine Cyanobacteria Research in India as revealed by the scholarly publication indexed in Aquatic Science and Fisheries Abstracts (ASFA) data base on CD/ROM for a period of ten years from 2005to 2014. It was seen that the analyses included research growth, author productivity, authorship pattern, Geographical distribution of the literature, citation analysis rank, global publications'share,citation impact, share of international collaborative papers and major collaborative partner countries and patterns of research communication in most productive journals. Most of the researchers preferred to publish their research results in 1869 journal articles. The authorship trend shows that, out of total2212 research literatures published, 85% of them or published under the joint author of publications in Marine Cyanobacteria research output. It is observed that author productivity is not in agreement with Lotka's law. This shows that team research is prevalent in the area of Marine Cyanobacteria. It also analyses the characteristics of most productive institutions, authors and high-cited papers.

Keywords : Cyanobacteria, Marine, Authorship Productivity, Scientometric Analysis.

1. INTRODUCTION

Cyanobacteria are a diverse group of prokaryotic organisms that can exist in a wide range of ecosystems. Capable to develop photosynthesis, cyanobacteria constitute one of the components of the primary first level organisms in water food chains. These organisms have also important roles in nutrient cycles such as nitrogen cycle, by converting atmospheric nitrogen into an organic form, in a process that releases some residual hydrogen1.

Marine cyanobacteria have been considered a rich source of secondary metabolites with potential biotechnological applications, namely in the pharmacological field. Chemically diverse compounds were found to induce cytoxicity, anti-inflammatory and antibacterial activities2. The potential of marine cyanobacteria as anticancer agents has however been the most explored and, besides cytotoxicity in tumor cell lines, several compounds have emerged as templates for the development of new anticancer drugs. The mechanisms implicated in the cytotoxicity of marine cyanobacteria compounds in tumor cell lines are still largely overlooked but several studies point to an implication in apoptosis. This association has been related to several apoptotic indicators such as cell cycle arrest, mitochondrial dysfunctions and oxidative damage, alterations in caspase cascade, alterations in specific proteins levels and alterations in the membrane sodium dynamics3. In this connection, a proper identification of existing levels of marine cyanobacteria research output performance could be assessed as per the purview of the present research.

The major focus of the study is to apply the scientometric analysis with a view to analyse the authorship pattern of research output in Marine cyanobacteria. This study related to authors and their productivity; collaborative patterns and other aspects is important and useful to understand the mechanism underlying the growth of knowledge of a discipline. This study to analyze the authorship pattern of Marine cyanobacteria research output in terms of its content and coverage relative growth rates, doubling time, source wise. Degree of collaboration, Collaborative index, Areas of research concentration, author productivity, authorship Pattern, and citation analysis is also noted.

2. OBJECTIVES OF THE STUDY

The researcher has framed the following objectives for the purpose of present research.

1. To identify the pattern of distribution of marine cyanobacteria research output at India level.
2. To examine the effectiveness of various sources of research publications in marine cyanobacteria research.
3. To identify the authorship pattern of marine cyanobacteria research output in India.
4. To identify the proportion of single and multi-authored papers of marine cyanobacteria research output.
5. To test the applicability of Lotka's law to the scientific productivity of authors.

6. The scientific productivity of authors in marine cyanobacteria research output conforms to Lotka's inverse square law of Scientific productivity

7. The distribution of marine cyanobacteria research output journals conforms the implication of Bradford's law.

8. To identify the geographical representation of journals. 291papers in 20112with 1295

3. METHODOLOGY

The present study is carried out about source documents and research output. The data is fed in to computer using MS-Excel software and the Statistical Package for Social Sciences (SPSS) for analysis. The published marine cyanobacteria documents and their research output are analyzed in terms of their distribution, both at national and international levels pertaining to Indian marine cyanobacteria scientists' contribution. This study examines the growth rates of research output in terms of absolute level of growth and relative level of growth over a period of time. An attempt is made to analyze the institution wise growth rate. The author productivity is examined in identifying the pattern of research contribution among marine cyanobacteria scientists. The study explores the research concentration in marine cyanobacteria and journals of priority in publishing marine cyanobacteria articles.

4. DATA COLLECTION

The publications of marine cyanobacteria scientists in India covered by Aquatic Science and Fisheries Abstracts (ASFA) data base on CD/ROM (2005-2014) were taken from Rajiv Gandhi Research Centre for Aquaculture, Sirkali, Tamilnadu as the predominant source of the present study. ASFA is one of the prominent abstracting journals which cover about 6500 primary journals, books, reports, conference proceedings, transactions and a wide variety of other source documents including literature of related disciplines.

5. DATA ANALYSIS AND DISCUSSION

5.1 Growth of Publications and Citation Scores

Table - 1 shows that a chronological histogram of citations, demonstrating that citation frequency grew steadily from 2005; it reached a maximum GCS of 1639 in 2011 and LCS of 84in 2013. The highest publication is 312 in 2008 with 895 Global Citation Scores followed by Global Citation Score and 265 papers in 2009 with 1241 Global Citation Scores. The lowest publication is 82 in 2005 with 461 Global Citation Scores. It shows that even minimum numbers of records were scored higher global citations. The study also reveals all these 2212 publications have 17415 cited references it shows that there is a healthy trend in citing reference is found among the Indian Scientists belongs to Green Energy.

Table 1
Year wise Distribution of
Publication and Citation scores

S.No.	Year	No.of Paper	TLCS	TGCS
1	2005	82	11	461
2	2006	181	13	767
3	2007	183	14	329
4	2008	312	11	895
5	2009	265	19	964
6	2010	241	26	896
7	2011	230	26	1639
8	2012	291	45	1295
9	2013	249	84	1275
10	2014	178	57	1170
	Total	**2212**		

5.2 Document wise Distribution of Publications

A study of data in table-2 indicates the Document wise distribution of research output in Marine Cyanobacteria. This study has observed a total of 2212 publications in Marine Cyanobacteria during the period of ten years from 2005 to 2014. Out of various sources of publications in Marine Cyanobacteria, journal articles that appeared in the journals have shown a predominant contribution (84.49%) with Global citation score is 8176 and this source occupies the first position. The source of conference proceedings comes second in order (7.14%) of sharing total research output in Marine Cyanobacteria during the period of analysis. The source of research reports comes in the third position (3.30%) with respect to total output in Marine Cyanobacteria research during the study period.

Table 2
Documentwise Distribution

S.No	Document Type	Recs	%	TLCS	TGCS	Mean	S.D	Co efficient Variation
1	Journal Articles	1869	84.49	295	8176	186.9	45.003	24.08
2	Conference proceedings	158	7.14	8	1317	15.8	8.55	54.11
3	Reports	73	3.30	3	194	14.6	12.26	83.97
4	Symposium	57	2.58	0	1	8.14	5.67	69.66
5	Seminars	53	2.40	0	0	7.57	6.12	80.85
6	Newsletters	2	0.09	0	3	2	-	-
	Total	**2212**	**100**	**306**	**9691**	**221.2**	**63.72**	**28.80**

5.3. Relative Growth rate of Articles

Various sources of marine cyanobacteria literature, the journals have registered a greater level of contribution. The output of journals in 2005 was 74 articles and it rose to 1869 by the end of the year 2014. Hence, there is a need to analyses its relative growth rates and doubling time for publications. Table - 3 reveals the relative growth rates of the number of articles appeared in the journals and also the doubling time for publications during the study period. It could be seen clearly that the relative growth rates for number of articles appeared in the journals have decreased from 1.13 in 2005 to 0.09 in 2009. Despite this declining trend, some years witnessed an increased performance particularly in 2006 and 2007. The mean relative growth rates for articles appeared in the journals for the periods of 2006-10 and 2011-14 are 0.53 and 0.36 respectively, whereas for the whole study period it is 0.36.

Consequently the doubling time for publication of articles in journals has increased from 0.61 in 2006 to 7.7 in 2014. The mean doubling time for the number of articles published in the journals for the periods of 2006-10 and 2011-14 are 1.75 and 5.12 years respectively. For the whole study period, the mean doubling time for publications is 3.43 years. Based on this observation one can conclude that the relative growth rates of the number of articles appeared in the journals have shown a declining trend. On the contrary, the doubling time for publication of articles has reflected an upward trend.

Table 3
Relative growth rates

Year	No.of Output	Cumulative No. of Output	$Log_e 1^p$	$Log_e 2^p$	R(a)	Mean R(a) 1-2	Doubling Time Dt(a)	Mean Dt(a) 1-2
2005	74	74		4.30				
2006	155	229	4.30	5.43	1.13		0.61	
2007	172	401	5.43	5.99	0.56		1..24	
2008	218	619	5.99	6.43	0.44		1.57	
2009	201	820	6.43	6.71	0.28		2.47	
2010	219	1039	6.71	6.95	0.24	0.53	2.89	1.75Years
2011	210	1249	6.95	7.13	0.18		3.85	
2012	225	1474	7.13	7.29	0.16		4.33	
2013	228	1702	7.29	7.44	0.15		4.62	
2014	167	1869	7.44	7.53	0.09	0.14	7.7	5.12Years
		Mean R(a)			**0.36**			**3.43 Years**

5.4. Distribution of Authorship Patten

The authorship pattern in green energy literature reveals the following facts. The present study brings papers under analysis contributed by one author to ten authors.

Table 4
Distribution of Authorship Patten

Authorship Patten	Publications	%
Single Author	337	15.24
Double Author	969	43.81
Three Authors	535	24.19
Four Authors	250	11.30
Five Authors	65	2.93
Six Authors	31	1.4
Seven Authors	11	0.50
Eight Authors	8	0.36
Nine Authors	4	0.18
Ten & above	2	0.09
Total	**2212**	

Tables 4 indicates that the two author's papers rank first in order (43.81%), where as three authors papers obtain the second order of priority (24.19%) and single authors papers obtain the third order of priority (15.24%). The present study brings papers under analysis contributed by one author to ten authors. It is noticed that from five author papers to ten authors' papers, the trend in number of publications has reduced. It is noticed that from five authors to ten author's papers, the trend in number of publication has reduced.

5.5 Degree of Collaboration

The analysis indicates that in recent years, research activities in marine cyanobacteria are mainly based on groups of scientists. It has resulted in an increased number of multi- authored papers appearing in the journals. In order to probe this fact, a method was applied here called the degree of collaboration[4].

It is inferred from the table-5 that at the aggregate level, the degree of collaboration is 0.85. The period wise analysis indicates that its level is somewhat less in the first period [2005-2009: 0.87] and it has shown. An increasing trend during the period [2010-14: 0.84]. This brings out clearly the high level of prevalence of collaborative research in marine cyanobacteria

5.6. Author Productivity

The study of author productivity is an important aspect in analyzing the performance of research output. Out of the various disciplines of science the analysis of author productivity in marine cyanobacteria research projects is the focal point as far as the present investigation is concerned.Table-6 indicates the contribution of research papers based on an author productivity levels. It is observed that 46.89 percent of authors have made single contribution in the field of marine cyanobacteria. It ranks first in order [46.89%] with respect to the total number of contributions in the Study. It is noticed that two papers contributed by author's record the second order [19.52%] in respect of an overall number of authors enlisted in the study. Three papers contributed by authors take the third place [10.14%]

Table 5
Showing Degree of Collaboration

Year	Single Authors		Multiple Authors		Total (%)	Degree of Collaboration	Mean in Degree of Collaboration
	No. of Output	Percentage	No. of Output	Percentage			
2005	8	9.76	74	90.24	82(3.71)	0.90	
2006	29	16.02	152	83.98	181(8.18)	0.84	
2007	17	9.29	166	90.71	183(8.27)	0.91	
2008	72	23.08	240	76.92	312(14.10)	0.77	
2009	23	8.68	242	91.32	265(11.98)	0.91	0.87
2010	30	12.45	211	87.55	241(10.90)	0.88	
2011	37	16.09	193	83.91	230(10.39)	0.84	
2012	51	17.53	240	82.47	291(13.15)	0.82	
2013	39	15.66	210	84.34	249(11.26)	0.84	
2014	31	17.42	147	82.58	178(8.05)	0.83	0.84
Total	**337**	**15.24**	**1875**	**84.76**	**2212**	**0.85**	**0.85**

of priority in their representation to the total. Four papers contributed by authors stand in the fourth order [7.22%]. It is interesting to note that when the number of contributions increases the authors number decreases. It indicates the fact that a greater level of research performance is noted only among few authors.

Table 6
Productivity of Authors

Number of Contributions	Number of Authors	Percentage	Cumulative Percentage
1	370	46.89	46.89
2	354	19.52	66.41
3	80	10.14	76.55
4	57	7.22	83.77
5	26	3.30	87.07
6	20	2.53	89.06
7	12	1.52	91.12
8	15	1.90	93.02
9	14	1.77	94.79
10	9	1.14	95.93
11	11	1.39	97.32
12	8	1.01	98.33
13	7	0.89	99.22
14	2	0.25	99.47
15	4	0.51	99.98
136	**789**	**100**	**100**

5.7 Scientific Research output of Lotka's law in Relations to Author Productivity

In this connection, it is relevant to analyse the implications of Lotka's law in relation to author productivity. It explains that a number of authors making 'n' contribution is about 1/n**2** of those making a single contribution and the proportion of the contribution that make a single contribution is about 60 per cent[5]. Lotka's findings that the proportion of all contribution that make a single contribution is less than 60 per cent. Further, Lotka's the calculation of exponent 'n' for over all author productivity data[6].

Table 7
Showing productivity of Author based on Lotka's law (Calculation of exponent 'n' for scientific research output in Marine Cyanobacteria)

Number of Contribution X	Number of Authors Y	X	Y	XY	X^2
1	370	0	5.9135	0	0
2	154	0.6931	5.0369	3.4911	0.4804
3	80	1.0986	4.3820	4.8141	1.2069
4	57	1.3863	4.0430	5.6048	1.9218
5	26	1.6094	3.2580	5.2434	2.5903
6	20	1.7918	2.9957	5.3677	3.2104
7	12	1.9459	2.4849	4.8354	3.7866
8	15	2.0794	2.7080	5.6310	4.3241
9	14	2.1972	2.6390	5.7984	4.8278
10	9	2.3026	2.1972	5.0593	5.3019
11	11	2.3979	2.3978	5.7497	5.7499
12	8	2.4849	2.0794	5.1671	6.1748
13	7	2.5649	1.9459	4.9910	6.5790
14	2	2.6391	0.6931	1.8292	6.9646
15	4	2.7081	1.3862	3.7540	7.3335
136	789	27.8992	44.284	67.3362	60.4512

The 'n' value in scientific research literature in marine cynobacteria is 1.7480 for all author data. Table-7 identify that the estimated value of 'n' for the data is calculated using formula[7].

$$n = \frac{N \Sigma xy - \Sigma x \Sigma y}{N \Sigma x2 - (\Sigma x2)}$$

$$= \frac{15*67.3362-27.8992*44.2484}{15*60.4512-(27.8992)^2}$$

$$= \frac{1010.0.43-1234.4949}{906.768-778.36536}$$

$$= \frac{- 224.4519}{128.4026}$$

$$= - 1.7480$$

5.8 Bradford Distribution

The Bradford law was formulated in the year 1948[8]. Table 8 indicates that the first three journals covered more than one third of the total articles published. The next six journals covered another one third of the articles. The remaining 209 journals covered the last one third of the published articles. According to Bradford's distribution the relationship between the zone is 1: a: a2[9], while the relationship in each zone of the present study is 3:6:209 which does not fit into Bradford's distribution.The easy and interesting observation from the table is the number of journals in each zone. As per Bradford's formulation, it should be 3:9:27, whereas the observed number of journals in the three zones stands as 3:6:209. This shows that core contributions are given by a very few journals, i.e., less than Bradford formulated and the final zone contains a very large number of journals, i.e, much more than the Bradfordian formula.

It is a clear indication that core zone is much concentrated and the other zone is much extended and that shows the scattering of information in marine cyanobacteria is more. When this analysis is done for a wider range of periods, the extent of scattering can get increased. Hence the analysis of data clearly discounts Bradford's law of scattering.

S.No	No. of Journals	No. of Articles	Total no. of Articles	Cumulative no. of Articles
1.	1	305	305	305
2.	1	164	164	469
3.	1	163	163	632
4.	1	82	82	714
5.	1	80	80	794
6.	1	52	52	846
7.	1	48	48	894
8.	1	43	43	937
9.	1	37	37	974
10.	1	36	36	1010
11.	1	32	32	1042
12.	1	31	31	1073
13.	1	28	28	1101
14.	1	26	26	1127
15.	1	23	23	1196
16.	1	21	21	1217
17.	1	20	20	1237
18	2	19	38	1275
19	4	17	68	1343
20	1	16	16	1359
21	2	14	28	1387
22	2	13	26	1413
23	2	12	24	1437
24	2	11	22	1459
25	2	10	20	1479
26	2	9	18	1497
27	3	8	24	1521
28	3	7	21	1542
29	5	6	30	1572
30	9	5	45	1617
31	9	4	36	1653
32	20	3	60	1713
33	25	2	50	1763
34	106	2	106	1869

6. FINDINGS

1. The findings of Indian research productivity in marine cyanobacteria has the highest publication as the highest publication is 312 in 2008 with 895 Global Citation Scores followed by 291papers in 20112with 1295 Global Citation Score and 265 papers in 2009 with 1241 Global Citation Scores. The lowest publication is 82 in 2005 with 461 Global Citation Scores.

2. It is found that the total of 2212 publications in Marine Cyanobacteria during the period of ten years from 2005 to 2014. Out of various sources of publications in Marine Cyanobacteria, journal articles that appeared in the journals have shown a predominant contribution (84.49%) with Global citation score is 8176 and this source occupies the first position. The source of conference proceedings comes second in order (7.14%) of sharing total research output in Marine Cyanobacteria during the period of analysis. The source of research reports comes in the third position (3.30%) with respect to total output in Marine Cyanobacteria research during the study period.

3. The findings of the authorship pattern in marine cyanobacteria literature reveal that the two author's papers rank first in order (43.81%), where as three authors papers obtain the second order of priority (24.19%) and single authors papers obtain the third order of priority (15.24%). The present study brings papers under analysis contributed by one author to ten authors. It is noticed that from five author papers to ten authors' papers, the trend in number of publications has reduced. It is noticed that from five authors to ten author's papers, the trend in number of publication has reduced.

4. The findings of degree of collaboration analysis reveal the following .facts that the case of single author contributed papers is less. It brings out clearly the high level prevalence of collaborative research in marine cyanobacteria.

5. The authorship pattern of Indian research productivity on marine cyanobacteria has identified that majority of papers are multi-authored. It is found from the analysis that Lotka's law may not be applicable with regard to author productivity in proliferation of research in Marine Cyanobacteria as the research papers equally distributed by a large number of authors.

6. The findings of distribution of Indian marine cyanobacteria scientists published articles in the journals of various countries .reveal the fact that Indian marine cyanobacteria scientists have contributed their research focus mainly in Indian journals. The countries such as Netherlands, USA and United Kingdom have considerably recognized the research articles of Indian marine cyanobacteria scientists and published the same in their journals. It is not up to the mark in the case of other countries

7. CONCLUSIONS

On the basis of the Scientometric study, it can be concluded that Marine Cyanobacteria research activity in India during 2005-2014 is equal to the World average and its growth pattern is positive and similar to the worldwide research growth. The present study has tried to find a statistically reliable method to measure author productivity in the field of Marine Cyanobacteria research. The results can be used to set mathematically proven thresholds for publication expectation in the field of Marine Cyanobacteria research across organization in different countries.

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