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MAPPING OF OCEANOGRAPHY RESEARCH PRODUCTIVITY IN INDIA: A SCIENTOMETRIC ANALYSIS

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Abstract

The study examines Oceanography Research in India as revealed by the scholarly publication indexed in Aquatic Science and Fisheries Abstract (ASFA) data base for a period of fifteen years from 2008 to 2013. It was seen that the analyses included research growth, author productivity, authorship pattern, Geographical distribution of the literature, global publications' share, of international collaborative papers and major collaborative partner countries and patterns of research communication in most productive journals. The study reveals that, most of the researchers preferred to publish their research results in journals; as such 61.78% of articles were published in journals, more numbers of articles were published in the year 2013. It is observed that author productivity is not in agreement with Lotka's law, but productivity distribution data partially fits the law when the value of Chi-square to 199.01. Further this study also identified to analyses coverage growth rates, coverage growth rates, source wise. Degree of collaboration, institutions wise and Geographical wise distribution of the literature.

Key Word: Scientometric, Oceanography, Degree of Collaboration, Lotka's law, Bradford's Law, Author Productivity, Authorship Pattern, Geographical, Institutions India.

Introduction

Scientometric study is a quantitative of written communication and it is essential for the effective management of libraries within their budget provisions. The quantitative data is used to keep control over the cost of library collection and essential books and periodical collections that satisfy the need of the readers. Librarians began to use quantitative techniques in their day to day administration, especially to evaluate libraries and their services. The scientometric studies play a vital role in the process of information research. Many reasons are responsible for the development of research in scientometric and they are discussed here. The major focus of the

study is to apply the Scientometric analysis with a view of analyze the performance of research output on Oceanography in India. Present study focuses attention on the growth of literature, authorship pattern, journal coverage, institutions involved in active research etc.

The scientometric studies play a vital role in the process of information research. Scientometric studies have shown that all the pieces of published information do not have equal importance. Present study focuses attention on the growth of literature, authorship pattern, journal coverage, institutions involved in active research etc. Citation studies are recognized as an indicator of influence of published work on the scientific community. This study attempts to analysis the performance of Oceanography research output in terms of its content and coverage, growth rates, areas of research concentration, author productivity, and authorship pattern, journals and articles and other means of assisting the peer review procedure. Performance of research institutions in promotion of Oceanography research is also given due emphasis.

2. Objectives of the Study

The main objective of this study is to examine the current status of Indian Oceanography, as reflected in the country research output during 2008–2013.The researcher has framed the following objectives for the purpose of present research.

1. To identify and analyses the rate of growth of research productivity;
2. To examine the Year wise distribution of publications;
3. To identify the Document wise distribution of publications output;
4. To analyses the authorship pattern and examine the extent of research collaboration and ranking of authors based on publications output;
5. To identify journal wise distribution of publications output;
6. To assess the Institution wise research concentration;
7. To identify Country – wise Collaborative Distribution of Publications;
8. To prepare a ranking list of core journals conforms the implication of Bradford's law.
9. To test the applicability of Lotka's law to the scientific productivity of authors.

3. Methodology

The study entitled "Mapping of Oceanography Research Productivity in India: A Scientometric Analysis" is a study encompassing records output on Science from Aquatic Science and Fisheries Abstract (ASFA) data base. The present study aims at analyzing the

research output of Researchers in the field of Oceanography. The growth rates of output in terms of research productivity are analyzed from 2008 to 2013. The authorship pattern and author productivity are examined to identify the pattern of research contribution in the field of Oceanography. All the publications of Oceanography Scientists in India in the field were retrieved. The data are retrieved were into a database management system for data cleaning and coding. In data cleaning, all duplicate records as well records pertaining to publication years not under the purview of our study, were eliminated It is also analytical in nature in strengthening the empirical validity due to application of suitable statistical tools.

Data Collection

The basic publication data used in this study is derived from the Aquatic Science and Fisheries Abstract (ASFA) data base on CD/ROM 2008-2013 were taken from Rajiv Gandhi Research Centre for Aquaculture, Sirkali, Tamilnadu as the predominant source of the present study. The raw publications data along with their citations has been downloaded from the Aquatic Science and Fisheries Abstract (ASFA) data base in August 2014. Publications data for six years from 2008 to 2013 were used for analyzing the growth and impact of Oceanography research.

ANALYSIS and Discussion

Source wise Distribution of Research output

The sources of Oceanography literature include articles published in the journals, conference / seminars, proceedings, reports, books and bulletins. This study has observed a total of 1193 publications in oceanography over a period of six years from 2008 to 2013. Out of them, articles appeared in the journals have shown a predominant contribution (61.78%). The year wise analysis indicates that the output of articles in the years 2008 was 21 whereas in the succeeding years contribution has increased considerably. However the whole study period records 737 journals articles.

The Oceanography research output appeared with conference / seminars proceedings rank as second in order (34.12%) in an overall output. The output from the reports publications records a third place (2.51%) in an overall Oceanography literature output. The books as the source of output come forth in order (1.09%) of the total Oceanography output. The bulletin constitute (0.50%) in overall Oceanography research output. It records the fifth place in the overall publications of Oceanography Literature..

Table-1: Showing Source wise distribution of Oceanography Research out put

Sources	2008	2009	2010	2011	2012	2013	Total
Journal Articles	21	83	131	147	153	202	**737(61.78%)**
Conference / Seminar Proceedings	10	12	17	25	170	173	**407(34.12%)**
Reports	-	5	3	10	5	7	**30(2.51%)**
Books	-	1	1	4	1	6	**13(1.09%)**
Bulletin	-	-	-	4	2	-	**6(0.50%)**
Total	**31**	**101**	**152**	**190**	**331**	**388**	**1193(100%)**

Oceanography Research output of International and National Level.

Table No.2 indicates International and National Oceanography Research output explicit the following facts. In the year 2008 the published Oceanography Research output was 545 at the international levels and it rose to 18661by the end of the year 2013.Regarding Indian Oceanography Research output was 31 in 2008 and it rose to 1193 by the end of 2013.

Table – 2: Showing Distribution of Oceanography Research output of International and National Level

Year	International Output	National Output (India)
2008	545	31(5.69)
2009	1187	101(8.51)
2010	2960	152(5.13)
2011	3549	190(5.35)
2012	4560	331(7.26)
2013	5860	388(6.62)
Total	**18661**	**1193**

Relative growth of India Research Output

Table-3 indicates the relative growth rate of National level (India) Oceanography Literature and also the doubling time for publications. It includes all sources of Publication. It could be observed that the relative growth rates for all sources of Oceanography Research output have decreased from 1.45 in 2009 to 0.39 in 2013. The mean relative growth rates for the periods 2009 – 2011 and 2012 – 2013 are 0.91 and 0.45 respectively. The overall study period has witnessed a mean relative growth rate of 0.72.

Contrastingly the doubling time for publications of all sources of Oceanography research output has increased from 0.48 in 2012 to 1.77 in 2013. The mean doubling time for publications for the periods of 2009– 2011 and 2012 – 2013 are 0.91 and 1.55 years respectively. The whole study period has witnessed a doubling time for publication at 1.16 years. In general, Oceanography research output has shown as declining trend as for as the National level (India) publications are concerned, inversely doubling time for publications has increased progressively.

Table No- 3: Showing Relative Growth Rate of National Output

Year	No. of Output	Cumulative No. of output	W_1	W_2	$\overline{R}$ (a)	Mean $\overline{R}$ (a) 1-2	Doubling Time Dt (a)	Mean Dt (a) 1-2
2008	31	31		3.43				
2009	101	132	3.43	4.88	1.45		0.48	
2010	152	284	4.88	5.64	0.76		0.91	
2011	190	474	5.64	6.16	0.52	0.91	1.33	0.91
2012	331	805	6.16	6.69	0.52		1.33	
2013	388	1193	6.69	7.08	0.39	0.45	1.77	1.55
	Mean R (a)				**0.72**		**1.16Yrs**	

It could be deducted from the above discussion that in generally progressive increase number of publications of research output on oceanography literature. However, its relative growth has shown a declined trend which means the rate of increase is low in terms of proportion and this has been highlighted by doubling time for publication, which is more than the relative growth rate.

Authorship Pattern

The findings of authorship pattern in Oceanography literature (Table -4) indicate the following facts. The two authors paper rank first in order (34.87%) where as three authors paper obtain the second order of priority (25.40%). The single author papers record the third order in priority (24.64%). The present study brings papers under analysis contributed by one author to ten authors & above. It is noticed that from four author paper to ten authors papers, the trend is under of publications has reduced significantly as the number of authors increases, in other words when the number of authors increases. Their combined contribution decreases and vice versa also.

Table-4: Showing Year wise Authorship pattern of Oceanography Literature

Year	One	Two	Three	Four	Five	Six	Seven	Eight	Nine	Ten & >	Total
2008	8	11	9	3		-	-	-	-	-	**31 (2.60)**
2009	14	43	24	10	6	3	-	-	-	-	**101 (8.47)**
2010	17	67	40	20	6	2	-	-	-	-	**152 (12.74)**
2011	52	64	48	17	1	2	2	2	-	2	**190 (15.93)**
2012	73	121	92	29	10	6	-	-	-	-	**331 (27.74)**
2013	130	110	90	39	8	2	5	2	1	1	**388 (32.52)**
Total	**294 (24.6)**	**416 (34.9)**	**303 (25.4)**	**118 (9.89)**	**31 (2.16)**	**15 (1.26)**	**8 (0.68)**	**4 (0.33)**	**1 (0.08)**	**3 (0.25)**	**1193**

Degree of Collaboration

It is inferred from the table -5 that at the aggregate level, the degree of collaboration is of 0.78 during the study period 2008 to 2013 i.e, that is out of total 1193 literature published, 78% of them or published under the joint author of publications in oceanography research output. This brings out clearly the high level of prevalence of collaborative research in Oceanography.

Table – 5: Showing Year wise Distribution of Degree of Collaboration

Year	Single Authors		Multiple Authors		Total	Degree of Collaboration
	No. of Output	Percentage	No. of Output	Percentage		
2008	8	2.58%	23	74.19%	31(2.6)	0.74
2009	14	13.86%	87	8.61%	101(8.5)	0.86
2010	17	11.18%	135	88.82%	152(12.7)	0.89
2011	52	27.37%	138	72.63%	190(15.9)	0.73
2012	73	22.05%	258	77.95%	331(27.7)	0.78
2013	130	33.51%	258	66.49%	388(32.5)	0.66
	294	**24.64%**	**899**	**75.36%**	**1193**	**0.78**

It could be seen clearly from the above discussion that the degree of collaboration in producing research output on oceanography research has shown an increasing trend during the study period since it is a new discipline. Based on this study, the result of the degree of collaboration **C=0.78** i.e., 78 percent of collaboration authors articles published during the study periods.

Author Productivity

The study of the author productivity is an important aspect in analyzing the performance of research output. Generally research activity is carried out by a scientist or groups a scientist depending on the nature and aim of the research. It also depends on the ability and efficiency of scientists. Depending on the skill and talent, a scientist may contribute a quite number of papers and it may not be the case with other scientists. The analysis of author productivity examines the prevailing trend in carrying out research in any discipline of science. Out of the various disciplines of science the analysis of author productivity in Oceanography research project is the focal point as for as the present investigation is concerned.

Table-6 indicates the contribution of research paper based on an author productivity levels. It is observed that 44.42 percent of authors have made single contribution in the field of Oceanography. It ranks first in order (44.42%) with respect to the total number of contributions in the study. It is noticed that two paper contributed by authors record the second in order

(20.63%) in respect of an overall number of authors enlisted in the study. Three papers contributed by authors take the third place (10.32%) of priority in their representation of the total output. Four papers contributed by authors stand in the fourth order (6.32%). It is interesting to note that when the number of contributions increases the number of authors decreases. It indicates the fact that a greater level of research performance in noted only among few authors

Table – 6: Showing Distribution of Author Based on Productivity

Number of Contribution	Number of Authors	Percentage	Cumulative Percentage
1	211	44.42	44.42
2	98	20.63	65.05
3	49	10.32	75.37
4	30	6.32	81.69
5	17	3.58	85.27
6	13	2.74	88.01
7	11	2.32	90.33
8	10	2.11	92.44
9	8	1.68	94.12
10	7	1.47	95.59
11	6	1.26	96.85
12	5	1.05	97.9
13	4	0.84	98.74
14	3	0.63	99.37
15	2	0.42	99.79
16	1	0.21	100
Total	**475**	**100.00**	

Lotka's law in relation to Author productivity

Lotka's is one of the three major laws of Bibliometrics study that mainly explain the literature distribution of various authors productivity in given field (Lotka, 1926). Table - 7 reveals that, the implication 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 percent. In the present study Oceanography scientists author productivity is examined. At the first observation that analyzed data invalidates. Lotka's findings that the proportion of all contribution that makes a single contribution is less than 60 percent. Further, Lotka's dx^2 model confirms the same fact.

It explains the fact that the calculated dx^2 value of 199.01 is much less than the table value in 11 degree of freedom at 5 percent level of significance.

Table-7 showing productivity of author based on Lotka's law

Number of Contribution	Observed Number of authors with 'n' or (an) or (f)	Observed percentage of authors 100 x an / a1	Expected number of authors (an=an/n^2)or (p)	Expected percentage of authors predicted by Lotka (1926) 100/n^2	(F-P) 2/P
1	211	100	213	100.00	0
2	99	46.92	52.75	25.00	40.55
3	50	23.70	23.44	11.11	30.09
4	32	15.06	13.19	6.25	26.82
5	19	9.00	8.44	4.00	13.21
6	14	6.63	5.86	2.77	11.31
7	13	6.16	4.31	2.04	17.52
8	11	5.21	3.30	1.56	17.96
9	8	3.79	2.60	1.23	11.21
10	7	3.32	2.11	1.00	11.33
11	6	2.84	1.74	0.86	10.43
12	5	2.37	1.46	0.69	8.58
	475			**X^2**	**199.01**

Degrees of freedom = 11; Level of Significant = 0.05

Ranking of Journals

Journals is one of the primary sources of information are the vehicles of current output of knowledge. A higher birth rate of periodicals can be a measure of the growth of in the field of knowledge. It is an accepted fact that in the field of science there is apparently on increasing rate of birth of journals to meet the rapid explosion of information. Table -8 shows that Top- 50 ranking of journals according to their productivity. The total number of 128 journals published 737 articles. These 128 journals are arranged in the decreasing order of productivity.

The Indian journal of marine science ranked first in order published 114(15.47%) articles. Journals of environmental biology occupied second in order published 89(12.08%) articles during the period of study. The Indian journals of Fisheries ranked third in order published 69(9.36%) articles. The journal of Current science ranked fourth in order published 65(8.82%) articles during the period of study the remaining journals ranked to their published articles.

Table-8 Showing Ranking of Journals according to Bradford's Distribution

Sl. No.	Title of the Journals	Country	No. of articles	%	Rank
1.	Indian Journal of Marine Science	India	114	15.47	1
2.	Journal of Environmental Biology	India	89	12.08	2
3.	Indian Journal of Fisheries	India	69	9.36	3
4.	Current science	India	65	8.82	4
5.	Indian Journal Fisheries Association	India	47	6.38	5
6.	Indian Asian Soc.Fisheries	India	31	4.21	6
7.	Bot.Mar	USA	27	3.66	7
8.	Indian J. of. Microbiol	India	19	2.58	8
9.	Hydro biologia	Netherland	17	2.30	9
10.	Environmental Biology	Netherland	11	1.49	10
11.	Comp. Physiology Ecol	India	11	1.49	10
12.	J. Eco. Boil	UK	11	1.49	10
13.	Ind. Journal of animal science	India	10	1.35	11
14.	Sier. Culture	India	10	1.35	11
15.	J. Mar. Biol Assoc. India	India	7	0.94	12
16.	J. Aquacult. Trop	India	6	0.81	13
17.	Estuar. Coast shelf Sci.	UK	6	0.81	13
18.	Coastal Res.	USA	6	0.81	13
19.	Mar. Environ Res.	UK	6	0.81	13
20.	Mar. Biol	Germany	6	0.81	13
21.	Ind. J.Environ Health	India	4	0.54	14
22.	Envi. Morit. Assess	Netherland	4	0.54	14
23.	Indian J.Ecol	India	4	0.54	14
24.	Environ. Bullut	UK	4	0.54	14
25.	Mar.Pollut Bull	UK	4	0.54	14
26.	Acta. Hydrobiol	Poland	4	0.54	14
27.	J.Plant Physiol	Germany	4	0.54	14
28.	J. Anim. Morphol. Physiol.	India	4	0.54	14
29.	Pestic Biochem. Physiol	USA	4	0.54	14
30.	Fish Chimes	Germany	4	0.54	14
31.	Water Res.	USA	4	0.54	14
32.	Chemosphere	USA	4	0.54	14
33.	Biol. Waster	UK	3	0.40	15
34.	Fish Farm Int.	UK	3	0.40	15
35.	Aqua	Netherland	2	0.27	16
36.	Cytobies	UK	2	0.27	16
37.	Odonatalogica	Netherland	2	0.27	16
38.	Dis.Aquat Org.	Germany	2	0.27	16
39.	Atmos. Environ	USA	2	0.27	16

40.	Ann. Biol	India	2	0.27	16
41.	Toxicology	Ireland	2	0.27	16
42.	J. Invertebr – Pathol	USA	2	0.27	16
43.	Ecol.Eng	UK	2	0.27	16
44.	Asian. Environ	Asia	2	0.27	16
45.	Chem. Speci. Bioavail	UK	2	0.27	16
46.	Proac. Acad. Environ Biol	Switzerland	2	0.27	16
47.	J.Foodsci. Tech.Mysore	India	2	0.27	16
48.	Acta. Bot. India	India	2	0.27	16
49.	Mutarres	Netherland	2	0.27	16
50.	J. Herpetol	USA	2	0.27	16

Bradford's Distribution

The Bradford's law was formulated in the year 1948. It examines essentially that a group of journals are arranged in an order of decreasing productivity. It means the journals that yield that most relevant article coming first and the most unproductive in the last. Table -9 shows clearly that the ranking list of journals contributed by Indian oceanography scientists in an order of decreasing productivity. Then journals will be grouped in to a numbers of zones each producing a similar number of relevant articles. However, the number of journals in each zone will be increasing rapidly. The relationship between the zone $1:n:n^2$

Table -9 indicates that the first three journals covered more then one third of total articles published. The next six journals covered another one third of the articles. Then remaining 119 journals covered the last one third of the published articles. According to Bradford's distribution the relationship between the zone is $1:a:a^2$ visible the relationship in each zone of the present study is 3:9:119 which does not fit in to Bradford's distribution. The easy and interesting observation from the table is the number of journals in each zone. After Bradford's formulation, it should be 3:6:27, where as the observed number of journals in the three zones stands as 3:6:119. This shows that core contributions are given by a very few journals, i.e., less than Bradford's formulated and the final zone contains a very large number of journals, i.e., much more than the Bradford's formula. It is clear indication that core zone is much concentrated and the other zone is much extended and that shows the scattering of information in Oceanography 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.

Table -9: Showing Ranking of journals According to Bradford's Distribution

S.No	No. of Journals	No. of Articles	Total no. of Articles	Cumulative no. of Articles
1.	1	114	114	114
2.	1	89	89	203
3.	1	69	69	272
4.	1	65	65	337
5.	1	47	47	384
6.	1	31	31	415
7.	1	27	27	442
8.	1	19	19	461
9.	1	17	17	478
10.	3	11	33	511
11.	2	10	20	531
12.	1	7	7	538
13.	5	6	30	568
14.	12	4	48	616
15.	2	3	6	622
16.	21	2	42	664
17.	73	1	73	737

Figure in parentheses denote percentage

Geographical distribution for published Articles

The analysis of country wise distributions of number of research output in an essential factor in high lighting the research and development in any discipline of Science. To evaluate the Indian Oceanography Scientist performance in publishing their research articles both in Indian journals as well as foreign journals. It is evident from the Table - 19 published that Indian oceanography scientist published their articles in journals of 18 countries including India. It is noted that Indian journals rank the second in order (21.09) in publishing research articles. It also comes in the first place (68.65) in terms of the number of articles published in total. It infers one of say that most of the Indian oceanography Scientist research outputs are validated among Indian publishers.

Next to Indian, USA ranks first in order (28.13) in published research articles. It also comes in the second place (10.85) in terms of the number of articles published in total. UK ranks third in order in publishing (21.09) Indian oceanography Scientist research articles. Netherland ranks fourth in order (10.16) in terms of the number of journals publishing Indian oceanography Scientists research output and also published articles (6.10) in relation to the total output.

Germany ranks fifth in order (6.25) in terms of journals publishing Indian oceanography Scientist research articles and also the number of published articles (2.84) in relation to the total output. Poland ranks sixth in order (1.56) in terms of journals publishing Indian oceanography scientists research articles and also the number of articles published in relation to the total output.Japan ranks seventh in order (2.34) in terms of the number of journals publishing Indian oceanography scientist research articles. France rank eight in order (1.56) in terms of the number of journals publishing Indian oceanography scientist research articles.

Table -10: Showing Country wise Distribution of Journals and Articles

Sl.No	Country of Publication	No. of Journals	No. of Articles
1.	India	27 (21.09%)	506 (68.65%)
2.	USA	36 (28.13%)	80 (10.85%)
3.	UK	27 (21.09%)	62 (8.41%)
4.	Netherland	13 (10.16%)	45 (6.10%)
5.	Germany	8 (6.25%)	21 (2.84%)
6.	Poland	2 (1.56%)	5 (0.67%)
7.	Japan	3 (2.34%)	3 (0.40%)
8.	France	2 (1.56%)	2 (0.27%)
9.	Spain	1 (0.78%)	2 (0.27%)
10.	Switzerland	1 (0.78%)	2 (0.27%)
11.	Ireland	1 (0.78%)	2 (0.27%)
12.	Yugoslavia	1 (0.78%)	1 (0.13%)
13.	Pakistan	1 (0.78%)	1 (0.13%)
14.	Narway	1 (0.78%)	1 (0.13%)
15.	Italy	1 (0.78%)	1 (0.13%)
16.	Australia	1 (0.78%)	1 (0.13%)
17.	China	1 (0.78%)	1 (0.13%)
18.	Canada	1 (0.78%)	1 (0.13%)
	Total	**128 (100.00)**	**737 (100.00)**

Major Findings

The Present study comes out the following remarkable observations

The findings of year wise distributions by sources of research output in oceanography publications in examined. It is found that the various kinds of sources are fallen of highest in the year 2012 & 2013.

The findings of source wise distribution of oceanography research output being out the facts that of the various sources of oceanography literature publications the articles that appeared in journals record to fist order followed by conference proceedings, reports, books and bulletin in their respective order. In general publications of articles in journals take the predominant

representation. It is due to the prevalence of greater level of provocative and dissemination effects of journals throughout the world.

The analysis of the growth of oceanography literature at the international level revels that the relative growth rates of oceanography research output have shown a declined trend. Contrastingly, the doubling time of publications that has increasing remarkably. The same trend is witnessed in terms of Indian level output.

The pattern of oceanography literature growth among various institutions reveals the following facts that the universities rank first in order in promoting more number of research output followed by Colleges, Research institutions and Autonomous organizations.

The findings of author productivity in terms of Lotka's law implications reveal the following facts that the analyzed data invalidate Lotka's finding. The proportion of all contributions that makes a single contribution is less than sixty percent particularly in the case of the number of authors contributed at various level of research output. Further, Lotka's dx^2 confirms the same fact. In another dimension, the same result is obtained in terms of the number of contributions made by various authors

The findings of degree of collaboration analysis reveal the following facts that the case of single author contributed papers are less. It begins out clearly the high level prevalence of collaborative research in oceanography. It indicates that research activity; now-a-days relies mainly on group of researchers.

From authorship pattern analysis collaboration author's productivity is more than single contribution. Single author productivity is 24.64 percent and multi author's productivity is 75.36 percent. The analyzed data show a clear picture that the tendency of scientists collaborating among themselves is increasing.

The findings of classification of journals according to Bradford's distribution reveal the fact that the first three journals covered more than one third of the total articles published. The next six journals covered another one third of total articles. The remaining 119 journals covered the last one third of published articles, suggesting the in validity of Bradford's law.

The findings of distribution of Indian oceanography Scientists published articles in the journals of various countries reveal the fact that Indian oceanography scientists have contributed their research articles mainly in Indian journals. The countries such as Netherlands, USA and United Kingdom have considerably recognized the research articles of Indian Oceanographers.

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