Mapping fish research in India*

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Fish and aquaculture research in India has been mapped using data from six databases. About 460 papers, roughly 5.5% of the world output, come from India every year, of which 82% are journal articles. Close to 70% of journal articles have appeared in 113 Indian journals. Less than a third of the journal articles are published in journals indexed in *SCI*. About 61% of publications are contributed by government laboratories and over 25% by academic institutions. Government laboratories publish most of their work in low impact and low visibility journals and academic institutions in journals of medium impact. However, even those papers appearing in better-rated journals are not cited well. Kochi, Chennai, Mumbai and Mangalore are the cities and Tamil Nadu and Kerala are the states contributing large number of papers.

Introduction

THIS paper aims to map fish and aquaculture research in India over the six-year period 1994–1999, as reflected by the literature. The study is intended to examine (a) the volume of work published in the discipline of fish science, (b) the journals used to publish this work and their standing (as reflected by their impact factors) and (c) the institutions which actively publish in this field.

Fish and aquaculture products contribute a significant amount of animal protein to the diets of people worldwide. Being highly nutritive they serve as valuable food supplement in diets lacking essential vitamins and minerals. Besides its role in food security, fishing is a source of income for millions of people around the world. Though the trade is not prominent at the global level, in some countries its contribution to foreign currency earning is vital to the national economy. India has a coastline measuring 7500 km, and its total fish catch in 1997–1998 was estimated to be more than 5.3 million tonnes from both marine and freshwater resources[1]. The estimated foreign exchange earning was US$ 1200 million, for the year 1998 (ref. 2). The number of fishermen is rising fast in labour-intensive economies[3]. There are nearly six million fishermen in India, of whom 2.4 million are full time, 1.45 million part-time and the rest occasional[2]. However, India occupies only the eighth rank in the FAO list of fish-producing countries which together account for more than 50% of world capture fisheries production[3]. Six of the top ten producers for inland capture fisheries are in Asia. China, with a production of 1.8 million tonnes, produces 23% of the world total and nearly three times as much as India, the second largest producer[3]. There is also a downside to fisheries in developing countries. While rising exports earn valuable foreign exchange, the diversion of fish and fish products from local communities and developing regions deprives needy people of a cheap source of nutrition. Besides, an increase in fishing beyond sustainable limits may lead to loss of coastal resources and biodiversity, harm the habitat and deplete freshwater[4]. All this makes fish research very important.

A very large number of meetings and conferences have focused exclusively on aquaculture, covering subjects such as the use of chemicals, environmental impacts of coastal aquaculture and food safety issues associated with products from aquaculture. This interest is being driven by a variety of factors, including considerable political attention due to increasing awareness of the economic importance and potential of aquaculture. Inland aquaculture has emerged as a major contributor to fish production in India, accounting for 1.7 million tonnes in 1998 (ref. 2). It is important then that research programmes be directed towards anticipating emerging opportunities in this field while also addressing the negative impacts on the ecosystem.

The Indian Council for Agricultural Research (ICAR), which coordinates fisheries research in India, has eight fisheries research institutes that conduct research on the survey, exploitation, experimentation, management and conservation of aquatic resources from fresh, cold and brackish water[5].

The exercise of mapping fish research in India, we hope, would help in assessing India's contributions to the world literature on fish science and also give an insight into how much of this research embraces modern molecular biology and biochemistry. It is also of interest to see whether research programmes are pertinent to the requirement of the fish sector, and if they address economic and sociological issues. That *Current Science* brought out a special section in early 1999 on Science and Technology of Fisheries[6], is a measure of growing interest in this field.

Arunachalam and Singh were among the earliest to quantify India's contribution to the world literature of narrow specialties such as liquid crystals[7], holography[8],

*Dedicated to Eugene Garfield, Information Scientist Extraordinaire, on his 75th birthday.

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superconductivity[9], and lasers[10] and its citation impact using the print version of INSPEC *Physics Abstracts* and *Science Citation Index*. More recently, Arunachalam and colleagues have mapped India's contributions to the literatures of mathematics[11], materials science[12], physics[13], medicine[14], agriculture[15], all of science[16], and life sciences[17], using CD-ROM versions of appropriate international bibliographic databases. Patterns of publication by the staff of an international fisheries research center has also been carried out earlier[18]. In this study, we have collected bibliographic data from six different international databases that index information on fish research, fisheries and aquaculture.

Methodology

All publications in fish and aquaculture having an author address in India were downloaded from *CAB Abstracts*, *SCI* (*Science Citation Index*), *BIOSIS Biological Abstracts*, *BBCI* (*Biophysics and Biochemistry Citation Index*), *BTCI* (*Biotechnology Citation Index*) and *ASFA* (*Aquatic Science and Fisheries Abstracts*). For the first five databases we used the CD-ROM version and for *ASFA* the web version. The fields downloaded included author names, affiliation, source, publication year, title, document type and descriptors. Unfortunately, fields such as descriptors were not available in every database and field codes were found to be dissimilar even within the same database over the six-year period. The search was made using the keywords 'fishes' and 'aquaculture', and 'India' and the names of about 300 Indian cities, towns, districts and states in the address field. If we had merely given 'India' in the address field, we would have missed many Indian papers indexed in non-ISI databases. We find that many databases take the address field as given in the original document and hence may not contain the country name. Finally, a manual check was made to remove entries that do not form part of fish and aquaculture research in India.

Bibliographic databases do carry some erroneous entries. Often, they reproduce what is given in the journals they index, and many journals are slack in giving accurate bibliographic information. For example, Panjab University (which is in Chandigarh) may be printed as Punjab University (which is in Lahore, Pakistan). We standardized different variants of names of institutions, e.g. we changed Sagar University to Dr H.S. Gaur Viswavidyalaya. We renamed several cities, e.g. Cochin became Kochi, Bombay was changed to Mumbai and Madras to Chennai. Names of states were added to all cities and towns in the addresses. For each journal, the country of origin was added by looking up *Serial Sources for the BIOSIS Previews Database* 1993, *Ulrich's International Periodicals Directory* 1995 (print version) and *CAB International Serials Checklist* 1995. Several Indian Journals (e.g. *Journal of Aquatic Biology*, *Journal of Freshwater Biology*, *Journal of Aquatic Biology and Fisheries* and *Journal of Environmental Pollution*) were not listed in any of these reference sources or in *JCR*.

The impact factor values from *Journal Citation Reports* (*JCR*) 1998 were also added to the journal titles. The various fields in the five databases were standardized, and the databases were merged. Inter-database record duplicates were identified and deleted. The data thus cleaned up were then analysed using Foxpro. We could not include analysis by sub-field because 'descriptors' or classification terms were not available in all the databases used in the study.

Analysis

Journal articles, meeting and conference publications and books and book chapters published in the six-year period were considered for this study. After the merging of records from the six databases and deletion of duplicate records, Indian researchers were found to have produced a total of 2454 publications in the six years. Of all the records downloaded from *ASFA* using the keywords 'fishes' and 'aquaculture', 6.35% was from Indian addresses, and the corresponding figure for *CAB Abstracts* was 4.5%. (In contrast, only 1.7% of records on fish and aquaculture in *SCI* originate in India!) Thus, about 5.5% of the world literature on fish and fisheries comes from India. Many journals covered in *ASFA* were not indexed in other databases.

The number of records obtained from all the databases for each publication year is given in Table 1. Of these, 2031 were journal articles, 365 were conference publications, 57 publications were in the form of books or book chapters and one article was classified 'miscellaneous'. One notices a steep drop in the number of papers in 1999. This is because most papers published in 1999 will be indexed by secondary services only much later. The journals used often by Indian researchers to publish their work on fish research are listed in Table 2. The country of publication of each journal and the impact factor (from *JCR*

Table 1. Indian research papers abstracted in one or more of six databases *ASFA*, *CAB Abstracts*, *Biological Abstracts*, *BBCI*, *BTCI*, *SCI* (arranged by publication year)

Publication year	Journal articles	Conference papers	Books/book chapters	Miscellaneous	Total no. of papers
1994	403	99	11	1	514
1995	429	27	10		466
1996	417	65	9		491
1997	333	81	12		426
1998	319	90	13		422
1999	130	3	2		135
Total	2031	365	57	1	2454

Table 2. Journals used often by Indian researchers to publish work on fisheries research

Rank (based on no. of papers)	Journal title	Publication country	Impact factor (JCR-1998)	No. of papers
Indian journals				
1	*Environment and Ecology*	IN	A	132
2	*Fishing Chimes*	IN	A	131
3	*Journal of Aquaculture in the Tropics*	IN	A	89
4	*Indian Journal of Fisheries*	IN	A	86
5	*Current Science*	IN	0.515	78
6	*Fisheries Technology Society of Fisheries Technologies*	IN	A	58
7	*Journal of Ecotoxicology and Environmental Monitoring*	IN	A	58
8	*Indian Journal of Marine Sciences*	IN	0.102	56
9	*Indian Journal of Experimental Biology*	IN	A	54
10	*Seafood Export Journal*	IN	A	54
11	*Journal of Environmental Biology*	IN	0.081	53
	102 other Indian journals			571
	Total			1420
Non-Indian journals				
12	*Bulletin of Environmental Contamination and Toxicology*	US	0.653	45
21	*Aquaculture Research*	GB	A	26
22	*Asian Fisheries Science*	PH	A	22
23	*Aquaculture*	NL	0.955	21
27	*Aquaculture International*	GB	0.721	16
28	*Journal of Fish Biology*	GB	1.112	15
31	*Infofish International*	MY	A	14
35	*Bioresource Technology*	GB	0.705	11
36	*Comparative Biochemistry and Physiology-A*	GB	0.645	11
37	*Fish Physiology and Biochemistry*	NL	0.656	11
38	*Naga*	PH	A	11
	184 other non-Indian journals			408
	Total			611
	Total number of journal papers			2031
	Conference			365
	Book/Book chapters			57
	Unknown			1
	Total			2454

A = Not indexed in *JCR*.

1998) for the journals most often used are also given. In all, Indian researchers have used 308 journals to publish their work. In the six years studied, more than 50 papers were published in 11 journals, and 5 or more papers in 55 journals. Only one paper each was published in 149 journals and two papers each in 50 journals. Figure 1 shows that the distribution of papers among journals is almost sigmoidal.

Use of letters journals

Unlike in physics, letters journals do not appear to be important in fish science. There seems to be no urgency. Indian researchers have used four letters journals to publish 12 papers (0.6% of the total output) in the six years: *Biomedical Letters* (1 paper), *Letters in Applied Microbiology* (3), *National Academy Science Letters* (7) and *Toxicology Letters Shannon* (1).

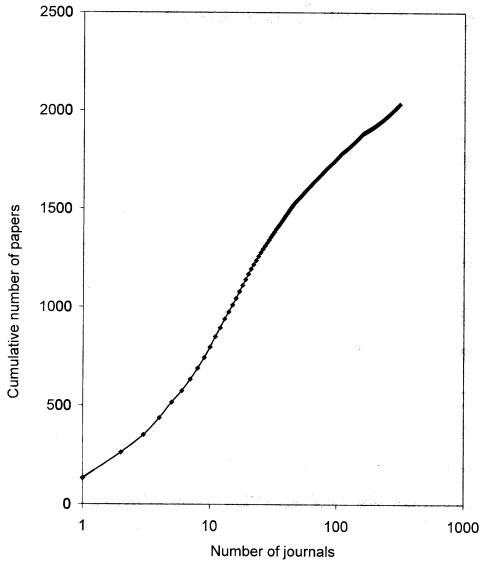

Figure 1. Number of journals vs cumulative number of Indian papers.

Classification by journal country

Research on fish science in India has figured in journals from 30 countries. All the 11 journals having more than 50 Indian papers are Indian journals (Table 3). A total of 113 journals used by Indian researchers are published in India accounting for 69.9% of the journal paper output. In contrast, in life sciences as a whole 55.4% of India's papers have appeared in Indian journals[17] and in mathematics 42% of Indian papers have appeared in Indian journals (Arunachalam, S., unpublished results). About 10% of India's journal papers were published in UK journals and 6.9% in US journals. These are followed by journals published in the Netherlands (4%), Philippines (1.66%), Germany (1.3%) and Japan (0.8%). The choice of journals for publishing papers by Indian fish researchers resembles that of other biologists in India, namely Indian journals followed by UK and US journals[17].

Of the 11 Indian journals in which Indian fish researchers have published often, nine are devoted to fish/fisheries or environment. Papers published in these 11 Indian journals account for 42% of India's journal articles output. Seventy-eight papers have been published in the multidisciplinary journal *Current Science*. In life sciences as a whole, 45 of the 50 frequently used journals are brought out in India[17]; in this study only 30 of the 50 most frequently used journals are from India. However, nine of the 20 frequently used non-Indian journals are non-*SCI* journals. *Journal of Fish Biology* (Great Britain, 15 papers) and *General and Comparative Endocrinology* (US, 10 papers) are the only two journals with an impact factor ≥ 1 amongst the 50 journals used often by Indian fish researchers. There are five papers also in the *FASEB Journal* (not a journal devoted to fish research), the journal of highest impact factor to be used by Indian researchers to publish their work on fish research.

Table 3. Country of publication of the journals used by Indian researchers to publish their work (arranged by number of papers)

No.	Publication country	No. of journals	No. of papers
1	India	113	1420
2	United Kingdom	57	205
3	United States	40	140
4	The Netherlands	24	82
5	Philippines	2	33
6	Germany	19	26
7	Japan	7	16
8	Italy	3	15
9	Malaysia	2	15
10	Switzerland	8	12
11	Poland	3	12
	19 other countries	30	55
	Non-journal items		423
	Total	308	2454

Table 4. Distribution of Indian papers by impact factor range of journals (based on impact factor data from *JCR* 1998)

Impact factor range	No. of journals	No. of papers
0.000	159	1365
> 0.0–≤ 0.5	38	222
> 0.5–≤ 1.0	56	325
> 1.0–≤ 1.5	29	71
> 1.5–≤ 2.0	11	22
> 2.0–≤ 2.5	10	15
> 2.5–≤ 3.0	2	3
> 4.5–≤ 5.5	1	2
> 8.0	2	6
Non-journal		423
Total	308	2454

Classification by journal impact factor

The 308 journals in which fish researchers have published their work have been classified under different impact factor ranges of journals, as seen from *JCR* 1998 (Table 4). Over 57% of papers from India have appeared in 159 journals which are either not indexed in *SCI* or which have been assigned an impact factor of zero. The most often used Indian journals are not indexed in *SCI* and *JCR*. Of the 113 Indian journals, all but 11 journals are non-*SCI* journals. About 11% of all papers published by Indian researchers have appeared in journals of impact factor less than 0.5. Only 26 papers (1.28%) have appeared in journals with an impact factor greater than 2, and only six papers have been published in the last six years in journals of impact factor greater than 8.0 (five papers in *FASEB Journal* (USA) and one in the *Proceedings of the National Academy of Sciences, USA*).

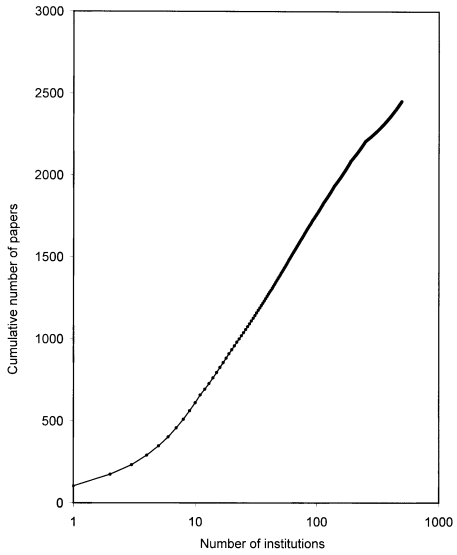

Figure 2. Number of institutions vs cumulative number of Indian papers.

Table 5. Indian institutions publishing papers (arranged by number of Indian papers)

No.	Institution	No. of papers
1	Central Marine Fisheries Research Institute, Kochi	103
2	Central Institute of Fisheries Technology, Kochi	72
3	College of Fisheries, Mangalore	58
4	University of Kalyani, Kalyani	58
5	University of Kerala, Thiruvananthapuram	57
6	Central Institute of Freshwater Aquaculture, Bhubaneswar	55
7	Tamil Nadu Veterinary and Animal Sciences University, Chennai	55
8	Andhra University, Visakhapatnam	52
9	University of Agricultural Sciences, Mangalore	52
10	Banaras Hindu University, Varanasi	49
11	Central Institute of Fisheries Education, Mumbai	47
12	Annamalai University, Parangipettai	35
13	Cochin University of Science and Technology, Kochi	35
14	Visva Bharati University, Santiniketan	35
15	Madurai Kamaraj University, Madurai	32
16	National Institute of Oceanography, Goa	31
17	Central Inland Capture Fisheries Research Institute, Bangalore	29
18	National Bureau of Fish Genetic Resources (ICAR), Lucknow	28
19	Osmania University, Hyderabad	27
20	Punjab Agricultural University, Ludhiana	25
21	Aligarh Muslim University, Aligarh	23
22	Bhabha Atomic Research Centre, Mumbai	23
23	University of Madras, Chennai	20
24	Bose Institute, Calcutta	19
25	Central Agricultural Research Institute, Port Blair	19
	432 other institutions	1357
	Home addresses	58
	Total	2454

Classification by institution

Indian institutions publishing in fisheries research between 1994 and 1999 have been listed in Table 5. The top 10 institutions include 6 universities. The most prolific publishers are the Kochi-based Central Marine Fisheries Research Institute (CMFRI) and Central Institute of Fisheries Technology, followed by the College of Fisheries, Mangalore, and University of Kalyani, Kalyani. A plot of the cumulative number of papers vs number of institutions is almost sigmoidal (Figure 2). Only nine institutions have published over 50 papers in the six-year period. The contributions from academic institutions (consisting of general, agricultural and medical universities and general, engineering and medical colleges), research institutions under different Central Government Agencies [Indian Council of Agricultural Research (491 papers), Council of Scientific and Industrial Research (88), Indian Council of Medical Research (30), Department of Atomic Energy (25), Defence Research and Development Organization (1)], and organizations under the Central Ministries of Agriculture, Environment and Forests, Science and Technology, Health and Family Welfare, private organizations, banks, and international organizations (ICRISAT, FAO and the UNDP) are indicated in Figure 3. In all, during the 6 years studied fisheries-related articles were published from 457 institutions and 61 home addresses in India.

Not all Central Government-funded laboratories have been equally productive in terms of number of papers. At one end is the CMFRI, Kochi, with 103 papers. At the other extreme are the CMFRI at Minicoy, Thiruvananthapuram and Tuticorin with one paper each. The CMFRI, Mumbai has published 8 papers and CMFRI, Chennai, 6

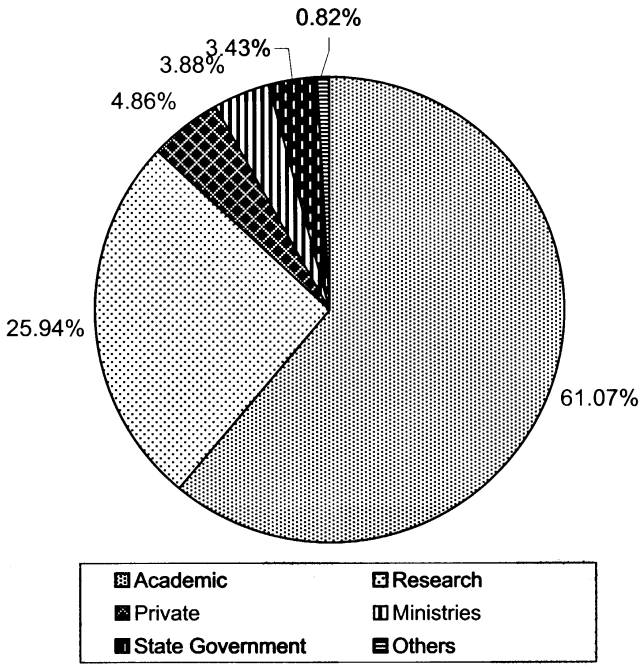

Figure 3. Contributions to fisheries research by different types of organizations.

papers over the six-year period. The Central Institute of Coastal Engineering for Fishery (CICEF) under the Ministry of Agriculture has not one article indexed in the six databases scanned.

Classification by city and state

Table 6 presents the number of papers published from different states, cities/towns of India. Tamil Nadu, Kerala and Uttar Pradesh account for the largest number of papers. Kochi (242 papers) leads as the city from where the largest number of papers have been published, followed by three other coastal cities, viz. Chennai (185 papers), Mumbai (128) and Mangalore (117). The clustering of ICAR institutes and active university departments and private institutes/enterprises in these cities is the reason. Papers have been published from 200 Indian cities and towns, of which only four cities have produced over 100 papers and 23 cities 20 or more papers.

Table 6. Indian cities and states contributing to the world literature of fisheries (arranged by number of papers)

City/town	No. of papers	State	No. of papers
Kochi	242	Tamil Nadu	390
Chennai	185	Kerala	370
Mumbai	128	Uttar Pradesh	281
Mangalore	117	West Bengal	244
Hyderabad	83	Karnataka	204
Calcutta	81	Andhra Pradesh	200
Thiruvananthapuram	73	Maharashtra	166
New Delhi	69	Bihar	99
Bhubaneswar	65	Madhya Pradesh	81
Visakhapatnam	61	Orissa	79
Bangalore	60	New Delhi	70
Kalyani	58	Punjab	41
188 Other cities	1232	10 Other states and 2 union territories	229
Total	2454	Total	2454

The number of papers published by selected institutions in journals of different impact factors is given in Table 7. Since the impact factors of most fish and aquaculture journals (both Indian and non-Indian) are low, not many papers can be found in the higher impact category. CMFRI, Kochi, which has produced the largest number of papers in this study, has published all but two of its 103 papers in journals with an impact factor of zero (non-*SCI* journals). Indeed, one expert whom we consulted felt that CMFRI's impact on the development of mariculture in India was meagre. Other ICAR institutes have not fared any better. Universities, especially the Banaras Hindu University and Madurai Kamaraj University, have published most of their work in *SCI*-indexed journals. Banaras Hindu University appears to publish predominantly in biochemistry, physiology and endocrinology journals. The Visva Bharati University, Santiniketan, follows a similar pattern. Amongst the leading institutions, only Osmania University, Hyderabad, had published a single paper in a high impact non-fisheries journal *FASEB Journal*, in a collaborative effort with the University of Mississippi. Four more papers have been published in *FASEB Journal* (the journal with the highest impact factor found in this

Table 7. India's contribution to the journal literature of fisheries categorized by institutions and impact factors of journals

Institution — Impact factor →	A	B	C	D	E	F	G	H	I	Total
Central Marine Fisheries Institute, Kochi	101	0	2	0	0	0	0	0	0	103
Central Institute of Fisheries Technology, Kochi	66	1	4	0	0	1	0	0	0	72
University of Kalyani, Kalyani	36	3	16	3	1	0	0	0	0	59
College of Fisheries, Mangalore	42	4	9	3	0	0	0	0	0	58
University of Kerala, Thiruvananthapuram	39	14	2	2	0	0	0	0	0	57
Tamil Nadu Veterinary and Animal Sciences University, Chennai	52	1	1	0	0	0	1	0	0	55
Central Institute of Freshwater Aquaculture, Bhubaneswar	50	3	2	0	0	0	0	0	0	55
Andhra University, Visakhapatnam	39	0	13	0	0	0	0	0	0	52
University of Agricultural Sciences, Mangalore	41	3	4	2	2	0	0	0	0	52
Banaras Hindu University, Varanasi	10	4	28	4	3	1	0	0	0	50
Central Institute of Fisheries Education, Mumbai	44	2	1	0	0	0	0	0	0	47
Visva Bharati University, Santiniketan	21	1	9	2	1	1	0	0	0	35
Cochin University of Science and Technology, Kochi	29	4	2	0	0	0	0	0	0	35
Annamalai University, Parangipettai	25	5	5	0	0	0	0	0	0	35
Madurai Kamaraj University, Madurai	10	3	18	1	0	0	0	0	0	32
National Institute of Oceanography, Goa	17	4	8	1	1	0	0	0	0	31
Osmania University, Hyderabad	14	5	7	4	0	0	0	0	1	31
Central Inland Capture Fisheries Research Institute, Bangalore	28	1	0	0	0	0	0	0	0	29
National Bureau of Fish Genetic Resources, Lucknow	26	2	0	0	0	0	0	0	0	28
Punjab Agricultural University, Ludhiana	19	2	6	1	0	0	0	0	0	28
Bhabha Atomic Research Centre, Mumbai	13	5	2	3	0	0	0	0	0	23
Aligarh Muslim University, Aligarh	18	0	4	1	0	0	0	0	0	23
University of Madras, Chennai	8	3	7	2	0	0	0	1	0	21
University of Calcutta, Calcutta	14	0	3	2	0	0	0	0	0	19
Total	762	70	153	31	8	3	1	1	1	1030

A = 0.000 or non-*SCI* C ≥ 0.5–1.0 E ≥ 1.5–2.0 G ≥ 2.5–3.0 I > 8.0
B ≥ 0.0–0.5 D ≥ 1.0–1.5 F ≥ 2.0–2.5 H ≥ 4.5–5.5.

study, 13.5), two from Sri Sathya Sai College in Bhopal, and one each from the Zoology Department of Krishnadevaraya University, Anantapur and the Pathology Unit of Sir Theyagaraya College, Chennai. The only paper in *Proceedings of the National Academy of Sciences, USA*, has come from the University of Roorkee. Thus the analysis does give the impression that in fish research, university departments and colleges have a qualitatively better output than centrally funded research laboratories. This mapping exercise has thrown up the names of various colleges, where researchers have undertaken some good work. Authors from S.M.M. Town P.G. College and the Zoology department of Tilak Dhari College from the academically not so well-known towns of Ballia and Jaunpur in Uttar Pradesh have published in the journal *Aquatic Toxicology* (IF = 2.025), which is a high impact journal in fish research. The only paper in *Freshwater Biology* (IF = 1.687) is again from a college, Takshshila College, Ujjain. An expert we consulted felt that the quest for promotion and getting confirmed in permanent positions in academic institutions is one reason for their interest in publishing in better journals. In most government laboratories, there is no such strong link between performance and promotions. In his words, they are seen more as employment providers than generators of research results.

On the whole, 444 papers have been published by Indian researchers in journals having an impact factor ≥ 0.5 and 26 papers in journals having an impact factor greater than 2.0. Indian researchers are in general unable to publish their work in high impact journals. Of the 59 journals devoted to fisheries and aquaculture that figure in this study, 33 are non-*SCI* journals and most others have a low impact factor. Journals such as *Aquatic Toxicology* (Netherlands, IF 2.025), *Fish and Shellfish Immunology* (UK, IF 1.3), *Canadian Journal of Fisheries and Aquatic Science* (IF 1.737), *Freshwater Biology* (UK, 1.687), *Journal of Fish Diseases* (UK, IF 1.239) and *Journal of Fish Biology* (UK, IF 1.112) figure as the high impact journals in the list. Papers that have been published in high impact journals have used biochemical and modern molecular biology methods. The paper published in the *Proceedings of the National Academy of Sciences, USA* is probably the only exception; it traces the evolution of whales from the fossils of *Himalayacetus subathuensis*, a new pakicetid archaeocete from northern India. A quick search with *SCI* revealed that even these papers in better impact journals are either not cited at all or are cited only infrequently.

Not all the databases give addresses of all authors, and hence the entire data could not be analysed for collaborators. But from amongst the data available, almost all Indian papers with co-authors abroad have been published in non-Indian journals indexed in *SCI* and *JCR*, and some of them in environment/toxicology/physiology/biochemistry journals of moderate impact. That internationally co-authored papers in general appear in higher impact factor journals than single-institution papers is well known[19]. The only Indian journal used to publish papers with foreign co-authors is *Current Science*. Though not a journal devoted to any specialized field, we find that a number of classical biology and modern biology papers in fisheries research have appeared in this journal.

Conclusion

Fish research in India appears to be mediocre in general. Although Indian researchers accounted for about 5.5% of the world publications on fisheries, and have the largest number of members in the Network of Tropical Aquaculture Scientists (NTAS)[20], a large majority of their papers got published either in non-*SCI* journals or low-impact journals of poor visibility. As was found earlier with agricultural researchers, Indian fish researchers probably find it best to publish in local journals. There could be two reasons for this: the subject is of local interest, and the papers do not match the quality demanded by even medium-impact international journals. We found that several Indian institutions bring out journals of their own, e.g. CMFRI, Kochi, publishes *Marine Fisheries Information Service* and *Indian Journal of Fisheries*; and NIO, Goa, publishes *Mahasagar*. Obviously, these journals publish many of the papers from the respective institutions. None of these papers was indexed in *SCI*. And since researchers tended to publish in their own institute publications, their work did not reach a wider readership or make an impact. Papers that reported the use of molecular biology techniques got published in journals with somewhat higher impact and better visibility, but even these were not cited often. We found that there are numerous fish-farming web sites. Though larger institutions have not taken up electronic or web publishing seriously in India, individual entrepreneurs and researchers have put up sites such as the Aquaculture Research and Development site which discusses research on innovative technologies in various aspects of aquaculture. Unfortunately, centrally funded institutes like the CICEF, Bangalore, which are meant to take up engineering and economics investigations, do not publish.

Fish research in India receives some monetary support from international organizations such as the World Bank, United Nations Development Programme, Danish Agency for Development Assistance (DANIDA), and the Overseas Development Administration (ODA), UK[2]. Some fisheries researchers we spoke to feel that the support the field receives from the Government is meagre. They point out that the budget outlay for fisheries research represents just 2.6% of the foreign exchange earned from the export of fish and fish products and only 6% of the total funds allocated to the agriculture and allied sector in the ninth five-year plan is granted to fisheries research[21]. Several projects have been started under the ICAR, Ministry of Agriculture and State Agricultural Universities, after the World Bank granted a loan of US$ 800 million for a

National Agriculture Technology Project in 1998. The projects are supposed to cover the areas of marine fisheries, aquaculture, pearl culture, development of cold-water fisheries and conservation of germplasm. It will be worthwhile to make grants to colleges and non-agricultural university departments that have a good record of research. Fisheries and aquaculture being an active trade, private organizations and entrepreneurs should also play a major role in supporting research.

This study emphasizes the need for databases to follow a standard format, so that the information derived from many databases can be used in conjunction without much difficulty. Craig Emerson of *ASFA* (personal communication) agrees that differences exist in descriptor fields, many of which are due to differences in technology and the use of different controlled vocabularies or thesauri. He also adds that standardization would be extremely difficult (laborious and expensive). We suggest that members of the National Federation of Abstracting and Indexing Services (NFAIS), Philadelphia, discuss this issue. In the case of the newly emerging Open Archives Initiatives, there is already considerable discussion and cooperation among the different archives towards achieving standard formats and complete interoperability. There is no harm if the secondary services that have been in existence for many decades take a similar initiative.

This study has had the limitations of being unable to comment on international collaboration in fish research in India, as not all databases list the addresses of all authors. Nor have we been able to comment on the number of papers that have been published with both the technology/scientific and sociology/economic angles in the field of fish science. Also, we have not gone beyond literature indicators. Ideally, one should have seen literature-based indicators in conjunction with manpower and budgetary data.

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