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Fish science research in China: How does it compare with fish research in India?

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Fish and aquaculture research in the People's Republic of China over the six years 1994-1999 has been mapped using data from six databases – three abstracting services and three citation indexes. The results are compared with fish science research in India. During the six years China has published 2035 papers (roughly 4.5 –5% of the world output) and India 2454. More than 95% of China's papers are journal articles, compared to 82.8% of Indian papers. About 78% of China's journal paper output has appeared in 143 domestic journals compared to 70% from India in 113 Indian journals. Less than one-eighth of the journal articles published by Chinese researchers are published in journals indexed in *SCI*, compared to 30% of journal articles by Indian researchers. Less than a dozen papers from each of these countries have appeared in journals of impact factor greater than 3.0. Fish research institutes and fishery colleges are the major contributors of the Chinese research output in this area. In India academic institutions are the leading contributors (61%), followed by central government institutions (>25%). Qingdao, Wuhan, Beijing and Shanghai are the cities and Shandong, Hubei and Fujian are the provinces contributing a large number of papers. As we do not have addresses of all authors in most of the papers, we are unable to estimate the extent of international collaboration. Although China's research output and its citation impact are less than those of India, China's fish production and export earnings are far higher than those of India. Probably China is better at bridging the gap between knowhow (research) and do-how (technology and creation of employment and wealth). China is pretty strong in extension.

Introduction

China and India, the world's most populous countries, depend a great deal on agriculture and fisheries to provide employment and feed their billions. Fish and aquaculture products contribute a significant amount of animal protein playing a vital role in food and nutritional security. The contribution of fishing to the foreign currency earnings of these two countries is vital to their national economies.

The area available for fishing/fish production in China is huge. Its total continental coastal line covers over 18,000 km and China has a total island coastal line of 14,000 km. It has the most inland waters in the world. Vast seas, abundant inland waters and

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appropriate climate are natural conditions for the growth of aquatic life. With favourable fishery development policies since the 1970s, China's total aquatic product output had grown to 36,017,759 metric tons (mt) from 400,000 mt in 1949. Today, China's fisheries have grown into a completely well integrated industrial system. China has the longest history in inland fish farming.[1] The earliest literature on fish farming in world history was published 2400 years ago, "Fan Li on pisciculture", 476 B.C.[2] Pond culture is the main form in China's present inland fish farming with total area reaching 1.75 million hectares. Fishing is currently done by collective and cooperative economic organizations, joint groups and individual fishermen. This sector alone is said to employ over 1.05 million people. By 1997, foreign trade of fishery products had reached 2,435,000 tons and about US$ 4.36 billion.[3] China has a thriving industry that consists of fishing, aquaculture, processing, marketing, fishing vessels and machinery industry, fishing port management, etc. We were interested in the importance placed on S & T, research and education in this field, as reflected in the literature. China dominates in both fisheries and aquaculture production (Table 1).[3-5] The Ministry of Agriculture of the People's Republic of China is the highest administrative body governing fisheries industry.

Table 1
Fishery statistics from China and India[3-5]

Component	China	India
Length of coastline (km)	18,000	8,129
Inland waters (hectares)	17, 471.30	3.15 million
Marine fishery labour force	2,240,263	Approx. 5 million
Full time labour force	1,525,233 (1992)	Approx. 1 million
Powered fishing boats (1992)	384,531	36,500
Total fish catch (1997) mt	36,529,071	5,378,004
Quantity exported (1997) mt	336, 929	3,608
Value of export (US$)	1,890 million (1996-1998 three-year average)	1,170 million (1999-2000)[+]
Total marine fish catch (mt)	10,774,593	2,477,747
Processed foods (total) mt	9,234,768	1,407,597
Export value of processed foods (US$)	5,364, 385	1,236,273
Number of researchers	10,271 (1990)	~ 2,150[#]
Educators in fish science	5171 (1990)	400
Extension workers	27,508 (1990)	Not available

mt = metric ton
[+]Sakthivel, M, in Sustainable Indian Fisheries, edited by T. J. Pandian, National Academy of Agricultural Sciences, New Delhi, 2001, 6-18
[#] T. J. Pandian, private communication

The bureau of fisheries is subordinate to this ministry. There are 192 fisheries and development institutes in China and fishery scientific research is also carried out in many institutes and universities. The Chinese Academy of fisheries with 11 subordinate research institutes directly under the Ministry of Agriculture serves as the backbone force in China's fishery research.[1] This body is similar to the Indian Council of Agricultural Research (ICAR) in India that coordinates fisheries research and has eight fisheries research institutes.[6]

We have recently completed a similar mapping exercise on fisheries research in India, and we wanted to extend the study to China and see how the two countries compare. Our interest in scientific research in China goes back to the early 1990s, when *Arunachalam* et al. mapped science in China using data collected from five years of *SCI* and six months of three editions of *Current Contents*.[8] More recently, *Arunachalam* and *Doss* have looked at international collaboration in science in India, China and other Asian countries.[9]

Our study on India[7] had revealed that government laboratories contributed to over 60% of total publications in the period 1994-1999, and that many researchers published in journals brought out by their own laboratories, catering to problem areas in the fisheries sector. Colleges and university departments were more academic, publishing in medium impact and high impact journals. Roughly 5.5% of the world output on fisheries came from India.[7]

The exercise of mapping literature on fisheries emanating from institutions, colleges and university departments in China, it was hoped, would (1) give an idea of the volume of research in this area, (2) provide a profile of leading institutes, journals used and their impact factors, and (3) reveal whether research embraces modern biology and addresses specific problems in the fisheries sector, such as economic and social aspects. It is always of interest to see if quantum of research is related to the amount of export earning and employment generated by this industry.

India ranks next to China in the list of top 10 fish producing countries in the world. In some places, we have compared the data on China with the data obtained from our study on India. The literature for both countries was gathered over the years 1994-1999 from six databases, using the same set of keywords as search terms.

Methodology

All publications in fish and aquaculture having an author address in People's Republic of China were downloaded for this study. Data were collected from *CAB Abstracts*, *BIOSIS Biological Abstracts*, *SCI* (*Science Citation Index*), *BBCI*

(*Biophysics and Biochemistry Citation Index*), *BTCI* (*Biotechnology Citation Index)* and *ASFA* (*Aquatic Science and Fisheries Abstracts*). We used the CD-ROM version of the first five databases and the web version of *ASFA*. The fields downloaded included author names, affiliation, source, publication year, title, document type and descriptors. 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" along with "China" and the names of about 150 Chinese cities, towns and provinces in the address field. This was done so as not to miss many papers published in journals that may not be indexed in ISI databases. Often other databases take the address field as given in the original document, which may not contain the country name. Moreover, the download would invariably include papers from Taiwan and Hong Kong, which had to be manually removed. During the manual check, papers that do not form part of fish and aquaculture research were also deleted. Names of journal countries were added by looking up the *Serial Sources for the BIOSIS Previews Database* 1993, *Ulrich's International Periodicals Directory* 1995 (print version) and *CAB International Serials Checklist* 1995. Several journals (16 of them) were not listed in any of the reference sources or in *Journal Citation Reports* (*JCR*).

The impact factor values from *JCR* 1998 were also added to the journal titles. The various fields in the six databases were standardized and merged. Inter-database record duplicates were identified and deleted. The data thus cleaned up was then analyzed using FoxPro.

Analysis

Literature considered in this study included journal articles, conference papers, books, symposia presentations and meeting abstracts. After deletion of duplicate records, a total of 2,035 publications were found to have been produced over the six-year period. The number of records obtained from all the databases for each publication year is given in Table 2. (The data obtained for India are also given.) Of these, 1,947 were journal articles, 36 were conference/symposia publications, 51 books or book chapters and one article was classified under miscellaneous. Figure 1 gives the curve of cumulative number of papers versus the number of journals. The drop in the number of publications in 1999 can be explained by the fact that secondary services index these papers only much later. The journals often used by Chinese researchers to publish their work on fish research are listed in Table 3. Chinese researchers have used a total of 328 journals to publish their work (143 journals are Chinese). More than 50 papers were published in

each of seven journals (six of them Chinese and one Taiwanese). Seventy-five journals published only 1 paper each of Chinese authors and 50 journals two papers each.

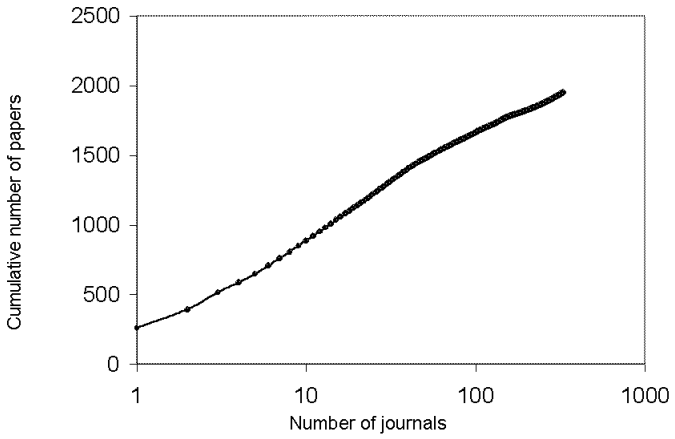

Figure 1. Number of journals vs. cumulative number of papers

Table 2
Chinese and Indian research papers abstracted in one or more of six databases
ASFA, CAB Abstracts, Biological Abstracts, BBCI, BTCI, SCI

Publication year	Journal articles	Conference papers	Books/ Book chapters	Miscellaneous	Total No. of papers
China					
1994	305	12	24	1	342
1995	337	8	6		351
1996	392	10	9		411
1997	365	4	11		380
1998	383	2	1		386
1999	165				165
Total	1947	36	51	1	2035
India					
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 3
Journals used often by Chinese researchers to publish work on fisheries research

Rank (based on no.of papers)	Journal	Publication country	Impact factor (*JCR* 1998)	No. of papers
1	ACTA HYDROBIOLOGICA SINICA	CN	A	263
2	SHANDONG FISHERIES	CN	A	132
3	JOURNAL OF FISHERIES OF CHINA	CN	A	121
4	ACTA ZOOLOGICA SINICA	CN	A	71
6	JOURNAL OF FISHERY SCIENCES OF CHINA	CN	A	59
7	CHINESE JOURNAL OF OCEANOLOGY AND LIMNOLOGY	CN	A	52
8	OCEANOLOGIA ET LIMNOLOGIA SINICA	CN	A	46
9	JOURNAL OF ZHANJIANG FISHERIES COLLEGE	CN	A	43
10	JOURNAL OF DALIAN FISHERIES COLLEGE	CN	A	37
11	JOURNAL OF OCEAN UNIVERSITY OF QINGDAO	CN	A	36
	133 other Chinese journals			656
	Total			1516
Non-Chinese journals				
5	JOURNAL OF OCEANOGRAPHY IN TAIWAN STRAIT	TW	A	63
17	AQUACULTURE	NL	0.996	21
32	SYSTEMATIC PARASITOLOGY	NL	A	12
36	ECOLOGICAL ENGINEERING	NL	A	11
37	JOURNAL OF FISH BIOLOGY	GB	0.918	10
40	HYDROBIOLOGIA	NL	0.526	9
41	ASIAN FISHERIES SCIENCE	PH	A	9
44	CHEMOSPHERE	GB	1.145	7
48	ANALYTICA CHIMICA ACTA	NL	1.778	6
50	JOURNAL OF SHELLFISH RESEARCH	US	0.506	6
	159 other non-Chinese journals			240
	Total			394
	16 other journals (country unknown)			37
	Total number of journal papers			1947
	Conference			36
	Book			51
	Miscellaneous			1
	Total			2035

A = impact factor not available in *JCR* 1998

Use of letters journals

Unlike in physics, letters journals are not important in fish science, probably because the authors do not feel the need for urgency. Indian researchers published 0.6% of their output (12 papers) in *Biomedical Letters* (1), *Letters in Applied Microbiology* (3), *National Academy of Science Letters* (1), and *Toxicology Letters Shannon* (1). Their Chinese counterparts have used *Analytical Letters* (4) and *Neuroscience Letters* (3) (0.35 % of their output). A total of 394 papers have been published in 169 non-Chinese journals, of which 109 are indexed in *SCI*. Two hundred and fourteen papers have been published in these journals. Five journals have over 10 papers – *Aquaculture* (21 papers, IF = 0.996), *Journal of Fish Biology* (10, IF = 0.918), *Systematic Parasitology* (12 papers, IF = 0), *Ecological Engineering* (11, IF = 0), and *Journal of Oceanography in Taiwan Strait* (63, IF = 0).

Classification by journal country

Research on fish science from China has figured in journals from 26 countries (Table 4). The country of origin for 16 journals carrying 37 Chinese papers could not be traced. Of the leading 50 journals used by Chinese researchers, only 10 are international journals. A total of 143 Chinese journals publish papers on fisheries research accounting for 77.8% of China's journal paper output. In India too, there are 113 Indian journals accounting for almost 70% of India's journal paper output. About 5.54% of Chinese papers are published in journals from the Netherlands, 3.44% in US journals, 3.33% each in British and Taiwanese journals. The choice of international journals used by Chinese researchers differs from that of their Indian counterparts. Indian researchers prefer UK journals (10%) after Indian journals, followed by US journals (6.9%). These are followed by journals published in the Netherlands (4%), Phillipines (1.66%), Germany (1.3%) and Japan (0.8%). Of the leading 50 journals used by Chinese researchers, 34 journals are devoted to fisheries/marine sciences. The other journals are environmental science/ecology/parasitology journals and a lone journal on genetics. Forty of these journals are Chinese and account for 89.5% of the output in the leading 50 journals. Only one of these 40 journals is indexed in the *SCI* (*Science in China Series C*). Of the remaining 10 international journals nine are indexed in *SCI*.

Table 4
Country of publication of the journals used by Chinese researchers to publish their work

Publication country	No. of journals	No. of papers
China	143	1516
Netherlands	31	108
United States	43	67
United Kingdom	36	65
Taiwan	2	65
Japan	9	13
Germany	11	13
Philippines	2	12
Australia	5	9
Malaysia	1	5
16 other countries	29	37
Unknown	16	37
Non-journal items		88
Total	328	2035

Classification by journal impact factor

The 328 journals in which Chinese fish researchers have published their work have been classified under different impact factor (IF) ranges of journals, as seen from *JCR* 1998 (Table 5). Over 64.9% of journals used are not indexed in *SCI* or have an impact factor of zero. Of the 328 journals used, 143 are Chinese, of which only six are *SCI* journals. About 87.7% of all published papers have appeared in journals of zero impact factor. About 2.3% papers have appeared in journals with an impact factor greater than 2, as against 1.28% by Indian researchers. There are only 5 papers in journals of IF > 8.0 (four in *Nature* and one in the *FASEB Journal*). All the four *Nature* papers are paleontology papers, coming from Geology/paleoanthropology departments of the Nanjing Institute of Paleontology and Geology, Nanjing; the Northwest University, Xi'an; and Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing. The last mentioned institute had only two papers, both in *Nature*.

Table 5
Distribution of Chinese and Indian papers by impact factor range of journals
(based on impact factor data form *JCR* 1998)

Impact factor range	No. of journals		No. of papers	
	China	India	China	India
0.000	213	159	1708	1365
>0.0 ≤ 0.5	20	38	51	222
>0.5 ≤ 1.0	39	56	106	325
>1.0 ≤ 1.5	26	29	37	71
>1.5 ≤ 2.0	15	11	24	22
>2.0 ≤ 2.5	6	10	9	15
>2.5 ≤ 3.0	1	2	1	3
>3.0 ≤ 3.5	2	–	2	–
>3.5 ≤ 4.5	3	–	3	–
>4.5 ≤ 5.5	–	1	–	2
>6.0 ≤ 7.0	1	–	1	–
>7.0	2	2	5	6
Non-journal			88	423
Total	328	308	2035	2454

Classification by institution

Institutes, university departments, fishery colleges and centers publishing papers in fisheries research between 1994 and 1999 are listed in Table 6. Amongst the top 10 publishers are four universities and one fishery college. The most prolific publisher is the Institute of Hydrobiology at Wuhan, followed by the Ocean University of Qingdao and Xiamen University, Xiamen. Only 8 institutes have 50 or more papers in a list of 383 institutions/departments contributing to research and development in fisheries science. A plot of the cumulative number of papers versus number of institutions is given in Figure 2. The Yellow Sea Fisheries Research Institute (74 papers), along with the 2nd and 3rd Institute of Oceanography (11 papers each), Institute of Hydrobiology (240 papers) and the South China Sea Institute of Oceanology (1 paper) are said to be major biotech research centers in China. Unlike what we did with the Indian data, it was not possible to split the institutions under different types such as academic, research institutions, government departments and organizations coming under the private or government sector. This was because it was not possible to source the individual institutes and we did not have a source book or database from which this information could have been obtained. Our list of 383 institutes includes 93 universities and 17 specialized colleges. While amongst the universities, the Ocean University of Qingdao has been a prolific publisher, amongst the specialized colleges the Dalian Fisheries

College figures in the list of 10 leading publishers. From the data it is obvious that numerous institutes and centers have been set up to encourage R&D in fisheries science and technology. On the Indian scenario, academic institutes contributed 61% of published literature, followed by research institutes under different central government agencies. Centers under various ministries, state departments, private and international organizations made up the remaining 13%.

Table 6
Chinese institutions publishing papers in fish science

No.	Institution	No. of papers
1	Institute of Hydrobiology, the Chinese Academy of Sciences, Wuhan	240
2	Ocean University of Qingdao	150
3	Xiamen Univ., Xiamen	82
4	Yellow Sea Fisheries Res. Inst., CAFS, Qingdao	74
5	Shanghai Fisheries University, Shanghai	68
6	Zhongshan University, Guangzhou	60
7	Dalian Fisheries College, Dalian	59
8	Instute of Oceanology, CAS, Qingdao	50
9	Freshwater Fishery Research Center, Chinese Academy of Fisheries Sciences, Wuxi	42
10	South China Sea Institute of Oceanol., CAS, Guangzhou	37
11	Institute of Zoology, Chinese Academy of Sciences, Beijing	30
12	Nanjing University, Nanjing	30
13	Fujian Provincial Institute of Fisheries Research, Xiamen	27
14	Wuhan University, Wuhan	27
15	Huazhong Agric. Univ., Wuhan	25
16	Zhanjing Fisheries College, Zhanjing	22
17	Institute of Biology, Hunan Normal University, Changsha	18
18	Chin. Acad. Fish. Sci., Shanghai	18
19	Nanjing Institute of Geography & Limnology, Chinese Academy of Sciences, Nanjing	18
20	Fish. Res. Inst. Qingdao, Qingdao	17
21	Mar. Fish. Res. Inst., Yantai	16
22	Fisheries College, Jimei University, Xiamen	16
23	Changjiang Fisheries Research Institute, CAFS, Jingzhou	15
24	Inst. Reservoir Fisheries, Ministry Water Conservancy, Wuhan	14
25	Zhejiang Fisheries College, Ningbo	13
	Other 358 institutions	1830
	Unknown	27
	Total	2035

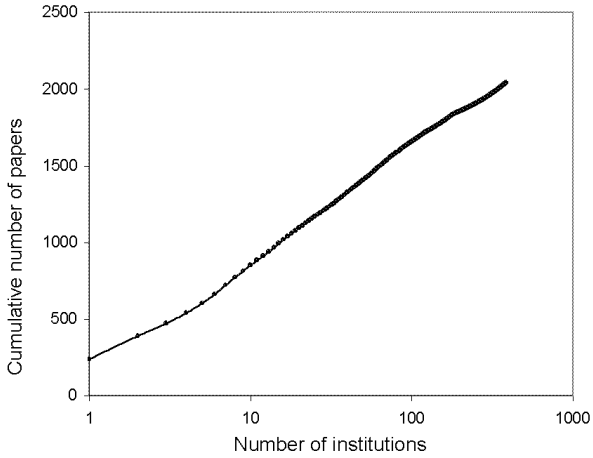

Figure 2. Number of institutions vs. cumulative number of papers

Classification by city and province

Table 7 presents the number of papers published from different cities, towns and provinces in China. Qingdao leads the list in the number of papers produced followed by Wuhan, Beijing and Shanghai. Qingdao is home to the Ocean University of Qingdao, the Yellow Sea Fisheries Research Institute, the Institute of Oceanology, all leading publishers, besides a host of institutes like the Fisheries Research Institute, First Institute of Oceanography, and the Marine Cultivation Research Institute. Wuhan and Beijing also have a cluster of institutes, colleges and universities. Amongst the provinces, Shangdong leads, followed by Hubei, Fujian and Guangdong.

Classification by institution and journal impact factor

The numbers of papers published by selected institutions in journals of different impact factors are given in Table 8. As can be seen, not many papers can be found in the high impact factor (IF) journal category. We find that the IF of most fish and aquaculture journals is low. This combined with the researchers' preference for national journals that are not indexed in *SCI* make it difficult to find papers in high impact journals.

Table 7
Chinese cities and provinces contributing to the world literature of fisheries

City	No. of papers	Province	No. of papers
Qingdao	334	Shandong	450
Wuhan	327	Hubei	356
Beijing	158	Fujian	181
Shanghai	141	Guangdong	175
Xiamen	135	Beijing	166
Guangzhou	129	Shanghai	141
Dalian	79	Jiangsu	118
Nanjing	63	Liaoning	98
Wuxi	50	Zhejiang	98
Hangzhou	44	Hunan	48
102 other cities	541	25 other Provinces	170
Unknown	34	Unknown	34
Total	2035		2035

Table 8
Distribution of papers from different institutions vs. impact factors of journals

Institution	Impact factor range							Total
	0.0	0.0-0.5	0.5-1.0	1.0-1.5	1.5-2.0	2.0-2.5	2.5-3.0	
Institute of Hydrobiology, CAS, Wuhan	223	4	10	2	0	1	0	240
Ocean University of Qingdao	123	3	16	8	0	0	0	150
Xiamen Univ, Xiamen	75	3	3	0	1	0	0	82
Shanghai Fisheries University, Shanghai	64	2	2	0	0	0	0	68
Yellow Sea Fisheries Res. Inst., CAFS, Qingdao	63	0	0	0	0	0	0	63
Zhongshan University, Guangzhou	56	1	1	0	2	0	0	60
Dalian Fisheries College, Dalian	56	1	2	0	0	0	0	59
Inst. Oceanology, Qingdao	47	1	2	0	0	0	0	50
Freshwater Fisherey Research Center, CAFS, Wuxi	42	0	0	0	0	0	0	42
South China Sea Inst. Oceanol., CAS, Guangzhou	37	0	0	0	0	0	0	37
Institute of Zoology, CAS, Beijing	31	0	0	1	0	0	0	32
Nanjing Univ, Nanjing	21	1	5	1	1	0	1	30
Fujian Provincial Institute of Fisheries Research, Xiamen	27	0	0	0	0	0	0	27
Wuhan University, Wuhan	27	0	0	0	0	0	0	27
Huazhong Agric. Univ., Wuhan	24	1	0	0	0	0	0	25
Zhanjing Fisheries College, Zhanjing	22	0	0	0	0	0	0	22
Institute of Biology, Hunan Normal Univ, Changsha	18	0	0	0	0	0	0	18
Total	956	17	41	12	4	1	1	1032

These institutions did not publish papers in journals whose impact factors were greater than 3.0 during 1994-1999.

The Institute of Hydrobiology, CAS, Wuhan, which is the most prolific institute in this study, has published all but 17 of its papers in journals with an IF of zero. University departments and specialized fishery colleges have not done any better. A similar trend was seen in the study on fish research in India. Only leading universities such as the Banaras Hindu University and Madurai Kamaraj University published most of their work in *SCI*-indexed journals. The Ocean University of Qingdao appears to be on a similar level with 27 of 150 papers in *SCI* journals, though all within an IF of less than 2.

On the whole, 188 papers have been published by Chinese researchers in journals having an IF > 0.5 and 21 papers in journals having an IF > 2.0. As was found with Indian researchers, Chinese fish researchers are also not publishing their work in high impact journals.

International collaboration

Arunachalam and *Doss*[9] have shown that China is emerging as a leader in regional collaboration in science and that all G7 countries collaborate more with China than with India. Unfortunately, as the major databases indexing papers in fish science do not provide addresses of all authors of papers indexed, we are unable to find out to what extent Indian and Chinese researchers collaborate with scientists abroad in fish science. *SCI*, *BBCI* and *BTCI* have indexed, among them, 51 papers from China, and these are the only ones out of the total of 2035 papers to have addresses of all authors. Of these 51 only 17 have international coauthors. Sixteen of these papers involve collaboration with one other country besides China. Only one paper is the result of collaboration between three countries (China, USA and France). The countries that collaborate with Chinese researchers include Japan (6 out of 17 papers), USA (3 papers), Germany (2 papers), and Canada (2 papers). There are only nine papers that are the result of collaboration between Chinese institutions. As was the case with India, internationally coauthored papers get published in journals of higher impact. That internationally co-authored papers in general appear in higher impact factor journals than single institution papers is well known.[10]

Conclusion

This work on the research output in fisheries science reveals many parallels in the publication patterns of Indian and Chinese researchers. While China commands a very large share of world fish production and trade, Indian research accounts for a slightly

larger share of world publications than China (5.5% vs. 5%, as seen from the *CAB Abstracts* and *ASFA* databases).[7] Researchers from both countries show a preference to publish in national journals. The tendency to publish in national journals is seen amongst other fields of science too but to a lesser degree.[11] International journals devoted to fisheries research on the whole have a lower impact factor than other life science research journals. Some Indian researchers feel that journal impact factor is an inadequate measure for evaluating fish research. Fish research as practised in India (and China), especially in government laboratories, relates to local problems in this sector. These could be anything from the technological innovations for local use to socio-economic issues such as ensuring a better deal for the lower level fisherfolk. These are subjects that are better published in local newsletters, which the local people are likely to read, rather than in high impact journals indexed in *SCI*, it was felt.[12] University departments and colleges, on the other hand, are under peer pressure and having to compete with other disciplines for funds makes them ensure regular publication at least in lower impact journals. Having found this in our study on India, we find a very similar picture in China too. Several Indian institutions bring out their own journals; we do not know if this is true of Chinese institutions and universities too. Obviously these journals publish many of the papers from the respective institutions. Not having a wider readership means not making an impact. The papers published in reasonable impact journals invariably reported studies in biochemistry/molecular biology of fishes. These papers would naturally be of interest to the wider world.

It is reported that a total of 30,000 research staff members of various kinds work in fishery science research in China. The Chinese Academy of Fisheries under the Ministry of Agriculture serves as the backbone force in China's fishery research. The Academy has eleven subordinate research institutes located in various parts of the country. To popularize fishery science and technology to the producers in the fishery sector, China has attached great importance to fish technology extensions. There are over 5,000 fishery technical extension organizations with 17,000 staff.[1] Five fishery universities and colleges, 40 university agricultural colleges and 17 secondary schools of fisheries and more then 20 agricultural and secondary technical schools offer courses on fisheries.[1] Thus popularizing this branch of science appears to be given a higher priority in China. Amongst aquatic biotechnology achievements, the Chinese Academy of Science's Institute of Development Biology at Beijing has developed transgenic fishes.[13] Indeed the very first claim on production of transgenic fish was made by *Zhu* et al. of the Institute of Hydrobiology, Wuhan. (T. J. Pandian, private communication)

Fisheries and aquaculture being such a flourishing trade it is worthwhile to make grants to small colleges and non-agricultural universities to encourage research and

development in this area. Our study on India reported that the budget outlay for fisheries research represented 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 was granted to fisheries research.[14] We do not have reliable data on the status of funding in China.

One fact stands out in our comparison of fish research in India and China. Although China's research output and possibly its citation impact are less than those of India, China's fish production and export earnings are far higher than those of India. Probably China is better at bridging the gap between knowhow (research) and do-how (technology and creation of employment and wealth). Says Sakthivel, President of the Aquaculture Foundation of India, "China was the first country to realize the capture fisheries had its limitations and culture fisheries could be the only answer for increasing fish production. Their progress during the last two decades was miraculous. It is not research alone that has contributed to its growth. Their development plan and open policy with a large financial outlay and borrowing technology from anywhere in the world have contributed to this rapid progress in fish production. Dietary habit of the Chinese has forced the government to produce more fish through aquaculture" (Personal communication, 25 April 2001.)

This study also brings out the need for databases to follow a standard format, which would facilitate easy use of information derived from different databases. Craig Emerson of *ASFA* (personal communication) had earlier mentioned that many of the differences that exist in descriptor fields are due to differences in technology and the use of different controlled vocabularies or thesauri. It also appears that the process of standardization is laborious and expensive. We had suggested in our earlier paper[7] too that the National Federation of Abstracting and indexing services (NFAIS), Philadelphia, discuss this issue. The Open Archives Initiatives (OAI) are already working towards achieving standard formats and complete interoperabilty; so it is only appropriate that secondary services take a similar initiative.

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