Scientometric Portrait of Ranjit Kumar Mitra

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ABSTRACT

Scientometric analysis of 91 publications by Ranjit Kumar Mitra, during 1965-2001 in domains: Biochemical Genetics (30), Molecular Biology (16), Bioenergetics (12), Plant Biochemistry (11), Biotechnology (10), Methodology (5), Popular Science (4), Gene Accessions (2), and Cytogenetics (1); revealed research team (53 collaborators) , prominent ones with their authorship credits being : C. R. Bhatia (43), T. Gopala Krishna (19), K. N. Suseelan (10), and S. E. Pawar (9). Productivity Coefficient was 0.59 and overall Collaboration Coefficient was 0.95. Publication Concentration was 36, Publication Density was 1.28, and average Bradford Multiplier was 1.5. Major achievements, authorship pattern, channels used, central tendencies on bibliographic characteristics, Synchronous Self-citation Rate, and keyword frequencies in titles of the publications are documented.

KEYWORDS: Scientometrics; Science of science; Individual scientist; Biobibliometrics; Scientific research output; Biochemical genetics; Molecular biology; Bioenergetics; Plant biochemistry; Biotechnology; Methodology; Popular science; Gene accessions; Cytogenetics; Groundnut; Wheat; Rice; *Vigna radiata*; *Vigna mungo*; *Brassica juncea*; *Chenopodium amaranticolor*; *Cajanus cajan*; *Hibiscus cannabinus*; *Hibiscus sabdariffa*; *Perilla*; Induced mutants; Seed proteins; Arachin; Isoenzymes; Nucleic acids; Plant Lectins; Crop productivity

INTRODUCTION

The term 'Scientometrics' was coined in Russia. Scientometrics investigates quantitative aspects of Science, Science of Science, Scientific Communication and Science Policy Studies. Scientometrics deals with creation, flow, dissemination and use of scholarly scientific information. Scientometrics has carved a niche between Science/Scientists and Texts. *Scientometrics*, *Journal of the American Society for Information Science* (JASIS), *Information Processing and Management*, *Research Policy*, and *Science and Public Policy* are the most important journals publishing articles related to scientometrics[1]. The majority of scientometric papers deal with empirical investigation of publications in specific scientific fields and subfields. Such research is often carried out by information specialists and is published in information science journals. Research publications useful to scientists – experts in specific scientific fields, are scattered in many specialised journals. From the scientometric point of view empirical investigations of this kind are of applied character. Their role is pivoted to creation of an empirical basis for scientometrics. Scientometrics is an independent branch of the Science of Science[2-4].

Scientometrics and R&D

Scientometrics is a powerful tool for visualising the cognitive landscape of an R&D field. It is interesting to know:

- how does an R&D field look like in terms of its cognitive, intellectual structure ?
- who and where are the most prominent researchers ?
- how is the field related to its direct 'scientific environment' ? and
- can these structural relations be represented in a 'graphics' ?

Progress with time over a range of years reveal visible dynamic changes in various domains of research and changes can then be used as an evidence of the impact of R&D programmes. These changes observed in the graphics can also be extrapolated to act as a foresight system for near-future R&D developments, as success breeds success and excellence proliferates excellence.

The Basis of Scientometrics

The core of scientometric research performance analysis can be described as follows. Communication-i.e., the exchange of research results- is a crucial aspect of the scientific endeavour. Publications are not the only, but certainly very important, elements in this knowledge exchange process. Work of high quality

provokes reactions of colleague-scientists. They are the international forum, the 'invisible college', by which research results are discussed. In most cases, these colleague-scientists play their role as a member of the invisible college by referring in their own work to earlier work of other scientists. The process of citation is a complex one, and it certainly does not provide an 'ideal' monitor of scientific performance in all respects. This is particularly the case on a statistically low aggregation level, e.g., just one publication. But the application of citation-analysis to the work of a group as a whole over a longer period of time, does yield in many situations a strong indicator of scientific performance, and in particular of scientific community.

Scope of Scientometric Studies

Scientometric study may encompass a 'fuzzy cognitive entity', e.g., a specific but not necessarily 'established' field of research, topics at global level [5-8], international [9-14], national [15-21], university/institutional [22-29], disciplinary [30-32], interdisciplinary [33-34], to the basic unit of scientific activity- an individual scientist [35-63].

MATERIALS

An up-to-date personal chronological author bibliography of publications by Ranjit Kumar Mitra (see Appendix 1 for biographical details) was compiled as a 'real life example'. Reprints/photocopies of all publications were assembled and classification was carried out as per the major thought contents of each publication. Thus, publications by an individual Indian scientist is the focus for present work.

METHODS

Present study uses following definitions [13]: **Outputs** are the routine *products* of research activity, which may include publications, conference papers, data sets, training courses and research degrees, etc. **Outcomes** are the *achievements* of the research activity, whether conceptual (a new theory), practical (a new analytical technique) or physical (a new device or product-although some authors regard this as an output). Research outcomes are potentially available for *use*. **Impact** is a measure of the *influence* or *benefit* (either realised or expected) of the research outcomes, either within the research community itself (through advancement of knowledge), or in the wider society. The economic, social or

environmental benefit to the community may be termed 'non-academic impact'- some authors use the term 'impact' only in this sense. Impact measures the scale, effects or implications of use.

Following well-known parameters were followed. **Score** : One score was given to every occurrence or frequency of the unit under consideration. **Authorship credit** : One score credit is given to each author. **Collaboration coefficient** : The ratio of the number of collaborative publications to the total number of publications. **Total productivity age** : Years between first publication and latest publication. **Fifty percentile age** : The most productive period i.e. the starting years required for fifty percent of all publications. **Productivity coefficient** : The ratio of fifty percentile age to the total productivity age. **Publication concentration** : The ratio in percentage of the number of topmost channels having fifty percent of the publications (when arranged in descending order by number of publications in the channel) to the total number of channels used. **Publication density** : Average frequency of the publications per channel. **Synchronous self citation rate** : The ratio in percentage of self references by the author in an article to the total number of references in the same article.

Bibliographic database on Ranjit Kumar Mitra was sorted field-wise as per requirements of documentation and analysis.

OBJECTIVES

Purpose of exploring the bio-bibliographic database on Ranjit Kumar Mitra was to identify characteristics of the centre of excellence around an individual scientist:

- to note major achievements through content analysis of publications;
- to document domainwise productivity and collaboration coefficients;
- to visualise domainwise growth in the publications and annual collaboration coefficients;
- to depict authorshipwise growth in the publications;
- to tabulate collaboration activity with all collaborators in various domains as authorship credits to each one;
- to represent through bar graphics the authorship credits to each collaborator in the team;
- to identify prominent collaborators;
- to know domainwise channels used;
- to draw Bradford-Zipf bibliograph;

- to calculate domainwise central tendencies for presentations in the texts of publications and referencing behaviour at the end of the publication;
- to find channelwise central tendencies for presentations and references;
- to calculate domainwise and channelwise synchronous self citation rate;
- to compare domainwise central tendencies for number of pages used for the publications; and
- to record frequencywise keywords in the titles of the publications.

RESULTS AND DISCUSSION

Major achievements

Biochemical genetics : Research group of Ranjit Kumar Mitra was one of the pioneers to show genetic basis of isoenzyme polymorphism in plants. He showed that the isoenzyme pattern was organ and species specific in barley. Isoenzyme polymorphism study demonstrated that the enzymes having stringent substrate specificity show least isoenzyme variation in diploid and polyploid wheat species, whereas enzymes with broad substrate specificity reveal considerable variation. It was further shown that the enzyme activity was not proportionate to gene dosage although the duplicate and triplicate genes were expressed in diploid and polyploid wheats. The isoenzyme phenotypes of the amphidiploids were additive and based on this expected isoenzyme phenotypes of B genome donor to wheat were predicted.

R. K. Mitra's group has contributed to the understanding on the factors governing increased accumulation of protein in grains of high protein genotypes of rice and wheat. They showed that :

- the rate and extent of nitrogen uptake and its partition between grains and crop residues is genetically controlled;
- high protein genotypes have increased rate of nitrogen metabolism;
- the rate of RNA and protein synthesis is higher in high protein genotypes ; and
- rate and duration of protein synthesis determine the concentration of protein in grains.

R. K. Mitra has worked extensively on biochemical and genetic characterisation of seed storage proteins of wheat, pigeon pea, mungbean, blackgram and groundnut. His group was first to study the inheritance of charge variation in vicilin of mungbean. One of the important findings was the discovery of a sulphur amino acid rich fraction of globulin protein in pigeon pea and its genetic variation. Sulphur amino acids are limiting in pulses. The extensive work on the storage protein of groundnut revealed

genetic basis of arachin variability across groundnut genotypes. His group has established that at least four genes are responsible for encoding the constituent polypeptide components of arachin. Two of these genes are non-allelic and non-allelism of arachin genes leads to the expression of four polymorphic forms of arachin found in groundnut. R. K. Mitra and his group has made significant contribution in characterisation of several radiation induced mutants and their physiological function in increased productivity and improved quality. These mutant genes have been used in crop improvement at Bhabha Atomic Research Centre.

Plant Molecular Biology : Ranjit Kumar Mitra , in 1965 had shown that the response to plant hormone action was mediated through the synthesis of new species of RNA and proteins and the application of hormone invoked selective derepression of genes that encoded hormone induced proteins. He also showed by equilibrium dialysis that strong auxin like indoleacetic acid binds strongly to thymine residues while weak auxin like phenylacetic acid binds weakly to DNA. This work indicated auxin-receptor mediated selective transcription of genes. In early 1970's, R. K. Mitra's group studied the DNA reassociation kinetics and demonstrated that wheat genome contains about 70-80% of the total DNA as repeated DNA. They found that non-repeated DNA appears to be conservative in composition since it showed least variation among the diploid and polyploid wheat species. It was speculated that the repeated DNA sequence might have a role in speciation as they showed considerable variation. Several genes were cloned which were expressed in response to low temperature in groundnut. One of the low temperature induced genes was characterised as a transcription factor. An apoplastic protein expressed in response to low temperature in groundnut leaves, showed homology with thaumatin-like protein and had functional attribute as cryoprotective protein.

Bioenergetics : Ranjit Kumar Mitra and C. R. Bhatia advanced a new concept in the analysis of agricultural productivity that may implicate new breeding strategies. The consistent negative correlation between protein or oil concentration and grain yield was considered from thermodynamic view point. The results showed that there could be bioenergetic constraints upon improving quantity or quality of protein or oil with simultaneous increase in grain yield unless total energy input in terms of photosynthate is enhanced. Similarly genetic resistance to diseases and pests has a bioenergetic cost.

Biotechnology : C. R. Bhatia and R. K. Mitra have made significant contribution to the area of biosafety of transgenic crop based on plant breeding system, genetics, risk assessment and advanced

arguments for continued research and development of transgenics in order to enhance crop productivity and quality.

Methodology : Ranjit Kumar Mitra developed powerful biochemical methods to study in vivo enzyme activity and amino acid biosynthesis. An intact tissue assay for enzymes that labilize C-H bonds by using tritiated metabolites was developed to monitor the activity of aminotransferases, proline dehydrogenase, etc. Another method has been developed by using deuterium oxide and GC-MS system to study amino acid biogenesis in any organism that can tolerate 20-40% D_2O for a period of a few hours to few days. This method gives an opportunity to study biosynthesis of all the amino acids at a time.

Plant Biochemistry : Ranjit Kumar Mitra and his group has made contributions to the understanding on the mechanism of action of plant growth substances, novel plant lectins, stress induced proteins, and biosynthesis, processing and targeting of seed storage proteins.

Domain-wise contributions

Domainwise cumulative publication productivity of Ranjit Kumar Mitra is depicted in Figure 1. He had contributed 30 publications in Biochemical genetics, 16 publications in Molecular biology, 12 publications in Bioenergetics, 11 publications in Plant Biochemistry, and 10 publications in Biotechnology (Table 1). He was instrumental in developing new sensitive methods of biochemical analysis, which resulted in five publications to his credit. Simultaneously, he had devoted himself to popularisation of science and published four articles also. He has contributed in the area of molecular cloning of stress-induced genes in groundnut. The sequences of these genes have been deposited in gene bank as new accessions. In collaboration with the cytogeneticists he has initiated work on the rapid assay of toxicity of heavy metals like uranium.

Ranjit Kumar Mitra had total productivity age of 37 years and fifty percentile age of 22 years. Thus productivity coefficient was 0.59.

All of the publications of Ranjit Kumar Mitra were multiauthored in Biochemical genetics, Biotechnology, Popular science, Gene accessions, and Cytogenetics, with highest collaboration coefficient (one). Multiple-authorship is widely used as an indicator to measure research collaboration.

The underlying assumption is that the authors involved carried out the research leading to the paper in collaboration. Not all collaborations, however, result in publications and, conversely, a joint paper does not always mean that the results presented in the paper are based on research collaboration [64].

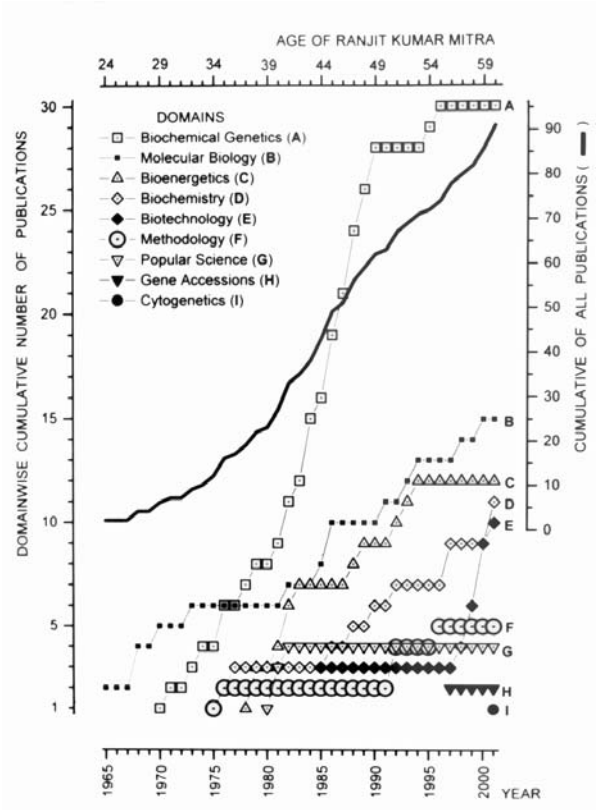

Fig. 1: Domainwise growth in publications of Ranjit Kumar Mitra

Authorship pattern

Ranjit Kumar Mitra had two single authored papers in Molecular Biology and one each in Bioenergetics, Plant Biochemistry, and Methodology. Maximum publications (10) in a single domain Molecular Biology were two authored (Table 1). He had number of following authored publications during 1965-2001: Single Authored (5), Two Authored (34), Three Authored (30), Four Authored (13), Five Authored (7), and Seven Authored and Eight Authored, one each. Total publications were 91 out of which multiauthored publications were 86. Collaboration coefficient was 1 throughout, except in the years 1982 and 1985 with 0.8 each, and 1992 and 1994 with 0.5 each. Cumulative growth in the number of publications as per authorship status is depicted in Figure 2.

Table 1: Domainwise authorship pattern in the publications of Ranjit Kumar Mitra during 1965-2001

Domain	Frequency of following authored (a) publications (p)							Total p	Rank	% p	CC	Author-ships (a.p)	Rank	% a.p
	One	Two	Three	Four	Five	Seven	Eight							
Biochemical Genetics	0	9	9	8	2	1	1	30	I	32.97	1.00	102	I	38.49
Molecular Biology	2	10	1	3	0	0	0	16	II	17.58	0.88	37	II	13.96
Bioenergetics	1	8	3	0	0	0	0	12	III	13.19	0.92	26	V	9.81
Plant Biochemistry	1	2	7	0	1	0	0	11	IV	12.09	0.91	31	IV	11.70
Biotechnology	0	2	4	1	3	0	0	10	V	10.99	1.00	35	III	13.21
Methodology	1	0	3	1	0	0	0	5	VI	5.49	0.80	14	VI	5.28
Popular Science	0	1	3	0	0	0	0	4	VII	4.40	1.00	11	VII	4.15
Gene Accessions	0	2	0	0	0	0	0	2	VIII	2.20	1.00	4	IX	1.51
Cytogenetics	0	0	0	0	1	0	0	1	IX	1.10	1.00	5	VIII	1.89
Total p	5	34	30	13	7	1	1	91		100.00	0.94	265		100.00
Authorships (a.p)	5	68	90	52	35	7	8	265						
Rank (a.p)	VII	II	I	III	IV	VI	V							
% a.p	1.89	25.66	33.96	19.62	13.21	2.64	3.02	100	**CC**= Collaboration Coefficient					

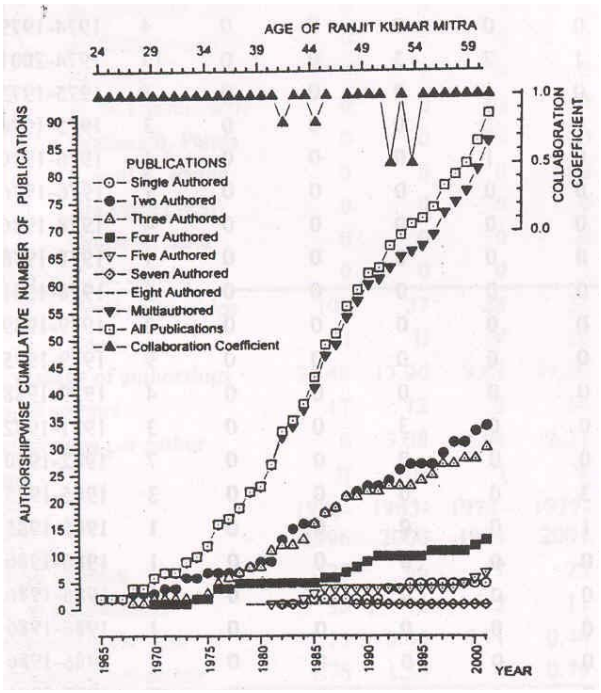

Fig. 2: Authorshipwise growth in publications of Ranjit Kumar Mitra

Collaborators

Ranjit Kumar Mitra team consisted of total 53 collaborators out of which 9 were woman scientists (WS) documented in the byline of his publications. Maximum collaborative publications (19) in a single domain Biochemical Genetics were with C. R. Bhatia (Table 2). Prominent collaborators (Figure 3) with number of collaborative publications were: C. R. Bhatia (43), T. Gopala Krishna (19), K.N. Suseelan (10), and S. E. Pawar (9). C. R. Bhatia had collaborated with him in all domains except in Methodology, Gene Accessions, and Cytogenetics (Table 3).

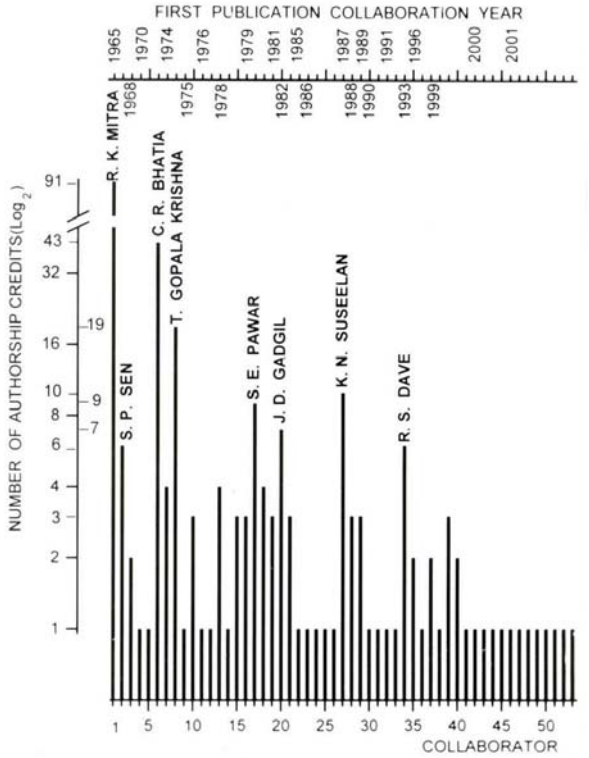

Fig. 3: Authorship credits to collaborators with R. K. Mitra

Thirty collaborators had only one publications in collaboration with Ranjit Kumar Mitra. Four collaborators had two publications in collaboration with him. Three collaborators had four publications each and two collaborators had six publications each in collaboration with him. Productivity

approximately follows 80/20 rule as 11 authors (which is 20.75 percent of the total authors i.e. 53) have 203 authorship credits (which is 76.6 percent of the total authorships i.e. 265).

Collaborators with first position in the byline of the number of publications with Ranjit Kumar Mitra were; **Biochemical Genetics**: R. K. Mitra (9), T. G. Krishna (5), J. D. Gadgil (4), C. R. Bhatia (3), S. G. Bhagwat (2), K. N. Suseelan (2), R. G. Thakare (2), P. Narahari (1), S. E. Pawar (1), and M. K. Sinha (1); **Molecular Biology**: R. K. Mitra (10), R. S. Dave (4), S. B. Allagikar (1), and A. Bhagwat (1); **Bioenergetics**: C. R. Bhatia (6), R. K. Mitra (5), and R. Rabson (1); **Plant Biochemistry**: K. N. Suseelan (4), R. K. Mitra (4), T. Gopala Krishna (1), M. S. Rajadhyaksha (1), and J. E. Varner (1); **Biotechnology**: C. R. Bhatia (3), Susan Eapan (2), S. B. Ghosh (1), V. H. Mathew (1), R. K. Mitra (1), G. B. Sunil Kumar (1), and K. K. Ussuf (1); **Methodology**: R. K. Mitra (3), Jin Ka Bang (1), and T. G. Krishna (1); **Popular Science**: I. Narayana Rao (3), and C. R. Bhatia (1); **Gene Accessions**: R. S. Dave (2); and **Cytogenetics**: Brahma B. Panda (1).

International Collaboration

Ranjit Kumar Mitra and his group at Bhabha Atomic Research Centre was involved in collaborative work on the use of radiation and radioisotope in agriculture sponsored by the International Atomic Energy Agency (IAEA). He was responsible for implementing IAEA's programmes in the Member States of the East and South Asia. The scientists from Syria, South Korea, Vietnam, and Sudan worked with him under the IAEA's training programmes. He had very useful collaborative programme under the IAEA post-doctoral fellowship with the well known American biochemist, J. Varner at Washington University, St. Louis.

Impact

R. K. Mitra's group has made important contribution to Indian agriculture and biotechnology. The understanding of the mutant gene function has been one of the important attributes of research of his group, which has resulted into the development of several commercially successful crop varieties at Bhabha Atomic Research Centre. R. K. Mitra provided most stimulating leadership in the areas like crop productivity and plant biotechnology in BARC.

Table 2: Authorship credits to collaborators with Ranjit Kumar Mitra during 1965-2001

Sl. No.	Researcher	Domainwise authorship credits									Total	FPY-LPY
		A	B	C	D	E	F	G	H	I		
1	Ranjit Kumar Mitra	30	16	12	11	10	5	4	2	1	91	1965-2001
2	S. P. Sen	0	5	0	1	0	0	0	0	0	6	1965-1970
3	S. N. Seal	0	2	0	0	0	0	0	0	0	2	1968-1970
4	J. Das	0	1	0	0	0	0	0	0	0	1	1970-1970
5	D. R. Jagannath	1	0	0	0	0	0	0	0	0	1	1970-1970
6	C. R. Bhatia	19	3	11	5	4	0	1	0	0	43	1970-1998
7	P. Narahari	4	0	0	0	0	0	0	0	0	4	1974-1979
8	T. Gopala Krishna	11	1	0	1	1	2	3	0	0	19	1974-2001
9	R. D. Gross	0	0	0	0	0	1	0	0	0	1	1975-1975
10	J. E. Varner	0	0	0	1	0	2	0	0	0	3	1975-1976
11	J. Burton (**WS**)	0	0	0	0	0	1	0	0	0	1	1976-1976
12	D. Flint	0	0	0	1	0	0	0	0	0	1	1976-1976
13	S. G. Bhagwat	4	0	0	0	0	0	0	0	0	4	1978-1986
14	R. M. Desai	1	0	0	0	0	0	0	0	0	1	1978-1978
15	R. Rabson	0	0	3	0	0	0	0	0	0	3	1978-1981
16	D. C. Joshua	3	0	0	0	0	0	0	0	0	3	1979-1989
17	S. E. Pawar	7	1	0	1	0	0	0	0	0	9	1979-1995
18	R. G. Thakare	4	0	0	0	0	0	0	0	0	4	1979-1988
19	I. Narayana Rao	0	0	0	0	0	0	3	0	0	3	1981-1982
20	J. D. Gadgil	6	0	0	1	0	0	0	0	0	7	1982-1990
21	Helena Mathews (**WS**)	0	0	0	0	3	0	0	0	0	3	1985-1985
22	P. S. Rao	0	0	0	0	1	0	0	0	0	1	1985-1985
23	M. S. Rajadhyaksha (**WS**)	0	0	0	1	0	0	0	0	0	1	1986-1986
24	D. S. Joshi	0	0	0	1	0	0	0	0	0	1	1986-1986
25	G. P. Phondke	0	0	0	1	0	0	0	0	0	1	1986-1986
26	K. Sundaram	0	0	0	1	0	0	0	0	0	1	1986-1986
27	K. N. Suseelan	3	0	0	4	2	1	0	0	0	10	1987-2001
28	M. K. Sinha	3	0	0	0	0	0	0	0	0	3	1988-1989
29	M. K. Guha Roy	3	0	0	0	0	0	0	0	0	3	1989-1989
30	P. S. Chauhan	1	0	0	0	0	0	0	0	0	1	1990-1990
31	D. S. Pradhan	1	0	0	0	0	0	0	0	0	1	1990-1990
32	S. B. Allagikar	0	1	0	0	0	0	0	0	0	1	1991-1991
33	N. K. Notani	0	1	0	0	0	0	0	0	0	1	1991-1991
34	R. S. Dave	0	4	0	0	0	0	0	2	0	6	1993-2000
35	Jin Ki Bang	1	0	0	0	0	1	0	0	0	2	1996-1996
36	U. J. Vaidya	0	0	0	0	0	1	0	0	0	1	1996-1996
37	S. A. Kotwal (**WS**)	0	0	0	0	2	0	0	0	0	2	1999-2000
38	S. B. Ghosh	0	0	0	0	1	0	0	0	0	1	1999-1999
39	Susan Eapen (**WS**)	0	0	0	0	3	0	0	0	0	3	1999-2000
40	K. K. Ussuf	0	0	0	0	2	0	0	0	0	2	1999-2001

(**A**= Biochemical Genetics, **B**=Molecular Biology, **C**=Bioenergetics, **D**= Plant Biochemistry, **E**=Biotechnology, **F**= Methodology, **G**=Popular Science, **H**= Gene Accessions, **I**=Cytogenetics, **FPY**=First Paper Year, **LPY**=Last Paper Year, **WS**=Woman Scientist)

Contd…

Table 2 continued

Sl. No.	Researcher	Domainwise authorship credits A	B	C	D	E	F	G	H	I	Total	FPY-LPY
41	S. M. Paul Khurana	0	0	0	0	1	0	0	0	0	1	1999-1999
42	G. B. Sunil Kumar	0	0	0	0	1	0	0	0	0	1	2000-2000
43	T. R. Ganapathy	0	0	0	0	1	0	0	0	0	1	2000-2000
44	V. A. Bapat	0	0	0	0	1	0	0	0	0	1	2000-2000
45	S. Tivarekar (**WS**)	0	0	0	0	1	0	0	0	0	1	2000-2000
46	A. Bhagwat (**WS**)	0	1	0	0	0	0	0	0	0	1	2001-2001
47	N. Jawali	0	1	0	0	0	0	0	0	0	1	2001-2001
48	N. N. Laxmi (**WS**)	0	0	0	0	1	0	0	0	0	1	2001-2001
49	Brahma B. Panda	0	0	0	0	0	0	0	0	1	1	2001-2001
50	Kamal K. Panda	0	0	0	0	0	0	0	0	1	1	2001-2001
51	Jita Patra (**WS**)	0	0	0	0	0	0	0	0	1	1	2001-2001
52	Gopal K. Sahu	0	0	0	0	0	0	0	0	1	1	2001-2001
53	K. B. Sainis	0	0	0	1	0	0	0	0	0	1	2001-2001
1-53	Total authorships	102	37	26	31	35	14	11	4	5	265	1965-2001
Rank		I	II	V	IV	III	VI	VII	IX	VIII		
Percentage authorships		38.49	13.96	9.81	11.70	13.21	5.28	4.15	1.51	1.89	100	
No. of authors		17	12	3	14	16	8	4	2	5	53	
Auhtorships per author		6	3.08	8.66	2.21	2.19	1.75	2.75	2.0	1	5	
Rank		II	III	I	V	VI	VIII	IV	VII	IX		
FPY-LPY		1970-1996	1965-2000	1978-1994	1977-2001	1985-2001	1975-1996	1980-1982	1997-1997	2001-2001	1965-2001	
Period in years		27	36	17	25	17	22	3	1	1	37	
No. of publications		30	16	12	11	10	5	4	2	1	91	
Publications per year		1.11	0.44	0.71	0.44	0.59	0.23	1.33	2	1	2.46	
Publications per author		1.76	1.33	4	0.79	0.63	0.63	1	1	0.2	1.72	

(**A**=Biochemical Genetics, **B**=Molecular Biology, **C**=Bioenergetics, **D**=Plant Biochemistry, **E**=Biotechnology, **F**=Methodology, **G**=Popular Science, **H**=Gene Accessions, **I**=Cytogenetics, **FPY**=First Paper Year, **LPY**=Last Paper Year, **WS**=Woman Scientist

Table 3 : Publication productivity of Ranjit Kumar Mitra and his collaborators in various domains during 1965-2001

Number of collaborative publications(p)	Domainwise authorship credits A	B	C	D	E	F	G	H	I	Number of authors (n)	Total author-ships (p.n)	Prominent collaborators
One	4	5	0	6	8	3	0	0	4	30	30	
Two	1	2	0	0	4	1	0	0	0	4	8	
Three	9	0	3	1	6	2	3	0	0	8	24	
Four	12	0	0	0	0	0	0	0	0	3	12	
Six	0	9	0	1	0	0	0	2	0	2	12	S. P. Sen, R. S. Dave
Seven	6	0	0	1	0	0	0	0	0	1	7	J. D. Gadgil
Nine	7	1	0	1	0	0	0	0	0	1	9	S. E. Pawar
Ten	3	0	0	4	2	1	0	0	0	1	10	K. N. Suseelan
Nineteen	11	1	0	1	1	2	3	0	0	1	19	T. Gopala Krishna
Forty three	19	3	11	5	4	0	1	0	0	1	43	Chittranjan R. Bhatia
Ninety one	30	16	12	11	10	5	4	2	1	1	91	Ranjit Kumar Mitra
Total	102	37	26	31	35	14	11	4	5	53	265	

(**A**=Biochemical Genetics, **B**=Molecular Biology, **C**=Bioenergetics, **D**=Plant Biochemistry, **E**=Biotechnology, **F**=Methodology, **G**=Popular Science, **H**=Gene Accessions, **I**=Cytogenetics)

Dissemination of Research Results

Total 91 publications of Ranjit Kumar Mitra were scattered in 71 channels of communication (Table 4 & 5). Topmost 26 channels had 50 percent publications. Thus, publication concentration was 36.11, publication density was 1.28, and average Bradford multiplier was 1.5 indicating very high scattering. Bradford-Zipf bibliograph is plotted in Figure 4. His number of publications in various channels of communications were: International Journals (26); International Symposia (15); Indian Journals (14); National Symposia/Meetings/Workshops (14); Chapters in Books (10); Book (Festschrift) edited (1); Newsletters (2); Abstracts published in International Conferences (3); DNA/Protein Sequences (2); and Popular Science (4).

Table 4: Channels of communication used by Ranjit Kumar Mitra for at least two publications during 1965-2001

Sl. No.	Channel	FPY – LPY	Domainwise number of publications									Total	Cumula-tive Total
			A	B	C	D	E	F	G	H	I		
1	*Science Today*	1980-1982	0	0	0	0	0	0	4	0	0	4	4
2	*Phytochemistry*	1970-1998	2	1	0	0	0	0	0	0	0	3	7
3	*Theoretical and Applied Genetics*	1976-1986	2	0	1	0	0	0	0	0	0	3	10
4	*Analytical Biochemistry*	1975-1976	0	0	0	0	0	2	0	0	0	2	12
5	*Cereal Grain Protein Improvement*, IAEA	1984-1984	2	0	0	0	0	0	0	0	0	2	14
6	*Euphytica*	1982-1988	1	0	1	0	0	0	0	0	0	2	16
7	*Global Sustainable Biotechnology Congress 2000 AD*	2000-2000	0	0	0	0	2	0	0	0	0	2	18
8	*Indian Journal of Agricultural Sciences*	1983-1986	2	0	0	0	0	0	0	0	0	2	20
9	*Indian Journal of Biochemistry and Biophysics*	2001-2001	0	0	0	2	0	0	0	0	0	2	22
10	*Jute Development Journal*	1988-1989	2	0	0	0	0	0	0	0	0	2	24
11	*Korean Journal of Breeding*	1996-1996	1	0	0	0	0	1	0	0	0	2	26
12	Mungbean (Book)	1988-1988	1	0	0	1	0	0	0	0	0	2	28
13	*Proc. Intern. Symp. on Plant Growth Substances*	1968-1968	0	2	0	0	0	0	0	0	0	2	30
14	Genetical Research (Festschrift)	1990-1990	2	0	0	0	0	0	0	0	0	2	32
15	*Synopses of Lectures and Experimental protocols. FAO/IAEA Regional (RCA) Training Course on Advanced Mutation Breeding of Tropical Crop Plants*	1992-1992	0	0	0	0	0	2	0	0	0	2	34
16	*Proc. Indian National Science Academy*	1993-1998	0	0	1	0	1	0	0	0	0	2	36
1-16	Total	1965-2001	15	3	3	3	3	5	4	0	0	36	
17-71	Single paper channels	1965-2001	15	13	9	8	7	0	0	2	1	55	91
1-71	All publications	1965-2001	30	16	12	11	10	5	4	2	1	91	

(**FPY**=First Paper Year, **LPY**=Last Paper Year, **A**=Biochemical Genetics, **B**=Molecular Biology, **C**=Bioenergetics, **D**=Plant Biochemistry, **E**=Biotechnology, **F**=Methodology, **G**=Popular Science, **H**= Gene Accessions, **I**=Cytogenetics)

Table 5: Channels having only one publication each by Ranjit Kumar Mitra during 1965-2001

Biochemical Genetics (15): *Genetical Research*, Cambridge (1971); *Nuclear Techniques for Seed Protein Improvement*, IAEA (1973); *Proc. DAE Symposium on Use of Radiation and Radioisotopes in Studies of Plant Productivity* (1974); *Evaluation of Seed Protein Alterations by Mutation Breeding* (STI/PUB/426), IAEA (1976); *Proc. 5th International Wheat Genetics Symp*., New Delhi (1978); *Seed Protein Improvement in Cereals and Grain Legumes* (IAEA SM-230/3), IAEA (1979); *Symp. on Induced Mutations-Tool in Crop Plant Breeding* (IAEA-SM-251/5), IAEA (1981); *Induced Mutants for Cereal Grain Protein Improvement* (IAEA-TECDOC-259), IAEA (1982); *Mutation Breeding Newsletter* (1982); *Pulse Production: Constraints and Opportunity* (1984); *First Congress of Plant Molecular Biology* (1985); *Gene Structure and Function in Higher Plants* (1986); *Biochemical Genetics* (1987); *Seed Science and Technology* (1989); and *Proc. Golden Jubilee Symp. Genetic Research and Education, Current Trends and Next 50 Years*, Indian Society of Genetics and Plant Breeding (1985).**Molecular Biology** (13): *Nature* (1965); *Plant & Cell Physiology* (1965); *Proc. DAE Symposium on Macromolecules in Storage and Transfer of Biological Information* (1970); *Heredity* (1973); *DAE Workshop on Molecular Biology for Crop Improvement* (1982); *DAE Workshop on Plant Molecular Biology* (1985); DNA Systematics Plants, USA (1986); *Indian Journal of Genetics and Plant Breeding* (1986); *Journal of Genetics* (1991); *DAE Symposium on Photosynthesis and Molecular Biology* (1993); *International Congress of Biochemistry and Molecular Biology* (1994); *International Arachis Newsletter* (2000); and *Plant Cell Reports* (2001). **Bioenergetics** (9): *Seed Protein Improvement by Nuclear Techniques*, IAEA (1978); *Cereal Chemistry* (1979); *Agricultural Systems* (1981); Genetics and Wheat Improvement (1982); *Biomass* (1983); *Proc. of International Biotechnology Workshop*, ICRISAT (1988); Nitrogen in Higher Plants (1989); Breeding Oilseed Brassicas (1992); and *DAE Symp. on Stress and Adaptive Response in Biological Systems* (1994). **Plant Biochemistry** (8): Genetic Improvement of Seed Proteins (1976); *The Plant Biochemical Journal* (1975); *National Academy of Sciences*, USA (1976); *Qualitas Plantarum*, (1977); *Proc. International Congress of Plant Physiology* (1990); *Journal of Biosciences* (1997); *Plant Foods for Human Nutrition* (1997); and *Cancer Biochemistry and Biophysics* (1986). **Biotechnology** (7): *Plant Science* (1985); Genetic Manipulation for Crop Improvement (1985); *Proc. DAE Symposium on Newer Approaches to Biological Applications* (1985); IANCAS Bulletin (1999); *Global Conference on Potato*, New Delhi (1999); *Proc. DAE-BRNS Symposium on the Use of Nuclear and Molecular Techniques in Crop Improvement* (2000); and *Current Science* (2001). **Gene Accessions** (2): *Acc#P80926 Swiss PROT* (1997); *and ACC#284819 EMBL/DDJB/GENBANK* (1997). **Cytogenetics** (1): *Indian Journal of Experimental Biology* (2001).

Central Tendencies on Bibliographic Characteristics

Central tendencies were calculated based on observed data for number of publications. A statistical average (mean) of data values is calculated by dividing the sum of all values by the number of values. The mean value typifies a set of numbers. The mode is the most frequently occurring number of a set of numbers. The median is determined by ranking the data values in ascending or descending order and then selecting the middle value: specifically, the quantity or value of that item is so positioned in the series, that there are equal number of items of greater magnitude and lesser magnitude. The median is useful when extreme values in the data distort the mean or the average. Standard Deviation (SD) is calculated as under root of the average of the squared deviations from the mean.

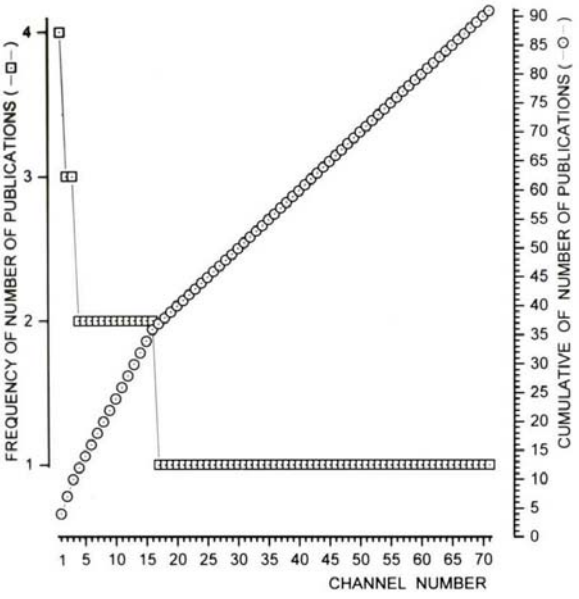

Fig. 4: Bradford-Zipf bibliograph of R. K. Mitra

Domainwise central tendencies for presentations (Tables, Graphics, and Photographs), and referencing (all citations and self citations) are provided in self explanatory Table 6. Similarly, channelwise (International Journals, International Symposia, Indian Journals, National Symposia, and Chapters in Books) central tendencies are documented in Table 7. Synchronous self-citation rates in various channels of communication and domains are provided in Table 8. Central tendencies for use of space (number of pages) per publication are recorded in Table 9.

Table 6 : Domainwise central tendencies for presentation and referencing style for publication of Ranjit Kumar Mitra during 1965-2001

Characteristics	A	B	C	D	E	F
Tables						
Mean	3.13	3.70	4.82	2.60	5.00	1.80
SD	2.11	2.71	2.32	2.84	2.83	1.48
Mode	2.00	3.00	4.00	2.00	N/A	2.00
Median	2.50	3.00	5.00	2.00	5.00	2.00
Graphs						
Mean	2.21	1.70	0.18	2.80	2.50	1.00
SD	2.73	1.89	0.60	3.46	2.12	1.00
Mode	0.00	0.00	0.00	0.00	N/A	2.00
Median	0.50	1.00	0.00	0.50	2.50	1.00
Photographs						
Mean	1.58	0.90	0.00	2.60	0.50	0.60
SD	2.48	1.91	0.00	3.84	0.71	0.55
Mode	0.00	0.00	0.00	0.00	N/A	1.00
Median	0.00	0.00	0.00	0.50	0.50	1.00
All References						
Mean	14.00	35.00	22.18	22.40	164.00	10.40
SD	7.22	26.67	8.75	11.72	108.89	4.77
Mode	14.00	12.00	26.00	20.00	N/A	N/A
Median	14.00	30.50	23.00	20.00	164.00	11.00
Self Citations only						
Mean	1.46	0.50	2.09	0.70	0.00	0.40
SD	1.41	0.97	1.97	0.95	0.00	0.89
Mode	1.00	0.00	2.00	0.00	0.00	0.00
Median	1.00	0.00	2.00	0.00	0.00	0.00

(**A**= Biochemical Genetics, **B**=Molecular Biology, **C**=Bioenergetics, **D**= Plant Biochemistry, **E**= Biotechnology, **F**= Methodology, N/A=Not Available, SD=Standard Deviation)

Table 7 : Channelwise central tendencies for presentation and referencing style for publication of R. K. Mitra during 1965-2001

Characteristics	Range	Mean	SD	Mode	Median
International Journals					
No. of Tables	0-7	2.20	1.53	2	2
No. of Graphs	0-6	1.72	2.21	0	1
No. of Photographs	0-10	1.88	2.74	0	1
Total No. of References	5-39	18.36	8.03	13	17
Total No. of Self-Citations	0-2	0.64	0.81	0	0
International Symposia					
No. of Tables	1-8	5.08	2.35	6	6
No. of Graphs	0-8	2.42	2.91	0	1
No. of Photographs	0-9	0.92	2.61	0	0
Total No. of References	2-41	16.67	10.12	14	15
Total No. of Self-Citations	0-6	1.67	1.97	0	1
Indian Journals					
No. of Tables	2-9	5.13	2.42	3	5
No. of Graphs	0-8	1.50	2.73	0	0.5
No. of Photographs	0-5	1.38	2.00	0	0
Total No. of References	11-241	55.63	77.15	11	30.5
Total No. of Self-Citations	0-3	1.13	1.25	0	1
National Symposia					
No. of Tables	0-4	1.88	1.81	0	2
No. of Graphs	0-2	0.38	0.74	0	0
No. of Photographs	0-7	0.88	2.47	0	0
Total No. of References	2-49	17.13	16.40	9	9.5
Total No. of Self-Citations	0-5	1.13	1.73	0	0.5
Chapters in Books					
No. of Tables	0-9	4.22	2.77	3	5
No. of Graphs	0-7	2.56	3.13	0	0
No. of Photographs	0-1	0.11	0.33	0	0
Total No. of References	5-92	32.56	32.88	24	19
Total No. of Self-Citations	0-5	2.00	1.66	3	2

(SD= Standard Deviation)

Keywords in Titles

Most prolific keywords in the titles of the publications of Ranjit Kumar Mitra were: Character/ization/istics, Groundnut, Bioenergetic/s/cost, Plant/s, Seed/Storage/Protein/s, Wheat, etc. (Table 10). Keyword frequencies (2-3) are given in Table 11 and single frequency keywords are given in Table 12.

Table 8 : Domainwise and channelwise Synchronous Self-Citation Rates in publications of R. K. Mitra during 1965-2001

Channel	Domainwise Synchronous Self-Citation Rate (SSCR)						
	Biochemical Genetics	Molecular Biology	Bioenergetics	Plant Biochemistry	Biotechnology	Methodology	Channel SSCR
International Journals	4.91	1.08	5.49	4.55	0.00	0.00	3.49
International Symposia	12.50	-	8.96	5.41	-	-	10.50
International Newsletters	0.00	40.00	-	-	-	-	28.57
Indian Journals	9.10	4.05	7.69	2.44	0.00	-	2.02
National Symposia	24.00	1.10	-	0.00	-	16.67	6.57
Chapters in Books	23.33	0.00	16.67	4.17	0.00	-	6.14

Table 9: Domainwise central tendencies for number of pages used per publication of R. K. Mitra during 1965-2001

Domain	Mean	SD	Mode	Median
Biochemical Genetics	7.41	3.34	7.00	7.00
Molecular Biology	9.73	7.04	2.00	8.00
Bioenergetics	8.25	3.62	9.00	8.00
Plant Biochemistry	12.33	4.50	8.00	13.00
Biotechnology	10.56	10.10	6.00	6.00
Methodology	8.80	4.90	5.00	8.00
Popular Science	2.50	0.58	3.00	2.50

(SD= Standard Deviation)

Table 10 : Most prolific keywords in the titles of the publications of Ranjit Kumar Mitra during 1965-2001

Keyword	Frequency
Character/ization/istics	12
Groundnut	11
Bioenergetic/s/cost	10
Plant/s	9
Seed/Storage/Protein/s	8
Wheat	7
Arachis hypogaea	6
Induced	6
Gene/s	5
Arachin	4
Derived/Derivatives	4
DNA/Sequence	4
Isozymes	4
Low temperature	4
Mungbean	4
Nucleic acid/s	4
Protein/Bio/Synthesis	4
Repeat/ed	4
Variation	4
Vigna radiata	4

Table 11 : Keyword frequencies (2 –3) in the titles of the publications of Ranjit Kumar Mitra during 1965-2001

Frequency 3 : Breeding; Cold-/induced/shock; Crop plants; Electrophoretic pattern; Evolution; Grain protein; High grain protein; Limit/ations/ing; Mutant/s; Mutation/s; Protein; Purification; Ribosomal/RNA; Yield/s.
Frequency 2 : Apoplastic; *Brassica juncea*; C-DNA clone; Cells; Chemical composition; *Chenopodium amaranticolor*; Chenopodium leaf hemagglutinin (CLH); Cultures; *Cajanus cajan*; Detect/ions/ing; Energy constraints; Evaluation; Expression; Gene expression; Genetic/s; Genetic improvement; Genetic varia/tion/bility; Hairy root/s; *Hibiscus cannabinus*; *Hibiscus sabdariffa*; High protein; Improvement; Indian; Inheritance; Insect; Isolate/d; Nitrogen; *Perilla*; Plant growth substances; Polyploidy; Resistan/ce/t; Rice; Source/s; Spring wheat/s; Stress; Synthesis; Two major lectins; Transform/ed/ation; Transgenic; Uptake; Uranium; Vectors; *Vigna mungo*.

Table 12 : Keywords used only once in the titles of the publications of Ranjit Kumar Mitra during 1965-2001

Agrobacterium tumefaciens; Alcohol dehydrogenase; Allium assay system; Amino acid composition; Amino acid metabolism; Amino acid sequence; Amphidiploid; Analogous enzymes; Analysis; Auxin; Biochemical; Biological activities; Biosafety; Biotechnologists; Biotic; Blackgram; Brassicas; Cereal productivity; C-H bonds; Chemical analysis; *Chenopodium*; *Chorchorus capsularis*; *Chorchorus olitorius*; Chromosomal location; Coat protein gene; Components; Concentration; Crop productivity; Cytogenetics; Determination; Deuterium oxide; Diploid wheat; Disease resistance; Dot Immunobinding Assay(DIBA); Durum wheat; Edible vaccines; ELISA; Energy inputs; Enzymes; Factor; Flag leaf senescence; Flowering; Genetic characterisation; Genetical Research; Genome donors; Genotoxicity; Genotypes; Grain legumes; Growth substances; Heat shock proteins; Hemagglutinin; Heterogeneity; High protein genotypes; High yielding varieties (HYV); Hordeum; Host proteins; Human; India; Indol-3-acetic acid; Induction; Insecticidal protein; Intact tissue assay; Intervarietal differences; Ions; Jute; Kernals; Labilize; Lactic dehydrogenase; Language; Leaves; Linolenic acid; Lymphocytes; Maize; Metabolic functions; Molecular cloning; Mice (normal/leukemic); Nitrogen assimilation; Non-repeated; Nopaline dehydrogenase; Nucleotide sequences; Oil content; Oil seed crops; Organ growth; Origin and evolution; Pathogen; Pathogen related (PR) proteins; Physiological components; Phytoextraction; Phytomass production; Phytotoxicity; Polyacrylamide gel electrophoresis; Polymorphism; Polypeptides; Polyploid wheat; Potato virus Y; Protein accumulation; Protein metabolism; Protein production; Protein variability; Protease inhibitors; Proximate; Pulse crops; Plant genetic engineering; Plant sterols, Steroids and triterpenoids; Qualitative; Quality; Quantitative; Raffinose; Regeneration; Rhizofiltration; Rice grains; Scientific; Seed globulins; Semi-dwarf; Shoots; Somatic instability; Species variation; Spot test; Stachyose; Stimulation; Strain; Subsidies; Sucrose; Technique; Thaumatin-like cryoprotective 33 kDa; Tool; Traditional agroecosystems; *Triticinae*; Trombay; Tropical legumes; Uranyl nitrate; Utilisation; Vaccines; Variant; Vicilin; *Vigna*; Viruses; Water.

CONCLUSION

Study on lifetime achievements of an individual scientist serves the purpose of factual documentation of Scientometric productivity outputs in terms of publications. It may nurture documentation culture. Projection of a role model scientist may encourage present younger generation to opt for scientific career. Pivotal work of an individual scientist and the team efforts recorded in one place may generate belongingness to the group among authors associated with the scientist for pride in performance as an indicator of a successful research group recognition.

REFERENCES

1 Egghe Leo, Rousseau Ronald. Conferences, journals, a society: scientometrics and informetrics come of age. *JISSI : The International Journal of Scientometrics and Informetrics* 1995; 1(1): 7-13

2 Haitun S D. Book Review. Granovsky Yu V. *Scientometric Analysis of Information Flows in Chemistry*. Moscow: Izd. Nauka, 1980: 141. *Scientometrics* 1982; 4(1): 77-79

3 Leydesdorff Loet. *Challenge of scientometrics: the development, measurement, and self-organization of scientific communications*. Leiden: DSWO Press, Leiden University, 1995: 231 pp

4 Lancaster F W. *Bibliometric methods in assessing productivity and impact of research*. Bangalore: Sarada Ranganathan Endowment for Library Science, 1991: 52 pp

5 Brown W B. Book Review. Frame J D. *International Business and Global Technology*. Lexington, Mass.: Lexington Books/D. C. Heath & Co., 1983: 224 pp. *Scientometrics* 1984; 6(1): 203-204

6 Kalyane V L. Establishing scientometric database for harnessing expertise and information sources. *International Information, Communication and Education* 1994; 13(2): 208-212

7 Kalyane V L, Kadam S N. Informetrics on accidents and trauma. In: *Towards the New Information Society of Tomorrow : Innovations , Challenges and Impact*. 49th FID Conference and Congress, 11-17 Oct., 1998. New Delhi: INSDOC. *FID Publication No.719*, Paper No.032015: III-119 - III-133

8 Kalyane V L, Kadam S N. Processing of bibliographic CD-ROM database into graphic images. *National Convention of Medical Library Association of India*, 19-21 Nov., 1998. Ranchi : Central Institute of Psychiatry , *Souvenir MLAI – 98*

9 Braun T, Gomez I, Mendez A, Schubert A. International co-authorship pattern in physics and its subfields, 1981-1985. *Scientometrics* 1994; 24(2): 181-200

10 Schubert A, Braun T. International collaboration in the sciences, 1981-1985. *Scientometrics* 1990; 19(1-2): 3-10

11 Blickenstaff J, Moravcsik M J. Scientific output in the third world. *Scientometrics* 1982; 4(2): 135-169

12 Braun T, Glanzel W, Schubert A. *Scientometric Indicators: a 32-Country Comparative Evaluation of Publishing Performance and Citation Impact.* Singapore: World Scientific, 1985

13 Garrett-Jones Sam. International trends in evaluating university research outcomes: what lessons for Australia. *Research Evaluation* 2000; 8(2): 115-124

14 Kalyane V L. Informetrics on *neem* research in India. *Library Science with a slant to Documentation and Information Studies* 1993; 30(4): 139-145

15 Venkataramana P, Kalyane V L, Munnolli S S. Informetrics on mushrooming growth of mushroom research in India. In: *LIBCON-94 National Conference on Bibliometrics, Informetrics and Scientometrics*. 14-16 Nov., 1994. Bangalore: State Youth Librarians' Association , *Souvenir and Abstracts* : 44

16 Arunachalam Subbaiah, Jinandra Doss M. Science in a small country at a time of globalisation: domestic and international collaboration in new biology research in Israel. *Journal of Information Science* 2000; 26(6): 39-49

17 Arunachalam Subbaiah, Singh Udai N, Sinha Rita. The sleeping dragon wakes up: a scientometric analysis of the growth of science and the usage of journals in China. *Current Science* 1993; 65(11): 809-822

18 Roseboom J, Pardey P G. Measuring the development of national agricultural research systems, *Scientometrics* 1992; 23(1): 169-190

19 Guay Y. Emergence of basic research on the periphery: organic chemistry in India, *Scientometrics* 1986; 10(1-2): 77-94

20 Verma R K, Sharma Y K, Khatri H S D. Trends in nuclear research and its publications – an analysis based on five years coverage in the Indian Science Abstracts, *Annals of Library Science and Documentation* 1982; 29(2): 64-69

21 Rigter H. Evaluation of performance of health research in The Netherlands, *Research Policy* 1986; 15(1): 33-48

22 Nederhof A J, Noyons E C M. Assessment of the international standing of university departments' research: a comparison of bibliometric methods. *Scientometrics* 1992; 24(3): 393-404

23 Cohen J E. Publication rate as a function of laboratory size in a biomedical research institution. *Scientometrics* 1980; 2(1): 35-52

24 Bindon G. Output measures of cooperative research: the case of the Pulp and Paper Research Institute of Canada. *Scientometrics* 1981; 3(2): 85-106

25 Kalyane V L, Kalyane S V. Scientometric dimensions of innovation communication productivity system. *Annals of Library Science and Documentation* 1991; 38(1): 8-29

26 Kalyane V L, Vidyasagar Rao K. Collaboration trends in sugarcane research - a case study. *Annals of Library Science and Documentation* 1992; 39(1): 9-11

27 Kalyane V L, Kalyane S V. R&D communication strategy vis-à-vis librarianship. *Journal of Information Sciences* 1994; 4(2): 105-135

28 Swarna T, Kalyane V L, Vijai Kumar. Scientometric dimensions of technical reports from Bhabha Atomic Research Centre (in press)

29 Kalyane V L, Vidyasagar Rao K. Quantification of credit for authorship. *ILA Bulletin* 1995; 30(3-4): 94-96

30 Narin F, Olivastro D. National trends in physics and technology, *Czech. J. Phys.* 1986; B36: 101-106

31 Fischer Klaus. *Changing landscapes of nuclear physics: a scientometric study on the social and cognitive position of German-speaking emigrants within the nuclear physics community, 1921-1947*. Berlin, New York: Springer Verlag, 1993: 256 pp

32 Braun T, Bujdoso E, Schubert A. *Literature of Analytical Chemistry: a Scientometric Evaluation*. Boca Raton: CRC Press, 1987

33 Amir S. On the degree of interdisciplinarity of research programs: a quantitative assessment. *Scientometrics* 1985; 8(1-2): 117-136

34 Kalyane V L, Sen B K. A bibliometric study of the Journal of Oilseeds Research. *Annals of Library Science and Documentation* 1995; 42(4): 121-141

35 Kalyane V L. Dr M. S. Swaminathan - biologist par excellence. *Biology Education* 1992; 9(3): 246-248

36 Kalyane V L, Kalyane S V. Scientometric portrait of Vinodini Reddy. *Journal of Information Sciences* 1993; 4(1): 25- 47

37 Kalyane V L, Kalyane S V. Scientometric portrait of M. S. Swaminathan. *Library Science with a slant to Documentation and Information Studies* 1994; 31(1): 31-46

38 Kalyane V L, Devarai Rajashekhar S. Informetrics on C. S. Venkata Ram. In: Vashishth C P, Ramaiah L S, Jaggarao N V, Prafulla Chandra T V; eds. *New Horizons in Library and Information Science: Dr Velaga Venkatappaiah Festschrift*. Madras: T. R. Publications, 1994: 475 – 478

39 Kademani B S, Kalyane V L, Balakrishnan M R. Scientometric portrait of P. K. Iyengar. *Library Science with a slant to Documentation and Information Studies* 1994; 31(4): 155-176

40 Kademani B S, Kalyane V L, Kademani A B. Scientometric portrait of Nobel laureate Dr C. V. Raman. *Indian Journal of Information, Library and Society* 1994; 7(3-4): 215-249

41 Kalyane V L, Kademani B S. Scientometric portrait of U. R. Murty. In: *LIBCON-94 National Conference on Bibliometrics, Informetrics and Scientometrics*. 14-16 Nov., 1994. Bangalore: State Youth Librarians' Association, *Souvenir and Abstracts*: 48

42 Kalyane V L. Role model scientist. *Whither Indian Science, Third National Convention of ISWA on* '*What is Wrong with Indian Science*'. New Delhi :

Indian National Science Academy, 1995. Indian Science Writers' Association *Souvenir* : 31-34

43 Kalyane V L, Munnolli S S. Scientometric portrait of T. S. West. *Scientometrics* 1995; 33(2): 233-256

44 Kalyane V L, Samanta R K. Informetrics on K. Ramiah. In: Raju A A N, Ramaiah L S, Laxman Rao N, Prafulla Chandra T V; eds. *New Vistas in Library and Information Science : Papers in Honour of Professor G. V. S. L. Narasimha Raju*. New Delhi: Vikas Publishing House, 1995: 565 –578

45 Kalyane V L, Kademani B S. Scientometric portrait of R. Chidambaram : a publication productivity analysis. *Journal of Information Sciences* 1995; 5(3): 101-140

46 Kalyane V L. Scientometric portrait of P. M. Bhargava. *Lucknow Librarian* 1995; 27(1- 4): 42-70

47 Kademani B S, Kalyane V L. Bibliometric indicators for publication productivity analysis of an individual scientist. In: *National Seminar on Progress in Bibliometric Indicators*. (Sponsored by U.G.C.) 28-29 Feb., 1996. Annamalainagar: Department of Library and Information Science, Annamalai University, 1996. *Book of Abstracts* : 9 –10

48 Kademani B S, Kalyane V L. Citation analysis as bibliometric indicator to evaluate individual scientist. *National Seminar on Progress in Bibliometric Indicators*. (Sponsored by U.G.C.) 28-29 Feb., 1996. Annamalainagar: Department of Library and Information Science, Annamalai University, 1996. *Book of Abstracts* : 13 -14

49 Kademani B S, Kalyane V L, Kademani A B. Scientometric portrait of Sir K. S. Krishnan. *Indian Journal of Information, Library and Society* 1996; 9(1-2): 125-150

50 Kademani B S, Kalyane V L. Outstandingly cited and most significant publications of R. Chidambaram, a nuclear physicist. *Malaysian Journal of Library and Information Science* 1996; 1(1): 21-36

51 Kalyane V L, Sen B K. Scientometric portrait of Nobel laureate Pierre-Gilles de Gennes. *Malaysian Journal of Library and Information Science* 1996; 1(2): 13-26

52 Kalyane V L, Kalyane S V. Database on creativity and innovation communication productivity of science in India: a case study. *Journal of Information Sciences* 1996; 7(1): 3-44

53 Kademani B S, Kalyane V L, Kademani A B. Scientometric portrait of Nobel laureate S. Chandrasekhar. *JISSI : The International Journal of Scientometrics and Informetrics* 1996; 2(2-3): 119-135

54 Kalyane V L. *Role Model for Modern Biology Students*. (Project work E S - 305, Post Graduate Diploma in Higher Education, PGDHE 941430053) New Delhi: School of Education, Indira Gandhi National Open University, 1996: 417 pp

55 Kademani B S, Kalyane V L. Bibliometric indicators for publication productivity analysis of an individual scientist. *JISSI: The International Journal of Scientometrics and Informetrics* 1996; 2(4): 49-58

56 Kalyane V L, Kademani B S. Scientometric portrait of Barbara McClintock: the Nobel laureate in physiology. *Kelpro Bulletin* 1997; 1(1): 3-14

57 Kalyane V L, Sen B K. Scientometric portrait of C. R. Bhatia , an Indian Geneticist and Plant Breeder. *Malaysian Journal of Library and Information Science* 1998; 3(1): 25-42

58 Kademani B S, Kalyane V L. Scientometric portrait of R. Chidambaram, the Indian nuclear physicist, based on citation analysis. *Kelpro Bulletin* 1998; 2(1): 13-29

59 Kalyane V L, Kadam S N. Centenary year of the discovery of radio-activity in Thorium, Polonium and Radium. In: *International Workshop on History of Science: Implications for Science Education*. 22-26 Feb., 1999. Mumbai: Homi Bhabha Centre for Science Education, 1999. *Readings and Abstracts*: 49

60 Kademani B S, Kalyane V L, Jange Suresh. Scientometric portrait of Nobel laureate Dorothy Crowfoot Hodgkin. *Scientometrics* 1999; 45(2): 233-250

61 Kademani B S, Kalyane V L, Vijai Kumar. Scientometric portrait of Vikram Ambalal Sarabhai: a citation analysis. *SRELS Journal of Information Management* (Incorporating *Library Science with a slant to Documentation and Information Studies*, founded by Dr S. R. Ranganathan) 2000; 37(2): 107-132

62 Kademani B S, Kalyane V L, Vijai Kumar. Scientometric portrait of Nobel laureate Ahmed Hassan Zewail (in press)

63 Kalyane V L, Madan V K, Vijai Kumar. Reference curve for Indian role model scientist (in press)

64 Dodgso Mark, Hinze Sybille. Indicators used to measure the innovation process: defects and possible remedies. *Research Evaluation* 2000; 8(2): 101-114

Appendix 1: Biographical details of Ranjit Kumar Mitra

Birth : January 6, 1941, Calcutta (now Kolkata)

Father : U. N. Mitra, a Civil Engineer

Mother : Nihar Bala Mitra

Education: M. Sc. in Botany with specialisation in Plant Biochemistry (1963), Gold Medal for being first class first, Kalyani University, West Bengal; Ph.D. in Plant Biochemistry (1969) Kalyani University, West Bengal

Wife : Jharna Mitra, Ph.D. in Microbiology working in Nuclear Agriculture and Biotechnology Division, at BARC on bioremediation of pesticide residues

Son : Deepanjan Mitra, M.S. in Mechanical Engineering from North-Western University, Evanston, USA, presently doing Ph.D. in Mechanical Engineering at the University of California, Los Angeles

Position: Kalyani University, 1963-1965 Council of Scientific and Industrial Research (CSIR) Research Fellow; 1965-1967 Department of Atomic Energy (DAE) Research Fellow; joined BARC as Scientific Officer in 1967; Washington University, St. Louis, (1973-1974 as Research Associate); Principal and Co-investigator of various IAEA research projects (1973 onwards); Ph.D. Guide for Mumbai University (since 1991); Secretary, Food and Agriculture Committee Board of Research in Nuclear Sciences, DAE; Scientific Officer (H), Group Leader, Plant Biochemical Genetics; Head, Nuclear Agriculture and Biotechnology Division, Bhabha Atomic Research Centre, Mumbai-400085, India