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Quantitative analysis of books by Bharat Ratna Professor C. N. R. Rao

Susanta Koley[a] and B K Sen[b]
[a]Librarian, Durgapur Institute of Advanced Technology & Management, G T Road, Rajbandh, Durgapur-12, Dist.-Burdwan, West Bengal, Email:
shayanikoley.2013@gmail.com
[b]Chairman, Bibliometrics Experts Committee, Dept. of Science & Technology, Govt. of India Member, Research Council, Indian National Science Academy, New Delhi Address for Correspondence: 80 Shivalik Apartments, Alaknanda, New Delhi-110019, Email: bksen1938@gmail.com

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The paper presents the results of the analysis of 49 books of Prof. C N R Rao, published during 1960 to 2013. The analysis shows that 18 books were written by him singly or jointly with other scientists. The rest (N=31) are works produced under his solo or joint editorship. Thirty five books were published abroad and 14 in India (11 from Delhi) World Scientific published 8 books, Wiley VCH published 4 books, Academic Press and Indian National Science Academy published 3 each, and the rest were published by 22 other publishers. His first book was published at the age of 27. Most of the books were authored by him during his 50s (16 books) and 70s (12 books). All his books were published in English. However, a number of books have been translated into Russian, Chinese, Hindi and Kannada. The popularity of his books can be gauged from the fact that two of his books have run into fourth edition, one to third edition, and five books to second edition. The largest number of books belong to physical chemistry, particularly to solid state chemistry.

Keywords: Quantitative analysis; Bibliometric analysis; Biobibliometrics; Book publication; C N R Rao; Chemical scientist; Chemistry

Introduction

C N R Rao is a renowned Indian chemical scientist is the National Research Professor, Linus Pauling Research Professor and Honorary President of Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore which he founded in 1989. He worked in Indian Institute of Science, Bangalore; and Indian Institute of Technology, Kanpur. He has also been a visiting professor at the Purdue University, University of Oxford, University of Cambridge and University of California, Santa Barbara. He was the Jawaharlal Nehru Professor at the University of Cambridge and Professorial Fellow at the King's College, Cambridge during 1983–1984. He was appointed Chair of the Scientific Advisory Council to the Indian Prime Minister in January 2005. He is also the director of the International Centre for Materials Science (ICMS)[1].

Rao has authored 1609 research articles and 49 scientific books during 1954-2013[2]. He has honorary doctorates from 60 universities from around the world. He is recipient of most of the major scientific awards including Fellow of the Royal Society, London and is member of many scientific organizations[1]. Recently he received Bharat Ratna, India's highest civilian award. Prior to him, C V Raman, eminent physicist, M Visvesvaraya, a distinguist engineer, scholar and statesman and APJ Abdul Kalam, aeronautical engineer and ex-President of India were the other scientists to be awarded Bharat Ratna.[3,4]

Definitions

First editor: Editor who is in the first position of the byline of multiple editors.

Joint author: Author who is in any position other than the first**.**

Joint editor: Editor who is in any position other than the first.

First author: Author who is in the first position of byline of multiple authors.

Original work: Work by the author himself, not in collaboration with any other.

Unnamed author: The name of the author is unknown**.**

Objective of the study

- To quantitatively analyze the following aspects of books produced by C N R Rao.

Methodology

The necessary data for this study have been collected from *Publications of Professor C. N. R. Rao (2013-1954)*, designed by Education Technology Unit, Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), Bangalore. It contains 49 books (44 monographs, 2 handbooks, 1 report, 1 biography and 1 conference proceedings). Rao has authored books on his own and also along with other authors. He has also edited a number of books either singly and along with other editors. The data were recorded in MS-Word and MS-Excel for analysis.

Results and discussion

Categories of books

Table 1 shows categories of books according to authorship and editorship. The books are grouped into two categories – authored books and edited books[5]. Eighteen are authored books (seven by the author himself, and ten along with other authors). The author of one book is unknown. Among collaborative works he leads as first author in eight books, and as joint author in two books. Rao edited 31 books, singly 10 books, 11 as first editor and 10 as joint editor.

Authorship and editorship pattern

Table 2 presents authorship and editorship patterns respectively. Out of 18 books, seven are singled-authored, nine two-authored, and one three-authored. There is no mention of author in one book. Similarly, ten books have been produced under single editorship, and 21 books are collaborative. Out of 21, eleven books have been produced under two editors, eight under three editors, and one under four editors. The editor status of one book is unknown.

Table 1—Categories of books according to authorship and editorship

Authored books			
Authorship	No. of books	Percentage of 49	Percentage of 18
Single	7	14.29	38.89
First	8	16.33	44.45
Joint	2	4.08	11.11
Unnamed	1	2.04	5.55
Total	18	36.74	100.00
Edited books			
Editorship	No. of books	Percentage of 49	Percentage of 31
Single	10	20.41	32.26
First	11	22.44	35.48
Joint	10	20.41	32.26
Total	31	63.26	100.00

Position in the byline of author/ editor

Table 3 identifies the position of Rao in the author/ editor byline in his collaborative works [i.e. N= 31(10+21)]. He appears as the first author in eight books and 2nd author in two books. It is also seen from the table that Rao appears as the first editor in 11 books, as 2nd editor in eight books and as 3rd editor in two books. In both the cases, he occupies mostly the first position indicating his dominance in his field.

Year of publication

From Table 4, it is seen that his first book was published in 1960 while he was 27 years of age. By

Table 2—Authorship and editorship pattern

Authorship pattern

Authorship Books	Single	Two	Three	Unknown	Total
Non-collaborative	7	-	-	-	7
Collaborative	-	9	1	-	10
Total	7	9	1	1	18
Percentage	38.88	50.00	5.56	5.56	100.00

Editorship pattern

Editorship Books	Single	Two	Three	Four	Unknown	Total
Non-collaborative	10	-	-	-	-	10
Collaborative	-	11	8	1	1	21
Total	10	11	8	1	1	31
Percentage	32.26	35.47	25.81	3.23	3.23	100.00

Table 3—Position of C N R Rao in the byline of authors/editors

Position in the byline of authors

	Positions			Total
Authored Books	First	Second	Third	
Two-authored	7	2	-	9
Three-authored	1	-	-	1
Total	8	2	-	10

Position in the byline of editors

	Positions				Total
Edited Books	First	Second	Third	Fourth	
Two-editor	7	4	-	-	11
Three-editor	2	4	2	-	8
Four-editor	1	-	-	-	1
Unknown	1	-	-	-	1
Total	11	8	2	-	21

Table 4—Years of publication of the books.

Publication year	No. of books	Cumulative total	Author's Age (DOB: 1934)
1960	1	1	27
1963	1	2	30
1967	2	4	34
1970	2	6	37
1973	1	7	40
1974	1	8	41
1975	1	9	42
1978	2	11	45
1980	1	12	47
1981	1	13	48
1982	1	14	49
1985	4	18	52
1986	3	21	53
1988	4	25	55
1990	1	26	57
1991	2	28	58
1992	2	30	59
1994	1	31	61
1995	2	33	62
1998	1	34	65
1999	1	35	66
2000	1	36	67
2004	1	37	71
2005	2	39	72
2007	2	41	74
2008	1	42	75
2010	3	45	77
2011	2	47	78
2013	2	49	80

the age of 55 he published fifty percent of his books. Largest number of books were published when he the age of was in his 50s and 70s – 16 books and 12 books respectively.

Translations

Rao's books (N=49) are basically in English and 18 books have been translated into different languages around the world - three in Russian, two each in Chinese, Hindi, Kannada, and the remaining six books are in six foreign languages such as Spanish, Polish, Japanese, Thai, Mongolian and Swedish. In addition, some of his books have been reprinted several times.

Publishers

Twenty-six publishers have been responsible for the publication of the books. It may be seen from Table 5 that *World Scientific* tops the list with 8 books

Table 5—Publishers

Sl. no.	Publisher's name	No. of books	FYP*	LYP*	Place
1	World Scientific	8	1988	2013	Singapore
2	Wiley -VCH	4	1995	2013	Weinheim
3	Academic Press	3	1963	1981	NewYork
4	Indian National Science Academy	3	1985	1986	New Delhi
5	IISc Press- World Scientific	2	2008	2010	Bangalore(-Singapore)
6	The Royal Society of Chemistry	2	1986	2005	London
7	Blackwell Scientific Publications	2	1988	1992	Oxford
8	Cambridge University Press	2	1986	2002	Cambridge
9	John Wiley	2	1994	2010	New York
10	National Council of Educational Research & Training	2	1978	1988	New Delhi
11	Taylor and Francis	2	1985	1995	London
12	University Press	2	1992	1999	New Delhi
13	East-West Press	2	1967	1967	New Delhi
14	Butterworths	1	1960	1960	London
15	COSTED, ICSU	1	1980	1980	France
16	Elsevier	1	1985	1985	Amsterdam
17	International Union of Pure & Applied Chemistry	1	1975	1975	Oxford
18	Macmillan	1	1973	1973	UK
19	Marcel Dekker	1	1974	1974	New York
20	McGraw-Hill Publishing	1	1978	1978	New York
21	National Book Trust	1	2005	2009	New Delhi
22	Nava Karnataka	1	2010	2010	Karnataka
23	Pergamon Press	1	1980	1980	Oxford
24	Plenum Press	1	1970	1970	New York
25	Sasta Sahitya Mandal Publication	1	2011	2011	New Delhi
26	Springer-Verlag	1	2007	2007	Berlin

* FYP – First year of publication. LYP –Last year of publication

followed by *Wiley VCH* with 4, *Academic Press* and *Indian National Science Academy* with 3 each. Next nine publishers including *IISc Press-World Scientific, The Royal Society of Chemistry*, *Blackwell Scientific Publications, Cambridge University Press, John Wiley, National Council of Educational Research & Training, Taylor and Francis, University Press*, *East-West Press* etc have published 2 books each. The

remaining 13 publishers include among others *Butterworths, Elsevier, East-West Press, Macmillian, McGraw-Hill, Springer-Verlag*.

It is also observed that some books have been published by two or three publishers. For example Handbook *of Chemistry & Physics* was first published by East West Press in 1967; and the British edition by Van Nostrand- Reinhold in 1970. Similarly, three publishers have published *Understanding Chemistry.* It was first published by University Press in 1999, and then the international edition by World Scientific in 2009; and translation by National Book Trust. Besides, East West Press and Van Nostrand- Reinhold have jointly produced the book *Experiments in General Chemistry* in 1967. IISc Press and World Scientific also have jointly published two books such as *Trends in Chemistry of Materials..,* and *Climbing the Limitless Ladder* in 2008 and 2011 respectively.

Co-authors and co-editors

This study finds that Rao has worked with nine co-authors and twenty-five co-editors. His co-authors have been K Biswas, J Gopalakrishnan, A Govindaraj, T V Ramakrishnan, Indumati Rao, K J Rao, B Raveau, and P J Thomas. All of them have co-authored one book each with Rao. He co-edited three books with S K Joshi, two books each with A K Cheethan, P P Edwards, and A Muller. This apart he co-edited with another 23 editors.

Places of publication

The place of publication is also an important bibliometric indicator[3]. The study shows that 11 of his books were published from Delhi, 8 each from Singapore and New York, 5 from London, 4 each from Oxford and Weinheim, 2 each from Cambridge, Bangalore and 1 each from Amsterdam, Berlin, France, Karnataka and UK. It may be noted that 35 books were published from abroad and 14 books from India.

Popularity of the books

The popularity of Rao's books can be gauged from the fact that 4th edition of two of his books have already come out. On of his books has run into its 3rd edition and five into its second edition.

Subject-wise distribution

Table 6 represents subject-wise distribution of books. The subjects of the books have been arranged according to Dewey Decimal Classification (DDC) numbers with the help of "Classify OCLC- an Experimental Classification Service"[6, 7]. The largest number of books written belong physical chemistry (36.73%) comprising, among others, chemistry (22.45%), analytical chemistry (8.17%), inorganic, and organic chemistry (6.12% each). Engineering accounted for 16.33%.

Table 6—Subject wise distribution of books

DDC No.	Subject	No. of books	%
300-399	**Social sciences**		
	-Elementary education (Science for children)	01	
	Total	**01**	2.04
500-509	**Natural sciences**		
	-Science (in India)	01	
	Total	**01**	2.04
540-549	**Chemistry**		
	-General chemistry	07	
	-Chemical education, research, related topics	03	
	-Biography (A life in Chemistry)	01	
	Total	**11**	22.45
541	**Physical chemistry**		
	-Solid state chemistry	14	
	-Molecular structure	01	
	- Chemistry of surface	01	
	-Catalysis	01	
	-Chemical reaction(synthesis)	01	
	Total	**18**	36.73
543	**Analytical chemistry**		
	-Optical spectroscopy	03	
	-Non-spectroscopy	01	
	Total	**04**	8.17
546	**Inorganic chemistry**		
	-Transition metal	02	
	- Manganese	01	
	Total	**03**	6.12
547	**Organic chemistry**		
	-Macromolecules compounds Supramolecular	01	
	-Aromatic compounds : graphene synthesis	02	
	Total	**03**	6.12
620-629	**Engineering & allied operations**		
	-Engineering materials/ Materials science	04	
	-Nanotechnology	04	
	Total	**08**	16.33
	GRAND TOTAL	49	100.00

Table 7—Frequency of key terms

Chemistry	12	Materials design	1
Solid state chemistry	4	Metal-insulator transitions	1
Superconductor	4	Metallic states of matter	1
Superconductivity	2	Molecular interactions	1
Chemical education	2	Nanomaterials	1
Graphene	2	Nanomaterials chemistry	1
High-temperature superconductors	2	Nanoworld	1
Materials chemistry	2	Non-metallic states of matter	1
Nanotubes	2	Oxide superconductors	1
Science	2	Phase transition in solid	1
Advanced materials	1	Physics	1
Catalyst design	1	Preparation of Materials	1
Characterization of materials	1	Solid state	1
Chemical approaches	1	Seventeenth century	1
Chemical aspects	1	Solid chemistry	1
Colossal magnetoresistance	1	Solid physics	1
Developing countries	1	Solid surface	1
Educational technology	1	Spectroscopy	1
Electron spectroscopy	1	Structural aspects	1
High-temperature oxide superconductors	1	Supramolecular organization	1
India	1	Surface chemistry	1
Infrared spectroscopy	1	Surface physics	1
Inorganic chemistry	1	Transition metal oxide	1
Inorganic materials	1	Ultraviolet spectroscopy	1
Inorganic materials synthesis	1	Visible spectroscopy	1
Manganese oxides	1	Visible spectroscopy	1

Key terms

Table 7 depicts frequencies of key terms used in the titles of his books. In all, 76 key terms have figured in 49 titles. Amongst these, chemistry has appeared in as many as 12 titles followed by solid state chemistry (4 titles); superconductors (4 titles), superconductivity; chemical reaction, chemical education, graphene, high-temperature superconductors, materials chemistry, nanotubes, science and materials appeared in 2 titles each. In the key terms two place names have also appeared. The terms show that his main focus was on chemistry, superconductors, and materials.

Conclusions

Generally bibliometric studies of articles published by scientists are done. Studies on books alone are rare. Of course, most scientists do not publish very many books. CNR Rao is but an exception. He has produced not only 1600+ articles but also around 50 books. This is a rare achievement of a scientist. He is 80 and still quite active.

Acknowledgement

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