

SCIENTOMETRIC PORTRAIT OF NOBEL LAUREATE DOROTHY CROWFOOT HODGKIN

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Dorothy Crowfoot Hodgkin (1910-1994), the renowned crystallographer and the Nobel prize winner in Chemistry (1964) was responsible for developing the X-ray diffraction method of finding the exact structure of large and complicated molecules, such as Penicillin, Vitamin B-12, Insulin, etc. Her 180 publications during 1932-1988 were analyzed by domains, authorship pattern, publication productivity, scattering of publications and the keywords used in the titles of her papers.

Introduction

Recently there is a growing awareness for the development of women in general who constitute roughly half of the population both in national and international levels. The United Nations had declared the decade of 1975 to 1985 as Decade for Women. The Nairobi Conferences adopted the document "Forward looking strategies" for creating a new world order based on equity, development and peace. When on December 10, 1975, a glittering array of laureates descended on Stockholm for the seventy fifth anniversary celebration of the establishment of the Nobel prizes, only one woman stood among them. At that time Dorothy Crowfoot Hodgkin was the sole representative of a small band of only 14 lady laureates. Among them more than seventy five male scientific colleagues she observed that she was used to being the only woman at scientific meetings. "After-all", she mused, "women have come rather late to science". And someone else has remarked, women have to be twice as determined and to work twice as hard as men. Too often lady scientists have come smack up against what Betsy Ancker-Johnson call the "conspiracy of discouragement".⁷

Dorothy belongs to a small group of woman who have changed the face of science, as will be abundantly clear from the papers in "The collected works of Dorothy Crowfoot Hodgkin". The early work in small crystallography developed naturally into macro-molecular crystallography; the landmarks are Cholesterol, Penicillin, Vitamin B-12 and Insulin, with excursion into the surrounding areas.¹¹ Dorothy Crowfoot Hodgkin developed the X-ray diffraction method of finding the exact structure of a molecule and applied it to complex organic molecules. Among her most striking successes were the three dimensional structure of antibiotic, Penicillin in 1949. This was followed by the structure of Vitamin B-12, lack of which leads to pernicious anaemia. This vitamin has over 90 atoms in a complex structure, and her analysis in 1956 was a high point for X-ray methods. And structure of Insulin (with 800 atoms) which she started in 1935 and described its detailed structure in 1972. She was awarded the Nobel prize for Chemistry in 1964 for her work on Vitamin B-12. Despite the demands of three young children and busy political life it was her persistence and talent that produced some of the first great success of X-ray analysis.

Dorothy suffered from arthritis for most part of her life. Although painful and sometimes almost crippling, she never let it prevent her from doing what she felt she should do. Dorothy had helped many budding crystallographers which include many women scientists by way of encouragement and welcome participation in her own laboratory. Her own contributions were rare gifts. As W. L. Bragg put it, her work passes the "sound barrier". Descriptive accounts of biographical details and achievements of Dorothy Crowfoot Hodgkin are available in Refs 1-13 and a brief resume of her is given as Appendix of this paper.

Objectives

Objectives of present work are to highlight the following quantitative aspects of the research communications of Dorothy Crowfoot Hodgkin and to analyze the variable of it so as to arrive at valid conclusions:

- Domainwise contributions,
- Authorship pattern and author productivity,
- Use of channels of communication, and
- Documentation of keywords from titles of papers.

The main concept of working on individual scientist is to provide "role model scientist" through highlighting their works scientometrically for the younger generation to emulate.

Methodology

Scientific publications seems to provide the best available basis for measuring the research output. One of the first writers to suggest scientific measure as a measure of research productivity was Nobel laureate William Shockley,¹⁴ who was interested in measuring the research productivity among individuals within a group by analyzing their publications. A few scientometric studies on Nobel laureates¹⁵⁻²¹ and others²²⁻³³ have been published. The 180 papers by Dorothy Crowfoot Hodgkin published during 1932 to 1988 were documented¹¹ and sorting was done as prerequisites.

Results and discussion

Domainwise contributions

Dorothy Crowfoot Hodgkin had research communications in the following domains

A = INSULIN,

B = STEROIDS,

C = ANTIBIOTICS,

D = VITAMIN B-12, and

E = GENERAL CRYSTALLOGRAPHY.

Domainwise productivity of cumulative papers is depicted in Fig. 1. Dorothy Crowfoot Hodgkin had contributed 48 papers in the domain Insulin during 1935-1988, 12 papers in Steroids during 1935-1963, 10 papers in Antibiotics during 1954-1984, and 81 papers in General crystallography during 1932-1987.

Authorship pattern and author productivity

Dorothy Crowfoot Hodgkin had 66 single authored papers in various domains as A(20), B(1), C(1), D(9) and E(35). She had 114 multi-authored papers in various domains as A(46), B(20), C(9), D(11), and E (28). Dorothy Crowfoot Hodgkin was main author in 34 papers and secondary author in 80 collaborative papers. Quinquennial publications productivity of Dorothy Crowfoot Hodgkin is shown in Fig. 2. Her first paper was published in 1932 in *Nature* at 22 years of her age in the domain E. To measure the collaborative research pattern, a simple indicator called collaboration coefficient obtained by the formula number of collaborative papers per number of total

papers is used. Highest collaboration coefficient was 0.9 during 1952-56. The productivity coefficient was obtained by the simple formula – 50 percentile age per total productivity age. Her productivity coefficient was 0.60 which is a clear indication that her publication activity accelerated after her 50 percentile age that is after she won her Noble prize in 1964. She did not publish any papers in 1942, 1947, 1978 and 1985.

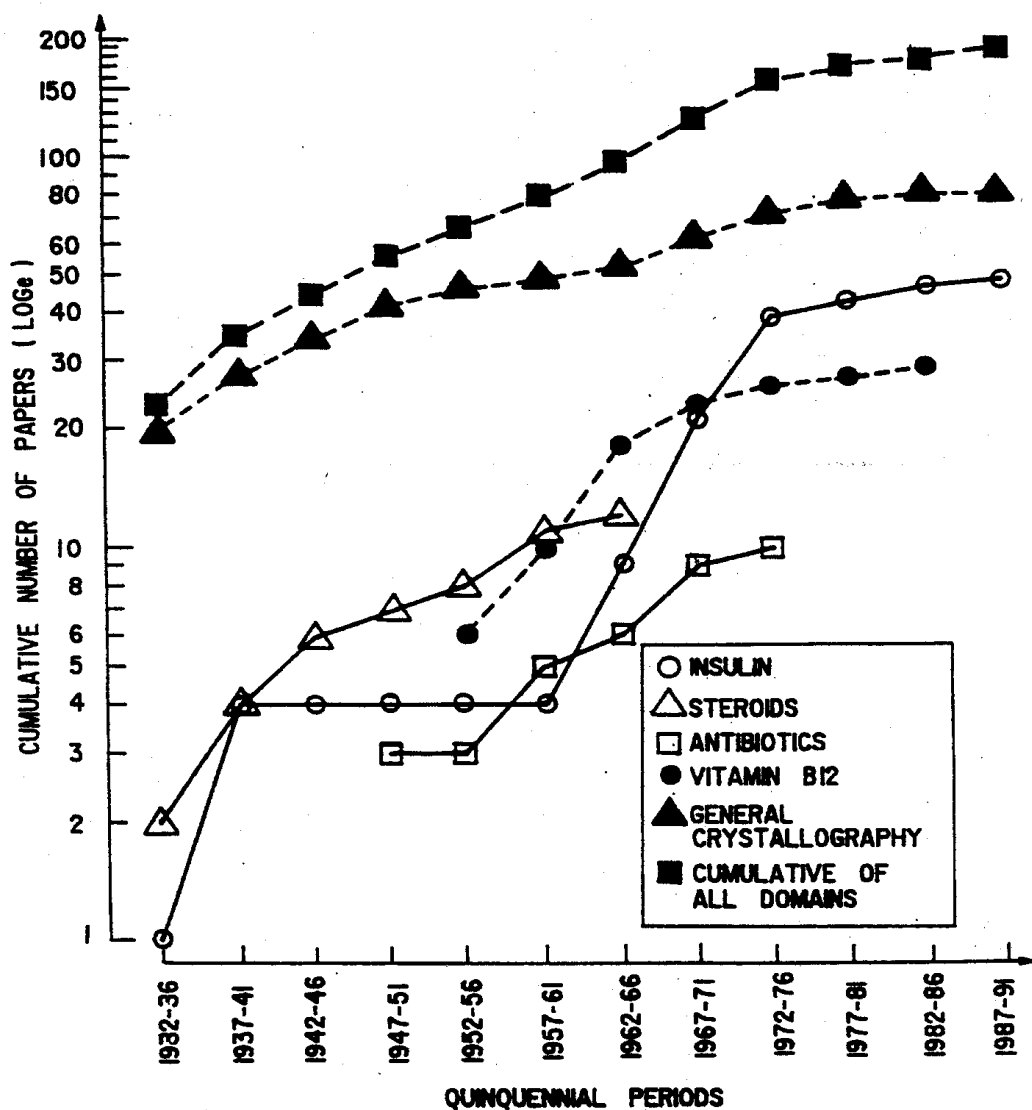


Fig. 1. Domainwise publication productivity of Dorothy Crowfoot Hodgkin

Table 1 shows author productivity and distribution of authors in various domains. The research group of Dorothy Crowfoot Hodgkin had the credits as number of authorships in various domains A(175), B(28), C(27), D(98) and E(149). Total number of authors in the research group were 119. Researchers and their authorships in collaboration with Dorothy Crowfoot Hodgkin in chronological order of their association (in first publication with Hodgkin) are depicted in Fig. 3 and Table 2.

Most active researchers and contributors with Dorothy Crowfoot Hodgkin were G.G. Dodson (22), E.J. Dodson (19), J.D. Bernal (13), T.L. Blundel (12) and D. Mercola (11). Other active collaborators were J.F. Cutfield (9), S.M. Cutfield (8), K.N. Trueblood (8), M. Vijayan (6), J.D. White (6), and J. Pickworth (5). Other collaborators having four papers each were six, three papers each were 15, two papers each were 23, and single paper each were 63. Interdomainers J.D. Bernal had collaborated with Hodgkin in domains B and E, and K.N. Trueblood in domains B and D.

Table 1
Author productivity and distribution of authors and papers by domains

No. of Papers*	Domainwise authorships					Total authorships	No. of authors	Prominent collaborators
	A	B	C	D	E			
1	10	4	9	12	28	63	63	
2	14	2	—	16	14	46	23	
3	12	5	5	9	14	45	15	
4	4	—	3	14	3	24	6	
5	—	—	—	5	—	5	1	Pickworth, J.
6	6	—	—	6	—	12	2	White, J. D. (Domain D)
8	8	1	—	7	—	16	2	Vijayan, M. C. (Domain A)
9	9	—	—	—	—	9	1	Trueblood, K. N. (Domain B&D)
11	11	—	—	—	—	11	1	Cutfield, S. M. (Domain A)
12	12	—	—	—	—	12	1	Cutfield, J. F.
13	—	4	—	—	9	13	1	Mercola, D.
19	19	—	—	—	—	19	1	Blundel, T. L.
22	22	—	—	—	—	22	1	Bernal, J. D.
180	48	12	10	29	81	180	1	Dodson, E. J.
								Dodson, G. G.
								Hodgkin, D. C.
Total	175	28	27	98	149	477	119	

A=Insulin, B=Steroids, C=Antibiotics, D=Vitamin B-12, and
E=General crystallography. * Number of papers in which an individual
collaborator was coauthor with Dorothy Crowfoot Hodgkin.

Table 2
Chronological profile of collaborators with Dorothy Crowfoot Hodgkin

S.No.	Researcher	Period of association		No. of authorships
		FPY LPY	TY	
1	Hodgkin, D.C.	1932-1988	57	180
2	Powell, H.M.	1932-1934	3	2
3	Bernal, J.D.	1933-1940	8	13
4	Gattiker, D.C.	1935-1935	1	1
5	Mann, F.G.	1935-1935	1	1
6	Wooster, N.	1935-1935	1	1
7	Blount, B.K.	1936-1936	1	1
8	Cox, E.J.	1936-1936	1	1
9	Jensen, H.	1936-1936	1	1
10	Rapson, W.S.	1936-1936	1	1
11	Robinson, R.	1936-1936	1	1
12	Fanckuchen, I.	1938-1940	3	2
13	Riley, D.P.	1938-1968	31	3
14	Carlisle, C.H.	1941-1945	5	3
15	Chalmers, J.G.	1941-1941	1	1
16	Brenblum, I.	1943-1943	1	1
17	Holiday, E.R.	1943-1943	1	1
18	Rogers-Low, B.W.	1943-1949	7	3
19	Schoental, R.	1943-1943	1	1
20	Schmidt, G.M.J.	1945-1957	1	2
21	Abraham, E.P.	1946-1946	1	1
22	Joseph, A.E.	1946-1946	1	1
23	Osborn, E.M.	1946-1946	1	1
24	Dunitz, J.D.	1948-1963	16	3
25	Bunh, C.W.	1949-1949	1	1
26	Turner-Jones, A.	1949-1949	1	1
27	Darwin, C.	1950-1950	1	1
28	Pitt, G.J.	1950-1951	2	2
29	Porter, M.W.	1950-1950	1	1
30	Spiller, R.C.	1950-1950	1	1
31	Cowan, P.M.	1951-1953	3	2
32	Thelwis, J.	1951-1951	1	2
33	Perutz, M.F.	1952-1952	1	1
34	Sayre, D.	1952-1952	1	1
35	Brink-Shoemaker, C.	1954-1964	11	3
36	DeSanctis, S.C.	1954-1964	11	3
37	Lindsey, J.	1954-1962	9	4
38	Pickworth, J.	1954-1959	6	5
39	White, J.G.	1954-1962	9	6
40	Johnson, A.W.	1955-1955	1	1
41	Kamper, M.J.	1955-1964	10	3
42	Mackay, M.	1955-1962	8	4

Table 2. (cont.)

S.No.	Researcher	Period of Association		No. of authorships
		FPY LPY	TY	
43	Roberston, J.H.	1955-1959	5	4
44	Todd, A.R.	1955-1955	1	1
45	Trueblood, K.N.	1955-1963	9	8
46	Kamper, J.	1956-1957	2	2
47	Monica, S.	1957-1957	1	1
48	Oughton, M.	1957-1957	1	2
49	Prosen, J.	1957-1959	3	3
50	Sparks, R.A.	1959-1962	4	2
51	Rollett, J.S.	1960-1960	1	1
52	Taylor, N.	1960-1973	14	3
53	Dietrich, H.	1961-1961	1	1
54	Lenhart, P.G.	1961-1961	1	1
55	Maslen, E.N.	1961-1971	11	3
56	Saunderson, C.P.	1961-1961	1	1
57	Abrahamsson, S.	1963-1963	1	1
58	Dale, D.H.	1963-1971	9	4
59	Rimmer, B.M.	1963-1969	7	2
60	Venkatesan, K.	1963-1971	9	2
61	Cruickshank, D.W.J.	1964-1964	1	1
62	Pilling, D.	1964-1964	1	1
63	Adam, M.G.	1966-1966	1	2
64	Coller, E.	1966-1966	1	1
65	Coller, L.	1966-1966	1	1
66	Dodson, E.J.	1966-1988	23	19
67	Dodson, G.G.	1966-1988	23	22
68	Hrding, M.M.	1966-1969	4	3
69	Kennedy, A.F.	1966-1966	1	1
70	O'Connor, A.	1966-1966	1	1
71	Ramaseshan, S.	1966-1967	2	2
72	Rossmann, M.G.	1966-1966	1	1
73	Weitzman, P.D.J.	1966-1966	1	1
74	Adams, M.J.	1967-1970	4	3
75	Cooper, A.	1967-1967	1	1
76	Moore, F.M.	1967-1967	1	1
77	Nockolds, C.K.	1967-1971	5	2
78	Waters, J.M.	1967-1967	1	1
79	Waters, J.N.M.	1967-1967	1	1
80	Willis, B.T.M.	1967-1984	18	2
81	Hall, D.C.	1968-1968	1	1
82	James, M.N.G.	1968-1968	1	1
83	Baker, E.N.	1969-1988	20	3
84	Blundel, T.L.	1969-1988	20	12
85	Gardnic, D.	1969-1973	5	2

Table 2. (cont.)

S.No.	Researcher	Period of Association		No. of authorships
		FPY LPY	TY	
86	Hoskins, B.F.	1969-1969	1	1
87	Sheat, S.	1969-1969	1	1
88	Thompson, B.	1969-1969	1	1
89	Vijayan, M.	1969-1988	20	6
90	Viswamitra, M.A.	1969-1970	2	3
91	Whillans, D.D.	1969-1969	1	1
92	Anderson, B.F.	1970-1974	5	4
93	Reuburn, U.A.	1970-1970	1	1
94	Cutfield, J.F.	1971-1988	18	9
95	Cutfield, S.M.	1971-1988	18	8
96	Harrison, H.R.	1971-1971	1	2
97	Hodder, O.J.R.	1971-1971	1	1
98	Mercola, D.	1971-1975	5	11
99	Moore, F.H.	1971-1984	14	2
100	Motherwell, W.D.S.	1971-1971	1	1
101	O'Connor, B.H.	1971-1984	14	2
102	Edmond, E.R.	1972-1975	4	2
103	Stoeckli-Evans, H.	1972-1972	1	1
104	Bentley, G.	1973-1976	4	3
105	Vijayan, K.	1973-1973	1	1
106	Bertczak, T.J.	1974-1974	1	1
107	Cutfield, J.C.	1975-1981	7	2
108	Dragay, J.	1975-1975	1	1
109	Issacks, N.W.	1975-1988	14	2
110	Sabesan, M.	1975-1975	1	1
111	Sakabe, K.	1975-1988	14	2
112	Sakabe, N.	1975-1988	14	2
113	Reynolds, C.	1979-1988	10	4
114	Chantry, D.	1982-1982	1	1
115	Cothia, C.	1982-1982	1	1
116	Harper, T.	1982-1982	1	1
117	Miao, F.M.	1982-1982	1	1
118	Lesk, A.M.	1983-1983	1	1
119	Hubbard, R.E.	1988-1988	1	1
1-119	Total			477

FPY=First Paper Year, LPY=Last Paper Year, TY=Total number of Years.

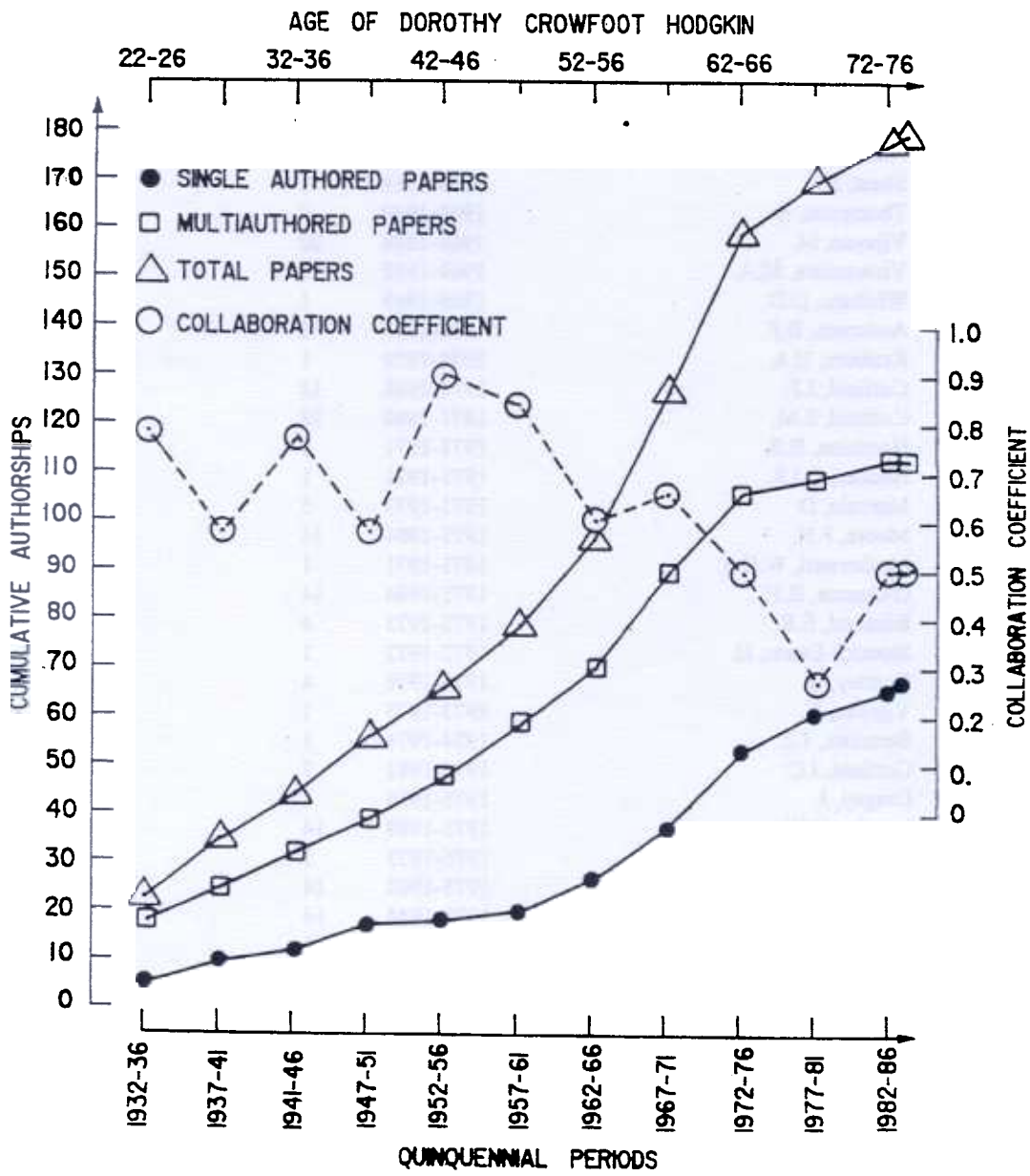


Fig. 2. Publication productivity of Dorothy Crowfoot Hodgkin

Indian scientists who collaborated with Dorothy Crowfoot Hodgkin were M. Vijayan (6), M.A. Viswamitra (3), S.Ramaseshan (2), K. Venkatesan (2), K.Vijayan (1), and Sabesan (1).

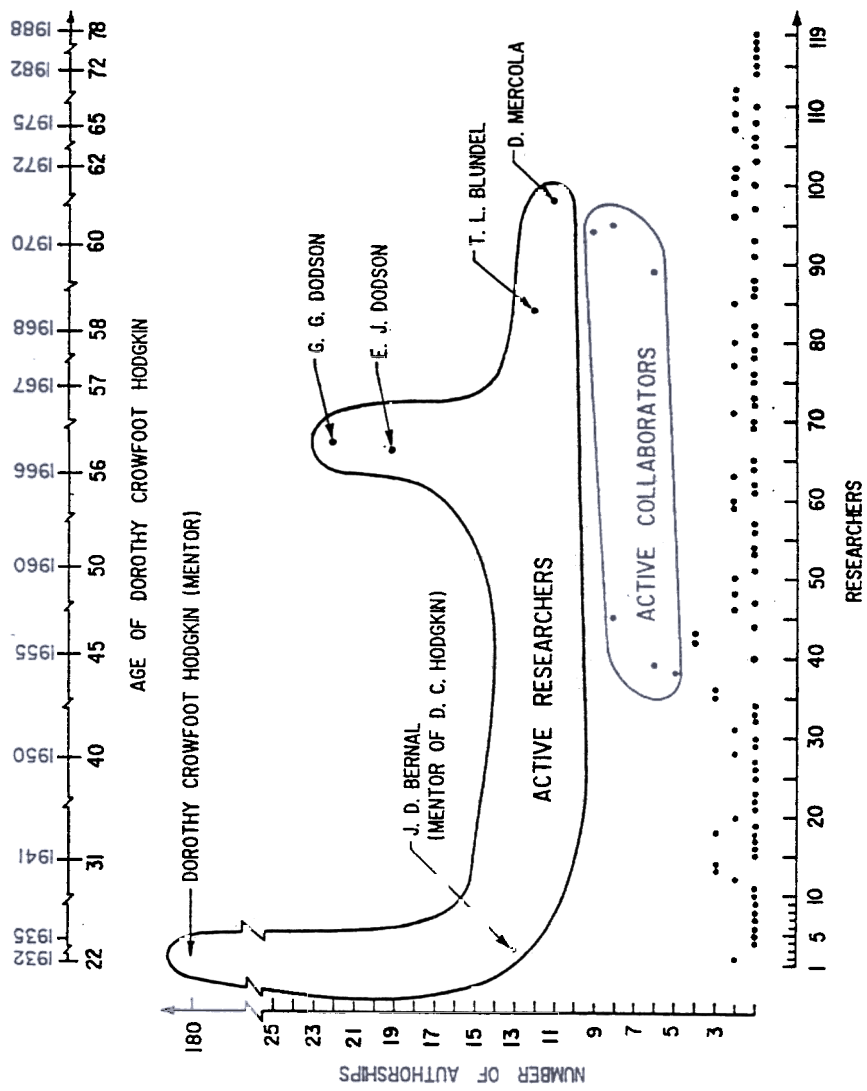


Fig. Researchers association with Dorothy Crowfoot Hodgkin in chronological order and authorship credits

Authorship pattern of Dorothy Crowfoot Hodgkin and her collaborators in different domains is as follows. There were 32 collaborators with Hodgkin in domain A. 64 percent of the authorship's were due to five authors viz., D.C. Hodgkin, G.G. Dodson, E.J. Dodson, T.L. Blundel and D. Mercola. In the domain B there were 11 collaborators with Hodgkin. 57.14 percent of the authorships credit goes to D.C. Hodgkin and J.D. Bernal. There were 12 collaborators with Hodgkin in domain C. 62 percent of authorship's were due to D.C. Hodgkin, B.F. Anderson, E.N. Maslen and M.A. Viswamitra. There were 31 collaborators with Hodgkin in domain D. 68.36 percent of the authorships credit goes to D.C. Hodgkin, K.N. Trueblood, J.G. White and J. Pickworth. K.N. Trueblood had two four-authorship papers, three five-authorship papers and one ten-authorship paper. J.G. White had one four-authorship paper, three six-authorship papers and one ten-authorship paper to his credit. J. Pickworth had four six-authorship papers and one ten-authorship paper to his credit. In domain E 47 collaborators worked with Hodgkin. 60.40 percent of authorships credit goes to D.C. Hodgkin and J.D. Bernal. J.D. Bernal had nine two-authorship papers in this domain. Domainwise authorship pattern is given in Table 3.

Table 3
Domainwise productivity of number of publications

No. of following authored papers	Domains					Total number of papers
	A	B	C	D	E	
ONE	20	1	1	9	35	66
TWO	4	7	2	2	34	49
THREE	1	3	6	6	4	20
FOUR	7	1	1	3	7	19
FIVE	4	—	—	3	—	7
SIX	3	—	—	5	1	9
SEVEN	3	—	—	—	—	3
EIGHT	2	—	—	—	—	2
NINE	2	—	—	—	—	2
TEN	1	—	—	1	—	2
THIRTEEN	1	—	—	—	—	1
TOTAL	48	12	10	29	81	180

A=Insulin, B=Steroids, C=Antibiotics, D=Vitamin B-12, and E=General crystallography.

Use of channels of communication

Distribution of her 180 publications were in 64 journals and 14 conference proceedings, books, etc. Journalwise scattering of publications of Dorothy C. Hodgkin in various journals is provided in Table 4. She has published 34 papers in *Nature* during 1932-83, 16 papers each in *Journal of the Chemical Society* during 1935-71 and *Proceedings of Royal Society*, London during 1938-74, seven papers each in *Acta Crystallography* during 1951-82, *Biochemical Journal* during 1941-71 and *Reports on Progress in Chemistry* during 1933-52, and five papers in *Chemical Industry*, London during 1933-57. In the highest impact factor journal *Nature* she has published 34 papers. In other highest impact factor journal *Diabetes*, she has published two papers.

Table 4
Journal preference of Dorothy Crowfoot Hodgkin

Rank	Journal	N	Cumulative	Period of journal usage		Country
				FPY – LPY	TY	
1	<i>Nature</i>	34	34	1932-1983	52	UK
2	<i>J. Chem. Soc.</i>	16	50	1935-1971	37	UK
3	<i>Proc. R. Soc.</i>	16	66	1938-1974	37	UK
4	<i>Act. Crystallogr.</i>	7	73	1951-1982	32	Denmark
5	<i>Biochem. J.</i>	7	80	1941-1971	21	UK
6	<i>Rep. Prog. Chem.</i>	7	87	1933-1952	20	UK
7	<i>Chem. Ind. Lond.</i>	5	92	1933-1957	25	UK
8	<i>Z. Krystallogr. Kristallogoem.</i>	4	96	1934-1960	27	Germany
9	<i>Chemiker. Zeitung.</i>	3	99	1970-1984	15	Germany
10	<i>Abstr. Pap Am. Chem. Soc.</i>	2	101	1975-1980	6	USA
11	<i>Biogr. Mem. Fellow. R. Soc.</i>	2	103	1975-1980	6	UK
12	<i>Bull. Atom. Sci.</i>	2	105	1981-1981	1	USA
13	<i>Cold Spring Harb Symp. Quant. Biol.</i>	2	107	1950-1971	22	USA
14	<i>Diabetes</i>	2	109	1972-1972	1	USA
15	<i>J. Chem. Soc. Perk. Trans. 2</i>	2	111	1972-1974	3	UK
16	<i>J. Mol. Biol.</i>	2	113	1966-1966	1	UK
17	<i>Les Prix Nobel</i>	2	115	1965-1965	1	Sweden
18	<i>Soviet Phys. Cryst.</i>	2	117	1972-1981	10	Russia
19	<i>Proc. Ind. Acad. Sci.</i>	2	119	1984-1984	1	India
20	<i>Philos. Trans. R. Soc.</i>	2	121	1970-1988	9	U K
21-80.	Others with only one article each	59	180			

N=Number of papers, FPY=First Paper Year, LPY=Last Paper Year, and TY=Total number of Years.

Journal of Molecular Biology where she has published two papers and in *Biochemical Journal* she has published seven papers. 56.4 percent of her publications were in the journals from following countries, 23 U.K(39.48%), 16 USA(20.5%) and Germany

(6.41%). Average Bradford multiplier was 4.7, publication density was 2.30 and publication concentration was 8.97. The frequency and cumulative number of papers published journalwise and core journals are depicted in Fig. 4.

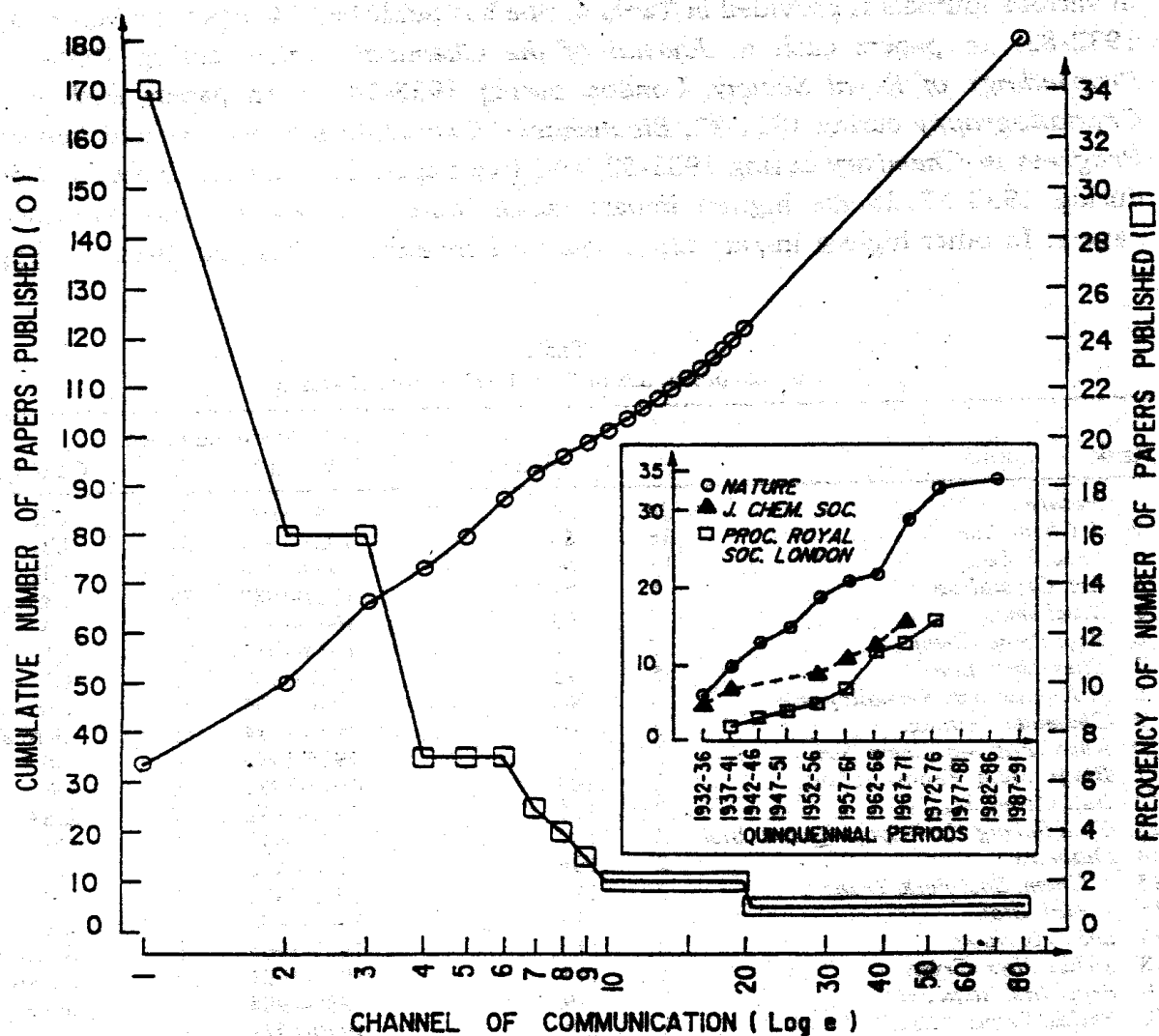


Fig. 4. Bradford-Zipf bibliograph on publications of Dorothy Crowfoot Hodgkin and inset: Quinquennial periodwise cumulative number of publications in the core journals

Analysis of keywords

Titles of the papers are one of the best indicators to understand and grasp instantaneously the thought content of the papers. The titles contain many important words called keywords. The keyword frequencies in the titles of papers is provided in Tables 5-6. High frequency keywords were Crystal Structure(20), Vitamin B-12 (17), X-ray Analysis (14), Insulin Structure (13), X-ray Crystallography(10), Crystal and Molecular Structure(6), Insulin(5) and Rhombohedral Zinc Insulin Crystals. These keywords indicate wide spectrum of interest, materials, methods, instruments used and subjects addressed to by the scientist.

Table 5
Keywords in the titles of the papers of Dorothy Crowfoot Hodgkin having a frequency of two or more

Keyword	Frequency	Keyword	Frequency
Crystal structure	20	Density	2
Vitamin B-12	17	Helvolic acid	2
X-ray-analysis	14	Insulin crystal structure	2
Insulin structure	13	Kathleene Lonsdale	2
X-ray crystallography	10	Molecules in crystals	2
Crystal and molecular structure	6	Proteins	2
Insulin	5	Rhombohedral zincInsulin crystals	2
Rhombohedral zinc insulin crystals	5	Sex hormones	2
Crystal structure of insulin	4	Small crystals	2
Crystallography	4	Structure of calciferol	2
Insulin molecules	4	Structure of penicillin	2
X-ray crystallographic studies	4	Thoistrepton	2
Air dried crystals	3	X-ray measurements	2
Molecular weight	3	X-ray studies	2
Protein crystals	3	Zinc insulin crystals	2
X-ray crystallographic examination	3		
Bernal, J.D.	2		
Centrifuge	2		
Ceventhol	2		
Cinobufagin	2		
Crystal structure of factor VIa	2		

Table 6
Keywords used only once in the title of papers

Acetylcyclohexene; Acetocyclopentene; Adenine hydrochloride; Air-dried insulin crystals; Air-dried tobacco necrosis protein crystals; Ampicillin:the tryhydrate; Ancient history; Androsterone; Animal body; Antibacterial substance; Antipernicious anaemia factor; Arctium minus; Atomic positions; Backerian lecture; Banting memorial lecture; Benzpyrene; 3:4-Benzpyrene; 3:4-Benzpyrene-5, 8-quinone; 3-Benzyl 7-t-butyl 2,2-dimethyl-8-oxo-4thia-1aza-k alpha H-bicyclo (4.2.0) octone-3c, 7alpha-dicarboxylate; Biological activity; Birkbeck; Black nitrosylpentamminecobalt dichloride; 6C-bromacetyl- and 6C-chloracetyl-3,5alpha-cyclo-5alpha-cholestane-Ci-Cholestane bromoacetate and chloroacetate; Butagin; Gamaac-15-cyano-1,2,2,7,7,12,12-hepatamethyl corrin hydrochloride; Calciferol; Calciferous derivative-crystal structure; cardiac aglucones; Cephalosporins; ceventhridine; Chemistry; Chemistry and bio-chemistry of insulin; Chemistry and biology of insulin; Chemistry of steroids; Chemistry of sterols; Chinese work on insulin; Cholesteryl iodide; Complicated molecules; Compounds of bio-chemical interest; Condensation products; Corrin nucleus; Cross-linked derivative; Crystal chemistry; Crystal structure of cobyric acid; Crystal structure of hexacarboxylic acid; Crystal symmetry; Crystalline forms; Crystalline modifications; Crystalline pepsin; Crystalline phases; Crystallographic data; Crystallographic examination; Crystallographic investigations; Crystallographic measurements; Crsyallographic study; Crystallography-1947,1948,1949; Cyanocobalamin; demonstration; Alpha C-Diethyldibenzyl series; 8,12-Diethyl-2,3,7,13,17,18-hexamethylcorrole hydrobromide; 12-Diethyl 1-2, 3, 7, 13, 18-hexamethylcorrole; Diamminopalladium compounds, 5, 6-Dimethylbenzimidazolylcobamide coenzyme; Diel's hydrocarbon C18H16; Dimethyl thallium halides; Dorothy Wrinch; Electron-microscope data; Fascination for discovery; Fatty acids; Fichtelite; Fifty years of x-ray diffraction; Fourier refinement; Fusidic acid; Gerhard schmidt; Gliotoxin globular protein molecules; Gramicidine derivatives; Growing points; Henry Dale lecture; Hexacarboxylic acid; Histidine hydrochloride; Hydrocarbons; Hydolysis; 8-Hydroxy-3,4 benzpyrine; Insulin activity; Insulin residues; Insulin-secondary and tertiary structure; Insulin-spatial structure; Insulin-structure and biological activity; Insulin-three dimensional atomic structure; Lactoglobulin; Layer-chain structures; Lead; Least squares; Lessons from history; Liquid crystals; Medicine; Mercury (II) Chloride; Metabolism of 3,4-benzpyrene; Metal free corrin; Methoxyturalone; Methyl ester; Methyl ester 3-p- bromobenzoate; Mice and rats; Microcosm; Molecular basis of insulin action; Molecular crystals; Molecular shape; Molecular symmetry; Moments of discovery; Mona wax; Monocarboxylic acid; Monoclinic ferroverdin crystals; Morphine; Neovitamin B-12; Neutron diffraction analysis; Neutron diffraction studies; Nitrosoisobutane; Nobel Lecture; Nucleic acids; Oestrone; Onopordon tauricum; Organic compounds; Oxidation product; Para-bromonitrosobenzene; Patterson and Pattersons; Pencillins; Peptide chain models; Peptides; Phase refinement; Phenoxymethyl pencillin; Phrenosonic (Cerebronic) acid; Piloty compounds; Progesterone; Propyryns; Protein x-ray analysis; Protien structure; Rhombohedral ferroverdin crystals; Rhombohedral insulin crystals; Science and history; Sterol structure; Sterols; Sticking points; 3-Strophanthidin; Structural crystallography; Structural ralationships; Structure analysis; Structure and biology of insulin; Structure of bromisterol; Structure of CephalosporinC; Structure of ferroverdin; Structure of lumisterol; Structure of proteins; Structure of red nitrosylpentamminecobalt (III) cation; Subcutaneous injection; Supersterol II; Synthetic compounds; Testosterone; Thakllium di-alkyl halides; Three-dimensional arrangement of atoms; Toad poisons; Tobacco necrosis virus derivatives; Tobacco seed globulin; Trans-and cis-1,4-dichloro-1,4-dinitrocyclohexane; Two crystalline modifications of insulin; Two-zinc insulin hexamer; Varieties of insulin; Vitamin B-12; Wandering scientist; Weissenberg photographs; Wet crystals; Wet insulin crystals; X-ray crystallographic data; X-ray crystallographic measurements; X-ray neutron diffraction studies; X-ray photographs; X-ray single crystal photographs of insulin; X-ray work; 4-Zinc-insulin; Zinc pig insulin crystals.

Conclusions

Quantitative analysis and graphic presentations of the publication productivity of a scientist facilitates easy and clear perceptions about the work of a scientist. Team of research collaborators working with a successful scientist documents the sociological aspects of history of science while generating knowledge by a leader in a domain. Core journal titles and keywords in the titles of the articles provide glimpses of the domains of interest to the researchers. This methodology has become successful in projecting the work of role model scientists.

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Appendix

DOROTHY CROWFOOT HODGKIN

Born on 16th May, 1910 in Cairo, Egypt

Father: John Winter Crowfoot

Mother: Mary Crowfoot

Education: Sir John Leman School, Beccles(1920) and Sommerville College, Oxford, (1928), Graduation, (1932), D.Phil (1937), Cambridge University (Dissertation: X Ray crystallography on the chemistry of steroids).

Marriage: Married to Thomas L. Hodgkin, (1937)

Children: Luke(1938), Elizibeth(1941), Toby (1946)

Positions held: University Lecturer and Demonstrator, Sommerville College (1946); University Reader in X-ray crystallography (Oxford), (1956); Wolfson Research Professor, Royal Society (1960-1977); Chancellor, Britol University (1970-1988).

Honours and Awards: elected Fellow of Royal Society (1947); Royal medal of Royal Society (1957); Nobel prize for Chemistry(1964); appointed to the order of merit by Queen Elizabeth (1965); President, International Union of Crystallography (1969-1975); President, Pugwash Conferences on Science and World Affairs(1975); President, British Association of Advancement of Science(1977-1978); Michael Lomonosov Gold Medal (1982); Dimitrov Prize (1984); Lenin Peace prize (1987) and Honorary Fellow, Bristol University (1988-)

Foreign member of: Royal Netherlands Academy of Sciences and Letters; American Academy of Arts and Sciences; Bavarian Academy; Yugoslov Academy of Sciences; Ghana Academy of Sciences; Puerto Rico Academy of Sciences; Australian Academy of Sciences; Leopoldina Academy of Sciences; Norwegian Academy of Sciences; Indian Academy of Sciences; Royal Irish Academy of Sciences; National Academy of Sciences, USA; Honorary member of USSR Academy of Sciences (1976), Royal Institute of Great Britain (1988-); Honorary Fellow of Somerville College (Oxford); Lincare College (Oxford); Griton College (Cambridge); Newman College (Cambridge).

Honorary Doctor of Science by the following universities: Leeds, Exter, Manchester, Kent, Cambridge, Mount Sanai Sussex, Bath, Ghana, Chicago, Hull, East Anglia, Narwick, London, Oxford, Delhi, St. Andrews, Harvard, Bristol, Dalhousie, Zagreb, York, Open, Modena.

Died: on 29th July 1994.