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THE PUBLICATION RECORDS OF CERTAIN AMERICAN CHEMISTS

ROBERT T. LAGEMANN

Vanderbilt University, Nashville, Tennessee

It is the purpose of this report to present information on the number of scholarly papers published by the members of a select group of chemists, namely, those starred¹ in *American Men of Science*, and to give the educational backgrounds of these men. More specifically, data will be given on the average number of papers published each year by each starred chemist, the number he publishes in his working lifetime, the institutions where starred chemists received their bachelor's degrees, and the institutions granting them the doctorate. This study gains added interest because of the existence of a recent similar report (Lagemann and Alter, 1948) on the publication records of starred physicists, so that comparisons can be drawn.

Although there is to be available a compilation² of certain personal information, including educational backgrounds, for more than 9,000 chemists listed in the 1944 edition of *American Men of Science*, it is a forbiddingly tedious task to gather information on their publication records. Instead, for the present study, the literary productivity of those 263 men, who have been starred as an indication of their outstanding contributions to chemistry, have been examined carefully for a 36 year period ending with 1942.

The productivity of these men will be measured, by definition, by the number of papers abstracted under their names in "Chemical Abstracts." It is clear that this criterion will not be an exact measure of a chemist's contribution to his science; it omits books and popular articles, the influence of his teaching, and his work on committees and commissions, for example. Nor can such a compilation as appears herein hope to measure the quality of the papers, be it judged now or later. The number of papers abstracted is merely a statement as to quantity of titles published.

¹In the preface to the first edition of *American Men of Science*, it is stated that a star placed in a biographical sketch means that the subject of the sketch is probably among the leading scientists in the United States whose work is thought to be the most important. For each science, the starred men are selected by ten leading workers in that field. The names of the members of the selection committee are not revealed by the editor.

²Lagemann, R. T., "A study of the educational backgrounds of the chemists listed in *American Men of Science*," soon to be published in the *Journal of Higher Education*.

PROCEDURE

In order to make some correlation with the similar study on physicists, the chemists selected for this survey were those listed in the seventh (1944) edition of *American Men of Science*, the last edition in which men are starred. Their names were obtained through a page-by-page search during which a list was compiled of those who listed chemistry or some of its branches as their field. Altogether, 263 names were recorded. During this process, there were also listed for each man the names of the institutions which granted the bachelor's, master's, and doctor's degrees, together with the year in which each degree was granted.

The author's index of *Chemical Abstracts* was then used for each year from 1907 to 1942, inclusive, to obtain for each starred chemist the number of papers abstracted^a for each year of the man's working life. The working life, for those men possessing an earned Ph.D. degree, was taken from and included the year in which the degree was obtained and extended through 1942. For those men, generally the older ones, who received a bachelor's degree but not a doctorate, the active period was chosen as beginning during the year in which the bachelor's degree was received and extending through 1942. The survey was not extended beyond 1942, because many chemists had gone into war research projects about that time; also the physics study covered only work done through that year. Credit for a paper was given to a man even though he was a co-author. Letters to the Editor, Notes, and Patents were included so long as they were listed in *Chemical Abstracts*.

Since the 1944 edition of *American Men of Science* lists only men living at the time of its publication, the 36 year period covers in many cases the entire working period of the oldest chemists included. For the younger men, only the early periods of their careers are covered. No effort was made to determine when a man retires from publishing, and every man, no matter what his age, was carried through 1942. No attempt was made to discover which period of a man's life had been most productive in numbers of papers published.

RESULTS

In table 1 are listed the institutions from which two or more starred chemists received the bachelor's degree. Fifty-six colleges not listed in the table graduated one starred man each. It is seen that the colleges enrolling the larger numbers of students show the larger numbers of men graduated who were later starred. Thus Harvard, M. I. T., Ohio State, Michigan, and Princeton head the list. Indeed, from these larger institutions—those of university standing where graduate work in chemistry is carried on—over 80 percent of the 263 starred men received their baccalaureate degrees. One might suggest, among other reasons, that high school graduates who have decided to be

^aNot necessarily submitted or published during that year. Books and popular articles are not included. Patents are included.

chemists choose institutions where graduate work is available, or that once in college students who are in contact with graduate students and graduate departments decide that a professional career in chemistry is attractive.

Nonetheless, a few small liberal arts colleges are outstanding in the numbers of the graduates who later became starred chemists. These are Williams, Amherst, and Wesleyan—all located in Massachusetts—and Albion, DePauw, Haverford, Miami, Pomona, Worcester, Wooster, and Vermont. Especially are these smaller colleges outstanding in the ratio of starred chemists to the total number of graduates (see column three of table 1) who become chemists listed in *American Men of Science*. Here, Williams leads with 24 percent, followed by Albion, Amherst, and Vermont, with only Princeton (of the university class) close behind. The success of the several small liberal arts institutions as revealed in table 1 is probably due in large part to a few men. It would be interesting to discover who the teachers were in each of those departments of chemistry during the period studied.

Turning to a consideration of the institutions granting the Ph.D. degree to chemists who were later starred, one can see in table 2 that Harvard also leads here in total number, as it did for the baccalaureate. Next in order are California, Chicago, Johns Hopkins, Leipzig, Yale, and Illinois. Interestingly enough, 27 starred men possessed no earned doctorate. The ratio of starred chemists who received the doctorate from each institution to the total number of chemistry Ph.D.'s from that same institution and who were listed in *American Men of Science* is given in column four of the table. Harvard again is at the top with about 10 percent. California stands high, as do the California Institute of Technology, Princeton, and Brown. It was found that 27 of the starred chemists never formally earned the Ph.D. degree, whereas for the almost equal group of physicists (Lagemann and Alter, 1948) a smaller number, or 19, never formally earned the degree. It will be noted that a considerable number of the men received their Ph.D. degrees at foreign universities, which were mainly German.

The average scholarly production of the starred men is given by schools in table 3. To obtain these data, a compilation was made for each man as to the number of papers abstracted during each calendar year of that individual's working period. The individual records were then collected under their respective Alma Maters, and the averages of column three were drawn up. From the table, it may be seen that Columbia leads in the category of "quantitative" productivity of scholarly papers in chemistry, with Berlin, the California Institute of Technology, Michigan, and Harvard high on the list. With so few cases involved, it should be remembered that one individual of outstanding accomplishment can affect the record of his school considerably.

From cursory inspection only, there does not appear to be any significant correlation between the record by schools for chemists

and the record by schools for physicists in the matter of publications. It is interesting that the average number of papers per man per year

TABLE 1. Institutions granting bachelor's degrees to two or more chemists who were later starred

INSTITUTION	NUMBER OF STARRED MEN GRANTED BACHELOR'S DEGREES	TOTAL NUMBER ¹ OF BACHELOR'S DEGREES GRANTED IN CHEMISTRY	RATIO OF NUMBER STARRED TO NUMBER GRADUATED (PERCENT)
No bachelor's degree listed . . .	17		
Harvard	16	188	8.5
Massachusetts Institute	10	220	4.6
Ohio State	10	151	6.6
Michigan	9	188	4.8
Princeton	9	66	13.6
Chicago	8	161	5.0
California	8	156	5.1
Yale	8	112	7.1
Illinois	7	272	2.6
Williams	6	25	24.0
Toronto	5		
Pennsylvania	5	139	3.6
Minnesota	5	139	3.6
Kansas	5	92	5.4
Columbia	5	132	3.8
Wisconsin	5	206	2.4
Amherst	4	32	12.5
Cornell	4	145	2.8
Edinburgh	4		
Wesleyan	4	46	8.7
DePauw	3	49	6.1
Liverpool	3		
Nebraska	3	84	3.6
Albion	2	12	16.7
Brown	2	52	3.9
California Institute	2	50	4.0
City College of New York	2	104	1.9
Colorado	2	58	3.5
Dalhousie	2		
Haverford	2	22	9.1
Kentucky	2	39	5.2
Manchester	2		
Miami	2	32	6.3
New York University	2	43	4.7
Oberlin	2	73	2.7
Oregon State College	2	31	6.5
Pomona	2	23	8.7
Royal College of Science	2		
Stanford	2	77	2.6
Syracuse	2	58	3.5
Washington (Seattle)	2	108	1.9
Washington (St. Louis)	2	37	5.4
Worcester Polytechnic	2	37	5.4
Wooster	2	28	7.2
Vermont	2	20	10.0

¹From a study of the educational backgrounds of over 9,000 chemists listed in *American Men of Science*, soon to be published by the author in the *Journal of Higher Education*.

written by the "no doctorate" starees is definitely below the average for the holders of the doctorate. For physicists, the two were equal.

The average output of papers per starred chemist each year was 2.87; per starred physicist, it was 0.93, or about one third the output per starred chemist. (The figure 2.87 was obtained from our compilation, which gave 22,963 papers published from 1907 to 1942 by the 263 starred chemists who worked a total of 8,008 man-years.)

The publication records of those starred chemists who published 100 or more papers in the 36 year period studied are given in table 4. This arrangement, of course, favors the older chemists who were

TABLE 2. *Institutions granting the doctorate to two or more chemists who were later starred*

INSTITUTION	NUMBER OF PH.D. ¹ GRADUATES WHO BECAME STARRED	TOTAL NUMBER ² OF PH.D.'s GRANTED IN CHEMISTRY	RATIO OF NUMBER STARRED TO TOTAL CHEMISTS GRADUATED WITH PH.D. (PERCENT)
Harvard	29	275	10.5
No doctorate	27		
California	22	231	9.5
Chicago	16	388	4.1
Johns Hopkins	15	359	4.2
Leipzig	13		
Yale	13	303	4.3
Illinois	11	415	2.7
Columbia	9	475	1.9
Göttingen	8		
Massachusetts Institute	8	252	3.2
Pennsylvania	8	170	4.7
Princeton	8	136	5.9
California Institute	7	88	8.0
Wisconsin	7	439	1.6
Berlin	6		
Cornell	6	303	2.0
Heidelberg	5		
Michigan	5	206	2.4
Brown	4	69	5.8
Ohio State	4	327	1.2
Breslau	2		
Edinburgh	2		
Liverpool	2		
London	2		
Minnesota	2	217	0.9
Munich	2		
New York University	2	115	1.7
Pittsburgh	2	109	1.8
Vienna	2		

¹A few M.D.'s and D.Sci.'s are included.

²From a study of the educational backgrounds of over 9,000 chemists listed in *American Men of Science*, soon to be published by the present writer in *Journal of Higher Education*.

publishing throughout this period. There were 111 of these men. The most prolific writer in terms of total papers and patents published is Gustav Egloff (552), with I. M. Kolthoff (512) close behind. Following these are H. Gilman, R. Adams, V. N. Ipatieff, T. B. Johnson, and M. Bergmann, in the order named.

The most prolific workers in any particular year were Egloff (with 53 papers and patents in 1940); Gilman—46 in 1930; Adams—with 42 in 1926; Kolthoff—34 in 1924; Fieser—28 and 32 in 1939 and 1940, respectively; Shepard—29 in 1926; and Bergmann, Mark, and Whitmore—28 each in single years.

Three chemists were starred who have never published a paper which has been abstracted in *Chemical Abstracts*; three others had published but one. Only one woman was starred.

It may be of interest to consider the average rate of production. This is given in column four of table 4. Here, Kolthoff and Egloff again are outstanding, with about 20 papers per working year on the average. Next are Henry Gilman (14 per year); Louis F. Fieser, Herman Mark, and Roger Adams (11 per year).

It might be well to repeat that the information contained herein pertains only to the starred chemists listed in *American Men of Science*. When only a few men are considered, one must beware of forming hasty judgements of the records compiled for the institutions these men represent. Lastly, it must be remembered that the information represents the records of the schools having long established programs of graduate work and covers a period ending about ten years ago. (Stars were first awarded in 1903, and, once a man was starred,

TABLE 3. *Papers published per starred Ph.D. graduate per year for those schools having four or more Ph.D. graduates starred*

INSTITUTION	NUMBER OF PH.D. GRADUATES STARRED	PAPERS PER MAN-YEAR
Columbia.....	9	5.46
Berlin.....	6	5.12
Michigan.....	5	3.89
California Institute.....	7	3.70
Harvard.....	29	3.45
Chicago.....	16	3.28
Princeton.....	8	3.24
Heidleberg.....	5	3.06
Illinois.....	11	3.04
California.....	22	2.93
Ohio State.....	4	2.90
Massachusetts Institute.....	8	2.88
Cornell.....	6	2.79
Brown.....	4	2.69
Wisconsin.....	7	2.67
Göttingen.....	8	2.64
Leipzig.....	13	2.54
Yale.....	13	2.40
No doctorate.....	27	2.13
Pennsylvania.....	8	2.12
Johns Hopkins.....	15	1.54

TABLE 4. A list of those starred chemists who had published 100 or more papers up to 1943, arranged in order of total papers published

STARRED CHEMIST	PAPERS PUBLISHED UP TO 1943	TOTAL WORKING YEARS UP TO 1943	PAPERS PER YEAR	RATE ORD _{ER} NUM
Gustav Egloff.....	552	27	20.4	2
Isaac M. Kolthoff.....	512	25	20.5	1
Henry Gilman.....	354	25	14.2	3
Roger Adams.....	338	31	10.9	6
V. N. Ipatieff.....	332	36	9.2	8
Treat B. Johnson.....	322	36	8.9	10
Max Bergmann.....	309	32	9.7	7
Samuel E. Shepard.....	294	36	8.2	12
Edwin B. Hart.....	263	36	7.3	14
Wilder D. Bancroft....	260	36	7.2	15
Leonor Michaelis.....	255	36	7.1	16
Harold Hibbert.....	250	36	6.9	17
Herman F. Mark.....	242	22	11.0	5
Hugh S. Taylor.....	231	29	8.0	13
William D. Harkins....	229	35	6.5	21
James W. McBain.....	219	35	6.3	22
Donald D. Van Slyke...	214	36	5.9	24
Louis F. Fieser.....	213	19	11.2	4
Marston T. Bogert....	211	34	6.2	23
Carl S. Marvel.....	209	23	9.1	9
Colin G. Fink.....	207	36	5.8	25
Walter A. Jacobs.....	204	36	5.7	26
Arnold C. Fieldner....	199	36	5.5	28
C. S. Hudson.....	192	36	5.3	29
H. C. Sherman.....	188	36	5.2	30
E. Emmett Reid.....	183	36	5.1	31
Ralph H. McKee.....	182	36	5.1	31
Raymond F. Bacon....	179	36	5.0	32
Gregory B. Baxter....	171	36	4.8	33
Irving Langmuir.....	171	36	4.8	33
Frank C. Whitmore....	171	29	5.9	24
George L. Clark.....	166	25	6.6	20
Morris S. Kharasch....	159	24	6.6	20
Homer B. Adkins.....	156	27	5.8	25
Kenneth C. Hickman..	149	18	8.3	11
Charles A. Browne....	147	36	4.1	38
E. C. Benedict.....	145	36	4.0	39
Arthur M. Buswell....	143	26	5.5	28
Ernest A. Hauser.....	142	21	6.8	18
Ralph G. Wyckoff....	140	24	5.8	25
R. J. Anderson.....	139	24	5.8	25
S. F. Acree.....	137	36	3.8	40
Edgar T. Wherry.....	137	34	4.0	39
B. T. Brooks.....	132	31	4.3	36
Linus C. Pauling.....	131	18	7.3	14
James B. Conant.....	130	27	4.8	33
Howard B. Lewis.....	126	30	4.2	37
Edward Bartow.....	125	36	3.5	42
Victor K. LaMer.....	122	22	5.5	28
Charles D. Hurd.....	121	22	5.5	28
Hans T. Clarke.....	120	29	4.1	38
John H. Northrop.....	120	28	4.3	36
G. N. Lewis.....	118	36	3.3	43
Lee I. Smith.....	118	23	5.1	31
Hubert B. Vickery....	118	21	5.6	27

Tenney L. Davis.....	117	26	4.5	35
Carl L. Schmidt.....	117	27	4.3	36
Worth H. Rodebush...	112	26	4.3	36
Henry D. Dakin.....	110	36	3.1	44
Herbert S. Harned.....	109	30	3.6	41
Reynold C. Fuson.....	108	19	5.7	26
Vincent du Vigneaud...	107	16	6.7	19
S. B. Hendricks.....	104	36	2.9	45
Samuel C. Lind.....	104	36	2.9	45
Ralph L. Shriner.....	102	18	5.7	26
Charles P. Smyth.....	101	22	4.6	34

¹By rank order number is meant the rank according to the average number of papers published per working year as listed in column four.

he remained so.) Further information concerning starred scientists may be obtained from the excellent compilation by Visser (1947). Sampey (1946) has given a list of the number of starred chemists who received their master's degrees and their Ph.D. degrees from each of the several institutions which granted the larger numbers of such degrees. His compilation is also based on the 1944 edition of *American Men of Science*. The few small discrepancies between his table and our table 2 are attributed mainly to our inclusion of chemists who listed chemistry as one of two specialties.

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THE ROYALFERN, THE CINNAMONFERN, AND THE INTERRUPTED-FERN IN TENNESSEE

JESSE M. SHAVER

George Peabody College for Teachers, Nashville, Tennessee

Cinnamonfern (Continued from July number). It resembles sterile leaves

Fig. 205. (Opposite page.) A single fertile plant of the cinnamonfern, Benton County, Tennessee. Photographed in April, 1935.