STATISTICAL ANALYSES OF INTERNATIONAL CHEMICAL RESEARCH BY INDIVIDUAL CHEMISTS, LANGUAGES AND COUNTRIES *

by

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Since June 1960, the Institute for Scientific Information has published the INDEX CHEMICUS. It is important for the reader to understand the scope and selection policies of INDEX CHEMICUS to appreciate the significance and conclusions to be drawn from this statistical report which is based on data extracted from the INDEX CHEMICUS.

The INDEX CHEMICUS is concerned primarily with novum organum -- new chemical compounds. For this reason the INDEX CHEMICUS is primarily of interest to organic and synthetic chemists, pharmacologists, agricultural chemists, medicinal chemists -- all those who are essentially "molecule manipulators". However, INDEX CHEMICUS does also cover new inorganic and metallo-organic compounds.

We wish to stress that this study, unlike most of the studies to be cited, is not based on a sampling. The unique selection criteria of the INDEX CHEMICUS, combined with the fortunate availability of indexing productivity records, has enabled us to compile this data with a minimum effort, a job that would otherwise be almost impossible without great expense.

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At the Institute for Scientific Information, a precise record is kept for each journal indexed, indicating the articles indexed and the number of compounds contained in each article. In the published issues of the INDEX CHEMICUS itself each abstract of a published article has a unique serial number and each compound indexed has a unique compound or line number. Consequently our inventory and production statistics correspond almost 1 to 1 to the data for the published issues.

This study is based on four years of indexing, 1960 through 1963. In Table I there is a tabulation of the exact number of articles covered for each year of the literature. The table also shows the corresponding number of compounds indexed. As will be seen later, this data is quite different from the number of abstracts published in each year of the INDEX CHEMICUS itself. (See Table II)

Table I

	Abstracts	Compounds	Cpds./Abst.	% Increase Abstracts	% Increase over 1960
1960	7,581	70,408	9.3		
1961	9,167	87,496	9.5	20.9%	20.9%
1962	9,899	94,172	9.5	7.4%	30.6%
1963	10,838	100,623	9.3	9.5%	43.0%
Totals	37,484	352,699	9.4	(Av.)12.5%	

It can be seen that over a four-year period the average number of compounds per paper has remained remarkably constant. Keep in mind, however, that these are not the same figures as one obtains for the number of abstracts and compounds indexed in the INDEX CHEMICUS itself, because the year of an abstracting service rarely corresponds to the year of the literature itself. (See Table II) For example, many of the

articles published in December 1963 were indexed in January and February 1964 issues of the INDEX CHEMICUS.

Table II
IC Data

	Abstracts	Compounds	Cpds/Abst.
1960	2,917	25,936	8.9
1961	11,655	110,087	9.5
1962	9,625	89,831	9.3
1963	11,373	107,619	9.5
TOTALS	35,570	333,473	9.4

During the past few years, there has been a growth of about 9% per year in the literature of organic chemistry. We have discounted the larger growth that took place in the literature from 1960 to 1961. There was therefore an average growth of 12.5% per year.

Analysis by Journal

Table IIIa is the first tabulation of its kind, we believe, to be published. It shows, over a four-year period, the exact number of articles abstracted and the exact number of compounds indexed in the INDEX CHEMICUS for the world's leading "chemical" journals. This data is vital because it gives important perspective on the extent of the so-called literature explosion. Though chemistry is germane to almost every branch of scientific investigation, only a small percentage of scientific journals report chemical articles that include new compounds and therefore satisfy the criteria of the INDEX CHEMICUS. It is interesting

to consider how many journals actually exist which include the word chemistry in the title. The leading 100 journals covered in the INDEX CHEMICUS include 71 of this type. In all probability there are no more than a few hundred such journals throughout the world, and, as will be seen from this study, only about half of them are journals of major significance for organic chemistry.

See Tables IIIa and IIIb (Appended)

Thus, from Table IIIb it can be seen that 10 journals account for 49.5% of the articles, 25 journals account for 72.1%, 50 journals account for 89.5%, and 100 journals 98.3% of the total. Fifty-five journals only add 1.7% more. Chemical librarians will recognize the importance of these figures in their acquisitions programs.

The main purpose of this study was to determine the language distribution of chemical journals. Such data is of importance to educators and administrators of information systems. For example, should a pre-doctoral graduate student in organic chemistry study French and German or Russian and Japanese? Before examining the data, one should never forget that organic chemists are frequent users of the older chemical literature.

The data in Table IIIb is also shown in a graph in which the number of journals is plotted against the totals for articles and then for compounds. (Figure 1)

Naturally the rankings of journals change -- new journals are founded, as for example J. HETEROCYCLIC CHEMISTRY which doesn't appear in this list. Others change titles (J. PHARM. SCI.), and others

subdivide (J. SCI. IND. RES.). This adds to the difficulties in making consistent comparisons. However, yearly tabulations of this type will be useful in watching changing developments.

Analysis by Language

In Table IVa language data is given for 36,730 articles and 347,535 compounds analyzed in this study. These figures are given in percentages and are based on the top 100 journals only.

Table IVa

Language	1960		1961		1962		1963		TOTAL	
	A	C	A	C	A	C	A	C	A	C
English	49.9	49.4	53.0	53.3	52.1	50.9	53.8	52.5	52.4	51.7
German	16.9	18.7	16.4	18.8	16.2	18.3	16.5	19.1	16.4	18.7
Russian	14.7	13.1	16.0	12.6	16.4	13.3	16.2	13.4	15.9	13.1
French	7.5	8.6	5.2	6.1	5.8	7.3	6.0	7.2	6.1	7.2
Japanese	7.0	6.2	5.7	5.3	6.5	6.0	3.5	3.2	5.3	5.1
Italian	2.4	2.9	2.0	2.6	2.0	2.6	2.4	3.4	2.2	2.9
Others	1.6	1.1	1.7	1.3	1.9	1.6	1.6	1.2	1.7	1.3

Key A = Articles C = Compounds

This table reveals some extremely interesting trends or lack of them. The percentage of English articles is remarkably consistent over the four-year period. Whatever fluctuation there is might be dependent upon the amount of Japanese publication. In other words, one might attribute the slight fluctuations in the English percentages to the percentages for Japanese. This has been verified by checking the data for the Japanese journals published in the English language as shown in Table IVa (Japanese data). In 1963 there is a definite increase in

English and a drop in Japanese articles originating from Japan. By observing the total number of source articles published in these journals in 1963, it has been determined that the fluctuation is not due to the selection criteria of INDEX CHEMICUS.

Table IVb

JOURNAL TITLE	1960		1961			1962			1963			1960-63	
	A	C	S	A	C	S	A	C	S	A	C	A	C
CHEM.PHARM.BULL.JAPAN (E)	175	1603	208	167	1597	243	166	1993	359	235	2223	743	7416
BULL.CHEM.SOC.JAPAN (E)	122	794	468	131	1114	522	156	1275	418	122	981	531	4164
AGR.BIOL.CHEM. (E)	30	171	173	53	568	147	40	299	155	50	412	173	1400
J.ANTIBIOTICS (E)	13	33	71	22	92	62	26	86	44	16	72	77	283
J.BIOCHEM.TOKYO (E)	7	64	219	21	89	157	17	71	180	21	74	66	298
J.PHARM.SOC.JAPAN (J)	242	2174	-	226	2480	387	247	2765	249	165	1644	880	9063
J.CHEM.SOC.JAPAN(PURE) (J)	195	1343	503	151	1224	370	129	1105	265	87	712	562	4384
J.CHEM.SOC.JAPAN(IND.) (J)	63	656	567	61	381	546	85	623	493	84	610	293	2270
J.SOC.ORG.SYN.CHEM.J. (J)	-	-	112	29	244	132	51	861	100	12	90	92	1195
J.AGR.CHEM.SOC.JAPAN (J)	19	113	321	44	240	217	20	135	161	5	26	88	514
CHEM.HIGH POLYMERS,J. (J)	-	-	-	-	-	116	13	109	119	16	57	29	166

Key S = Source articles scanned, A = Articles covered in IC, C = Compounds listed in I

A significant percentage of the German language articles were written by Swiss scientists, mostly in HELVETICA CHIMICA ACTA. Though a small country, Switzerland has one of the world's leading pharmaceutical industries.

Almost all the literature written in Russian is produced by Soviet chemists. (Our figures include papers published in Ukranian.) Similarly, most of the articles written in the French language were published in France. These are in contrast to the data on German language articles. German is still a widely used international language of chemistry.

The analysis of English language journals is the most significant and difficult, since English is widely used as the language of science. A comprehensive analysis of the English language data revealed that 8613 new chemical papers, or 45%, of the 19,246 written in English were

published in U.S. journals. It was further determined by an article-by-article examination of the INDEX CHEMICUS during the 1960-63 period that 88.6% of the articles published in U.S. journals are, in fact, a result of U.S. research while 4.7% of the articles published in foreign journals were actually reports of research performed in the U.S. Though in total less than 25% of the world's chemical research was produced in the United States, the U.S. retains undisputed first place. These figures do not justify any provincial attitudes on our part. Over 75% of the research covered in the INDEX CHEMICUS is foreign research.

Most Productive Organic Chemists

In Table V there is a rather unusual compilation of the 103 organic chemists throughout the world with the highest publication rates. Naturally many of these names will come as no surprise to organic chemists. But, on the other hand, we believe that a number of highly productive chemists in this list may not be too well known to many of their colleagues in other countries.

See Tables V and VI (Separate Pages)

The data in Tables V and VI are best described as sociometric tables. As with any data of this kind one must always keep in mind the way in which it was compiled, namely, by examining the cummulative author indexes to the INDEX CHEMICUS. In some respects, this data tells us less about individuals than it does about groups or countries. To merely state that a man had his name on 100 papers over a four-year period is not an adequate qualitative measure of his rank as an organic chemist. For this part of the four-year study of 38,055 articles abstracted in the INDEX

CHEMICUS, we prepared 100,695 author index punched cards, an average of 2.65 per abstract. This is important to note, as the summation of articles for all authors would not equal the number of articles published, but rather the number of index entries.

In Table VI one is impressed with the disproportionately large number of Soviet authors among the top 100 chemists. One possible explanation of this observation is that the Soviet practice might be to present an exceptionally large number of authors per paper while maintaining relatively stable groups of co-authors. In such a case, each of the individual authors have a better probability of accumulating enough articles to rank among the top 100. However, there is neither an unusual number of authors per Russian paper nor did the 30 Russian authors on this list co-author papers in such a way as to increase their representation. One possible explanation one can offer is that leading Soviet chemists appear to be more prolific than others. Perhaps **this shows that leading chemists are provided maximum possible support. On the other hand Soviet chemists may publish more frequently for other reasons.**

Another aspect of this list may be examined by determining how many times the chemist in question chose to place his name first on the papers he authored. Thus, in Djerassi's case, his name appeared first 54 times out of his total of 117. In the case of Sorm, his name was first on 5 papers. It is difficult to attribute significance to these data, but they stress the differences in sociometric analyses based on first author versus complete author data.

Another interesting comparison is to see how these men ranked on the basis of the number of citations to their work in the SCIENCE CITATION INDEX. There is a slight bias here as the SCI data is based

on 1961 citations only, whereas the overall study covers 1960-63. There are some names in this list which would not have appeared had the study been limited to e.g. 1960 publications. Based on 1961 SCI data most of the Soviet chemists fall out of the list. This may be due to many factors but certainly failure to cite their work correlates with the fact that they are not as well known to Western scientists as other Soviet chemists who are frequently cited. Their fields of research, on the other hand, could be so different that their work may not warrant citation at the present time.

As far as number of compounds is concerned, our sampling shows that there is considerable variation. Consequently, a ranking by the number of compounds reported for each individual might produce a very different list. For example, Djerassi's 117 articles contained 1220 new compounds, an average of 10.4 per paper as compared to the overall average of 9.45. The figures in Table V are not based on compounds reported by these individuals, but rather on the number of articles published. Consequently there may be certain chemists who infrequently publish articles which contain large numbers of compunds. Papers reporting 50 to 100 compounds are frequently found in the INDEX CHEMICUS. Unfortunately, however, our production figures are not organized so as to permit us to make an exact count of the number of compounds reported by each indivudal chemist. We also have not made corrections for duplication that occurs as a result of publishing preliminary communications. However, it should be noted that in general, as seen in Table III, journals such as CHEMISTRY AND INDUSTRY report a much smaller number of compounds per paper, and the follow-up versions of preliminary communications usually give many more compounds than reported originally.

One might expect that pharmacologists occupy a prominent place in these lists because they must prepare long series of compounds for biological testing. However, this is only a guess. Agricultural chemists produce long series of homulogus compounds or Markush similar cases can be cited for dye chemistry, etc.

Clearly the sociometric "victory" here (i.e. the predictive value of the sociometric data) is that the leading chemist of each country, in terms of publications, is clearly an outstanding internationally recognized organic chemist. Sorm (Czech), Barton (England), Buu-Hoi (France), Wittig (Germany), Seshadri (India), Bergmann (Israel), Testa (Italy), Tsuda (Japan), Bowers (Mexico), Michalski (Poland), Cherbuliez (Switzerland), Pelkis (Ukraine), Djerassi (USA), Andrianov (USSR), are clearly all outstanding chemists.

Table VI (geographical) shows the list arranged by countries. Unquestionably the Soviet Union has the highest number of chemists on this list, which, including the Ukraine, is 30 chemists. These chemists produced 1910 INDEX CHEMICUS papers. Since the Soviet Union produced 5838 articles during this four-year period, these 30 chemists accounted for 32.7% of the Soviet articles. (See Figure 3) Of these, the top 18 accounted for 1415 Soviet papers or 24.2%. Eighteen German chemists produced 761 papers out of a total of 4953 German articles or 15.4%, and 18 U.S. chemists produced 818 or 9.5% of U.S. papers.

The top 16 U.S. chemists in this list accounted for 8.7% of U.S. publications or 756 papers out of a total of 8645 as compared to 22.3% for the top 16 Russian, 14.0% for the top 16 German chemists.

In Japan, 13 scientists produced 473 papers out of 3534 Japanese articles published during this period or 13.4% as compared to 18.7% for the top 13 Soviet, 7.6% for the top 13 U.S., and 11.9% for the top 13 German chemists.

The general patterns of scientific publication observed by Price are also evident in organic chemistry. 103 chemists participated in 5087

papers out of a total of 38,055 or 13%. Thus, a small number of prolific men account for a large percentage of research. If one considers the membership of the world's chemical societies, these are startling figures indeed.

In conclusion, some of the cardinal points of this paper can be summarized as follows:

1. The literature of organic chemistry has been growing at an average rate of approximately 12.5% per year.
2. The contribution of Soviet organic research to the literature of new compounds has remained remarkably constant over the past four years, i.e., a little less than 16% of the papers.
3. The percentage of French and German language material has also remained constant, about 6% and 16.5% respectively.
4. Japanese scientists appear to be publishing to an increasing extent in the English language.
5. Approximately 25% of the world research in organic chemistry is produced in the United States.
6. Over half the literature is published in the English language.
7. Fifty journals account for 90% of the literature while 100 journals account for 98%.
8. About 100 chemists produced 13% of the literature. Of these a surprisingly large number, 30, were Soviet chemists, when one might have expected about half that number on the basis of the amount of Soviet literature. On the other hand, only 16 U.S. chemists were found when 25 would be expected.
9. Of the top 20 organic chemists publishing papers abstracted by INDEX CHEMICUS 17 were Soviet.

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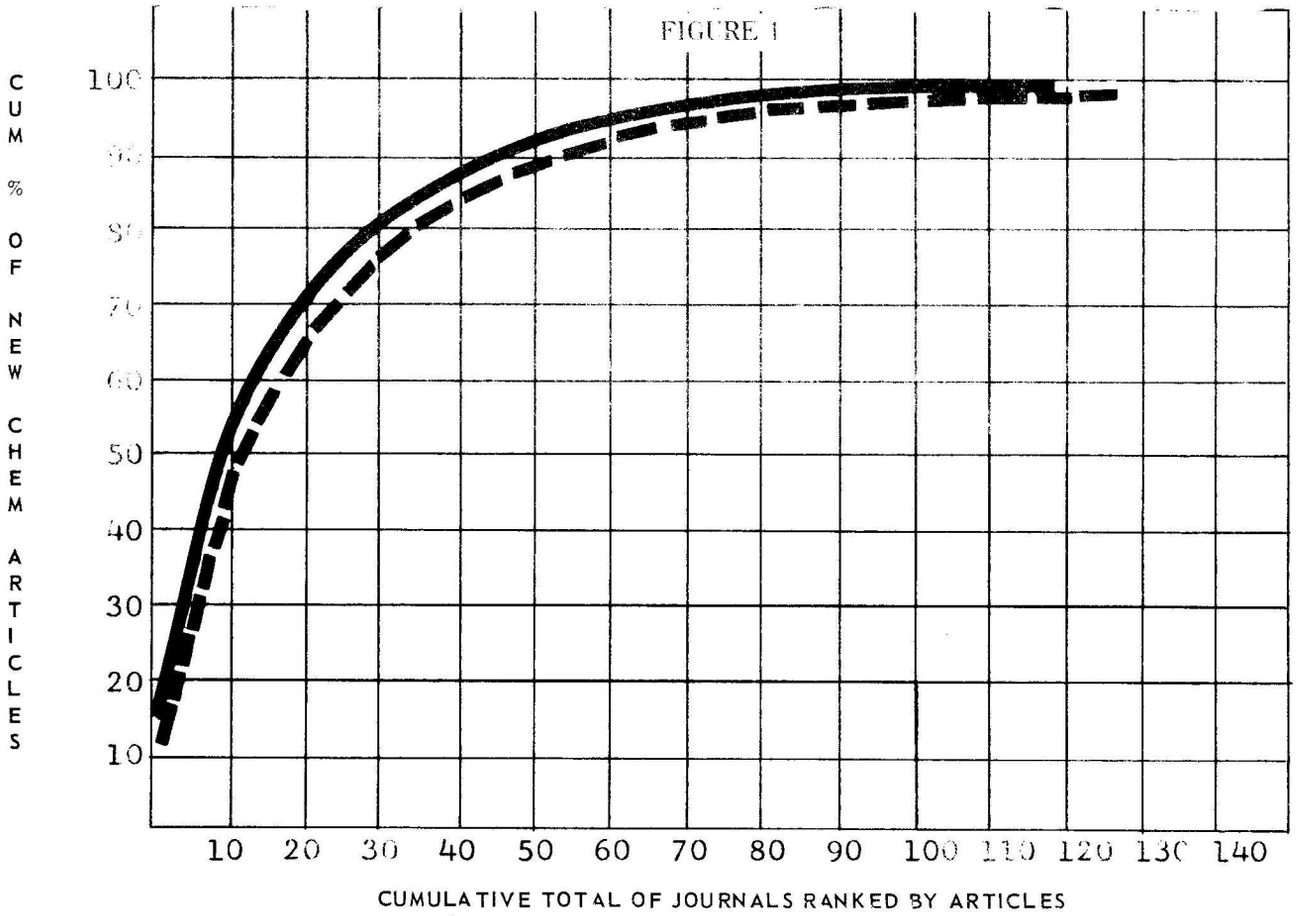

FIGURE 3
COMPARISON OF AUTHORSHIP BETWEEN U.S.A., U.S.S.R., GERMANY, JAPAN AND WORLD

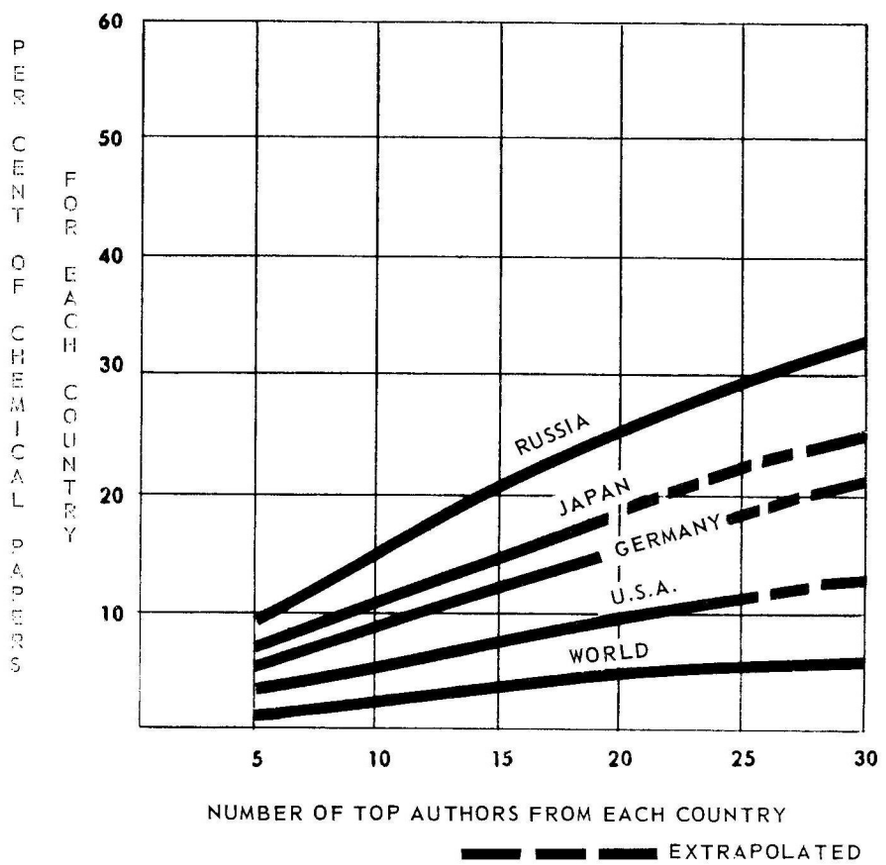

FIGURE 2
YEARLY RANKING OF TOP 10 JOURNALS FROM 1960 TO 1963

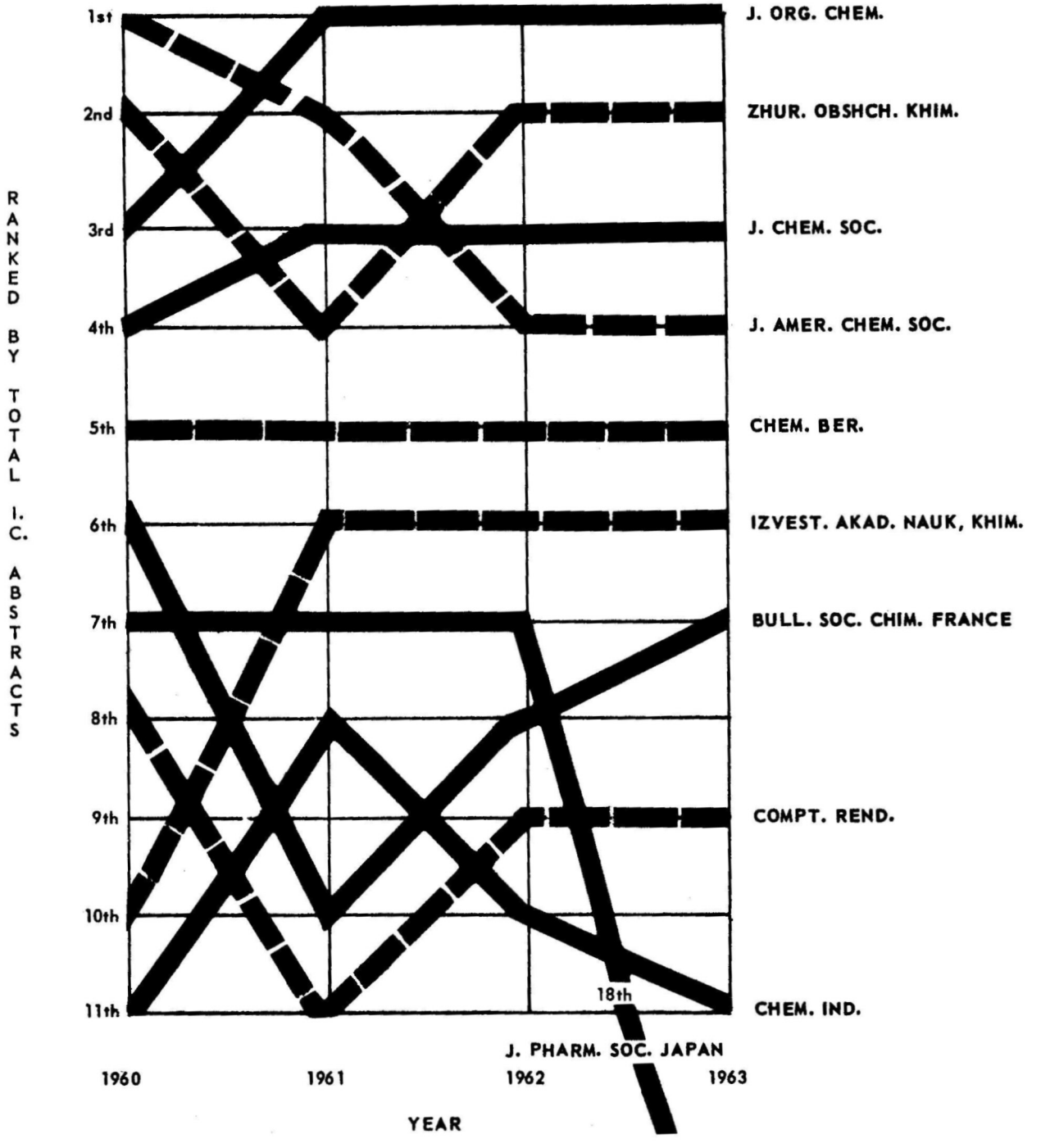

Table IIIa

Journal Titles	1960		1961		1962		1963		1960-63	
	Art.	Cpds.	Art.	Cpds.	Art.	Cpds.	Art.	Cpds.	Art.	Cpds.
1. J.Org.Chem.	627	6324	1391	15559	1151	12367	956	9344	4125	13594
2. Zhur.Obshch.Khim.	676	6116	670	5959	789	7085	812	7457	2947	26617
3. J.Amer.Chem.Soc.	902	8622	673	5465	630	5114	621	4856	2826	24057
4. J.Chem.Soc.	565	6714	670	8052	636	7185	727	9129	2598	31080
5. Chem.Ber.	423	4710	411	4766	398	4326	370	4728	1602	18531
6. Izvest.Akad.Nauk,Khim.	192	1440	241	1580	293	1912	289	2023	1015	6955
7. Bull.Soc.Chim.France	237	3117	189	2634	222	3524	277	3831	925	13106
8. J.Pharm.Soc.Japan	242	2174	226	2480	247	2765	165	1644	880	9063
9. Compt.Rend.	217	1730	178	1549	214	1723	218	1761	827	6763
10. Chem.Ind.	190	860	213	1044	209	973	211	1081	823	3958
11. Chem.Pharm.Bull.Japan	175	1603	167	1597	166	1993	235	2223	743	7416
12. Ann.Chem.Liebigs.	140	2085	209	3623	192	2727	179	3019	720	11454
13. Helv.Chim.Acta	175	1842	141	1749	187	2641	198	2767	701	8999
14. Dokl.Akad.Nauk.,SSR	156	1091	174	1317	137	923	154	916	621	4247
15. Angew.Chem.	105	717	159	780	172	987	182	967	618	3451
16. Tetrahedron Letters	127	231	69	501	182	1240	203	1985	581	3957
17. J.Chem.Soc.Japan,Pure	195	1343	151	1224	129	1105	87	712	562	4384
18. Tetrahedron	98	1111	104	1295	142	1719	210	2718	554	6843
19. Can.J.Chem.	103	775	109	854	140	1106	194	1287	546	4022
20. Bull.Chem.Soc.Japan	122	794	131	1114	156	1275	122	981	531	4164
21. Coll.Czech.Chem.Comm.	124	1184	140	1463	125	971	138	1204	527	4822
22. J.Med.Chem.	34	717	73	1700	135	3363	216	5176	458	10956
23. Acta Chem.Scand.	63	560	117	964	113	738	160	1132	453	3394
24. J.Indian Chem.Soc.	90	1785	105	1643	109	1790	147	2019	451	7237
25. Zhur.Neorg.Khim.	-	-	164	881	127	656	142	621	433	2158
26. Rocznicki Chem.	96	542	91	622	138	972	105	774	430	2910
27. Proc.Chem.Soc.London	76	301	112	543	93	458	120	511	401	1813
28. Gazz. Ital.	88	874	74	810	75	985	110	1300	347	3969
29. J. Poly.Sci.	23	144	98	596	90	412	127	606	338	1758
30. Inorg. Chem.	-	-	-	-	128	772	209	1403	337	2175
31. J.Prakt.Chem.	54	607	66	761	107	1614	105	1630	332	4612
32. Monatsh.Chem.	68	801	90	897	75	959	89	657	322	3314
33. Annali Di Chim.	91	1110	73	793	62	659	89	1066	315	2628
34. Arch.Pharm.	75	876	69	823	77	1058	80	955	301	3712
35. J.Chem.Soc.Japan,Ind	63	656	61	381	85	623	84	610	293	2270
36. Indian J. Chem.	48	471	50	420	71	974	118	1221	287	3086
37. Rec.Trav.Chim.	50	401	61	661	73	668	74	462	258	2192
38. Z.Naturforsch.	37	153	60	394	74	338	84	486	255	1371
39. J.Biol.Chem.	36	120	50	109	70	237	87	340	243	806
40. Naturwissenschaften	51	237	61	197	55	255	63	225	230	914
41. Nature	48	171	62	241	50	185	62	231	222	828
42. Vysokomol Soed	-	-	46	323	79	345	92	462	217	1130
43. J.Inorg,Nuclear Ch.	-	-	31	157	98	582	83	429	212	1168
44. J.Pharm.Sci.	32	265	54	517	55	618	62	666	203	2006
45. Australian J.Chem.	32	348	36	328	41	299	86	663	195	1638
46. Makromol.Chem.	18	146	41	364	54	496	74	487	187	1493
47. Agr.Biol.Chem.	30	171	53	568	40	249	50	412	173	1400
48. Biochem.Biophys.Acta	13	29	25	49	60	166	73	206	171	450
49. Ukrainian Khim.Zhur.	28	231	48	421	32	283	59	423	167	1358
50. Biochem. J.	29	76	34	124	46	221	52	194	161	615
51. Farmaco Ed.Sci.	-	-	36	611	49	790	50	959	135	2360
52. Zhur.Priklad.Khim.	23	181	36	143	31	134	37	218	127	676
53. Z.Anorg.Allgem.Chem	-	-	-	-	4	16	119	705	123	721
54. Experientia	23	116	34	178	28	219	37	251	122	764

TABLE IIIa continued

Journal Titles	1960		1961		1962		1963		1960-63	
	Art.	Cpds.	Art.	Cpds.	Art.	Cpds.	Art.	Cpds.	Art.	Cpds.
55. Arkiv Kemi	21	143	35	246	18	73	37	[illegible]	111	669
56. Zhur.Vses.Khim.Mend	-	-	34	148	30	199	37	230	101	577
57. Z.Physiol.Chem.	26	262	30	93	14	133	28	204	98	692
58. Acta Chim.Acad.Hung.	16	136	12	54	41	319	25	341	94	850
59. J.Soc.Org.Syn.ChemJ	-	-	29	244	51	861	12	90	92	1195
60. Arch.Biochem.Biophy	17	91	16	78	32	86	27	83	92	338
61. Anal.Soc.Espan.Fiz.Q.	23	260	28	273	19	150	19	116	89	799
62. Biochemistry	-	-	-	-	34	196	55	374	89	570
63. J.Agr.Chem.Soc.Japan	19	113	44	240	20	135	5	26	88	514
64. Bull.L'Acad.Polonaise	-	-	35	277	22	150	29	211	86	638
65. Arzneimittelforsch.	-	-	20	496	34	639	29	602	83	1737
66. J.Phys.Chem.	21	131	24	61	9	64	29	100	83	356
67. Izvest.Akad.Nauk.Arm.	-	-	-	-	33	577	46	660	79	1237
68. J.Pharm.Pharmacol.	20	603	18	243	17	330	22	373	77	1549
69. J.Antibiotics	13	33	22	92	26	86	16	72	77	283
70. Bull.Soc.Chim.Belges	18	120	16	134	18	215	23	243	75	712
71. Bull.Res.Council Israel	5	16	34	176	36	189	-	-	75	381
72. Zhur.Anal.Khim.	15	57	14	36	17	115	28	97	74	305
73. J.Chem.Engn.Data	-	-	-	-	21	467	46	804	67	1217
74. J.Biochem.Tokyo	7	64	21	89	17	71	21	74	66	298
75. Biochem.Biophys.Comm.	6	6	12	21	28	49	16	38	62	114
76. J.Am.Oil Chem.Soc.	11	67	9	93	19	105	21	145	60	410
77. Annales De Chimie	16	430	15	332	20	474	8	181	59	1417
78. Croat.Chem.Acta	18	122	14	106	15	103	11	96	58	427
79. Magyar Kem.Folyoirat	-	-	6	18	18	177	31	238	55	433
80. Chem. Zvestia	-	-	28	208	11	109	15	107	54	424
81. J.Chem.Phys.	11	36	7	12	18	120	18	59	54	227
82. Arch.Intern.Pharmaco	24	155	6	256	2	3	19	245	51	659
83. Anal.Chim.Acta	9	26	12	39	12	83	16	68	49	216
84. Rev.Chim.	-	-	-	-	40	386	9	96	49	482
85. Current Science	-	-	19	144	8	48	20	98	47	290
86. Vestnik Moscow Univ.	-	-	8	16	16	79	23	108	47	203
87. Soumen Kemi	-	-	15	49	15	78	16	60	46	187
88. Steroids	-	-	-	-	-	-	45	335	45	335
89. Ann.Pharm.Franc	18	180	5	17	14	65	8	68	45	330
90. Pharmazie	9	108	8	212	9	129	18	470	44	919
91. Proc.Roy.Soc.Edinburgh	40	50	-	-	-	-	-	-	40	50
92. Biochem.Pharmacol.	3	8	9	40	16	134	11	46	39	228
93. Biochem.Z.	13	76	5	20	17	90	3	16	38	202
94. Anal. Chem.	6	8	4	7	6	50	21	125	37	190
95. Bull.Soc.Chim.Biol.	17	70	3	12	10	98	7	45	37	225
96. Dokl.Bolgar.Akad.Nauk	-	-	12	61	16	93	7	41	35	195
97. Am.Mineral	-	-	7	7	16	28	10	15	33	50
98. Chimia	-	-	19	285	9	69	5	22	33	376
99. J.Agr.Food Chem.	9	68	11	72	9	71	4	33	33	244
100. J.Appl.Chem.	6	43	5	31	12	78	10	88	33	240
101. Can.J.Biochem.Physiol.	5	12	4	13	5	15	9	18	33	58
102. Science	3	13	4	8	4	14	20	52	31	87
103. Trans.Faraday Soc.	1	1	3	6	17	91	8	63	29	161
104. Biokhimya	3	3	8	12	8	16	3	14	22	

TABLE IIIa continued

Journal Titles	1960		1961		1962		1963		1960-63	
	Art.	Cpds.	Art.	Cpds.	Art.	Cpds.	Art.	Cpds.	Art.	Cpds.
105. Chim.Ind.	-	-	-	-	-	-	22	147	22	[illegible]
106. Przem.Chem.	-	-	9	106	4	49	9	131	22	286
107. Indian J.Exp.Chem.	-	-	14	250	7	171	-	-	21	421
108. Proc.Natl.Acad.Sci.	2	4	4	4	9	29	8	14	21	49
109. Kristallografiya	-	-	11	60	3	9	6	42	20	111
110. Brit,J.Pharmacol.	4	114	3	59	7	42	5	42	19	257
111. J.Pharmacol.Exp.Ther.	5	9	8	9	-	-	5	6	18	24
112. Zhur.Fiz.Khim.	5	11	9	35	3	11	1	7	18	64
113. Chem.High Polymers J	-	-	-	-	-	-	16	57	16	57
114. Anal.Biochem.	2	5	4	8	5	18	3	6	14	37
115. Antibiot.Chemother.	6	42	5	18	3	13	-	-	14	73
116. J.Chinese Chem.Soc.	-	-	3	43	5	74	6	18	14	135
117. Antibiotiki	-	-	6	103	1	1	6	13	13	117
118. Israel J. Chem.	-	-	-	-	-	-	13	146	13	146
119. Pharm.Acta Helv.	-	-	-	-	-	-	13	217	13	217
120. Dissertations Pharm	-	-	-	-	-	-	12	117	12	117
121. I.E.C.Prod.Res.Dev.	-	-	-	-	7	33	5	16	12	49
122. Mikrochim.Acta	2	2	5	8	3	11	2	3	12	24
123. Proc.Japan Acad.	5	36	2	13	-	-	5	8	12	57
124. Spectrochim.Acta	-	-	-	-	-	-	11	93	11	93
125. Z.Physol.Chem.	1	8	5	12	1	2	4	27	11	49
126. Analyst	-	-	5	14	5	15	-	-	10	29
127. J.Res.N.B.S.	-	-	4	34	2	10	2	54	8	98
128. Ind.Eng.Chem.	4	10	3	91	-	-	-	-	7	101
129. Indian J. Tech.	-	-	6	65	1	2	-	-	7	67
130. Microchem.J.	2	6	2	4	1	2	2	14	7	26
131. Zhur.Strukt.Khim.	-	-	-	-	-	-	7	26	7	26
132. Hiroshima J.Med.Sci.	3	8	-	-	3	13	-	-	6	21
133. Periodica Polytech.	-	-	-	-	4	34	2	17	6	51
134. J.Histochem.Cytochem.	1	1	2	43	1	5	1	8	5	57
135. Bol.Inst.Quim.	-	-	-	-	4	20	-	-	4	20
136. Lloydia	-	-	2	5	2	2	-	-	4	7
137. Vestnik Leningrad U.	-	-	-	-	3	14	1	3	4	17
138. Anal.Asoc.Quim.	-	-	-	-	1	24	2	10	3	34
139. Dokl.Akad.Nauk BSSR	-	-	-	-	-	-	3	28	3	28
140. Arch.Exp.Path.Pharm.	1	2	-	-	1	3	-	-	2	5
141. Chem.Listy	-	-	2	4	-	-	-	-	2	4
142. Compar.Biochem.Phys.	-	-	-	-	2	3	-	-	2	3
143. I.E.C.Process Design	-	-	-	-	2	32	-	-	2	32
144. J.Chromatography	2	14	-	-	-	-	-	-	2	14
145. Magyar T.A.Kem,Kozl.	-	-	-	-	2	12	-	-	2	12
146. Am.Dyestuff Res.	-	-	1	3	-	-	-	-	1	3
147. Am.Rev.Resp.Dis.	-	-	1	1	-	-	-	-	1	1
148. Ann.Biochem.Exp.Med	1	11	-	-	-	-	-	-	1	11
149. Clin.Chim.Acta	-	-	-	-	-	-	1	1	1	1
150. Clin.Pharmacol.Ther.	-	-	1	1	-	-	-	-	1	1
151. Enzmologia	-	-	-	-	1	1	-	-	1	1
152. J.Assoc.Off.Agr.Chem	-	-	-	-	-	-	1	4	1	4
153. J.Colloid Sci.	1	2	-	-	-	-	-	-	1	2
154. Kolloid Zhur.	1	1	-	-	-	-	-	-	1	1
155. Ukrain.Biochem.J.	-	-	-	-	1	1	-	-	1	1

Table IIIb

JOURNAL TITLE	ARTICLE	PER CENT	CUM PER CENT
1. J ORG CHEM	4125	11.00	11.00
2. ZHUR OBSHCH KHIM	2947	7.86	18.86
3. J AM CHEM SOC	2826	7.53	26.39
4. J CHEM SOC	2598	6.93	33.32
5. CHEM BER	1602	4.27	37.59
6. IZVEST AKAD NAUK	1015	2.70	40.29
7. BULL SOC CHIM FR	925	2.46	42.75
8. J PHARM SOC JAPAN	880	2.34	45.09
9. COMPT REND	827	2.20	47.29
10. CHEM IND	823	2.19	49.48
11. CHEM PHARM BULL J	743	1.98	51.46
12. ANN CHEM LIEBIGS	720	1.92	53.38
13. HELV CHIM ACTA	701	1.87	55.25
14. DOKL AKAD NAUK SSR	621	1.65	56.90
15. ANGEW CHEM	618	1.64	58.54
16. TETRAHEDRON LET	581	1.54	60.08
17. J CHEM SOC J PURE	562	1.49	61.57
18. TETRAHEDRON	554	1.47	63.04
19. CAN J CHEM	546	1.45	64.49
20. BULL CHEM SOC JAP	531	1.41	65.90
21. COLL CZECH CHEM	527	1.40	67.30
22. J MED CHEM	458	1.22	68.52
23. ACTA CHEM SCAND	453	1.20	69.72
24. J INDIAN CHEM SOC	451	1.20	70.92
25. ZHUR NEORG KHIM	433	1.15	72.07
26. ROCZNICKI CHEM	430	1.14	73.21
27. PROC CHEM SOC LON	401	1.06	74.27
28. GAZZ ITAL	347	.92	75.19
29. J POLY SCI	338	.90	76.09
30. INORG CHEM	337	.89	76.98
31. J PRAKT CHEM	332	.88	77.86
32. MONATSH CHEM	322	.85	78.71
33. ANNALI DI CHIM	315	.84	79.55
34. ARCH PHARM	301	.80	80.35
35. J CHEM SOC J IND	293	.78	81.13
36. INDIAN J CHEM	287	.76	81.89
37. REC TRAV CHIM	258	.68	82.57
38. Z NATURFORSCH	255	.68	83.25
39. J BIOL CHEM	243	.64	83.89
40. NATURWISSENSCHAF.	230	.61	84.50
41. NATURE	222	.59	85.09
42. VYSOKOMOL SOED	217	.57	85.66
43. J INORG NUCL CHEM	212	.56	86.22
44. J PHARM SCI	203	.54	86.76
45. AUSTRALIAN J CHEM	195	.52	87.28
46. MAKROMOL CHEM	187	.49	87.77
47. AGR BIOL CHEM	173	.46	88.23
48. BIOCHEM BIOPHYS A	171	.45	88.68
49. UKRAIN KHIM ZHUR	167	.44	89.12
50. BIOCHEM J	161	.42	89.54
51. FARMACO ED SCI	135	.36	89.90
52. ZHUR PRIKLAD KHIM	127	.33	90.23
53. Z ANORG ALLGEM	123	.32	90.55
54. EXPERIENTIA	122	.32	90.87
55. ARKIV KEMI	111	.29	91.16
56. ZHUR VSES KHIM	101	.26	91.42
57. Z PHYSIOL CHEM	98	.26	91.68
58. ACTA CHIM SCI HUNG	94	.25	91.93
59. J SOC ORG SYN CHEM	92	.24	92.17
60. ARCH BIOCHEM BIOPHY	92	.24	92.41
61. ANAL SOC ESPAN FIZ	89	.23	92.64
62. BIOCHEMISTRY	89	.23	92.87
63. J AGR CHEM SOC J	88	.23	93.10
64. BULL L ACAD POLON	86	.22	93.32
65. ARZNEIMITTELFORSCH	83	.22	93.54
66. J PHYS CHEM	83	.22	93.76
67. IZVEST AKAD ARM	79	.21	93.97
68. J PHARM PHARMACOL	77	.20	94.17
69. J ANTIBIOTICS	77	.20	94.37
70. BULL SOC CHIM BELG	75	.20	94.57
71. BULL RES COUN ISR	75	.20	94.77
72. ZHUR ANAL KHIM	74	.19	94.96
73. J CHEM ENGN DATA	67	.17	95.13
74. J BIOCHEM TOKYO	66	.17	95.30
75. BIOCHEM BIOPHYS C	62	.16	95.46
76. J AM OIL CHEM SOC	60	.16	95.62
77. ANNALES DE CHIMIE	59	.15	95.77
78. CROAT CHEM ACTA	58	.15	95.92
79. MAGYAR KEM FOLY	55	.14	96.06
80. CHEM ZVESTIA	54	.14	96.20

TABLE III b continued

JOURNAL TITLE	ARTICLE	PER CENT	CUM PER CENT
81. J CHEM PHYS	54	.14	96.3
82. ARCH INTERN PHARM	51	.13	96.4
83. ANAL CHIM ACTA	49	.13	96.6
84. REV CHIM	49	.13	96.7
85. CURRENT SCIENCE	47	.12	96.8
86. VESTNIK MOSCOW U	47	.12	96.9
87. SOUMEN KEMI	46	.12	97.0
88. STEROIDS	45	.12	97.2
89. ANN PHARM FRANC	45	.12	97.3
90. PHARMAZIE	44	.11	97.4
91. PROC ROY SOC EDIN	40	.10	97.5
92. BIOCHEM PHARMACOL	39	.10	97.6
93. BIOCHEM Z.	38	.10	97.7
94. ANAL CHEM	37	.09	97.8
95. BULL SOC CHIM BIOL	37	.09	97.9
96. DOKL BOLGAR AKAD	35	.09	98.0
97. AM MINERAL	33	.08	98.0
98. CHIMIA	33	.08	98.1
99. J AGR FOOD CHEM	33	.08	98.2
100. J APPL CHEM	33	.08	98.3
101. CAN J BIOCHEM PHY	33	.08	98.4
102. SCIENCE	31	.08	98.4
103. TRANS FARADAY SOC	29	.07	98.5
104. BIOKHIMYA	22	.05	98.6
105. CHIM IND	22	.05	98.6
106. PRZEM CHEM	22	.05	98.7
107. INDIAN J EXP CHEM	21	.05	98.7
108. PROC NATL ACAD S	21	.05	98.8
109. KRISTALLOGRAFIYA	20	.05	98.8
110. BRIT J PHARMACOL	19	.05	98.9
111. J PHARMACOL EXP T	18	.04	98.9
112. ZHUR FIZ KHIM	18	.04	98.9
113. CHEM HIGH POLYMERS	16	.04	99.0
114. ANAL BIOCHEM	14	.03	99.0
115. ANTIBIO CHEMOTHER	14	.03	99.0
116. J CHINESE CHEM S	14	.03	99.1
117. ANTIBIOTIKI	13	.03	99.1
118. ISRAEL J CHEM	13	.03	99.1
119. PHARM ACTA HELV	13	.03	99.2
120. DISSERTATIONS P	12	.03	99.2
121. I E C PROD RES DEV	12	.03	99.2
122. MIKROCHIM ACTA	12	.03	99.3
123. PROC JAPAN ACAD	12	.03	99.3
124. SPECTROCHIM ACTA	11	.02	99.3
125. Z PHYSIOL CHEM	11	.02	99.3
126. ANALYST	10	.02	99.3
127. J RES N B S	8	.02	99.4
128. IND ENG CHEM	7	.01	99.4
129. INDIAN J TECH	7	.01	99.4
130. MICROCHEM J	7	.01	99.4
131. ZHUR STRUKT KHIM	7	.01	99.4
132. HIROSHIMA J MED S	6	.01	99.4
133. PERIODICA POLYTECH	6	.01	99.4
134. J HISTOCHEM CYTOC	5	.01	99.4
135. BOL INST QUIM	4	.01	99.4
136. LLOYDIA	4	.01	99.5
137. VESTNIK LENINGRAD	4	.01	
138. ANAL ASOC QUIM	3	.01*	
139. DOKL AKAD NAUK BSSR	3	"	
140. ARCH EXP PATH PHARM	2	"	
141. CHEM LISTY	2	"	
142. COMPAR BIOCHEM PHY	2	"	
143. I E C PROCESS DES	2	"	
144. J CHROMATOGRAPHY	2	"	
145. MAGYAR T A KEM K	2	"	
146. AM DYESTUFF RES	1	"	
147. AM REV RESP DIS	1	"	
148. ANN BIOCHEM EXP M	1	"	
149. CLIN CHIM ACTA	1	"	
150. CLIN PHARMACOL TH	1	"	
151. ENZOMOLOGIA	1	"	
152. J ASSOC OF AGR CH	1	"	
153. J COLLOID SCI	1	"	
154. KOLLOID ZHUR	1	"	
155. UKRAIN BIOCHEM J	1	"	100.0

*LESS THAN .01%

Table V

ARTICLES	AUTHORS	COUNTRIES
119	Sorm, F.	Czechoslovakia
117	Djerassi, C.	U.S.A.
117	Shostakovskii, M.F.	U.S.S.R.
114	Andrianov, K.A.	U.S.S.R.
105	Nesmeyanov, A.N.	U.S.S.R.
89	Prebrazhenskii, N.A.	U.S.S.R.
88	Petrov, A.A.	U.S.S.R.
87	Petrov, A.D.	U.S.S.R.
78	Kochetkov, N.K.	U.S.S.R.
77	Kucherov, V.F.	U.S.S.R.
75	Buu-Hoi, N.P.	France
73	Kirsanov, A.V.	U.S.S.R.
73	Knunyants, I.L.	U.S.S.R.
72	Mikhailov, B.M.	U.S.S.R.
72	Yurev, Y.K.	U.S.S.R.
70	Korshak, V.V.	U.S.S.R.
66	Baker, B.R.	U.S.A.
66	Terentev, A.P.	U.S.S.R.
63	Levina, R.Y.	U.S.S.R.
60	Arbuzov, B.A.	U.S.S.R.
57	Petrov, K.A.	U.S.S.R.
57	Wittig, G.	Germany
56	Hauser, C.R.	U.S.A.
54	Barton, G.H.R.	England
54	Goodman, L.	U.S.A.
54	Zakharkin, L.I.	U.S.S.R.
53	Herout, V.	Czechoslovakia
53	Schmidt, M.	Germany
52	Ried, W.	Germany
52	Wilkenson, G.	England
51	Riemschneider, R.	Germany
51	Seshadri, T.R.	India
49	Cotton, F.A.	U.S.A.
49	Julia, M.	France
49	Kost, A.N.	U.S.S.R.
48	Beyer, H.	U.S.A.
47	Bergmann, E.D.	Israel
47	Cologne, J.	France
47	Novikov, S.S.	U.S.S.R.
47	Testa, E.	Italy
46	Gilman, H.	U.S.A.
45	Goldfarb, Y.L.	U.S.S.R.
45	Tsuda, K.	Japan
44	Bredereck, H.	Germany
44	Drefahl, G.	Germany
44	Huisgen, R.	Germany
44	Kabachnik, M.I.	U.S.S.R.
44	Kuhn, R.	Germany
44	Mehrotra, R.C.	India
44	Robins, R.K.	U.S.A.
44	Treibs, W.	Germany
43	Johnson, A.W.	England
43	Shchukina, M.N.	U.S.S.R.
43	Shuikin, N.I.	U.S.S.R.
42	Bohlmann, A.T.	Germany
42	Fischer, E.O.	Germany
42	Profft, E.	Germany
42	Suzuki, S.	Japan
41	Lukes, R.	Czechoslovakia
41	Razuvaev, G.A.	U.S.S.R.
40	Cherbuliez, E.	Switzerland
40	Julia, S.	France
40	Shemyakin, M.M.	U.S.S.R.
39	Rabinowitz, J.	Switzerland
39	Takeda, K.	Japan
38	Friedlina, R.K.	U.S.S.R.
38	Mousseron, M.	France
38	Nozoe, T.	Japan
37	Oda, R.	Japan
37	Reichstein, T.	Switzerland
37	Stone, F.	U.S.A.
37	Ueda, T.	Japan
36	Hawthorne, M.F.	U.S.A.
36	Imoto, E.	Japan
36	Korte, F.	Germany
36	Pelkis, P.F.	Ukrain. S.S.R.
36	Pudovik, A.N.	U.S.S.R.
36	Schmid, H.	Switzerland
36	Seyferth, D.	U.S.A.
36	Tomita, M.	Japan
35	Chatt, J.	England
35	Foster, A.B.	England
35	Overberger, C.G.	U.S.A.
35	Suzuki, K.	Japan
34	Hellmann, H.	Germany
34	Michalski, J.	Poland
34	Montgomery, J.A.	U.S.A.
34	Sondheimer, F.	Israel
34	Wolfrom, M.L.	U.S.A.
34	Horner, L.	Germany
33	Helferich, B.	Germany
33	Mueller, E.	Germany
33	Nyholm, R.S.	England
33	Reutov, O.A.	U.S.S.R.
32	Bowers, A.	Mexico
32	Ikehara, M.	Japan
32	Kametani, T.	Japan
32	King, R.B.	U.S.A.
32	Matsuo, M.	Japan
32	Ohta, M.	Japan
32	Tatlow, J.C.	England
32	Taylor, E.C.	U.S.A.
32	Zahn, H.	Germany

TOTAL 5087

Table VI

Czechoslovakia (3)	
Sorm, F.	119
Herout, V.	53
Lukes, R.	41
	213

England (7)	
Barton, D.H.R.	54
Wilkinson, G.	52
Johnson, A.W.	43
Chatt, J.	35
Foster, A.B.	35
Nyholm, R.S.	33
Tatlow, J.C.	32
	284

France (5)	
Buu-Hoi, N.P.	75
Julia, M.	49
Cologne, J.	47
Julia, S.	40
Mousseron, M.	38
	249

Germany (18)	
Wittig, G.	57
Schmidt, M.	53
Ried, W.	52
Riemschneider, R.	51
Bredereck, H.	44
Drefahl, G.	44
Huisgen, R.	44
Kuhn, R.	44
Treibs, W.	44
Bohlmann, A.T.	42
Fischer, E.O.	42
Profft, E.	42
Korte, F.	36
Hellmann, H.	34
Horner, L.	34
Helferich, B.	33
Mueller, E.	33
Zahn, H.	32
	761

India (2)	
Seshadri, T.R.	51
Mehrotra, R.C.	44
	95

Israel (2)	
Bergmann, E.D.	47
Sondheimer, F.	34
	81

Italy (1)	
Testa, E.	47
	47

Japan (13)	
Tsuda, K.	45
Suzuki, S.	42
Takeda, K.	39
Nozoe, T.	38
Oda, R.	37
Ueda, T.	37
Imoto, E.	36
Tomita, M.	36
Suzuki, K.	35
Ikehara, M.	32
Kametani, T.	32
Matsuo, M.	32
Ohta, M.	32
	473

Mexico (1)	
Bowers, A.	32
	32

Poland (1)	
Michalski, J.	34
	34

Switzerland (4)	
Cherbuliez, E.	40
Rabinowitz, J.	39
Reichstein, T.	37
Schmid, H.	36
	152

Ukrainian S.S.R. (1)	
Pelkis, P.F.	36
	36

U.S.A. (16)	
Djerassi, C.	117
Baker, B.R.	66
Hauser, C.R.	56
Goodman, L.	54
Cotton, F.A.	49
Beyer, H.	48
Gilman, H.	46
Robins, R.K.	44
Stone, F.	37
Seyferth, D.	36
Hawthorne, M.F.	36
Overberger, C.G.	35
Montgomery, J.A.	34
Wolfrom, M.L.	34
King, R.B.	32
Taylor, E.C.	32
	756

U.S.S.R. (29)	
Shostakovskii, M.F.	117
Andrianov, K.A.	114
Nesmeyanov, A.N.	105
Prebrazhenskii, N.A.	89
Petrov, A.A.	88
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