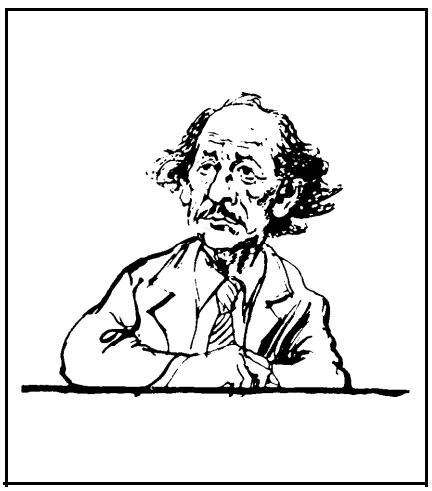
Science and Public Policy, p.112-127, June 1983. Also reprinted as a two-part essay in Essays of an Information Scientist, Vol:6, p.253 and 264, 1983



Mapping science in the Third World

Dr E. Garfield contributes importantly to the world information order debate through an analysis of Third World Science employing the cluster mapping methodology developed by the Institute for Scientific Information

Eugene Garfield, PhD
Presider1 t
Institute for Scientific Jnformation
3501 Market Street
University city Science Center
Philadelphia, PA I91 04
USA

This article is an edited version of' the 1982 Annual Magnus 4/ke Science Policy Foundation Lecture.

Eugene Garfield PhD ***is u piouccr in*** *the field of information science. He is founder and presiden t oj'the Institute jbr Scientijic Irij&mation (iSI), \rvhich produces a broad spectrum of' inf&-mation services and systems. The inventor of 'Current Contents'and the 'Science Citation Index ', he received his BS in chemistry ji-om Columbia University, and returned there jtir a Master's degree in library science. He was arr-arded his PhD in structural linguistics at the University oj' Pennsylvania.*

Cartoons by Richard Willson

Keywords: information science; Third World science; cluster mapping

I am honoured to present the 1982 Annual Magnus Pyke Science Policy Foundation Lecture. It gives me an opportunity to expand on a topic that has interested me for many years – science in the developing cquntries. Most scientists in the West are not aware of research going on in Peru, Ghana, Singapore, or other countries collectively called the Third World. And what they do know about Third World science is dominated by the research of one or two Third World 'research superpowers' – India or Argentina, for example.

An analysis of Third World science is especially relevant today. The New Information Order is a much debated issue in international forums, such as UNESCO.'4 Third World countries have charged that news from their part of the world is under-reported in the international press. And what little news of the developing countries is reported allegedly gives a biased and sensational view of the Third World – earthquakes and revolutions, eruptions and government overthrows.

Only four news agencies cur-1eritly account for more than 90% of all foreign news transmitted around the world.5 All are in the West Reuters, Agence France-Presse. Associated Press, and United Press International. In the light of the Western **moiiopoly ori interiiat ional int~orm;ltioii.** Third **WOI ld wt Ions sc~iiletiilles feel powrless t o c'cjrlt tol** and **a,ntrlhute** 10 **wl131** 1s **bait! ;ih~ut** them. **As** 4 result. a New lnt'c)rrnatioil Order has been proposed, one in which Third World news is given increased and more balanced coverage.

This is a controversial issue, but perhaps I can demonstrate statistically why the Third World feels the way it does. The representation of Third World research in international scientific journals is a neglected aspect of the New Information Order debate. How many research articles from Third World countries are published in journals from the developed countries? And what impact does Third World research have on the international scientific community? The term 'impact' is vague without a definition. Here, impact is defined in **terms** of citations. I realize that this, too, is controversi+al.

Citation method

When a scientist cites a given article, he or she indicates that the article was somehow relevant to the research performed. The citing author calls attention to some useful place of information included in that article a method, statistic, result. or- whatever. And when an article is cited many times, it can be considered to have had a significant impact on the conduct of scientific research. I do not discuss here the vast literature which supports the validity of this premise.

If we take into account **only the llumber** of articles ;ti eiitirt' nation's scicnlists uutliored. wc get 311 idc'3 ot' Illcir level **ot' productivity. But** wllcri

we also consider the number of citations these articles received, we have a measure of their utility or impact. The purpose here is to document the level and impact of Third World research in the world's scientific journals. Perhaps it will serve as a point of departure for a wider discussion on the need for a ***New Scientific*** Information Order.

The Institute for Scientific Information@ (ISI®), of which I am founder and chairman, offers a unique viewpoint on Third World science. Every year, we monitor several thousand scientific journals in our ***Science Citation Index@*** (*SCI*®) database. We record bibliographic information on every item published in these journals. Last year, we processed 540 000 research articles, reviews, notes, letters, editorials, and other scientific communications. Similar data are available from our ***Social Sciences Citation Index@*** (*SSCI*®) database, and the ***Arts & Humanities Citation Index@*** (A&HCI®) data. Here, I restrict myself to the *SCI*.

SCI source index

We recorded the names and addresses of about 1.5 million authors, the title, issue, and pages of 3 000 journals they published in, and about nine million references they cited. This information allows us to tabulate the number of articles written by Third World researchers that were published in the journals we covered. That is, we can identify all articles with first authors who list a Third World country as their address.

SCI citation index

Our records also let us calculate the number of citations these Third World articles received. We can tell who the citing author is, and the journal, volume, page, and year of the citing article.

Third World study

For convenience, we used the ***Encyclopedia of the Third World***[6] to define which countries are considered as member states of the Third World. In 1982, the encyclopedia listed ***122*** developing nations. These countries met a variety of economic requirements in order to be considered developing nations. In addition, they were nonaligned with the USA or USSR.

As a source year for this study, we decided to use the 1973 ***SCI*** database. This gives a base year to compare the performance of Third World researchers in the future. In fact, we are now processing both the 1978 and 1981 ***SCI*** files to update this study. Of course, it takes an immense effort to produce and collate these data. But in a short time, we shall be able to chart the growth or decline of Third World science from 1973 to 1978 and 1981.

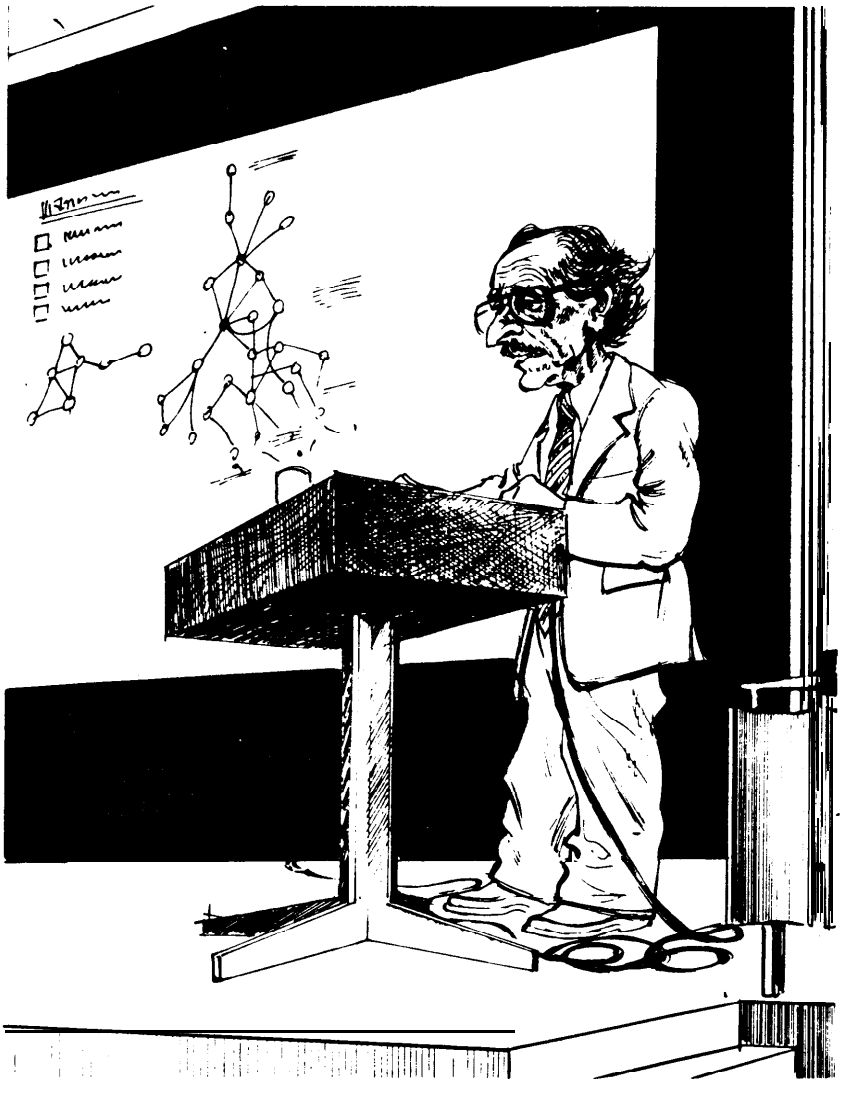
Also, using 1973 as a base year gives us enough time to measure the impact of Third World research on the international scientific community. That is, we can determine the number of citations these Third World articles received over a period of several years. The data are taken from six annual ***SCI*** files, covering 1973-1978.

There are a few important caveats. This discussion of Third World science is limited to that fraction of the international scientific press covered in the 1973 ***SCI.*** In 1973, it was estimated that 50000 science journals were published worldwide.' This figure is a gross distortion, and it is safe to say that over 90% of these publications are of minor significance. The *SCI* covered about 2 500 carefully selected journals that year.

Our studies indicate that the 'important' high-impact science journals actually amount to no more than 500 to 1000 journals.[8,9] For example, the solid line in Figure 1 shows that only 80 journals are cited in 25% of all references processed in the 198 1 ***SCI.*** In other words, only 2% of the 4000 journals covered in the ***SCI*** that year account for 25% of all citations. And only 700 journals account for 52% of all citations. Thus, a small number of journals account for the majority of citations.

Further evidence of the concentration of scientific literature in a small group of journals is provided by the dotted line in Figure 1 which shows that 20% of all 1981 articles were published in only 60 journals. And 400 journals account for 50% of all published articles. Again, a small group of journals predominates in the scientific literature.

I am confident that the journals *ISI* covers represent the major channels of international scientific communication. It should be borne in mind that we are assessing the level and impact of Third World research in



international scientific journals it is not intended to provide an inventory of Third World scientific output in every journal from every country of the world.

Table 1 shows how the articles in the 1973 *SCI* were distributed by country of publication. About 353 000 articles were indexed in the *SCI* that year, and these articles received 2 million citations from 1973 to 1978. US journals alone published 48% of all *SCI* articles in 1973, and US published articles account for 60% of the 2 million citations in the 1973-78 *SCI* files. The average article published in a US journal received about seven citations over that six-year period.

If we add together the publication output of the USA, the UK and Commonwealth countries, Western Europe, Japan and Scandinavia, we see that these 'First World' countries account for 84% of 1973 articles, and 89% of 1973-78 citations. Clearly, the *SCI* database reflects the dominance of First World scientific publications. Western journals control the flow of international scientific communication almost as much as Western news agencies 'monopolize' international news. This is not a judgement, but simply a statement of fact.

Table 2 shows how the 1973 articles were distributed by nationality of the first author. Articles written by first authors listing a US institution as their address account for the largest portion – 43%. These articles also account for the lion's share of citations – more than half. And if we add together articles authored in the USA, UK and Commonwealth countries, WesternEurope,Japan and Scandinavia, they account for 83% of 1973 articles, and 93% of 1973-78 citations. The data indicate that researchers from First World countries are the major participants in international science, at least as it is reflected in the *SCI*.

Position of India

Table 3 identifies the top 25 countries in terms of the number of articles written by their authors, only two Third World countries appear – India and Argentina. India's rank is significant. It is considered to rank third in the world in the number of researchers, behind the USA and USSR.' But it ranks eighth when we consider the number of articles its researchers authored in the international journals discussed here.

We can expect India to dominate the Third World when we rank

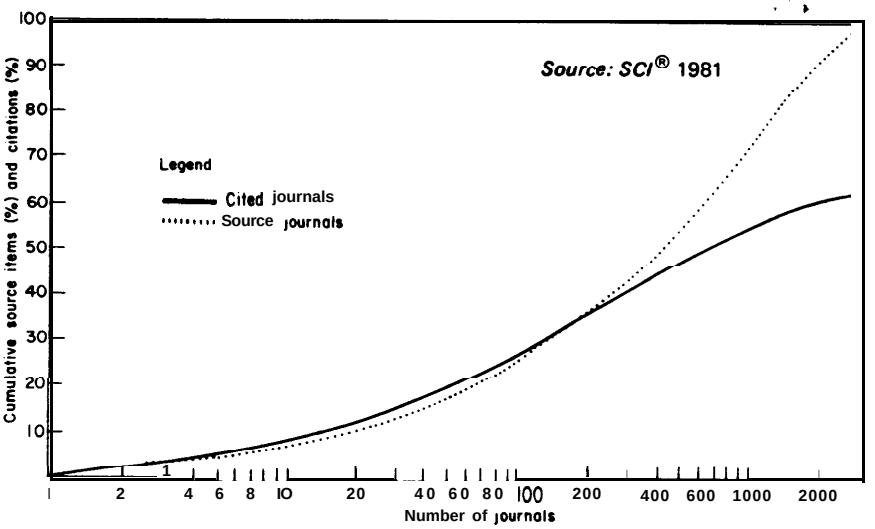


Figure 1. Distribution of published items and citations among science journals

Table 1. Publishing countries represented in the 1973 SCI® database

Geographical region	% of 1973 SCI articles	% of 1973-78 SCI citations	Impact
USA	48	60	6.9
UK/Commonwealth	16	16	5.5
Western Europe	15	10	3.4
USSR	6	2	1.4
Eastern Europe	3	1	1.9
Japan	3	2	2.9
Scandinavia	2	2	7.6
All Third World	2	–	.8
All others	1	–	1.4

Table 2. Locations of authors in the 1973 *SCI*® database

Geographical region	% of 1973 SCI articles	% of 1973–78 SCI citations	Impact
USA	43	54	6.9
Western Europe	17	14	4.6
UK/Commonwealth	16	17	5.9
USSR	7	2	1.6
All Third World	5	2	2.3
Eastern Europe	4	2	2.5
Japan	4	3	4.1
Scandinavia	3	4	7.4
All Others	2	2	5.2

Table 3. Top 25 countries, ranked by number of articles their authors produced. Asterisks indicate Third World countries

Country	Articles	Citations	Impact	Cited articles	Uncited articles	% citedness
USA	151939	1047854	6.9	97-852	54087	64
UK	32189	202600	6.3	21387	10802	66
USSR	24715	40455	1.6	11159	13556	45
FRG	20137	93233	4.6	12981	7156	64
France	17707	72912	4.1	11069	6638	62
Japan	15569	64160	4.1	10161	5408	65
Canada	15362	86654	5.6	10688	4674	70
"India	7888	15515	2.0	4568	3320	58

continued on page 115

"developing countries by the number of articles their researchers authored (Table 4). In fact, Indian researchers alone authored half the 16 000 articles from the Third. World. Out of 93 Third World author countries in the 1973 *SCI* database, 30 developing countries authored 50 or more articles. These 30 countries accounted for 95% of all Third World articles. Clearly, India is the research 'superpower' of the Third World. Argentina is a distant second, accounting for 10%, or a fifth of India's output.

Ranking countries by the number of authored articles has its disadvantages. Small developing ***and*** developed countries producing high-quality science would tend not to appear. Their overall output is dwarfed by that of the large superpowers. But when we rank all countries by the ***impact*** of their authored articles, we see some interesting results.

Impact of Third World articles

Thirty countries averaged four or more citations to their authored articles from 1973-78 (Table 5). Twelve are developing countires, and they are indicated by asterisks. Three developing countries rank among the top ten in the world on impact – Liberia, Jamaica, and Thailand. However, we should note that Liberia's high impact is based on only seven authored articles. It would be difficult to derive much significance from so small a sample.

Articles authored in Liberia, Jamaica, and Thailand together averaged seven citations over a six-year period. This comes close to matching the impact of those Scandinavian countries in the top ten – they averaged eight citations. Liberian, Jamaican, and Thai articles, together or singly, had a greater impact than US articles. But India is conspicuous by its absence.

If we examine the impact of Third World articles only (Table 6), we see that 27 developing countries had an impact of 2.5 or greater. But India still does not appear, even though it dominated the Third World in authored articles. The average article from Indica was cited twice over six years. Argentina, which accounted for only a fifth of India's output, had a higher impact – 2.7.

Languages

Third World articles were written in ten different languages. More than

Table 3. continued

Australia	6985	38342	5.5	*4798*	2187	69
Italy	6012	22276	3.7	3448	2564	57
Sweden	4989	42078	8.4	3748	1241	75
Switzerland	4483	29078	6.5	2940	1543	66
Netherlands	4114	28415	6.9	2971	1143	72
Czechoslovakia	3497	9 859	2.8	2207	1290	63
Israel	3199	20788	6.5	2274	925	71
Poland	2918	7072	2.4	1676	1242	57
Belgium	2675	12532	4.7	1772	903	66
Denmark	2398	18460	7.7	1745	653	73
GDR	2344	6401	2.7	1463	881	62
Hungary	2209	5025	2.3	1068	1141	48
Norway	1850	11200	6.0	1292	558	70
Austria	1753	5205	3.0	1106	647	63
South Africa	1676	5182	3.1	992	684	59
Finland	1669	9467	5.7	1162	507	70
*Argentina	1526	4110	2.7	655	871	43

Source of data on articles: 1973 *SCI*®
Source of data on citations: 1973–78 *SCI*®

Table 4. Third World countries whose authors produced 50 or more articles, ranked by the number of articles

Country	Articles	Citations	Impact	Cited articles	Uncited articles	% citedness
India	7888	15515	2.0	4568	3320	58
Argentina	1526	4110	2.7	655	871	43
Brazil	812	2355	2.9	401	411	49
Egypt	713	1306	1.8	451	262	63
Venezuela	589	702	1.2	127	462	22
Chile	565	1228	2.2	227	338	40
Mexico	535	1652	3.1	258	277	48
Niger ia	354	866	2.4	229	125	65
Iran	196	444	2.3	107	89	55
Turkey	184	405	2.2	110	74	60
Malaysia	154	361	2.3	96	58	62
Lebanon	153	401	2.6	90	63	59
Singapore	139	305	2.2	88	51	63
Thailand	138	970	7.0	96	42	70
Uganda	132	587	4.4	93	39	70
Kenya	127	595	4.7	89	38	70
Pakistan	111	197	1.8	60	51	54
Zimbabwe	87	236	2.7	53	34	61
Ghana	79	140	1.8	44	35	56
Jamaica	77	545	7.1	63	14	82
Philippines	61	190	3.1	38	23	62
Peru	59	125	2.1	25	34	42
Tanzania	58	159	2.7	39	19	67
Sri Lanka	58	123	2.1	43	15	74
Sudan	57	161	2.8	36	21	63
Uruguay	57	121	2.1	24	33	42
Algeria	56	82	1.5	28	28	50
Colombia	54	159	2.9	35	19	65
Iraq	54	248	4.6	31	23	57
Ethiopia	50	247	4.9	40	10	80
Totals	15123	34535	23	8244	6879	54
All other Third World nations	755	1630	2.2	410	345	54
Grand totals	15878	36165	2.3	8654	7224	55

Source of data on articles: 1973 *SCI*®
Source of data on citations: 1973-70 *SCI*®

85% of the 16 000 Third World articles are in English. Spanish is a distant second, accounting for 11%. Also, Third World articles had the highest impact (measured as total articles published divided by number of citations) when they were authored in English (impact of 2.6). German langauge articles had the next highest impact (2.0), followed by French (1.4) and Italian (1 .O).

Clearly, English is the *lingua franca* of Third World science. This is even more true in recent years. For example, the 1978 *SCI* database included 22 000 articles from the Third World; 92% of these were in English. And English language articles again accounted for 92% of the 27 000 Third World articles in the 1981 SCI file.

In fact, the same pattern holds true for *all* the author countries in the *SCI* files, developed or developing. More than 80% of the 350 000 articles in the 1973 *SCI* were in English. And English language articles had the highest impact 6.3. In the 1978 SC/, 87% of the 530000 articles were in English. And English language articles accounted for 88% percent of the 605 000 articles in the 1981 *SCI* file.

This reminds me of a controversy involving France that developed in 1976. I presented data showing that most French research had a low impact relative to many other countries." And this was even worse when they published their results in French. I showed that the best articles from France, with a significantly higher impact, were written in English.' [1] This so offended the francophile establishment that I was accused of linguistic imperialism.'* In fact, Michel Debré, a former Prime Minister of France, suggested that my data might threaten "the existence and permanence of the French nation" if it encouraged French scientists to publish in English! [13]

But a recent survey of PASCAL, a French documentation system, yielded some ironic results. In 1979, PASCAL indexed 155 000 articles in its life sciences file. Of these, 70% were in English. French amounted to only 12%, and German to 7%.[14] Unfortunately, PASCAL does not record citations, so we have no measure of the relative impact of these articles. Even a database that "is supposed to be strongly biased in favor of European languages"[14] shows that English *is* the *lingua franca* of international science.

So tar, we have looked at 350 000

Table 5. Countries with impact of 4.0 or greater for articles their authors produced, ranked by impact. Asterisks indicate Third World countries

Country	Impact	Articles	Citations	Cited articles	Uncited articles	% citedness
Bermuda	11.5	2	23	2	–	100
*Liberia	8.7	7	61	7	–	100
Sweden	8.4	4 989	42078	3 748	1241	75
Denmark	7.7	2398	18460	1 745	653	73
Antilles	7.5	4	30	4	–	100
*Jamaica	7.0	77	545	63	14	82
*Thailand	7.0	138	970	96	42	70
Netherlands	6.9	4114	28415	2971	1 143	72
USA	6.9	151 939	1047 854	97 852	54 087	64
Israel	6.5	3199	20788	2274	925	71
Switzerland	6.5	4483	29078	2940	1543	66
UK	6.3	32 189	202600	21 387	10802	66
Norway	6.0	1850	11200	1292	558	70
Finland	5.7	1 669	9467	1 162	507	70
Canada	5.6	15362	86654	10688	4 674	70
Australia	5.5	6 985	38342	4798	2187	69
*Guatemala	5.3	18	96	12	6	67
Northern Ireland	5.2	539	2791	359	180	67
*Panama	5.2	16	83	13	3	81
*Ethiopia	4.9	50	247	40	10	80
Belgium	4.7	2 675	12532	1 772	903	66
"Iraq	4.7	54	248	31	23	58
• Kenya	4.7	127	595	89	38	70
FRG	4.6	20 137	93 233	12 981	7156	64
*Uganda	4.4	132	587	93	39	70
*Zambia	4.4	41	179	24	17	58
Japan	4.1	15569	64 160	10 161	5 408	65
*Cameroon	4.1	16	65	9	7	56
France	4.1	17 707	72912	11069	6 638	62
*Congo Peop Rep	4.0	8	32	5	3	62

Source of data on articles: 1973 *SCI*®
Source of data on citations: 1973-78 *SCI*®

Table 6. Third World countries with impact of 2.5 or greater for articles their authors produced, ranked by impact

Country	Impact	Articles	Citations	Cited articles	Uncited articles	% citedness
Liberia	8.7	7	61	7	–	100
Jamaica	7.1	77	545	63	14	82
Thailand	7.0	138	970	96	42	70
Guatemala	5.3	18	96	12	6	67
Panama	5.2	16	83	13	3	81
Ethiopia	4.9	50	247	40	10	80
Iraq	4.7	54	248	31	23	58
Kenya	4.7	127	595	89	38	70
Uganda	4.4	132	587	93	39	70
Zambia	4.4	41	179	24	17	58
Cameroon	4.1	16	65	9	7	56
Congo Peop Rep	4.0	8	32	5	3	62
Mexico	3.1	535	1652	258	277	48
Philippines	3.1	61	190	38	23	62
Burundi	3.0	1	3		–	100
Lesotho	3.0	2	6	2		100
Brazil	2.9	812	2 355	401	411	49

continued on page 117

articles in the 1973 SCI file by the nationality of the first author. We identified about 16 000 articles as having been authored in 93 Third World countries. India was found to be the 'superpower' of Third World research, accounting for half of all articles from developing countries. But when impact was considered, Indian articles did not rank among the top 25 countries, developed or developing. But three Third World countries – Liberia, Jamaica, and Thailand – had a combined impact close to Scandinavia's, and greater than that of the USA. Also, English language articles dominated the total output of Third World authors, and they had the highest impact.

Nationality

We now consider the same articles by the nationality of the publisher. Fifteen Third World publishing countries are represented in the 1973 *SCI* database. We covered 52 of their journals. These journals published 5 500 of the 16000 articles written by Third World authors. That is, 35% of all the articles by Third World authors were published in Third World journals.

Impact of Third World publishing countries

Again, India is the giant of Third World science. It published 60% of all articles in the Third World scientific press (Table 7). Argentina ranks second, accounting for 20%. The remaining 13 Third World publishing countries account for only 20%.

India and Argentina also rank among the top 25 scientific publishing countries in the world. India ranks 13th and Argentina 20th.

India also ranks first among Third World publishing countries when impact is taken into account (Table 8). The average article published in an Indian journal was cited once from 1973-78. Costa Rica has an equivalent impact, even though its output of published articles was much smaller than that of India. The publications of Peru, Kuwait, Philippines, and Colombia are not listed here because they were not cited from 1973-78.

Publishing opportunities

The USA published more Third World articles than any other country (Table 9). It published 3 700 Third World articles. This amounts to only 2% of all US published articles. But it

Table 6. continued

Colombia	2.9	54	159	35	19	65
Barbados	2.8	5	14	4	1	80
Ivory Coast	2.8	35	99	28	7	80
Saudi Arabia	2.8	13	37	8	5	61
Sudan	2.8	57	161	36	21	63
Argentina	2.7	1 526	4110	655	871	43
Indonesia	2.7	23	62	10	13	43
Tanzania	2.7	58	159	39	19	67
Lebanon	2.6	153	401	90	63	59
Zimbabwe	2.6	87	236	53	34	61
Totals	3.2	4196	13352	2140	1966	52
All other Third World nations	1.9	11772	22813	6514	5258	55
Grand totals	2.3	15 878	36165	8654	7224	54

Source of data on articles: 1973 SCI®
Source of deta on citations: 1973-79 SCI®

Table 7. Third World publishing countries, ranked by the number of articles published in their journals

Publishing country	Articles	Citations	Impact	Cited articles	Uncited articles	% Citedness
India	3 486	3815	1.1	1657	1829	48
Argentina	1 137	379	.3	157	980	14
Venezuela	473	93	.2	49	424	10
Chile	288	123	.4	61	227	21
Mexico	187	99	.5	42	145	22
Brazil	109	29	.3	15	94	14
Costa Rica	71	74	1.0	31	40	44
Lebanon	21	6	.3	5	16	24
Ghana	18	3	.2	3	15	17
Peru	16	0		0	16	–
Nigeria	13	5	.4	4	9	31
Kuwait	10	0	–	0	10	–
Thailand	7	1	.1	1	6	14
Philippines	5	0	–	0	5	–
Colombia	2	0	–	0	2	–
Totals	5843	4 627	.8	2025	3818	35

Source of data on articles: 1973 *SCI®*
Source of da& on citations: 1973-79 *SCI®*

Table 8. Third World publishing countries, ranked by impact of articles their journals published

Publishing country	Impact	Articles	Citations	Cited articles	Uncited articles	% Citedness
India	1.1	3 468	3815	1657	1829	48
Costa Rica	1.0	71	74	31	40	44
Mexico	.5	187	99	42	145	22
Chile	.4	288	123	61	227	21
Nigeria	.4	13	5	4	9	31
Argentina	.3	1 137	379	157	-980	14
Brazil	.3	109	29	15	94	14
Lebanon	.3	21	6	5	16	24
Ghana	.2	18	3	3	15	17
Venezuela	.2	473	93	49	424	10
Thailand	.1	7	1	1	6	14

Source of date on articles: 1973 *SCI®*
Source of data on citations: 1973–78 *SCI®*

Table 9. Countries that published 50 or more Third World articles, ranked by the number of articles. Asterisks indicate Third World countries

Publishing country	Articles	Citations	Impact	Third World countries
USA	3 755	13706	3.6	75
*India	3 351	3 690	1.1	12
UK	2 542	8401	3.3	68
*Argentina	1069	348	.3	13
Netherlands	885	3 440	3.9	53
FRG	648	1512	2.3	43
Switzerland	555	1488	2.7	41
*Venezuela	431	53	.1	5
France	360	566	1.6	42
GDR	319	602	1.9	17
Japan	293	477	1.6	19
*Chile	283	123	.4	5
Italy	228	280	1.2	29
*Mexico	174	94	.5	7
Australia	134	267	2.0	20
Denmark	126	351	2.8	23
*Brazil	89	22	.2	2
Canada	86	152	1.8	20
Hungary	74	84	1.1	10
Austria	64	107	1.7	8
Czechoslovakia	54	94	1.7	9
*Costa Rica	50	58	1.2	12
Totals	15 570	35 915	2.3	
All others	308	250	.8	
Totals	15878	36 165	2.3	

Source of data on articles: 1973 *SCI*®
Source of data on citations: 1973-78 *SCI*®

Table 10. Publishing countries with an impact of 1.5 or greater for Third World articles, ranked by impact

Publishing country	Impact	Articles	Citations	Third World countries
Netherlands	3.9	885	3 440	53
USA	3.6	3 755	13706	75
UK	3.3	2 542	8401	68
Ireland	3.0	1	3	1
Denmark	2.8	126	351	23
Switzerland	2.7	555	1488	41
FRG	2.3	648	1512	43
Sweden	2.2	28	61	14
Australia	2.0	134	267	20
GDR	1.9	319	602	17
Canada	1.8	86	152	20
Israel	1.8	18	32	7
Austria	1.7	64	107	8
Czechoslovakia	1.7	54	94	9
France	1.6	360	566	42
Japan	1.6	293	477	19
Norway	1.5	2	3	2
Totals	3.2	9 888	31298	
All others	.8	5990	4 867	
Grand totals	2.3	15878	36 165	

Source of data on articles: 1973 *SCI*®
Source of data on citations: 1973-78 *SCI*®

accounts for 24% of all Third World articles. Also, Third World articles published in the USA came from 7.5 different developing countries. That is, more Third World nations found a publishing opportunity in the US than in any other publishing country.

India is a close second, publishing 3 300 Third World articles. But 98% of all Third World articles published in India were authored by Indian scientists. Eleven other developing countries managed to publish only 56 articles in Indian journals.

The other Third World publishing countries, indicated by asterisks, followed the same pattern. 75% of the Third World articles published in Argentina were authored by Argentinian scientists. For Venezuela, this figure is 97%; for Chile, 98%; for Mexico, 95%; and Brazil, 99%. Only Costa Rica published more articles from Third World countries other than itself. Of the 50 articles published in Costa Rican journals, 23 were from Costa Rica.

Significantly, no Third World publishing country had an impact of 1.5 or greater for the Third World articles it published (Table 10). Costa Rica had an impact of 1.2, the highest of all 15 Third World publishers. India followed with an impact of 1 .1 . Third World articles had the greatest impact when they were published in the Netherlands, USA, or UK.

Journals

We can now identify the journals from the developed countries that published at least 50 articles from the Third World. Nineteen journals are shown (Table 11). Included is the overall number of articles each journal published to give an idea of the proportion from the Third World.

Six of these journals were published in the UK, the USA has five, and the Netherlands three. Switzerland and Italy account for two journals each, and one journal was published in East Germany.

Twenty-one Third World journals published at least 50 articles from the developing countries (Table 12). More than half (13) are Indian journals. The remaining eight were published in Central or South America: two each in Argentina, Chile, and Mexico; and one each in Costa Rica and Venezuela. These journals published Third World articles almost exclusively. 96% of all articles in these journals, taken together, were from the Third World.

When we rank journals that published Third World articles by

Table 11. Journals that published 50 or more Third World articles, 1973 SC/@

Journal	Third World articles	Total number of articles	Third World impact
Journal of Inorganic and Nuclear Chemistry (USA)	138	634	3.6
Phytochemistrv (UK)	121	655	3.6
Experientia (Switzerland)	104	1114	1.9
Transactions of the Royal Society of Tropical Medicine and Hygiene (UK)	100	312	3.6
Lancet (UK)	88	2 626	6.9
Notices of the American Mathematical Society (USA)	78	2 236	0
International Journal of Electronics (UK)			
Genetics (USA)	73	1033	0
Pure and Applied Geophysics (Italy)	68	224	6
Biochimica et Biophysica Acta (Netherlands)	66	2311	13.0
Physical Review B-Solid State (USA)	66	1382	4.9
Bulletin of the World Health Organization (Switzerland)	60	177	4.0
Lettere al Nuovo Cimento (Italy)	60	571	1.3
Physica Status Solidi B-Basic Research (GDR)	60	669	1.5
Physics Letters A (Netherlands)	57	996	2.0
British Medical Journal (UK)	56	1 776	7.4
Journal of Tropical Medicine and Hygiene (UK)	52	72	2.1
Tropical and Geographical Medicine (Netherlands)	52	66	1.8
Tetrahedron Letters (USA)	51	1406	0

impact (Table 13), no Third World journal appears among the top 25. The USA accounts for two-thirds of the journals with the highest impact for Third World articles. Seven were published in the UK, and one each in Denmark and Switzerland.

For 18 of these journals, the impact of Third World articles was greater than the journal's overall impact. That is, Third World research reported in their pages added to the overall impact of these journals.

Of the 52 Third World journals covered in the 1973 *SCI*, 14 had an impact of 1.0 or greater for articles it published from developing countries (Table 14). The highest impact for any Third World journal was 2.3. Nine Indian journals are listed. Argentina accounts for three. Mexico and Costa Rica account for one journal each.

Most-cited articles

We now examine the Third World articles that were cited at least 50 times from 1973-78. Full bibliographic information is given for 23 articles, including the institutional affiliations of all authors (Table 15). First authors who were based in India, Argentina, and Thailand each account for five most-cited Third World articles. Brazilian authors contributed four articles. Uganda, Chile, Iran, and Jamaica account for one article each.

We also checked to see if these first authors listed different institutional affiliations on other articles. For example, some may have been visiting researchers at institutions in the developed countries. On the other hand, they may have been researchers from developed countries who worked in Third World institutes for a time. We found that four first authors also listed addresses at institutions in developed countries – K.H. Graefe, R. Edelman, R.D. Keynes, and V.A. Bokisch.

In addition, five of the 23 articles were co-authored with researchers from developed countries. Thus, including a scientist from a developed country on the research team may be an effective strategy for increasing the impact of Third World research.

Although we have listed the overall number of citations each article received from 1973-78, we can identify the 'nationality' of these citations. That is, we can tell how many citations were given by authors from the same developing nation of the first author, from other Third World countries, and from developed countries.

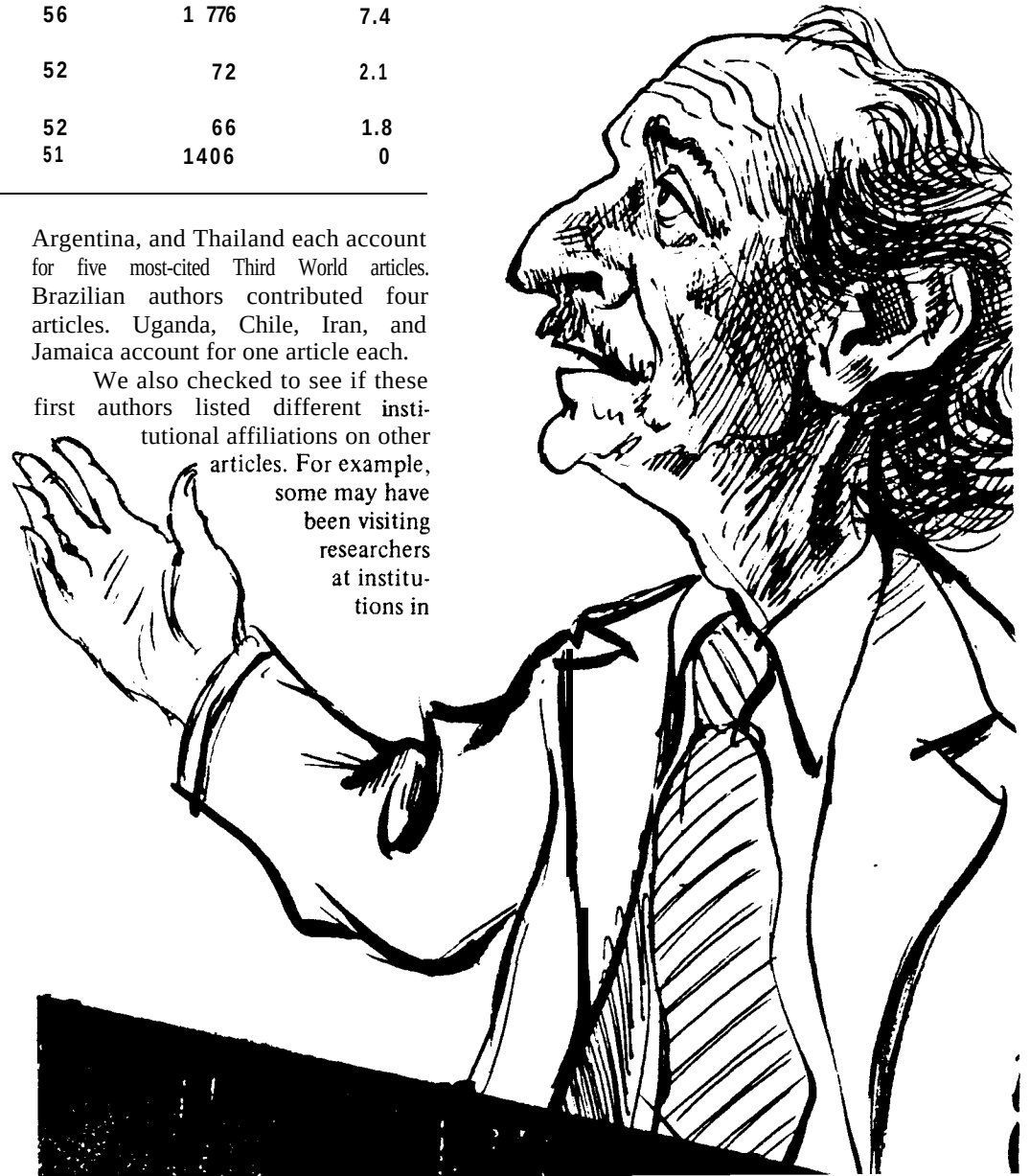


Table 12. Third World journals that published 50 or more Third World articles, 1973 *SCI®*

Journal	Third World articles	Total number of articles	Third World impact
Current Science (India)	620	629	.8
Acta Physiologica Latino-Americana (Argentina)	613	647	.3
Indian Journal of Chemistry (India)	544	553	1.9
Acta Cientifica Venezolana (Venezuela)	431	473	.1
Medicina (Argentina)	359	374	.2
Indian Journal of Pure and Applied Physics (India)	335	340	1.1
Journal of the Indian Chemical Society (India)	309	312	1.2
Indian Journal of Medical Research (India)	269	272	1.5
Indian Journal of Agricultural Sciences (India)	261	266	.4
Indian Journal of Experimental Biology (India)	221	230	1.3
Revista Medica de Chile (Chile)	181	185	6
Indian Journal of Technology (India)	157	188	.4
Indian Journal of Physics and Proceedings of the Indian Association for the Cultivation of Science (India)	108	112	.7
Archivos de Biologia y Medicina Experimentales (Chile)	102	103	0
Indian Journal of Biochemistry and Biophysics (India)	98	98	2.3
Revista de Investigacion Clinica (Mexico)	73	76	.4
Indian Journal of Genetics and Plant Breeding (India)	72	75	.4
Archivos de Investigacion Medica (Mexico)	60	65	.5
Journal of Scientific and Industrial Research (India)	57	79	1.2
Proceedings of the Indian Academy of Sciences Section B (India)	57	57	.9
Turrialba (Costa Rica)	50	71	1.2

Table 13. Top 25 journals with highest impact for Third World articles, 1973 *SCI®*

Journal	Impact of Third World articles	Impact of all articles	Third World articles	Number of citations
Physiological Reviews (USA)	192.0	103.5	1	192
Reviews of Modern Physics (USA)	59.0	86.9	2	118
Proceedings of the National Academy of Sciences of the USA (USA)	57.0	46.8	2	114
Journal of Immunology (USA)	44.2	22.6	5	221
Proceedings of the Nutrition Society (UK)	39.0	3.1	1	39
Journal of Clinical Investigation (USA)	37.5	41.6	2	75
Hormones and Behavior (USA)	36.0	12.8	2	72
Journal of Lipid Research	33.7	19.2	4	135
Cell and Tissue Kinetics (UK)	28.0	14.3	1	28
Tissue Antigens (Denmark)	25.0	13.9	1	25
Astrophysical Journal Supplement Series (USA)	24.0	30.3	1	24
Infection and Immunity (USA)	23.3	13.5	10	233
Biochemistry (USA)	23.0	26.0	4	92
Proceedings of the Royal Society Series B-Biological Sciences (UK)	23.0	15.8	1	23

continued on page 121

These 23 articles received about 1800 citations. 86% were from authors in developed countries. 10% were from the first author's developing country. Only 40% were from authors in other Third World nations. Thus, whether or not a Third World article is highly-cited depends on the recognition it gets from authors in the developed countries.

Part of the reason for this is that no Third World journal published the most-cited articles from the developing countries. Thirteen of the 23 most-cited articles appeared in US journals. Seven were published in the UK. Two were published in the Netherlands, and one in West Germany.

We have not yet discussed, in a cognitive sense, the most active areas of Third World research. We have shown some research their scientists do best by examining the most-cited articles from the Third World. But any conclusion drawn from such a limited sample of Third World articles would be tentative, at best.

Clustering method

At *ISI*, a method has been developed to bring into view the cognitive structure of science." Here, I limit myself to a brief explanation of what is actually a complex procedure (Figure 2).

When we record the references in an article, we also keep track of the ***pairs*** of papers it cited together, or cocited. When the same pairs of papers are cited together with other papers by many authors, a cluster of research begins to form. The idea underlying this method is that co-cited articles share a common topic, subject area, or method. That is, when an author cites two papers together, he or she indicates that both papers applied to some aspect of the research he or she performed. When the same cluster of papers are co-cited by several authors, a cognitive link is established between the research these authors perform. That is, the citing authors reveal what research area they 'belong to' through their citations. By examining the titles of the citing articles, we get an idea of the cognitive content of their research , concentration. That is, the citing authors themselves provide the words to define what their research area is about.

At another level, we can also identify co-citation links between clusters. This is possible when authors cite together articles included in different clusters. Again, we assume

that authors who use the same clusters of articles are engaged in similar types of research. The more frequently two clusters of articles are cocited, the clusters, we use this relationship to determine how close or far apart clusters should be depicted in relation to each other.

We used the 1981 *SCI* file to see what clusters were cited in articles from Third World countries. This gives an understanding of the ***current*** areas of activity in Third World science. We started by identifying all articles from Third World countries in the 1981 SCI. We then identified all the articles they cited that year. We then determined which 1981 articles from developed countries referred to the same group of papers cited by Third World authors. These data were entered into our computer, and more than 2 000 clusters of co-cited papers were generated.

Before we identified clusters that were cited by Third World articles, we decided to separate India from the developing countries. As we have seen, India overshadows the rest of the Third World in the number of scientific articles it authors and publishes. By considering India separately, we have a clearer picture of Third World scientific activity.

Maps of clusters

Thirty-nine clusters were cited by at least 15 articles from the Third World, excluding India (see Figure 3). Each circle represents a single cluster. The shading indicates different disciplines of research. Connecting lines indicate co-citation links between these disciplines.

The clusters are densely packed and highly interconnected for a good reason. 90% of them deal with topics in closely related fields – clinical and biomedical science. Thirteen clusters concentrate on various aspects of immunity, particularly to viral and bacterial diseases; seven deal with **hormones** and fertility; and four discuss circulatory and heart disease. The ten clusters on 'miscellaneous' topics in clinical and biomedicine concern cancer, neurotransmission, physiology, metabolism, and other topics! The remaining five clusters in this figure are in fields other than clinical and biomedicine – two in physics, one in astronomy, and two in agricultural and environmental sciences.

Obviously, Third World research activity is focused on clinical and biomedical science. That is, developing country scientists tend to cite clusters of articles in clinical and biomedical research almost exclusively. But what specific areas of clinical and biomedical research are cited *most* frequently by Third World scientists? This can be determined by considering the proportion of all articles citing these clusters that were from the Third World.

Third World articles amounted to at least 15% of all citing articles for 11 clusters. As we can see in Figure 4, the level of Third World participation is significant in seven clusters of research on immunology and infectious disease.

Another area of Third World scientific expertise is in hormone and fertility research. Third World scientists also accounted for a significant proportion of all papers citing research in the agricultural cluster.

The cluster names read like an agenda of Third- World concerns: diseases transmitted by parasites, bacteria, and viruses; immune responses to these and other infectious diseases; hormones, steroids, and fertility; and grains and legumes. Except for the last, all Third World science is focused on clinical and biomedical research. Of course, Third World scientists do

Table 13. continued

Chemical Society Reviews (UK)	21.5	34.9	2	43
Human Pathology (USA)	20.5	8.0	2	41
Nephron (Switzerland	20.5	6.5	2	41
Journal of Membrane Biology (USA)	20.0	14.8	7	140
Inorganic Chemistry (USA)	19.4	11.9	9	175
Philosophical Transactions of the Royal Society of London Series A– Mathematical and Physical Sciences (UK)	19.0	7.9	2	38
Blood (USA)	18.3	12.0	3	55
Annual Review of Microbiology (USA)	17.5	30.9	2	35
Endocrinology (USA)	17.4	21.4	7	122
Clinical and Experimental Immunology (UK)	16.8	23.0	5	84
Journal of Physiology London (UK)	16.4	11.0	16	262

Table 14. Third World journals with an impact of 1.0 or greater for Third World articles, 1973 SCI@

Journal	Impact of Third World articles	Impact of all articles	Third World articles	Citations
Indian Journal of Biochemistry and Biophysics (India)	2.3	2.3	98	223
Indian Journal of Chemistry (India)	1.9	1.9	544	1027
Anales de la Asociacion Quimica Argentina (Argentina)	1.8	1.8	39	71
Acta Endocrinologica Panamericana (Argentina)	1.6	1.2	7	11
Indian Journal of Medical Research (India)	1.5	1.5	269	404
Phyton (Argentina)	1.5	1.1	8	12
Indian Journal of Experimental Biology (India)	1.3	1.2	221	286
Journal of the Indian Chemical Society (India)	1.2	1.2	309	381
Journal of Scientific and Industrial Research (India)	1.2	1.3	57	71
Phytomorphology (India)	1.2	1.6	4	5
Turrialba (Costa Rica)	1.2	1.0	50	58
Indian Journal of Pure and Applied Physics (India)	1.1	1.1	335	384
Patologia (Mexico)	1.1	1.3	16	18
Nucleus (India)	1.0	1.3	26	25

Table 15. Third World articles cited at least 50 times from 1973-78

Citations 1973-1978 *SCI*® Total	First author's country	Third World	Developed world	Bibliographic data
192	8	1	183	Paintal A.S. Vagal sensory receptors and their effects. *Physiol Rev* 53:159–227, 1973. Delhi Univ, Vallabhbhai Patel Chest Inst, Delhi, India.
166	13	1	152	Mendes N F, Tolnai M E A, Silveira N P A, Gilbertsen R B and Metzgar R S. Technical aspects of the rosette tests used to detect human complement receptor (B) and sheep erythrocyte-binding (T) lymphocytes. *J Immunol* 111:860–7, 1973. Escola Paulista Med. Dept Microbiol, Immunol Parasitol, Sao Paulo, Brazil; Duke Univ Med Ctr, Dept Microbiol Immunol, Durham, NC.
118	1	0	117	Punsalang A P and Sawyer W D. Role of pili in the virulence of *Neisseria gonorrhoeae*. *Infec Immunity* 8:255–63, 1973. Mahidol Univ, Dept Microbiol; Rockefeller Found, Bangkok, Thailand.
109	16	0	93	Behrens N H, Carmingatti H, Staneloni R J, Leloir L F and Cantarella A I. Formation of lipid-bound oligosaccharides containing mannose. Their role in glycoprotein synthesis. *Proc Nat Acad Sci US 70:* 3390–4, 1973. Univ Buenos Aires, Inst Invest Bioquim. "Fundación Campomar", Buenos Aires, Argentina.
88	10	16	62	Sirisinha S, Suskind R, Edelman R, Charupatana C and Olson R E. Complement and C3-proactivator levels in children with protein-calorie malnutrition and effect of dietary treatment. *Lancet* 1:1016–20, 1973. Mehidol Univ. Dept Microbiol; SEATO Med Res Lab, Dept Virol, Bangkok, Thailand;Chiang Mai Univ, Anemia Malnutr Res Ctr, Chiang Mai, Thailand; St. Louis Univ Sch Med, Dept Biochem Pediat, St. Louis, MO.
68	10	11	47	Edelman R, Suskind R, Olson R E and Sirisinha S. Mechanisms of defective delayed cutaneous hypersensitivity in children with protein-calorie malnutrition. *Lancer* 1:506–8, 1973. SEATO Med Res Lab, Dept Virol, Bangkok, Thailand; Chiang Mai Univ, Anemia Malnutr Res Ctr, Chiang Mai, Thailand; St. Louis Univ Sch Med. Dept Biochem Pediat, St. Louis, MO; Mahidol Univ, Dept Microbiol, Bangkok, Thailand.
65	1	0	64	Thongthai C and Sawyer W D. Studies on the virulence of *Neisseria gonorrhoeae*. I. Relation of colonial morphology and resistance to phagocytosis by polymorphonuclear leukocytes. *Infec. Immunity 7:* 373-9, 1973. Mahidol Univ. Dept Microbiol; Rockefeller Found, Bangkok. Thailand.
61	5	6	50	Bokisch V A, Top F H, Russell P K, Dixon F J and Müller-Eberhard H J. The potential pathogenic role of complement in dengue hemorrhagic shock syndrome. N. *Engl. J. Med.* 289:996–1000, 1073. SEATO Med Res Lab, Dept Virol, Bangkok, Thailand; Scripps Clin Res Found, Dept Exp Pathol, La Jolla, CA; Walter Reed Army Inst Res, Div Communic Dis Immunol, Washington, DC.
61	14	0	47	Leloir L F, Staneloni R J, Carminatti H and Behrens N H. The biosynthesis of a N,N'.-diacetylchitobiose containing lipid by liver microsomes. A probable dolichol pyrophosphate derivative. *Biochem Biophys Commun* 52:1285–92, 1973. Univ Buenos Aires, Inst Invest Bioquim. "Fundación Campomar", Buenos Aires, Argentina.

Table 15. continued

80	2	2	76	Jacob G and Maris Th A J. Quasi-free scattering and nuclear structure. II. Rev *Mod Phys* 45:6–21, 1973. Univ Fed Rio Grande Sul, Inst Fis, Porto Alegre, Brazil.
80	2	9	69	Karim S M M, Carter D C, Bhana D, Ganesan P A. Effect of orally administered prostaglandin E_2 and its 15-methyl analogues on gastric secretion. *Brit Med J. 1:* 143-6, 1973. Makerere Univ Med Sch, Kampala, Uganda.
79	4	2	73	Garay R P and Garrahan P J. The interaction of sodium and potassium with the sodium pump in red cells, *J Physiol London* 231: 297-325, 1973. Univ Buenos Aires, Dept Quim Biol, Buenos Aires, Argentina.
79	23	0	56	Graefe K H, Stefano F J E and Langer S Z. Preferential metabolism of $(-)$-^{3} H-norepinephrine through the deaminated glycol in the rat vas deferens. *Biochem Pharmacol* 22:1147–60, 1973. Consejo Nac Invest Cientif Tecn Inst, Invest Farmacol, Buenos Aires, Argentina.
72	10	0	62	Ramachandran G N, Lakshminarayanan A V and Kolaskar A S. Theory of the non-planar peptide unit. *Biochim Biophys Acta* 303:8–13, 1973. Indian Inst Sci, Mol Biophys Unit, Bangalore, India; Univ Chicago, Dept Biophys, Chicago, Il l.
70	3	0	67	Raheja R K, Kaur C, Singh A and Bhatia I S. New colorimetric method for the quantitative estimation of phospholipids without acid digestion. *J Lipid Res* 14:695–7, 1973. Punjab Agricult Univ. Dept Chem Biochem, Ludhiana, India.
68	3	4	61	Keynes R D, Rojas E, Taylor R E and Vergara J. Calcium and potassium systems of a giant barnacle muscle fibre under membrane potential control. *J Physiol London* 229:409–55, 1973. Univ Chile, Lab Cell Physiol, Casilla, Chile.
58	8	3	47	Reinhold J G, Nasr K, Lahimgarzadeh A and Hedayati H. Effects of purified phytate and phytate-rich bread upon metabolism of zinc, calcium, phosphorus, and nitrogen in man. *Lancer* 1:283–8, 1973. Pahlavi Univ Sch Med. Inst Nucl Med, Shiraz, Iran.
58	5	1	52	Seakins M, Gibbs W N, Milner P F and Bertles J F. Erythrocyte Hb-S concentration. An important factor in the low oxygen affinity of blood in sickle cell anemia. *J Clin Invest* 52:422–32, 1973. Univ West Indies, Dept Chem Hematol, Kingston, Jamaica; St. Luke's Hosp Ctr, Hematol Div, New York, NY.
57	4	7	46	Chandra R K. Reduced bactericidal capacity of polymorphs in iron deficiency. *Arch Dis Child.* 48:864–6, 1973. All India Inst Med Sci, Dept Paediat, New Delhi, India
54	10	0	44	Karniol I G and Carlini E A. Pharmacological interaction between cannabidiol and Δ^9-tetrahydrocannabinol. *Psychopharmacol* 33:53–70, 1973. Escola Paulista Med. Dept Psicobiol, Sao Paulo, Brazil.
53	7	3	43	Blaquier J A and Calandra R S. Intranuclear receptor for androgens in rat epididymis. *Endocrinology* 93:51–60, 1973. Inst Biol Med Exp, Lab Esteroides, Buenos Aires, Argentina.
53	2	0	51	Srivastava R K, Kulshrestha V K, Singh N and Bhargava K P. Central cardiovascular effects of intracerebroventricular propranolol. *Eur J Pharmacol* 21:222–9, 1973. Univ Lucknow, King George's Med Coll, Lucknow, India.
52	14	7	31	Toma H E and Malin J M. Properties and reactivity of some pentacyanoferrate (I I) complexes of aromatic nitrogen heterocycles. *Inorg Chem* 12:1039–45, 1973. Univ Sao Paulo, Inst Quim, Sao Paulo, Brazil.

research in physics, chemistry, mathematics, and other fields. But they are *most* active in clinical and biomedical research.

Indian clusters

When we examine Indian science and exclude the rest of the Third World (see Figure 5), we see that 32 clusters were cited by at least 16 articles from India. The smaller structure that stands apart to the left includes seven clusters. They are all in chemistry: these clusters discuss valence states, electron density, and phase transitions of various crystals and liquids.

The larger structure to the right includes 25 clusters. They can be organized into three separate fields of concentration. Eleven clusters deal with the synthesis and properties of various metal and ligand complexes. For convenience, we categorize them as being in chemical physics.

Nine clusters concentrate on biochemistry, and deal with protein analysis, plant genetics, DNA conformation, and the structure and bioactivity of various substances. One of these discusses viral gastroenteritis, the only biomedical cluster on the map of Indian science. But only 3% of the articles citing this cluster were from India.

The remaining five clusters, deal with physics. They discuss quantum chromodynamics, quark models, unified field theories, and other topics.

Unlike the other developing countries, Indian science is not focused on any one field. It is interesting that Indian science was not active in clinical and biomedical research, which preoccupied the rest of Third World science. Instead, Indian scientists cited research in biochemistry, physics, chemistry, and chemical physics. But Indian research activity was concentrated in chemical physics.

Indian articles amounted to at least 25% of all citing articles for 12 clusters (see Figure 6). Nine of these clusters deal with metal and ligand complexes, which we have categorized as topics in chemical physics. In the cluster named 'Stability Constants of Metal Complexes with Asymmetric Multidentate Ligands', the level of Indian participation was very high. More than 100 articles published in 1981 cited this cluster, and 77% were from India.

Chemistry is another active area of Indian science. These clusters deal with chemical properties of alcohol and various crystals. And one cluster

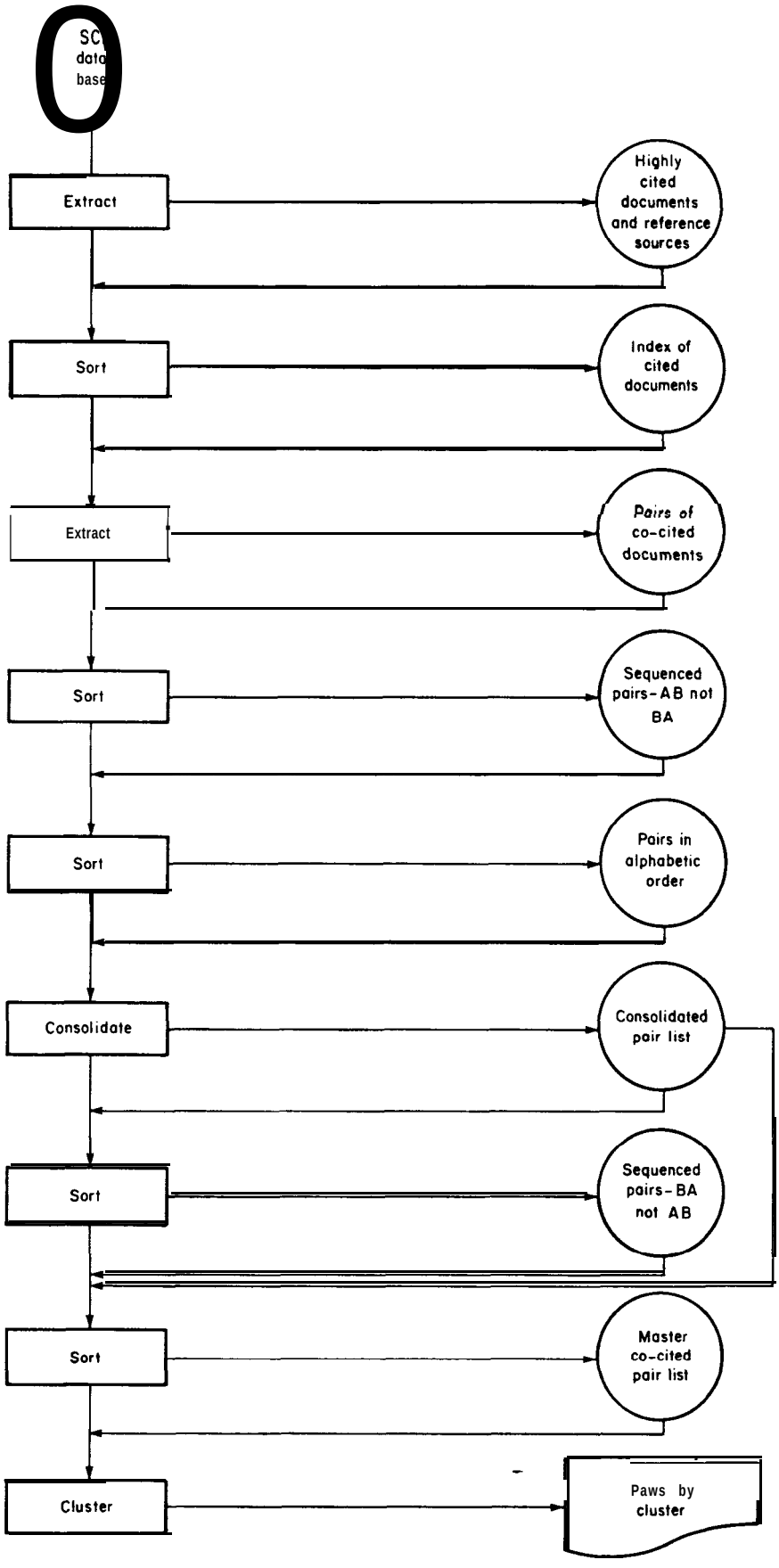


Figure 2. Diagrams of ISI's clustering method

Source: *SCI*® 1981

in biochemistry, colored blue, showed a significant level of participation by Indian researchers. Of the 108 articles that cited this cluster on 'Diallyl Analysis and other Biometrical Genetics Studies', 27 were from India.

Conclusions

When we talk about Third World science, we have to distinguish between India and the rest of the developing world. In many respects, Indian science is unlike the mainstream of Third World research.

First, Indian science is not clustered in clinical or biomedical research. Of course, Indian scientists do research in clinical and biomedicine, but they are not the ***most*** active areas of Indian research. In contrast, the rest of the Third World actively participates in clinical and biomedical research.

Also, Indian science is clustered in research fields that other Third World scientists have not significantly penetrated — biochemistry, physics, chemistry, and chemical physics. And the level of participation of Indian scientists in chemical physics is especially remarkable.

India also stands apart from all other developing nations in the number of articles its scientists authored. Remember that half the 16 000 Third World articles in the 1973 *SCI* were authored in India. And India's dominant position in the Third World has remained constant over the years. For example, there were 22000 Third World articles in the 1978 SCI database. Of these, 52% were authored in India. The 1981 ***SCI*** database included 27000 Third World articles, and 49% of these were from India.

India overshadows the rest of the Third World in the number of articles published in its scientific press, as well. Indian journals accounted for 60% of all 1973 articles published in the Third World.

Thus, we get a skewed impression of Third World science when we do not take separate account of India. For example, 5% of the 353000 articles in the 1973 *SCI* were authored in the Third World. But when India's contribution is subtracted, the proportion of Third World articles drops to only 2%. And 2% of the 1973 *SCI* articles were published in Third World journals. But this drops to less than 1% when India is excluded.

#en we consult data from other indexing services that claim to be comprehensive for the world's publications in physics, chemistry, and biology, India's position remains the same. For example, the number of particle physics papers from India accounted for 3% of the input to ***Physics Abstracts*** in 1982[16] Indian chemistry papers represented another ***3%*** of the ***Chemical Abstracts file*** in 1981. And Indian biology papers again accounted for 3% of the ***BIOSIS*** file from 1978 to 1981.

It is interesting to note the USSR's position in this context. In 1970, Soviet chemistry papers represented 24% percent of the ***Chemical Abstracts*** file. This number declined to 17% in 198 1. This decline can be traced to the Soviet practice of depositing papers instead of publishing them." In fact, the USSR passed a resolution in 1979 to ***reduce*** the number of their journal publications. The result has been-a 10% decrease in the amount of Soviet literature in various areas of science and technology."

I can not say whether the data presented indicate that Third World research, with or without India, is 'under' -represented in international scientific journals. Granted, articles

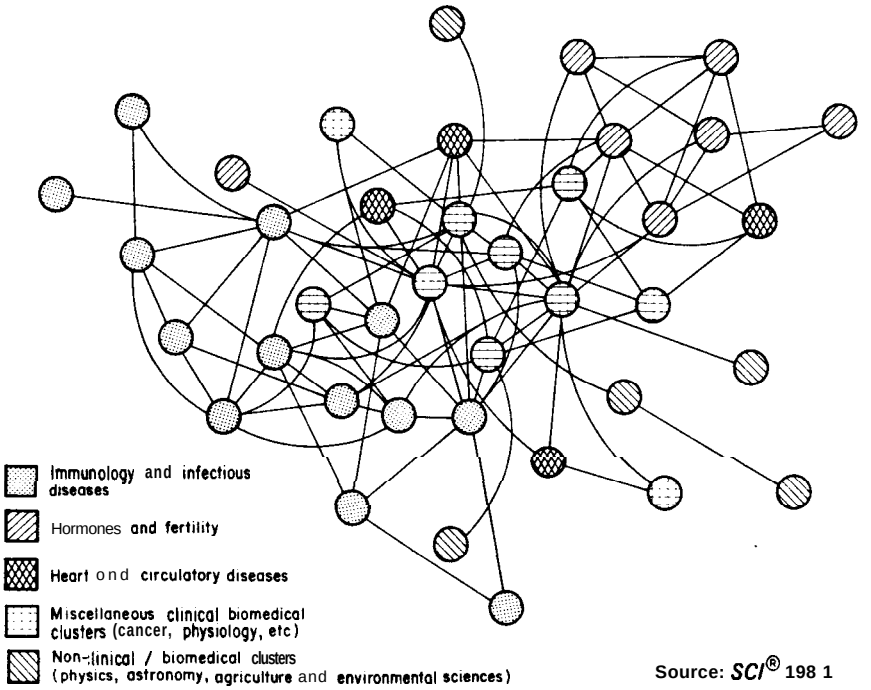


Figure 3. Clusters of research cited by 1981 articles from Third World countries, excluding India

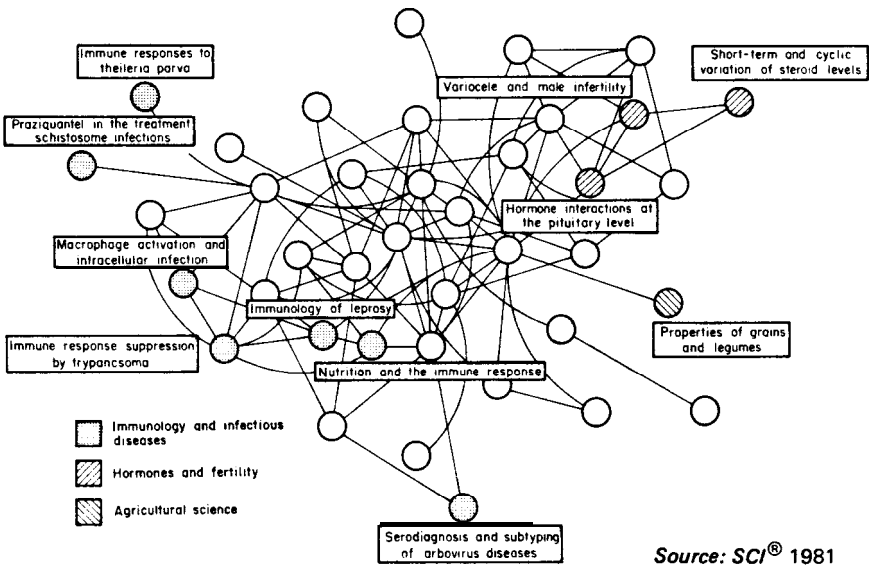


Figure 4. Names of clusters for which Third World articles amount to at least 15% of all 1981 cit ing articles

authored and published in Third World countries amount to a very small proportion of the international scientific press. But this might be explained in several ways.

For example, Third World countries cannot afford to devote a large percentage of their gross national products to scientific research. This has an obvious effect on the availability of scientific instruments, supplies, and materials in developing countries. Without all this, the conduct of research in the Third World is diminished.

Or, Third World countries may not have a large enough research community to generate significant numbers of articles. This would also affect the number of scientific journals the research community can support.

I am sure there are many other factors that might explain why Third World scientific output amounts to such a small proportion of the international scientific output. Until these factors are analysed, we cannot decide if the coverage of Third World research is equitable. And until we make that decision, we cannot talk about the need for restructuring the world scientific press. This lecture is intended to serve as a point of departure for what I hope will be a continuing analysis of the level and impact of Third World science. It remains to be seen whether or not a New Scientific Information Order is needed.

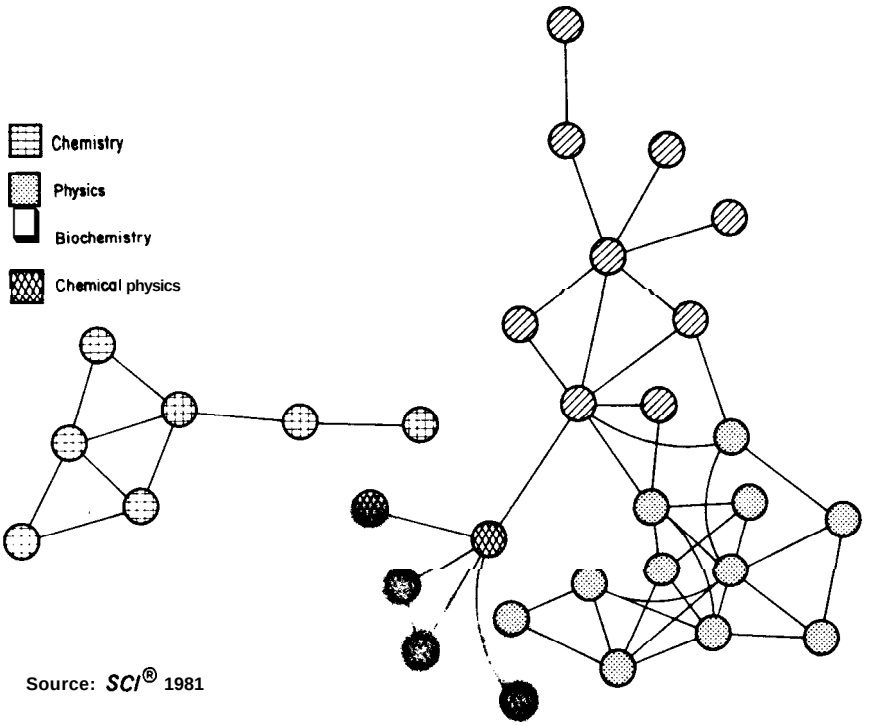


Figure 5. Clusters of research cited by 1981 articles from India, excluding the rest of the Third World

References

1 UNESCO, International Commission for the Study of Communication Problems *Many Voices, One World* (New York, Unipub, 1980)

2 Masmoudi, M. *The New World Information Order* (Paris, UNESCO, International Commission for the Study of Communication Problems, 1978), Document 31

3 Hamelink. C.J. *The New International Economic Order and the New International Information Order* (Paris, UNESCO, International Commission for the Study of Communication Problems, 1978), Document 34

4 Osolnik, B. *Aims and approaches to a New International Communication* Order (Paris, UNESCO, International Commission for the Study of Communication Problems, 1978) Document 32

5 Smith, A. *The Geopolitics of Information* (New York, Oxford University Press, 1980), p 14

6 Kurian, G.T. (ed) *Encyclopedia of the Third World* (New York, Facts on File, 1981, 3 vols)

7 Gupta, B.M. and Nathan, S.S. 'Scientific and technical journals in the developing countries', *ILA Bulletin, 15,* 1979, 1 l-9

8 Bradford, S.C. *Documentation* (Washington, DC, Public Affairs Press, 1950), 156 pp

9 Garfield, E. *Citation Indexing – Its Theory and Application in Science, Technology, and Humanities (New* York, Wiley 19791,274 pp

10 Garfield, E. "Le nouveau défi Amhricain, I, *Essays of an Information Scientist* (Philadelphia, ISI Press, 1980), Vol 3, pp 88-94

(reprinted from *Current Contents* (15), 11 April 1977, pp 5-I 1, translation of Garfield, E. "La science française est-elle trop provinciale?", Recherche, 7, 1976, pp 757 – 760

11 Garfield, E. "Do French scientists who publish outside of France and/ or in English do better research?", *Essays of an Information Scientist* (Philadelphia, ISI Press, 1980), 3, pp 498-503 (reprinted from *Current* Contents, (22), 29 May 1978. pp 5-10

12 Burke, B. "French scientists resent dominance of English", *Washington Post, 20* March 1977. p E6

13 Debre, M. "La Langue française et la science universelle" ("The French language and universal science"), *Recherche, 7,* 1976. p 956

14 Jogadzinski-Sigogneau, M Courtial, J.P. and Latour, B. "How to measure the degree of independence of a research system", *Scientometrics,* 1982, *4*(2), pp 119-133

15 Garfield, E. "ABCs of cluster mapping. Parts 1 and 2. Most active fields in the life and physical sciences in 1978". *Essays of an Information* Scientist (Philadelphia, ISI Press, 1981), Vol 4. pp 63449 (reprinted *from Current Contents* (40), *6* October 1980, pp 5-I 2 and (41), 13 October 1980, pp 5-12

16 Vlanchy, J. "World publication output in particle physics". *Czech J Phys,* 832.1982. pp 1065-72

17 Baker. D.B. "Recent trends in chemical literature growth", *Chem Eng News, 59* (22), 1981, pp 29-34

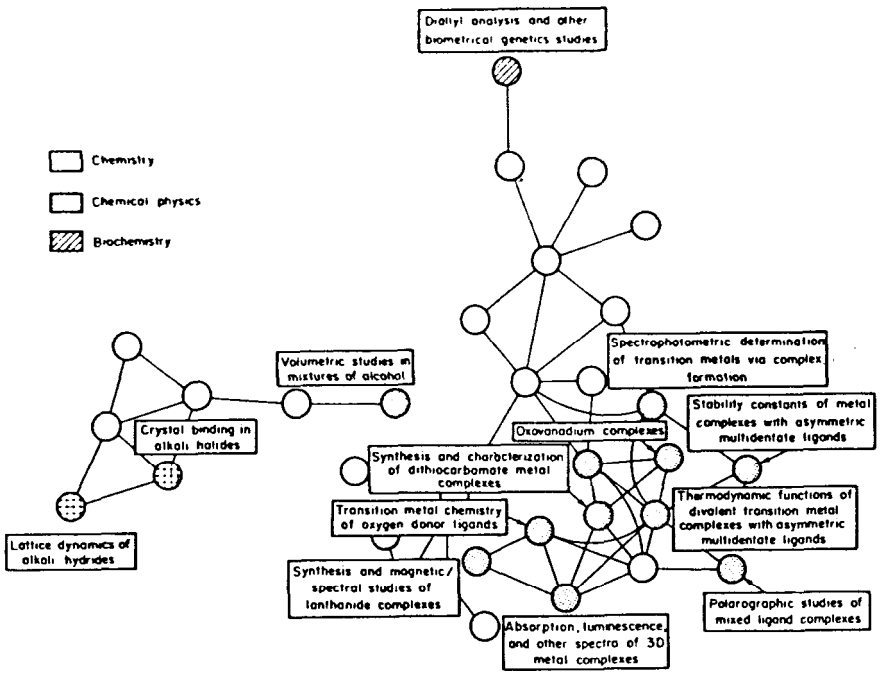


Figure 6. Names of clusters for which Indian articles amount to at least 25% of all citing articles

Source: SCI® 1981