SCIENCE CITATION INDEX

An International Interdisciplinary
Index to the Literature of Science

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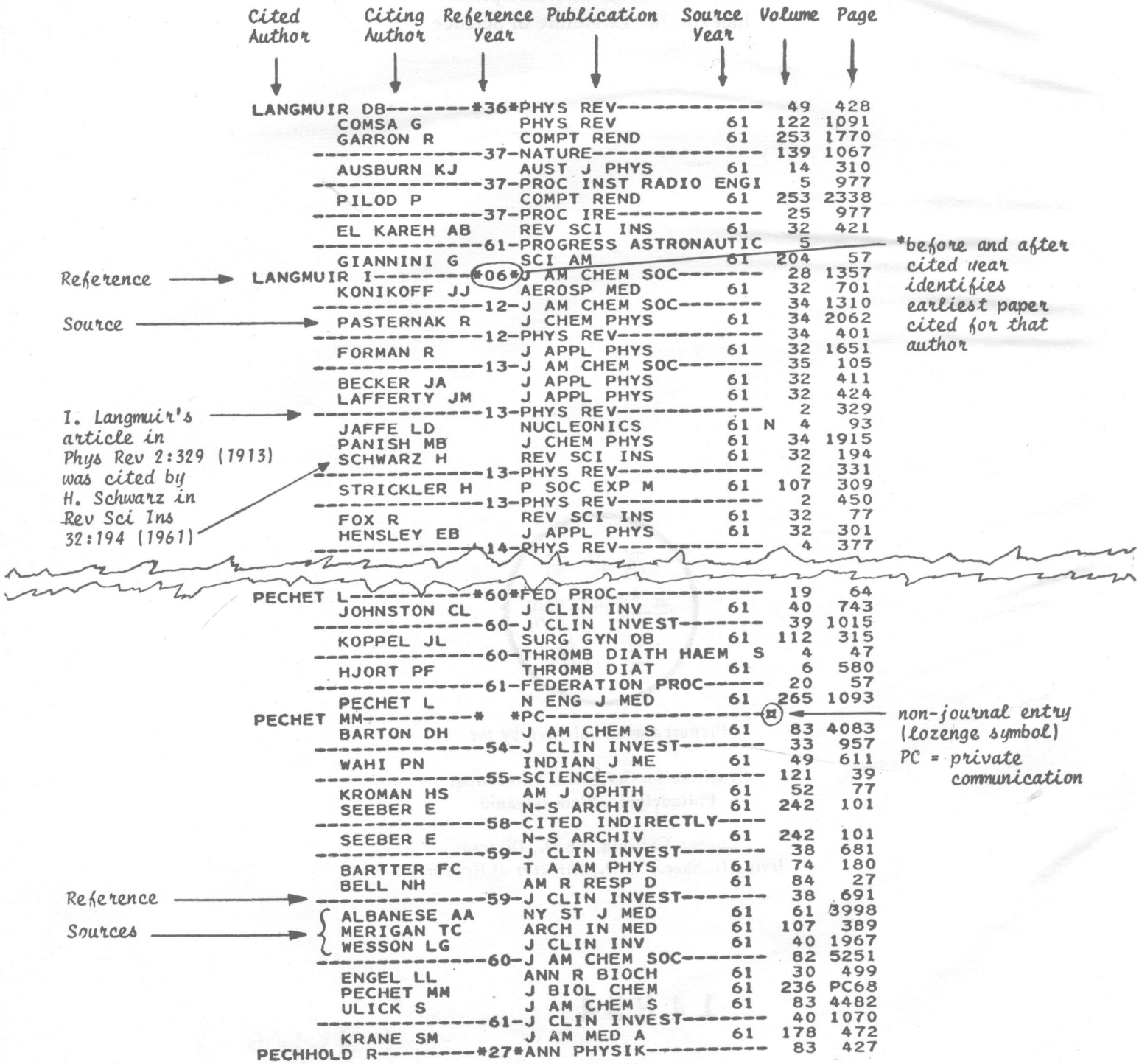
Eugene Garfield, Ph.D., *Director*
Irving H. Sher., Sc.D., *Director of Research*

To find citations to a specific paper:

1. **locate cited author**
2. **locate reference year**
3. **locate reference publication, volume and page**
4. **note that source citations follow reference lines**



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Science Citation Index

INTRODUCTION

Ten years ago, the "First Symposium on Machine Methods in Scientific Documentation" was sponsored by the Johns Hopkins University Machine Indexing Project and the American Documentation Institute at the Welch Medical Library in Baltimore (1). Brief papers on this pioneering project have been published (2,3). Unfortunately, its voluminous final reports (4) were not widely disseminated. However, as a result of national publicity given to the above-mentioned symposium, W.C. Adair, a former Vice-President of *Shepard's Citations*, learned of our work. Though in retirement, he wrote and suggested that the so-called *citator* system used by attorneys be tested for scientific literature (5). Mr. Adair's letter struck a highly responsive chord as I had been working out a method of utilizing the sentences and citations appearing in review articles as entries in large-scale interdisciplinary science indexes (6).

Though the Johns Hopkins Project was discontinued in 1953, I continued to correspond with Mr. Adair while at Columbia University during the academic year 1953-54, and I conducted some experiments on "citation indexing". As the Associate Editor of *American Documentation*, I then suggested that Mr. Adair write an article on "Citation Indexes for Scientific Literature?" (7) which was to be followed by my own "Citation Indexes for Science", a paper sent to Professor H. Bentley Glass for review. His generous editorial efforts made the article acceptable for publication in *Science* (8). The article aroused the early interest of many individual scientists especially Professor Joshua Lederberg and Dr. Gordon Allen. In later years they both were extremely helpful in a large-scale experimental study of citation indexing (9,10).

In January, 1961, with the partial support of National Institutes of Health grant #RG-8050, the Institute for Scientific Information expanded the personal research I had conducted from 1955 to 1961 (11,12,13), during which time the concepts were greatly refined. In May, 1961, contract #C-201 was also negotiated with the National Science Foundation for the purpose of studying the methodology of preparing citation indexes based on comprehensive processing of scientific journals. In addition to the preparation of experimental subject-specialized citation indexes (14), the research program ultimately led to the preparation of the initial volumes of this comprehensive *Science Citation Index*, probably the largest single international-interdisciplinary index to the literature of science ever compiled.

An introduction to the *Science Citation Index*, therefore, would not be complete without briefly discussing previous attempts to index the scientific literature on an international-interdisciplinary scale. Kathrine Murra has discussed in detail such efforts between 1850 and 1950 (15). She describes seven significant large-scale projects, including those of the Royal Society of London and the Brussels Institute, the predecessor of the International Federation of Documentation (FID). The latter group is best known for its Universal Decimal

Classification (UDC) system while the Royal Society produced the famous *International Catalogue of Scientific Literature, 1901-1914.*

While Murra does not cover many other indexes which surely can be characterized as either international and/or interdisciplinary, the bibliographic scene, especially in the past fifty years, has been dominated by selective, discipline-oriented efforts in chemistry, physics, engineering, medicine, and biology.

The failure of various groups to compile a so-called unified index to science (13) has been variously attributed to problems in financing, inadequate technology, inflexibility, and lack of imagination. It is probably true that some proponents of UDC were extreme in their belief that it was *the* solution to the information problem. Early promoters of microfilm, computers, and other hardware were equally certain that technology was *the* major problem.

The potentialities of citation indexing are so broad, and preliminary studies so encouraging, that it is easy to appear overzealous. It is not claimed that the *Science Citation Index* is a panacea. During its formative years, it will often be used in conjunction with, and supplementary to, conventional searching tools. However, as the scope is increased and the technical qualities are improved, the *Science Citation Index* promises to meet most of the major desiderata of an international, interdisciplinary science index.

If regular use of citation indexes points up the need and value of selective or categorical citation indexes as, for instance, in physics, chemistry, or biology, techniques are already available which permit us to produce such smaller indexes. In this respect computers have overcome the previous inertial problems of the older systems, which always involved enormous manual effort for even a simple change in approach.

In response to user demands, the Institute for Scientific Information plans to prepare categorical citation indexes but only after a massive multi-disciplinary reservoir of citations has been created. The categorical citation indexes extracted from such a "unified" reservoir of citations will be far more useful than those prepared from any arbitrarily restricted subject coverage. As a large-scale centralized activity the *Science Citation Index* solves the dilemma of Bradford's Law (16) which states that it is necessary to cover an exponentially larger number of journals in order to cover the literature of any particular discipline. This is another version of Pareto's Law used so heavily by Price (17).

It is recognized that in the major universities the *Science Citation Index* may reinforce the trend towards larger centralized libraries of science. The publication of subject-categorized citation indexes might temporarily alleviate the problems of departmental libraries. The increasing interdisciplinary trend of science indicates that categorical citation indexes would indeed only be a temporary or partial solution to the problem. As Professor Lederberg has said: The citation index is "a large undertaking but of course no larger than the problem to which it is addressed" (18).

Scientific research is in a transition state. I believe that the *Science Citation Index* is a major indicator of even greater changes to come. The so-called Weinberg report to the President's Science Advisory Committee (19) recently recommended: "Transfer of information is an inseparable part of research and development. ...The technical community generally must devote a larger share than heretofore of its time and resources to the discriminating management of the ever-increasing technical record. Doing less will lead to fragmented and ineffective science and technology." Your support and constructive criticism of our initial steps can help foster this kind of discriminating management. The *Science Citation Index* can be the expression of a useful *partnership* between the researcher and the information scientist, between government and industry, between all sectors of our society concerned with scientific information including all educational media, institutions, and the press (20).

Eugene Garfield, *Director*
Institute for Scientific Information
Philadelphia, Pennsylvania
November 30, 1963

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GLOSSARY

Citation Index	A directory of cited references, each of which is accompanied by a list of citing source documents
Science Citation Index	A comprehensive citation index containing all references appearing in the bibliographies or footnotes of source articles published in a large number of multidisciplinary and specialty journals. Each reference is accompanied by its list of citing articles
Author Citation Index	A citation index which is alphabetized by the first reference author. The *Science Citation Index* is an author citation index
Source	The original citing publication from which references are obtained
Reference	Any item cited in the bibliography or text of a source document or publication
Target Reference	Any reference used as a starting point in a search
Source Article Index	An index, alphabetically arranged by first citing (source) author, of those source articles used to produce the citation index. The *Science Citation Index* contains a source article index

WHAT IS A CITATION INDEX?

A citation index is a directory of cited references where each reference is accompanied by a list of source documents which cite it. The most characteristic feature of the citation index is that the user begins a search with a specific known paper (target reference). From this starting point one is brought *forward* in time to subsequent papers related to the earlier paper.

In using the *Science Citation Index*, the reader must differentiate between comprehensiveness of sources and of references and should understand the distinction between source year and reference year.

"Comprehensiveness of sources" applies to the breadth of source journal coverage, that is, the number of journals and disciplines covered, countries represented, etc., as well as chronological depth. Source data in these initial five volumes of the *Science Citation Index* was taken from 613 key source journals published in 1961 in 28 countries. All major fields of scientific research are covered. Every 1961 issue of these journals was included.

"Comprehensiveness of references" refers to the scope of reference coverage. In this *Science Citation Index* every reference citation in every journal issue processed was included, no matter where or when the reference originally appeared. Over 20,000 reference journals are cited. In these first five volumes there are 1.4 million citations describing articles published in *any* period of recorded history up until 1961 on *any* subject ever cited by the sources used. The validity of this statement is indicated by the following summary statistics on the references in the *Science Citation Index*. The user should keep in mind that the relatively low number of citations to earlier years is partly a function of the lower volume of scientific publication in those years.

REFERENCE STATISTICS

Total Citations	1,370,000*
Total Unique References Cited	890,000
Total Unique Reference Authors Cited	258,000

*Includes 222,000 non-journal and 20,200 anonymous references

Chronological Distribution of References

Reference Year	Cumulative Percentage of Total Citations	Cumulative Percentage of Unique References
1961	3.51	4.14
1960	15.09	15.04
1959	27.29	26.07
1958	37.30	35.21
1957	45.46	42.72
1956	52.34	49.15
1955	58.16	54.72
1954	63.01	59.46
1953	67.26	63.58
1952	70.82	67.10
1951	73.94	70.16
1950	76.60	72.82
1949	78.75	75.03
1948	80.51	76.79
1947	82.55	78.19
1946	82.86	79.28
1945	83.68	80.12
1944	84.43	80.93
1943	85.19	81.75
1942	85.97	82.61
1941	86.84	83.55
1940	87.71	84.52
1939	88.57	85.50
1938	89.42	86.47
1937	90.17	87.38
1936	90.87	88.22
1935	91.50	88.99
1934	92.08	89.69
1933	92.63	90.35
1932	93.17	90.99
1931	93.63	91.56
1930	94.07	92.12
1929	94.47	92.61

HOW IS THE SCIENCE CITATION INDEX PREPARED?

For *every* reference appearing in *every* article in each source journal a separate IBM punched-card is prepared containing both the source data and the reference data. The punched-cards are subsequently converted to magnetic tapes. The tapes are then sorted and otherwise processed on IBM 1401, 1410, and 7074 computers. The sorted data are printed on an IBM 1403. The master copy is then photographed and reproduced by offset printing.

REFERENCE PUBLICATION POLICIES

Both journal and non-journal citations are processed. Non-journal references are readily identified in the index by a lozenge symbol (⌑) at the end of the publication column. Non-journal references include references to books, meetings, dissertations, reports, contracts, patents, circulars, etc. In these first five volumes titles of books or meetings are presented as acronyms. In subsequent volumes acronyms will be replaced by full titles or easily understood abbreviations. Reports and circulars may be identified either by numbers, or, if the reference to the report included a title, by acronym. Dissertations and these are recorded as "Diss." The following is a list of common abbreviations in non-journal citations:

IP	In Press
PC	Private Communication
TBP	To Be Published
U	Unpublished
UD	Unpublished Data

The original rationale for using acronyms, however, is better appreciated if the user keeps in mind that in the *Science Citation Index* the target reference is usually known. Please note that acronyms may not be unique. For example, U generally means "unpublished" but in the case of Svedberg's book it signifies "Ultrazentrafuge". To illustrate the acronyms, fuller identification of some well known works is given below.

FREQUENTLY CITED NON-JOURNALS

AEC	ATLAS OF EXFOLIATIVE CYTOLOGY	PAPANICOLAOU GN
AMQM	ANGULAR MOMENTUM IN QUANTUM MECHANICS	EDMONDS AR
BMDB	BERGEYS MANUAL OF DETERMINATIVE BACTERIOLOGY	ANON
BS	BIOCHEMISTRY OF SEMEN	MANN T
BTCM	BLOOD TRANSFUSION IN CLINICAL MEDICINE	MOLLISON PL
CBA	CONSTITUTION OF BINARY ALLOYS	HANSEN M
CBH	CHEMICAL BASIS OF HEREDITY	VOGEL HJ
CDBM	CHEMICAL DYNAMICS OF BONE MINERAL	NEUMAN WF
CMBNA	CHEMICAL AND MOLECULAR BASIS OF NERVOUS ACTIVITY	NACHMANSOHN D
DBS	DIELECTRIC BEHAVIOUR AND STRUCTURE	SMYTH CP
DHBG	DISTRIBUTION OF THE HUMAN BLOOD GROUPS	MOURANT AE
DHC	DISEASES OF THE HEART AND CIRCULATION	WOOD P
DTEDCA	DIAGNOSIS AND TREATMENT OF ENDOCRINE DISORDERS IN CHILDHOOD AND ADOLESCENCE	WILKINS L
E	ENZYMES	DIXON M
EA	EXPERIMENTAL ATHEROSCLEROSIS	KATZ LN
EDPR	EXPERIMENTAL DESIGN IN PSYCHOLOGICAL RESEARCH	EDWARDS AL
EFAHB	EPILEPSY AND THE FUNCTIONAL ANATOMY OF THE HUMAN BRAIN	PENFIELD W
EH	ELEKTROPHYSIOLOGIE DER HERZMUSKELFASER	WEIDMANN S
EIIP	ELECTRONIC AND IONIC IMPACT PHENOMENA	MASSEY HS
ES	ELECTROLYTIC SOLUTIONS	ROBINSON RA
ETAM	ELEMENTARY THEORY OF ANGULAR MOMENTUM	ROSE ME
FRS	FREE RADICALS IN SOLUTION	WALLING C
GH	GENETIC HOMEOSTASIS	LERNER IM
HB	HYDROGEN BOND	PIMENTEL GC
HBP	HIGH BLOOD PRESSURE	PICKERING GW
HD	HEMORRHAGIC DISEASES	QUICK AJ
HDIC	HEART DISEASE IN INFANCY AND CHILDHOOD	KEITH JD
HRNMR	HIGH RESOLUTION NUCLEAR MAGNETIC RESONANCE	POPLE JA
HRP	HEMOLYSIS AND RELATED PHENOMENA	PONDER E
HTPH	HISTOPATHOLOGIC TECHNIC AND PRACTICAL HISTOCHEMISTRY	LILLIE RD
ICC	INTERNAL CONVERSION COEFFICIENTS	ROSE ME
IE	IDENTIFICATION OF THE ENTEROBACTERIACEAE	EDWARDS PR
LLLT	LYMPHATICS LYMPH AND LYMPHOID TISSUE	YOFFEY JM
MAI	MEASUREMENT OF ADULT INTELLIGENCE	WECHSLER D
MBA	METHODS OF BIOCHEMICAL ANALYSIS	WINZLER RJ
MBA	METHODS OF BIOCHEMICAL ANALYSIS	KUNKEL HG
MBA	METHODS OF BIOCHEMICAL ANALYSIS	FRAENKELCONRAT H
MC	MAST CELLS	RILEY JF
ME	METHODS IN ENZYMOLOGY	SCHACHMAN HK
ME	METHODS IN ENZYMOLOGY	LAYNE E
ME	METHODS IN ENZYMOLOGY	KORNBERG A
ME	METHODS IN ENZYMOLOGY	KORNBERG A
MM	MEASUREMENT OF MEANING	OSGOOD CE
MMS	MATHEMATICAL METHODS OF STATISTICS	CRAMER H
MPPS	MICROSOMAL PARTICLES AND PROTEIN SYNTHESIS	HALL BD
MS	MICROWAVE SPECTROSCOPY	TOWNES CH
MT	MANOMETRIC TECHNIQUES	UMBREIT WW

MTGL	MOLECULAR THEORY OF GASES AND LIQUIDS	HIRSCHFELDER JO
MTS	MODERN THEORY OF SOLIDS	SEITZ F
NA	NUCLEIC ACIDS	HOAGLAND MB
NA	NUCLEIC ACIDS	CHARGAFF E
NBE	NEW BASES OF ELECTROCARDIOGRAPHY	SODIPALLARES D
NCB	NATURE OF THE CHEMICAL BOND	PAULING L
NCB	NATURE OF THE CHEMICAL BOND	PAULING L
NCPG	NEURAL CONTROL OF THE PITUITARY GLAND	HARRIS GW
NSR	NUCLEAR STRIPPING REACTION	BUTLER ST
OB	ORGANIZATION OF BEHAVIOR	HEBB D
OMA	OFFICIAL METHODS OF ANALYSIS	ANON
PA	PLANT ANATOMY	ESAU K
PB	PRINCIPLES OF BEHAVIOR	HULL CL
PBS	PHYSIOLOGY AND BIOCHEMISTRY OF THE SKIN	ROTHMAN S
PBT	PHARMACOLOGICAL BASIS OF THERAPEUTICS	GOODMAN LS
PFIG	PHYSICS OF FULLY IONIZED GASES	SPITZER L
PH	PRACTICAL HAEMATOLOGY	DACIE JV
PNC	PHYSIOLOGY OF NERVE CELLS	ECCLES JC
PO	PRINCIPLES OF OPTICS	BORN M
POC	PHYSICAL ORGANIC CHEMISTRY	HAMMETT LP
POCF	PHYSIOLOGY OF THE OCULAR AND CEREBROSPINAL FLUIDS	DAVSON H
PPC	PRINCIPLES OF POLYMER CHEMISTRY	FLORY PJ
PRP	PRINCIPLES OF RENAL PHYSIOLOGY	SMITH HW
PT	PATHOLOGY OF TUMOURS	WILLIS RA
RACS	REFLEXOGENIC AREAS OF THE CARDIOVASCULAR SYSTEM	HEYMANS C
SCB	STRENGTHS OF CHEMICAL BONDS	COTTRELL TL
SDM	SPECTRA OF DIATOMIC MOLECULES	HERZBERG G
SI	STATISTICAL INFERENCE	WALKER HM
SM	STATISTICAL METHODS	SNEDECOR GW
SMBA	STATISTICAL METHOD IN BIOLOGICAL ASSAY	FINNEY DJ
SMOC	STRUCTURE AND MECHANISM IN ORGANIC CHEMISTRY	INGOLD CK
SP	STOCHASTIC PROCESSES	DOOB JL
SP	SUBCELLULAR PARTICLES	DEDUVE C
SSR	SPECIFICITY OF SEROLOGICAL REACTIONS	LANDSTEINER K
TH	THYROID HORMONES	PITTRIVERS R
TNP	THEORETICAL NUCLEAR PHYSICS	BLATT JM
TRP	THEORY OF RATE PROCESSES	GLASSTONE S
TTCBJ	TUMORS AND TUMOROUS CONDITIONS OF THE BONES AND JOINTS	JAFFE HL
U	ULTRAZENTRIFUGE	SVEDBERG T

"Cited Indirectly" appearing in the reference publication column means that the citing author learned of the reference work through reading a third work, which may or may not have given a complete citation. The user can retrieve the citing paper to identify this third work, which also appears in the index as a reference. The latter may be used as an additional target reference in searching with the citation index.

UNIFICATION AND STANDARDIZATION

Frequently, a given reference is cited in different ways in the literature. For example, different abbreviations for the same journal may occur. In compiling a citation index, we must pull together all citations to the same reference, in spite of these variations. Unification and partial standardization of reference citations is accomplished by special computer programs. In these first five volumes, references are considered identical if they match on minimal distinctive citation data. The computer then tallies variations in the presentation of authors and journals within each cluster of "identical" references, selects the most frequently cited or, in case of ties, the longest version of these elements and standardizes the reference. As a result, in most cases, the common reference will be listed only once, and all the descriptions of articles citing it will follow in one group. In subsequent volumes even greater standardization will be achieved by use of new systems of processing and new computer programs. Nevertheless, in some cases, citations to the same reference may be separated. This occurs whenever the reference is presented in a variation that defied the unification procedure. For example, though a reference author's name will usually appear in the literature with two initials (if indeed he has two initials), it may occasionally be cited with only one initial or even none. These alternatives should be checked. Differences in spelling or transliteration of an author's name from country to country may also defy the unification procedure and cause some duplication. Cases of references which are not unified due to incomplete or incorrect reference data, different page numbers and variant titles will also occur. However, the so-called "unification" procedure actually corrects many errors in reference journal titles and in reference authors' names. Eventually our processing system will make possible the correction of literature errors in dates, volume numbers, etc.

FORMAT

The *Science Citation Index* is arranged alphabetically by first reference author, year, publication (usually a journal), volume, and page. The source articles citing a particular reference article are arranged alphabetically by the first source author -- immediately under each reference line. Citations to anonymous *reference* articles follow the author section of the citation index. Descriptions of anonymous *source* articles appear immediately under the corresponding reference line, preceding the other sources citing the same reference.

In the source lines, the year follows the publication, instead of preceding it, as in the reference lines. While reference years may be any year in recorded history, the source year in these first five volumes will always be 1961. In subsequent volumes the source year will be the current year.

A maximum of eighteen characters was allotted for the reference author and eleven characters for the source author. In both cases, a maximum of two initials was allowed. Twenty characters are allotted for the reference publication, and eleven characters for the source publication. Thus, the source authors and journals may be shorter than corresponding reference entries. A list of the full titles of all source journals precedes the Source Article Index.

Asterisks flanking the reference year identify the first reference line, and usually the first year cited, for a given author. Additional dashed lines indented under the reference author identify other cited articles or books published by the same author. Additional uncited works can sometimes be found in the source article index.

An illustrative page of the *Science Citation Index* will be found inside the covers of each volume.

Those of us who helped prepare the index are well aware of imperfections such as truncated source authors or journals. Source authors' last names may sometimes be truncated to eight characters. The source journal abbreviations are limited to eleven characters. The size of print is much smaller than the average index, but this has saved shelf space. And surely it would have been most desirable, though not economically feasible, to include the full titles of source articles in these first volumes. However, improvements will be incorporated in subsequent volumes of the *Science Citation Index*. Thus, the source article index in future issues of the *Science Citation Index* will include source article titles. This decision is important to the scientist and librarian as this feature will constitute the first comprehensive, interdisciplinary inventory of current scientific publications available. Furthermore, future volumes of the *Science Citation Index* will include all source co-authors' names. The cumulation of this improved source article index will obviate the search through numerous fragmentary, selective indexes to identify a scientist's publications -- whether they have been cited or not. The reader should note, however, the function of the citation index is primarily to disclose by whom and where individual papers have been cited. Thus, while Lineweaver and Burk are the co-authors of "The Determination of Enzyme Dissociation Constants" *J. Am. Chem. Soc.* 56, 658 (1934), it is only necessary to refer to Lineweaver, the first author, to find who has cited this paper (see page 1514).

HOW IS THE CITATION INDEX USED?

As with any conventional index, experience in using a citation index increases one's ability to find information quickly. However, unlike language-oriented indexes, training in medical, chemical, or other nomenclature is not required to use a citation index effectively.

In the citation index the "subject" is the information or concept contained in the starting point -- the target reference. Thus the search is independent of subject nomenclature and quickly leads to current papers related to the target reference.

The citation index is concept oriented. It is, therefore, a relatively sophisticated searching tool which presupposes some knowledge of a starting point. A target reference must either be known or first identified through a footnote, an encyclopedia, book, or subject index. The citation index then answers the question, "What has happened since?" We believe this question is fundamental to research activity.

SEARCH STRATEGY

To locate sources which cite a particular target paper, it will usually suffice to know the name of the first author, year, and page. It is generally not even necessary to know the title of the journal or publication in which the paper appeared. In the citation index the cited or reference author is easily located on the left. For each cited paper by that author there is a dashed line which continues to the column reserved for the year of the reference publication. The journal abbreviation (or non-journal acronym), volume and page are found to the right of the reference year. Indented under each dashed line are data identifying source articles which have cited that specific reference. When a given reference has been cited by several sources the latter are arranged alphabetically by source authors.

On the average, the user will find only a few source papers which cite a particular target paper. The citation index is highly specific and the retrieved sources have a direct relationship to the starting point. By various techniques a search may be readily expanded in order to build more extensive bibliographies. For instance, one may select relevant citations appearing in the bibliographies of the source articles disclosed by the first stage of the search. These citations, as well as the sources which contained them, can now become new target references or entry points to the citation index. This "cycling" procedure may be repeated.

Another technique takes advantage of the fact that the same author will frequently write more than one closely related paper. Therefore when using the citation index, additional relevant articles by the author of the first target reference can be used as target references and the sources citing these articles may be examined. Additional current articles by a given author may also be found in the separate source article index even though they may be too current to have been cited yet.

Starting with a given target reference paper one may find that it is not cited at all. This may or may not be good news. Do not give up! Examine the target paper itself and look over the citations contained in it. Identify the reference most pertinent to your search. Then, in the citation index, locate sources which cite this new reference. If not, try another relevant reference from the same target paper. Since the average paper has a bibliography of fourteen items it is rare that a pertinent source is not located, *provided there has been some work done on the subject.* When using a citation index a negative result

may have more significance than in any other indexing system since the problem of synonymy does not exist. There will be therefore, less uncertainty about the meaning of a negative result. No index can locate information that does not exist. A key problem is to obtain this negative information quickly.

Naturally a citation index will be most helpful when used in conjunction with a large library. Since the scope of these indexes is quite broad, source articles may be encountered which are not readily available. The Institute for Scientific Information will assist in the procurement of articles in any source publication through the *Original Article Tear Sheet* service (OATS) of the Institute for Scientific Information.

Citation indexing is not recommended merely as a substitute for conventional indexes. Rather, the citation index adds a new dimension to the pursuit of scientific knowledge. The citation index is your historical roadmap of the literature. Where you travel is primarily your decision. What you find depends on you and what is available. Only you can measure its relevance. What may be valuable to one man is irrelevant to another. Two otherwise unrelated scientific observations may be correlated in the citation index through a common reference or through a chain of source-reference links. However, you must select the starting point, trace the network, and detect the correlation -- if it exists.

A few actual searches will quickly demonstrate the simplicity of the citation index system.

APPLICATIONS OF THE SCIENCE CITATION INDEX

The fundamental question one can answer quickly through the *Science Citation Index* is, "Where, and by whom, has this paper been cited in the literature?" The significance of the answer is fundamental to the method and the scholarly tradition of science in that appropriate references -- methodological, ideational, historical, or otherwise -- are cited to support arguments or facts. We have found this tradition is, in general, closely followed. Naturally there are violations and abuses but these are the exceptions and not common practice.

The *Science Citation Index* will enable the user to trace new applications of theories, methods, instruments, chemicals, etc. Corrections, errata, amendments, refutations, letters, editorials, discussions, translations, reviews, etc. can also be located though, in the past, they may have been buried in the literature.

The *Science Citation Index* follows the thread of a theme through the years and across artificial boundaries imposed by classification schemes and journal titles. For example, consider Einstein's 1905 paper analyzing Brownian movement and diffusion (*Ann. Physik.* 17, 549). This paper was cited in 1961 not only in chemistry, mathematics and physics journals but also in a biological study on the immunological application of double diffusion (C.J. Van Oss, *Zeit. Immunitatsforsch.* 122, 44 (1961)).

The disclosure by the *Science Citation Index* of current improvements in methodology may be illustrated by the literature on the determination of thiamine and its phosphoric acid esters in animal tissues. Using any one of several target papers describing various earlier methods, one would be led to the article by G. Rindi, *Biochem. J.* 78, 602 (1961) in which he reports a new chromatographic method which is claimed to be an improvement over the previous quantitative and qualitative methods which he cites.*

Furthermore, continuing another cycle and using Rindi's article as a new target reference, the *Science Citation Index* reveals four more recent papers which cite this work. In three, the new method has been applied and the fourth describes a method for determining the related compound, pyrithiamine.

A secondary application of the *Science Citation Index* is its use as a conventional author index to help identify an author's publications. Note, however, that in these first five volumes only papers in which he appears as first author can be found under a specific author's name. Further, only if the work was cited will it be found in the main body of the citation index.

The citation index is invaluable in preparing historical introductions to scientific papers, critical reviews, and books. Related to historical studies are the sociological applications of citation indexes for evaluation of scientists and their work. These applications are legitimate to the extent that one judiciously uses a citation index as a retrieval tool to facilitate the location of criticisms of a man's work. Qualitative judgements must always temper quantitative data. The *Science Citation Index* can also be used to identify quickly, scientists currently working on special problems.

A great deal has been said about the use of citation indexes for ego gratification and it is important to briefly discuss the subject here. Well-meaning individuals may reject citation in-

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* Bartley W., Biochem. J., **56**, 379 (1954)
Bernabei, O., Naturwiss., **46**, 229 (1959)
Gurtner, H.P., Helv. Physiol. Acta, **15**, C66 (1957)
Kaziro, Y., J. Biochem., Tokyo, **44**, 827 (1957)
Kiessling, K.H., Ark. Kemi, **6**, 271 (1953)
Rossi-Fanelli, A., Science, **116**, 711 (1952)
Spadoni, M.A., Quad. Nutr., **11**, 26 (1950)
Westenbrink, H.G.K., Int. Z. Vitaminforsch., **21**, 461 (1949).

dexing because they assume it was designed for vainglorious purposes. We do not believe the *Science Citation Index* will be supported purely for ego gratification of subscribers. Ego gratification, however, is not the only motivation for a scientist who wishes to determine whether his work has been applied or criticized by others. Each scientist evaluates the citations to his works differently. One man's work stimulates another. The citation index facilitates feedback in the communication cycle. Any author may choose to ignore citations to his own work (lest he feed his vanity) and still, as described previously, wish to retrieve publications which cite other works, by other scientists, in which he is interested.

SOURCE COVERAGE AND STATISTICS

SOURCE JOURNALS

The journals processed for the first five volumes of the *Science Citation Index* are presented in several auxiliary lists. The first gives the source journal abbreviations used in the index along with the full journal titles. The second list is the same data arranged by full title. The third list shows the source journals grouped by country of origin. Several Soviet journals are listed under both the Union of Soviet Socialist Republics as well as the country of translation, because some translation issues were processed for convenience. In these cases, translation journals are also asterisked.

In future volumes of the *Science Citation Index* the number of source journals to be processed will increase to several thousand. However, journal and article statistics sometimes can be quite deceiving. To process a single weekly journal like *Nature* requires far more effort than the processing of fifty smaller quarterlies. One large journal may produce several thousand original articles per year, whereas a small journal may contribute a few dozen.

The emphasis in our journal selection has been the multidisciplinary journals. These are, generally, recognized as important in each country, but are only selectively and fragmentarily covered by the discipline-oriented indexing services. Our policy is to treat each journal *comprehensively*. This policy will eliminate the previous doubts as to whether or not a particular article met the selection criteria of a specialty index.

While many of the journal titles are in the life sciences this also can be somewhat deceiving. The field of chemistry is very well represented but may be considered a physical or life science according to one's viewpoint. Further, in chemistry and physics, in contrast to biology, the main journals are generally quite large. It is necessary therefore to cover more journals in biology and medicine in order to cover a comparable number of articles. More articles are published in the *Physical Review* each year than in dozens of smaller, but also significant, biological publications.

While it is important for the user to know the scope of these first five volumes, we wish to stress the basis for *future* selections of journals. The number of source journals to be included in future volumes of the *Science Citation Index* is limited strictly by the economic factors involved. It is our intention to expand source journal coverage as broadly and rapidly as economics permit. The Institute for Scientific Information has now amassed considerable data which enables us to make source journal selections based on several criteria of importance.

The initial corps of journals will be those of interest to the widest possible audience of scientists with primary emphasis on multidisciplinary and interdisciplinary journals as well as the most significant journals in every branch of science. The subscribers will be consulted and their interests must also affect the selection criteria. The number of source journals that will be covered will be increased as support for the service increases. However, it should be emphasized that source journal coverage in no way limits reference journal coverage. In these first five volumes alone, approximately 20,000 different reference journals were cited. The combination of a judicious selection of source journals together with comprehensive treatment of reference journals produces an index which extends far beyond the scope of ordinary indexes.

The non-journal material which is picked up as references may prompt the user to ask whether

non-journal *source* material can or will be processed in the future. The *Science Citation Index* can easily accommodate such source materials as patents, government reports, proceedings, books, etc. It is our intention to give these materials high priority in future processing as we believe it is artificial to separate these materials. The rapidity with which we are able to process these sources is again, a matter of response by the scientific and technical community.

SOURCE ARTICLES

There were 102,000 source articles processed for the first five volumes of the *Science Citation Index*. The list of these articles is arranged alphabetically by first author. All processed papers published in 1961 by a given author are listed together, provided he was the first-named author. The author's name is printed once next to his first paper. Successive papers by the same first author are arranged alphabetically by source journal.

The source year appears between the author and journal. In these first five volumes the source year is always 1961. The number of references (R) in each source article is given in a separate column to the right of the source volume and page number. If the R column is blank, it usually signifies the article contained no references. The number of references for the articles between the names Bhalla and Bickel were lost during processing. In some cases, there may be multiple versions listed for what is apparently the same source article. Select the last of these versions. There is an instance of an erroneous source journal title appearing in the citation index proper. Whenever a source article is encountered reading "AM J PHA ED, volume 29" it should be corrected to "AM J PHYS, volume 29". Anonymous source articles appear at the end of the source article index and are arranged by journal, volume and page.

SOURCE DATA SUMMARY

SOURCE JOURNALS	613
SOURCE ARTICLES	102,000
SOURCE ARTICLES CONTAINING NO CITATIONS	12,100
ANONYMOUS SOURCE ARTICLES	1,880
UNIQUE SOURCE AUTHORS	57,800