and the identification of animal and plant protoplasm was proved by Max Schulze, in a paper printed in the *Archiv für Anatomie und Physiologie* in 1861. Th. Schwann, in his famous *Microscopic researches,* had parallelized the animal with the vegetable structures and recognized the nucleus (discovered by Robert Brown in 1831), but not the medium within the cell. After 1861, and when chemical stains were used on microscopic structures, chromosomes were discovered, and with them began the study and philosophy of inherited characters, which brings us to August Weismann's *The evolution theory* (1904).

Two other publications, Gregor Mendel's *Versuche über Pflanzenhybriden* (two papers, 1865 and 1869, available in several editions) and Hugo De Vries' *Die Mutationstheorie* (1901–03), are founded on studies of plants and supported by statistical methods. Francis Galton, in his *Natural inheritance* (1889), indicated perfected methods later used by W. Johannsen and others. The wide publicity of these studies and their application in many fields made these works widely known. Mendel's hybridization experiments, forgotten by his contemporaries and rediscovered by De Vries, showed that ripe germ cells will produce the pure character of only one parent or of the other. De Vries' experiments showed that new modifications will occur suddenly and will account for permanent variation if they breed true. These new forms are his mutations and are considered subject to, but not evoked through, gradual selection. We should not, however, overlook T. H. Morgan's *The mechanism of Mendelian heredity* (1915). Here also belong Øjvind Winge's recent studies of hybrids developed from traditional pure cultures of yeast (*C. R. Lab. Carlsberg*).

While the atomic theory continued to develop, the molecular unit of organic bodies was ingeniously explained by C. Nägeli, in his excellent work, *Die Stärkekörner* (1858). Starch is the first visible product of photosynthesis, and Nägeli studied several thousand forms. Quite as important was his theory of the growth of these bodies, by apposition and by intussusception. Although this does not fit all cases, as Arthur Meyer (1895) and others showed, it still remains satisfactory, even for membranes.

The biographies of the men and women who have given their lives to the progress of science afford in many ways the cultural background on which our composite picture is drawn. Each has his specialty, each student his favorites. There is abundant inspiration in this biographical literature.

In conclusion, the following works, which are of fundamental importance to any student of the history of science, are noted: Walter Libby's *Introduction to the history of science* (1917); George Sarton's *Introduction to the history of science* (1927) and *The history of science and the new humanism* (1937); and Lynn Thorndike's *A history of magic and experimental science* (6 vols., 1923–41).

The Development of Scientific Publications and Their Importance in the Promotion of International Scientific Relations

Frans Verdoorn, *Managing Editor, Chronica Botanica, Waltham, Massachusetts*

INTERNATIONAL RELATIONS IN SCIENCE may be promoted in many ways. Before discussing some of these, however, we should have before us a clear idea of the aims of international scientific cooperation. If we consider the major issues only, we may define the principal aims as:

(1) The exchange of information, whether scientific, professional, or practical, in such a way that it will be available to anyone who can profit by it.

(2) The attainment of objectives which individuals or scientists of a single institution or nation cannot accomplish. These objectives may be projects in the field of pure or applied scientific research, they may be cooperative, scientific, or practical publications, or they may be objectives of a more general or methodological nature.

(3) The formation of an *esprit de corps* which may, at least at some times and at some places, counteract the evils of human international politics and contribute to the establishment of a commonwealth of nations.

The means by which these aims may be approached include: (a) various forms of cooperative research, (b) international conferences and congresses, (c) the activities of international commissions and committees responsible for the solution of specific problems—often problems of a practical or methodological nature, (d) personal contacts, visits, and correspondence, (e) exchanges of research materials, specimens, literature, etc., (f) exchanges of professors, research workers, and students, and, last but not least, (g) various publications. In this particular case we find that there are a number of possible types to be considered.

Scientific Journals

After the invention of printing, in the 15th Century, which contributed more than any other single factor to the promotion of international scientific relations, scientific material was published in book form or, very rarely, on a broadside. Scientific journals did not exist until the middle of the 17th Century. It is useful and interesting to follow the origin and development of these journals. Their origin, it appears, is clearly connected with the origin and development of scientific societies.

Scientific academies, *i.e.* publicly recognized scientific societies with a limited membership, the members of which often received some salary or a pension, were established in Italy about 1560. Then followed the founding of the Academia Naturae Curiosorum in Vienna in 1651, the Académie des Sciences in 1666, and the Collegium Curiosum in Germany in 1672. The Royal Society of London had been established since 1660 and began its *Philosophical Transactions* in 1665. General scientific societies, in which a membership could be obtained more easily, found their origin, of course, in the academies but did not flourish until the number of scholars increased in the late 18th and early 19th Century. The Linnean Society of London was founded in 1788 and began its *Transactions* in 1791. The *Transactions* of the American Philosophical Society, which was established in Philadelphia in 1744, have been published since 1771. Migratory societies which meet each year in a different town have been popular since the establishment of the Gesellschaft deutscher Naturforscher und Ärzte in 1822, the British Association for the Advancement of Science in 1831, and the AAAS in 1848. These were soon followed by international congresses and societies; in the biological field one of the first international meetings (1864) was devoted to horticulture.

During the Middle Ages and the Renaissance most scientific research was done on a very individual basis. Later, as Martha Ornstein outlines in her classic book, *The rôle of scientific societies in the seventeenth century,* the function of the new scientific societies was "really twofold; they created laboratories and observatories and did a great deal to encourage original work; but they often, in addition, undertook to publish, periodically, news of the work done under their auspices, and often the work of other learned men, in order to make it known as quickly and as widely as possible. . . ." "The only means," Ornstein continues, "of scientific intercommunication in the early seventeenth century was private correspondence. Hence the great significance of such men as Mersenne, Peiresc, Collins, and Wallis, who kept up a voluminous correspondence, and the necessity that such scientists as Huygens and Boyle should be in personal com-

munication with other scientists. The unreliability of this form of communication is self-evident. It depended too much on friendly or hostile feeling, and at times on geographical contiguity. The numerous quarrels regarding scientific discoveries, as for instance between Torricelli and Pascal, Newton and Leibniz, Hooke and Huygens, best prove the insufficiency of such informal intercommunications. In order to secure priority while keeping discoveries secret, ciphers were used. The right road to a solution of all these difficulties was clearly indicated when Denis de Sallo published in 1665 the first volume of the *Journal des sçavans.* . . . It proposed, first, to give a catalogue and short description of books; second, to give obituaries of famous men and summarize their works; third, and most significant for us, the prospectus proclaims that the *Journal* will publish experiments in physics and chemistry which serve to explain natural phenomena, new discoveries in arts and sciences, useful machines, curious inventions of mathematicians, observations of the heavens, meteorological phenomena, and new anatomical findings in animals. The fourth point of the program was the publication of the principal decisions of tribunals and universities; the fifth, of current events in the world of letters." One will note that this early scientific magazine differs quite a little from most of today's scientific journals. It was almost more a newsletter or a *Fachblatt* than a scientific journal and clearly patterned on contemporary newspapers (newspapers were not common until after the early 1600s).

The *Journal des Sçavans,* which, of course, had a few forerunners, was soon followed by a variety of other scientific journals, some of them, as briefly outlined above, issued by the Academies and others by individuals or booksellers. Several of these journals reported primarily on the scientific activities and researches of the members of the Academies; others, often with the word *Correspondence* or *Korrespondenz* in the title, were newsletters with an intriguing, constantly changing scheme of contents—journals in which an enormous amount of historically valuable material remains hidden. When preparing entries for the Index Botanicorum, I often deplore the lack of good cumulative indices to most of the early scientific journals, feeling that more details about many colleagues of the past must be available in contemporary scientific journals. In fact, many data on Linnaeus' early life, directly copied from "releases" which he sent to the editor, were discovered nicely printed in the *Hamburgischen Berichten von neuen gelehrten Sachen* (1732 et seq., reprinted by Bryk in 1919)!

Several of the scientific journals of the early 1800s still look very much like the newsletters of the 17th and 18th Centuries. Though some of them are chiefly or entirely devoted to reports of the results of original work, many others devote much space to news, abstracts, personalia, letters, quotations from, or reprints (often in translation) of, materials published elsewhere. Many early 19th-century journals contain material of the sort published today in such journals as *Science* and *Nature* or in such professional news journals as *Chemical and Engineering News* rather than in our regular scientific journals. Since the middle of the past century most scientific journals have devoted their columns almost entirely to original scientific contributions with a sprinkling of biographical notices, discussions of the aims and scope of research in certain fields, reviews of recent advances—not to speak of polemics, which were so common one or two generations ago—etc.

During the past 100 years the number of scientific journals has increased manyfold. Many of the new journals are no longer devoted to an entire branch of science, as zoology or chemistry, but concentrate, with the increase of scientific specialization, on a limited field, e.g. ornithology or colloid chemistry. During the late 19th and the present Century we find an increasing tendency among scientific journals to concern themselves with only very limited subjects, subjects often narrower than the specialism of the average individual worker. Generally speaking, the biological journals tend to fission more than those in the chemical and physical field.

The Modern Scientific Journal

The modern scientific journal offers a number of problems to its readers or, rather, to its authors and editors which were unthought of one or two generations ago.

For almost a century, the production costs of scientific journals have increased approximately in the same ratio as the number of subscribers. The increasing number of subscribers found in such *terrae novae* as North America, Russia, and Japan contributed much to the development of continental scientific journals. In recent decennia the existence of many journals has been possible only by the backing of a society or a university or by the income from advertisements. Specialized journals which do not have such support often operate at a loss and cause their sponsors many difficulties. At one time the prices of continental, particularly German, journals were absolutely and relatively so much higher than those of journals published elsewhere that an organized action of North American librarians was needed to force prices down.

It would be interesting to compare the way in which the average scientific journal was read a century ago with today's modus of use. A hundred

years ago the average worker in the natural sciences (often a physician by training or profession) found in almost every natural science journal much that he could read with profit and pleasure. Today we approach our journals, either via the abstracting journal or by glancing through the table of contents, and quickly copy on an index card whatever seems essential. Many scientists have now lost the reading habit to such an extent that the few good general news and review journals, as one may observe in any large institutional library, are often only hastily scanned for material in the user's immediate department.

Much has lately been said and written about the editing of scientific journals. Some authors feel that their papers should be published exactly as presented, whereas certain editors want to make all contributions uniform, not only as to typography (which seems desirable under all circumstances) but also as to style and internal matters. During these heated discussions it is often forgotten that there is a difference between journals open for the publication of papers on any subject in a certain field and journals the editors of which endeavor to obtain chiefly papers on subjects specified by them, making their journals more into a series of symposia than into a collection of transactions. Journals of the latter type will be read more widely and will necessarily need a more exacting editing of their contents than journals which serve only as an outlet for the writings of those who are entitled to use them as a medium of publication.

Even those who are only slightly familiar with the history of science know that the majority of great, original workers published during their lifetime only a limited number of papers, often chiefly extensive memoirs and a few books. This, most certainly, does not mean that there were not many others, just as great, who produced a stream of papers, almost each of them a gem and a real contribution to the advancement of science. On the other hand, many less important workers, who really do not contribute substantially to the advancement of science, pour out a steady stream of articles and cover another's desk with an amount of print which must often be embarrassing to the editors of the journals which are somehow called upon to publish it. There should be freedom in the world of science, yet it seems very desirable that we teach our students early that one good original memoir, or one careful essay or discussion, or one good book may be worth a dozen small communications, and that the number of one's writings can and should never be a yardstick of one's stature. Unfortunately, all over the world, there exist today factors in academic life which lead to the habit of publishing a great many small papers.

From time to time these and other problems have been surveyed by individual colleagues or special committees. In this connection some mention may well be made of Wellensiek's studies of publication problems which, undertaken shortly before World War II, did not find the attention they deserve. In a number of papers based on an analysis of all botanical articles published during 1930 and 1934 (but not referring only to botany), Wellensiek suggests that certain changes seem desirable in the modus of publishing scientific material and in the publishing behavior of scientists. In a report presented at the 6th International Botanical Congress, he suggested that some useful changes might be proposed by an international committee after a thorough study of the problems involved. This met with opposition, because certain scientists felt that they would not be able to publish in the future as much and as freely as they had been able to do. This, however, was not the idea. Wellensiek's proposals called chiefly for a study of the manner in which research data are presented for publication, a study of the language problem (he suggested English as an exclusive scientific language), a certain standardization of the format and modus of printing of journals, the need for a register of all scientific journals (with suitable subject and geographical indices), a study of the way in which individual articles are presented in journals, with special reference to the title, author's name and address, mention of date of publication, table of contents, literature citations, reprints, etc.

Publications containing reports of original research remain the oldest and most important way of contributing not only to science itself but also to international scientific relations generally, in which every scientist takes part whenever he has an article published. This also is almost the only form of international cooperation which is continued to a considerable extent in times of turmoil and war.

When those concerned with such things consider the promotion of international relations through publications, they often take original scientific publications too much for granted, as one will notice from the reports and resolutions of certain recent international conferences. This is not as it should be; also, in this field there are specific international problems and possibilities. I believe one of the great possibilities to be the establishment of large, international, scientific journals. In biology, for instance, we have many international journals, but almost all of these are small journals with a limited scope and therefore, in spite of their world-wide circulation, of a much smaller circulation than certain of the leading national biological journals. Yet there seems to be quite a *raison d'être* for journals which could publish short, somewhat important material quickly, journals which could bring

out 100–200 articles in one monthly number and which, as a result of their truly international character and scientific importance, could easily obtain such a circulation that they could be made available much more cheaply than the average journal. Whenever I see a number of the fine *Journal of the American Chemical Society,* I cannot help feeling that we could produce something of this kind in the less opulent branches of science by international cooperation.

The type of journal I have in mind has, in biology, been approached perhaps most closely by the *Journal of Economic Entomology.* Noteworthy in this journal is the space- and time-saving separation of longer articles and brief communications. At the end of each issue some space is given to the discussion of professional problems or important news.

Scientific News Journals

No effective international cooperation, in any field of science, is possible unless one is well informed about what is going on in the world of science. Some scientists feel satisfied if they keep themselves informed on scientific progress. In addition to our regular, modern scientific journals and our general scientific news journals, such as *Science* and *Nature,* we need specialized journals devoting all or most of their space to the publication of intelligence concerning the activities and plans of scientists, scientific institutions, and scientific societies, discussions, announcements, requests, notices, and other types of special documentation, rather than to the results of research. It takes scientists as well as *objets d'étude* to make science. For example, more than 2,000 journals are at present devoted to plants, yet only very few of them contain news and information of the kind referred to above. Linnaeus devoted much of his *Philosophia Botanica* to information of this type. The modern worker, oddly enough, often forgets that plants alone cannot yield a grain of botany.

I have done much experimenting along these lines in biology and believe that in that field we badly need an international, monthly or biweekly, professional news journal consisting of review articles, discussions, international and national news, personalia, book reviews, and similar material, as outlined in Dr. Merrill's and my report to the National Research Council's International Relations Committee in 1944. Last year I experimented with a very inexpensive, concise newsletter, *Biologia,* which emphasized international biological affairs, with the typical four-page format of many early English and Colonial American newspapers. This greatly appealed to those directly engaged in international relations work and similar activities but did not give the average working scientist too much of interest or stimulation.

Reviews of recent advances can perhaps be published most usefully in scientific news journals in order that they will be read well and widely. Since the second part of the 18th Century quite a few journals have specialized in review articles. Sometimes they deal with the past year's progress, but for the most part they are concerned with advances during the past few years and occasionally, as in the case of the excellent *Reviews of Modern Physics,* which might well be imitated in other branches of science, with progress during a much longer period. These review journals have lately been issued often as yearbooks of the now well-known annual review and *Fortschritte* type.

Abstracting Journals

In considering the abstracting journals, and limiting ourselves to the biological field, we may say that, before the war, the Germans had their *Centralblätter*; the British—at least workers in the applied field—the reviews of their Commonwealth Bureaux; and the North Americans, their *Biological Abstracts.* In such internationally minded countries as Sweden and the Netherlands it is considered *bon ton* to use all three. As none of the abstracting journals existing before the war was too complete or up to date, the question of whether it would not be better to have one single, fast, and truly international abstracting journal will be raised by many. The answer, generally speaking, will be *yes,* and emphatically so. There are, however, some problems. As is so often the case, the language problem comes first. If abstracts in various languages are mixed as Lotsy used to do in the early *Botanisches Centralblatt,* the Anglo-American reader will miss quite a little; if English only is used, the needs of all will not be served. Yet the language problem is being solved for us (as a result of the general political situation) in such a way that English is now much more dominant and useful than it ever has been.

Then too, experience has taught us that it is useful to see certain publications abstracted in different journals. Those who use some of the reviews of the Commonwealth Bureaux in addition to another abstracting journal will easily agree. We must remember, however, that the world of biology, and of many other branches of science, is small and that its resources are limited. International relations will be promoted best by our support of *Biological Abstracts,* which is now the most truly international abstracting journal, and only in the second place such special journals as may be of additional use to us. Mention should also be made of UNESCO's recent efforts to avoid the overlapping of abstracting services, particularly between the existing biological and the mushrooming new medical abstracting journals.

A third problem has been presented to us by the able and active librarians of the U. S. Department of Agriculture. Their new *Bibliography of Agriculture,* a monthly list of agricultural and biological publications, is so complete, reliable and up to date that for many purposes it will be more useful than any abstracting journal. This again raises the old problem of titles of new publications *versus* abstracts—a problem which several German abstracting journals attempted to solve by dividing their contents into two sections. It is not impossible that this method has its advantages and that abstracting journals of the future will consist of as complete lists of new literature as can be compiled, followed by a limited number of abstracts of the more important papers. Many papers can be abstracted in very few words; an explanation of the title will often do quite well. Such explanatory abstracts can be given in the list of new publications, as Lotsy did in the *Botanisches Centralblatt* lists and as the U. S. Department of Agriculture group often does in the *Bibliography of Agriculture.* It often seems that abstracting and review journals, including the annual reviews, by devoting some 5 or 10% of their space to the material which now appears in the few scientific news journals—particularly intelligence concerning international and social affairs, about which the average scientific worker is badly informed—could promote international scientific relations and professional standards greatly without, in any way, lowering their standards.

Textbooks, Handbooks, and Reference Books

Text-, hand-, and reference books also offer a number of problems of international interest. The most timely of these, and one with which we are all familiar, is the technique of reprinting by various processes books which are in some way or another not available for international distribution. This was done on a large scale during the recent war under the auspices of the U. S. Alien Property Custodian, and, as a result, many rare and out-of-print, important books and periodicals have now been made easily available to the entire world.

There is another important problem which should be discussed briefly in this connection. In science many important and interesting books have, in recent decennia, been published at a considerable loss by institutions and individuals, and many other books remain unpublished because sufficient funds for their publication cannot be raised. This is not always necessary. In somewhat normal times it is often felt—and erroneously so—that a book has been made available to the world at large by the mere fact that it has been produced in printed form. Every sound scientific memoir, unless it is of very special and local interest, can be produced without too much loss and be made widely available if: (1) one makes sure that the book is reviewed well all over the world, particularly also in journals which one does not normally see and which are even in a language one cannot read; nearly every major country of the world has journals of the type of *Nature* or *Science,* and though they may not always appear too important from our point of view, they offer excellent review media for our books; (2) a descriptive circular about the book is distributed among the principal libraries and institutions throughout the world; (3) arrangements are made so that the book will be available directly from a good number of leading foreign booksellers. The latter is particularly important under present circumstances, when it is often difficult for an individual abroad to send even the smallest payment to another country. Such matters will be expedited when UNESCO's book coupon scheme materializes.

Popular Books and Journals

Popular books and journals often exercise much more influence than one would expect. Such German journals as *Die Umschau* and *Mikrokosmos,* for example, had a surprising number of readers in southeastern Europe, just as today such journals as *The Scientific Monthly, Science Newsletter,* and many popular North American natural history journals find many regular readers in Latin America.

Directories

Since the middle of the last century international scientific address books have exercised much useful influence. Unfortunately, they cannot be prepared too soon after a major war. Today it might be best to prepare emergency directories in certain fields by reproducing by offset the latest membership lists of the leading societies of the world, with a good index, under one cover.

The number of active workers in even such a special field as the plant sciences (at least 100,000) is now so large that it will be difficult to include them all in a future directory. If one starts dividing plant scientists into various groups, e.g. plant pathologists, physiologists, taxonomists, etc., as has been suggested, one finds that the amount of overlapping is so considerable that it becomes very difficult to decide who should be included and who not.

In whatever way scientific address books are prepared in the future, there should be a clear differentiation between the general scientific interests (e.g. plant pathology) of those included and their current activities (e.g. research on cereal rusts). If those included are made to report well about their current activities, international scientific directories will play,

in the future, a much more important part in the promotion of international relations than they have in the past.

Bibliographies and Indices

Large bibliographies, encyclopedias, and indices, formerly often prepared on a national basis, obviously can be prepared much better on an international basis. Many publications issued in Germany or Great Britain before World Wars I and II can now be resumed or continued and developed only by a world-wide network of collaborators. The problem of organizing things well and issuing instructions which will be really understood and followed by those taking part in the project, in order to obtain a certain degree of uniformity and the necessary scientific accuracy, looms much larger than ever before.

The National Diet Library of Japan

Verner W. Clapp, *Chief Assistant Librarian, The Library of Congress, Washington, D.C.*

ON FEBRUARY 4, 1948, THE TWO HOUSES of the National Diet of Japan enacted legislation, by unanimous votes, establishing a National Diet Library and making provisions for a building to house its activities. Dr. Tokujiro Kanamori, who, as minister without portfolio in the Yoshida Cabinet of 1946–47, was conspicuously successful in negotiating the adoption of the new Japanese Constitution, has been appointed the first chief librarian of the new institution, which will attempt to provide a number of services not heretofore supplied by the Japanese library system.

That the development of libraries in Japan is a comparatively recent phenomenon is illustrated in Table 1, in which only libraries of 3,000 or more volumes are represented. The data for this table are taken, to the extent that they are available therein, from the special report on "Libraries in Japan (Each Containing 3,000 Volumes or Over)," issued by the Civil Information and Education Section of General MacArthur's Headquarters on March 29, 1947 (AR-279-CR-A-11).

TABLE 1

Date of establishment	No. of libraries
Before 1860	2
1860 to 1869	4
1870 to 1879	11
1880 to 1889	16
1890 to 1899	16
1900 to 1909	109
1910 to 1919	186
1920 to 1929	330
1930 to 1939	123
1940 to 1946	61
	858

Of the 49 libraries which were established prior to 1900, 30 are attached to institutions of learning; only 8 are public libraries, 7 are privately-owned establishments, and 4 are collections belonging to the national government, including the Imperial (now the National) Library in Tokyo. The enormous increase in the rate of establishment of libraries after the beginning of the century is to be attributed specifically to the enactment of a library law in 1899. At the Louisiana Purchase Exposition in 1904 the Japanese Government presented an exhibit calling attention to its rapidly growing library system (*Public Libraries*, 1904, **9**, 467). Library development from 1900 to 1946 was, in fact, very general. Of the 809 institutions represented in the table, public libraries claim 391, but 246 are designated as "private" and include the research collections of industrial and other corporations as well as special collections devoted to public use by foundations and private owners. One hundred fifty-four of the total are attached to schools, colleges, and universities, and 18 are the libraries of national governmental agencies. Including collections of all sizes, the Japanese Ministry of Education has reckoned that there were in Japan no less than 3,398 library installations as of May 1, 1946.

One-sixth of all the libraries of 3,000 and more volumes were concentrated within the Tokyo area. (The past tense must be used, because a number of these libraries were destroyed during the war.) In addition to the National Library at Ueno Park, there were in this group 25 libraries belonging to the national government. The Tokyo metropolitan system included 28 libraries, of which the oldest and largest was the Hibya Library, founded in 1906, while the rest consisted for the most part of very moderate-sized collections. There were 67 school, college, and university libraries and 24 privately-owned collections. There were a number of scientific and technological libraries in each class, but few good collections. While it is true that roughly one-half of the 145 libraries in the group were of less than 20,000 vol-