Research or Available Knowledge:

A Matter of Classification

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THE SCIENTIFIC DEVELOPMENTS of the past five years are fabulous by previous standards. Some are widely known. Radar and the atomic bomb, for example, have become household words. Many of the less spectacular developments are no less important, even though known and understood only by those few people who have taken part in their evolution and application to practical purposes. Impressive and vast as are the projects in which these accomplishments have been made, they actually consist of countless thousands of individual details of scientific progress. In the majority of cases these details have been worked out as a result of long and painstaking efforts and a great deal of "research."

The term "research" has gained the respect and even the awe of our people because they are shown results on an impressive scale flowing out of large-scale efforts described as "research." But the condition of the sources of information which must be searched by research workers is chaotic indeed. Two and a half million different U. S. Patents stand as one example of the number of items that can be involved in dealing with technical information, not to mention the many additional millions of foreign patents. Scientific papers and dissertations in this and other countries add a formidable number of possible sources of detailed information and guidance. As long ago as 1933, S. C. Bradford, of the Science Museum Library in London, estimated that 750,000 scientific and technical papers were published annually in 14,000 different periodicals. More recent estimates indicate that the rate has doubled since then.

In the early days of science, when it was much less complex and confusing, philosophers discoursed on how it grew. Progress, they discovered, came most effectively when that which was already known was fully organized and sorted out. Generalities on which future advances could be based were made only by a careful analysis of the pattern formed by that which was already known. This was obvious to Aristotle 2,300 years ago and was expounded in his *Posterior analytics*. Today science has acquired so many facets, so many millions of possible channels of development, that it is far more difficult to organize into a coherent pattern. Our libraries, universities, research laboratories, learned societies, and industrial organizations all struggle in futile fashion with their individual segments of the problem.

The obvious need is for the coordination and standardization of the system by which all such material is sorted and classified, so that all who may be interested can at least direct their attention to a certain small portion of the whole mass of published material, selected in terms which are defined alike for all. Some organization, either public or private, must accept the burden of taking the infinite pains necessary to see that all scientific subject matter is classified according to logical principles, on a standardized basis acceptable to all who need it, whether for future scientific development or for the application of that development to industrial production.

Libraries classify their books and periodicals according to a number of systems, two of which are the most widely recognized. In this country many libraries follow a system established by the Library of Congress, using an arbitrary combination of letters and numerals. Many others, both here and abroad, follow a generally standard decimal system. This latter has great possibilities in providing a precise diagnosis, especially when the number of decimal places used grows to 12 or 15 digits. Unfortunately, much of the expansion has been made by people whose interest was in sorting and finding material for strictly literary purposes.

The Patent Office, faced with a growing mountain of patents to be issued, has been forced to make some progress toward a universal classification system as applied to technical subjects. The millions of patents are now grouped in some 300 main classes, which are further divided into over 40,000 specific subclasses. Each subclass contains a particular field of inventions, with an explicit definition. This definition is carefully worked out to indicate material excluded from the particular subclass defined, with guiding search notes to help find such material. Obviously, the subclasses themselves are grouped to facilitate the selection of the minimum field of search necessary to assure finding the particular subject matter required. Necessity has also brought into existence in the Patent Office a small staff of experienced workers constantly studying the need for additional subdivisions or arrangements to provide for growing arts.

The system used in the classification of patents has been dictated by the needs of those who must use it constantly in their work, in examining patent applications for novelty and in making searches to determine whether a given patent is completely valid and infringed by the manufacture or sale of some device or the use of a certain process. The controlling factor in classifying patents must be the most generic or essential function of the device classified. An internal combustion engine, for example, is a device for producing power, whether that power drives an automobile or pumps water. Classifying the engine under automobile engines would effectively

lose it for anyone seeking the details of an exactly similar engine which he had conceived as part of a system for pumping water.

In patent searching it is necessary to be certain that the search can be absolutely complete after looking at as few disclosures as possible. One patent erroneously classified and not located may turn up later and destroy a business founded on the studied belief that no patent was infringed or that the patents on which it was founded were completely new and valid. Yet there is a practical limit to the searching possible to determine those facts. However detailed a library type of classification may become, it is not concerned with the problem of limiting the number of items placed in a given subclass.

Many large corporations have collected the few thousands of patents in fields of special importance to them and have then sorted them still further according to systems which happen to meet their particular requirements. In some cases the same system is then used to some extent to sort and classify collections of published articles and other available material in the selected field, and frequently is used as a guide to research programs. The problem of handling published material faces all organizations engaged in scientific and technical research. There are countless librarians and clerks in research laboratories all over the country, patiently making card files and cross-indexes of journal articles and other material that has been found useful or for which a future need is anticipated. Some few of these collections have been further organized to permit the use of mechanical devices such, for example, as punch-card collections and sorting machines to select cards that may represent precise groups of patents or published articles pertaining to a particularly defined problem.

There are machines now available which can select such things as cards or films according to codifications of an almost infinite number of subdivisions. The card or film may also carry microfilm or microprint reproductions of the material it classifies. The interest in this type of equipment was illustrated recently during the symposium of the American Chemical Society at Chicago. A day was devoted to the discussion of the use of such mechanical contrivances for preparing bibliographies on chemical subjects. The scientists attending were so absorbed in the possibilities presented that the normal day session was carried on well into the night. In conjunction with some of the large chemical companies the American Chemical Society is continuing to pursue this attractive project.

It seems a pity that such interest and effort cannot be organized to develop and maintain a single standard system whereby many can benefit from the accomplishments of the various individual efforts now isolated in their own narrow activities. The infinitude of detail which can be studied and arranged by particular organizations dealing with a small section of scientific thought might well benefit all who worked in that field if it were collected in a central agency and coordinated with similar work done by hundreds of similar organizations working in their own particular fields. This system need not be limited to a single type of arrangement for a given subject. There may be alternative classification schedules for a given subject matter to serve different users. With modern equipment these may be solved as simultaneous equations to find, for example, a specific structure used for a particular purpose.

If we carry our dreaming far into the remote future, it is possible to imagine a National Library of Science, patterned after the present Library of the Department of Agriculture, with facilities organized on a scale to embrace all of the fields of scientific and technical effort. With truly modern methods of sorting and filing material, using machines and microphotography, any item of scientific knowledge could be selected almost immediately and furnished to some worker in a position to carry it on to some additional purpose, at a very nominal cost if done on a sufficiently large scale.

The Department of Agriculture Library has already established a very high reputation for service in its field. Any research worker in agricultural subjects is able to obtain very quickly photostatic or microfilm reproductions of practically any published article desired. Specially trained experts are on hand to prepare bibliographies on selected topics for the Department or for other government agencies. Every effort is made to have this type of information readily available.

It is logical to consider such facilities as the Search Room of the Patent Office, for example, as a nucleus of such an ultimate Library of Science. It has a great store of disclosures of inventions which are dedicated to the free use of the public after a few years of exclusive control by the inventor. A system of classification such as is used in the Patent Office, integrated perhaps with the Universal Decimal System, could serve as a basic framework on which to build a really effective system of technical and scientific classification. Such a system would justify a corps of specialists continually supervising its development in accordance with the needs of scientific and technical workers using it. A council of recognized leaders in the major fields of science and technology should meet at periodical intervals to study proposed revisions and guide the efforts of the staff to maintain the system effective and acceptable to all concerned.

Once a system is accepted as standard, the actual labeling of the material with its class and subclass numbers can be done, in many cases, at the source. Magazines and journals, for example, could readily indicate this information with each article, just as the present-day manufacturer of bolts and nuts can indicate on the label pasted on a container the size and number of threads on these useful devices, according to a standard system. Until such complete acceptance is reached, the libraries

and technical societies and organizations can gradually make more and more widespread use of the system in steadily progressive stages.

Such devices as the punched card make it possible to correlate a number of systems of classification, so that a user familiar with any one system may be guided into a mass of information organized according to another system. Over a period of time, the ineffective systems would clearly display their weakness and fall into disuse. Thus, it is unnecessary to contemplate the obviously impossible sudden shift from present systems, representing the accumulated efforts of many years, to a new and different system.

Once we all learn that there are certain effective principles which are most successful in organizing and relating information, and that there are guides and mechanical aids to conduct us from our familiar paths into those chosen by others, much of the bitter controversy as to the respective merits of various systems should disappear. Every creative worker in scientific fields will become a contributor to the development of the eventual standard or truly universal system. When that system is accepted and maintained, time now spent in uncertain hunting for clues to likely sources of information will be substantially eliminated.

Obituary

Leo Černosvitov

1902–1945

Although the common earthworm is one of the most widely investigated of laboratory animals, the number of competent students of oligochaete taxonomy has always been very limited. Perhaps this is due to the intrinsic difficulty of the subject, since the description of each new species is in itself almost an anatomical memoir. Leo Černosvitov, whose untimely death has deprived the scientific world of one of its most promising oligochaetologists, possessed the special qualifications so essential for an investigator in this field of knowledge. He received a thorough training in zoology at the University of Prague, where the subject of his Doctor's dissertation (1927), "La régression physiologique des organes génitaux du *Tubifex tubifex*," prepared him for both biological and taxonomic investigations.

His career was a stormy one, but filled with interest and adventure. Born at Poltava, Russia, in 1902, he fought with the White Army and was later evacuated, as a boy of 17, to Constantinople. In 1921 he went to Prague and received his higher education under the auspices of the Czech Government. After graduation he began an intensive study of the Oligochaeta which culminated in the publication of some 55 papers in this field alone. A survey of the *Zoological Record* shows that he described, in his short and much interrupted career, some 86 new species, exclusive of redescriptions and assignations of new names. His work on oligochaetes was not confined to a limited group or to a restricted geographical region, but, at one time or another, he studied representatives of nearly every family and from many different parts of the world. Among his more important contributions are a long series of articles dealing with the oligochaete fauna of the Balkan countries, that hotbed of zoological endemicity; a systematic revision of the *Enchytraeidae*, as well as numerous shorter papers on this, the most difficult of oligochaete families; and a review of the literature on cavernicolous oligochaetes. He was the first to observe uniparental reproduction in oligochaetes, and his studies on the resorption of spermatozoa are of equally general interest and importance.

In addition to his work on oligochaetes, Černosvitov engaged in many other activities, earning his living in a variety of ways, as lecturer, as entomologist, and as research technician in the Dental Clinic of the University of Prague. As entomologist he visited the Argentine in 1931–32 to study the control of insect pests in the plantations, and as a result of this visit he published several papers on South American oligochaetes. He investigated spruce sawfly for the British Imperial Institute of Entomology and was in Finland, engaged in this work, at the outbreak of the war. Returning to London, he became monitor for the BBC, feeling this to be his most useful service as a refugee alien, on account of his exceptional knowledge of foreign languages.

At the time of his sudden death from a heart attack, on December 15, 1945, he was on the threshold of happiness and security. Four days previously he had been appointed to the staff of the British Museum, and at last it had seemed that he could devote his entire energies to the work that he loved best. It is to be hoped that arrangements can be made for the completion of his unfinished Monograph of the British Oligochaeta, if not for his projected review of the economic importance of earthworms.

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