

posed manifestation is of itself enough to secure its success. Allow me, my dear colleague, to express my feelings of affectionate devotion."

AN INDEX TO SCIENCE.

I HAVE lately received the "Sach Register" of the *Berichte der Deutschen Chemischen Gesellschaft*, 1868-87, in three volumes, indexing the twenty years of publication (thirty-six volumes). The work is admirably done, and is of inestimable value to the student of science generally. German scientific men and scientific Societies are far in advance of the English in the art of making the results of scientific research readily accessible. Witness the admirable "Bibliotheca Zoologica," by Engelmann and Carus, and still continued by Taschenberg; the "Sach Registers" to Liebig's *Annalen der Chemie*, 1832-83, to Poggendorff's (now Wiedemann's) *Annalen der Physik und Chemie*, 1824-87, and to the *Journal für Praktische Chemie*, 1833-87; and the "Repertorium Commentationum a Societatibus litterariis editarum," by Reuss, in sixteen quarto volumes, which last valuable production covers the whole ground down to the end of the last century.

The fact is very suggestive with regard to the English neglect of the scientific knowledge, experiment, and discovery locked up in the long series of English scientific journals to be found in our public libraries. The journals have usually, but not always, a short index at the end of each volume, obliging the student to occasionally spend days and weeks in searching through the series for what has been written on a subject he is investigating. The volumes accumulate on the shelves, and the experiments and investigations are repeated again and again.

The Royal Society, with a lively sense of the necessity for a remedy to the existing chaos, some twenty years ago commenced, and continues at intervals the issue of "A Catalogue of Scientific Papers contained in the Transactions of Societies, Journals, and other Periodical Works from the Year 1800." It is an author-list, and does not at all meet the requirements of the case. It necessitates a knowledge, by the inquirer, of the names of all the men who are likely to have written on the subject of inquiry. Life is not long enough for this. Librarians are occasionally of some assistance in the matter, but they often fail. What occurred lately has occurred to me often: I submitted to a chemist of some note the records of experiments published in 1820, which would have saved him many months of investigation of the same subject if a reference to the previous work had been accessible by index or by personal knowledge. It is the experience of all men of science that days may be spent in obtaining a reference to what may be read in five minutes, usefully or uselessly.

The Royal Society Catalogue originated from a suggestion of the late Joseph Henry, the Director, for thirty years, of the Smithsonian Institution (Washington) for the Increase and Diffusion of Knowledge, who said ("Smithsonian Miscellaneous Collections," vol. xxi. p. 295):—

"One of the most important means for facilitating the use of libraries (particularly with reference to science) is well-digested indexes of subjects, not merely referring to volumes of books, but to memoirs, papers, and parts of scientific transactions and systematic works. I know of no richer gift which could be bestowed upon the science of our own day than the provision of these. Everyone who is desirous to enlarge the bounds of human knowledge should, in justice to himself as well as to the public, be acquainted with what has been previously done in the same line."

Henry afterwards communicated with the British Association on the subject (in 1855). The Association appointed

a Committee (Mr. Cayley, Mr. Grant, and Prof. Stokes), who reported:—

"The Committee are desirous of expressing their sense of the great importance and increasing need of such a Catalogue. . . . The Catalogue should not be restricted to memoirs in Transactions of Societies, but should comprise, also, memoirs in the Proceedings of Societies, in mathematical and scientific journals, &c. . . . The Catalogue should begin from the year 1800. There should be a Catalogue according to the names of authors, and also a Catalogue according to subjects."

The Committee succeeded in interesting the Royal Society of London in the undertaking, and that body ultimately assumed the direction of the work.

But they have achieved an instalment only of the recommendation of the distinguished Committee at whose suggestion they took action. They have produced an author-list, but the "Catalogue according to subjects" is wanting. All the subjects in the Royal Society's Catalogue should be at once placed under a subject-heading as well as under the author-heading in alphabetical arrangement, as near a concordance as possible by means of cross-references, and should be systematically continued and published annually. What has been done by Mr. Poole, of Chicago, for the great portion of English *general* periodical literature in publishing a subject-list, alphabetically arranged, of the articles contributed to 238 periodicals from 1802-81, and to 141 periodicals in the supplemental volume for 1882-87, should be done for all the scientific publications. The principle of the work is simple, and could be readily carried out. "The main purpose of this (Poole's) work was to meet the average wants of students, literary men, and writers for the press—in other words, to help general scholars, who are many, in preference to the few who give their whole attention to a single topic." From an experience of thirty-two years in libraries, I must say, with all due deference to Mr. Poole, that a subject-index of the scientific journals would be of vastly greater benefit to the community—material benefit, if he pleases. I ought, however, to add my meed of praise to the practical, sensible, and sufficient way in which the work that he attempted has been done.

An attempt at remedying our great literary defect was made by Robert Watt, 1819-24, when he added to the two quarto volumes of an alphabetical list of 40,000 authors in his "Bibliotheca Britannica, or General Index to British and Foreign Literature," an additional two volumes of an index of subjects. This has all the disadvantages of a first attempt. The study of bibliography was little known, and less cultivated, at the time. The book is almost entirely out of date. A great deal more may be said in favour of the combination of authors and subjects in one general catalogue, as successfully achieved by Lieutenant-Colonel Billings in the "Index Catalogue of the Library of the Surgeon-General's Office, United States Army," as far as the letter N, in nine volumes, royal octavo. This is a specimen of cataloguing almost perfect: every article, and every disease, and the complications of every disease, with the various organs, being catalogued and sub-catalogued with their cross-references.

The history of scientific research exhibits a continual tendency towards specialization; and as the sphere of the labourer has become limited each area of research has expanded, so that it has become essentially necessary that every subdivision of knowledge should be digested and arranged. With the co-operation of a few librarians, a subject-catalogue of all scientific literature might be readily undertaken by the Royal Society or the Society of Arts, the publications contained in the British Museum being marked by an asterisk or other sign. Or a system similar to that of the "Smithsonian Catalogue of Scientific and Technical Periodicals (1665-1882)" might be

adopted, in which, by means of a check list at the end, it is shown in what American libraries all the periodicals may be found. A good portion of the work is done in such works as have been mentioned: in the indexes to the literature of special subjects in the Smithsonian collections, in the publications of the Harvard University, and in the indexes to the publications of Societies, such as the Chemical, Geological, Zoological, Linnean, Astronomical, Geographical, Engineers, Statistical, the Society of Arts, and the Royal Society, and in the indexes of various periodicals. These should be systematically arranged; the chaos should be organized and classified, to enable the man of science to find out at a glance all that has been published on any branch of his subject, and the work would be of value to the country.

The range of subject-headings should include everything relating to scientific and technical subjects. These would include (taking Comte's classification for convenience in the serial arrangement), Mathematics, Astronomy, Physics, Chemistry, Physiology (or what is commonly understood as Natural History, with the generic term of Physiology or Physio-Philosophy), and Social Physics (including Sociology). These subjects are clear, well defined, and well known to the librarians.

There is nothing so necessary as that scientific thought and method should be embodied, classified, and arranged, preliminary to its organization as a whole. It would quicken the slow process of improvement that has extended over a thousand years. It is wonderful that it should be necessary to say this in the nineteenth century. The need for organization in all departments of science is keenly felt; and the growth of Positivism in these latter days is one of the expressions of that need. Three centuries ago Bacon aimed at the organization of the sciences, holding that the sciences can be advanced only by combining them; that, as natural laws are invariable and uniform, "Physics being the mother of all science," so moral and civil philosophy could not flourish when separated from their roots in natural philosophy.

On national grounds it is necessary that this work should be done, for it is in the interest of the community generally, of the nation, that we should know what we possess. Public libraries and educational institutions are increasing; scientific experiment, discovery, and invention are increasing; and the demand for such a subject-catalogue will increase. Its value to the community would be inestimable. If it is thought advisable that the Royal Society or the Society of Arts should take the work in hand, the work should be subsidized by the Government, for the simple reason that it would be of national value. Scientific research is not so remunerative but that the student may fairly expect facility of access to the labours of those who have gone before. The want of a serviceable key to the vast body of scientific work contained in our literature is daily experienced by cultivators of science. There is a serious necessity that this material should be made more readily accessible for comparison, for verification, and for improvement. Much of it is a monument of shattered hopes, the unsuccessful efforts of poverty and despair; but all of it is suggestive to the earnest student.

No one Society or publisher can take the work in hand without Government support or benefaction. Attempts have been made, such as the attempt of the Royal Society, and that of Agassiz in his "Bibliographia Zoologiae et Geologiae," published by the Ray Society, which voluminous work, be it remembered, "was mainly compiled by the Professor for his own private use during the leisure moments of a life of almost incessant scientific research." In whatever hands the work may be placed, there is no doubt that the co-operation of the scientific Societies might be relied upon. With regard to the question of assistance from the Government, the following

Minute of the Lords Commissioners of Her Majesty's Treasury, dated November 28, 1864, referring to the Royal Society's Catalogue, is very suggestive:—

"Having regard to the importance of the work with reference to the promotion of scientific knowledge generally, to the high authority of the source from which it comes, and to the labour gratuitously given by members of the Royal Society to its production, my Lords consider themselves justified in having the work printed at the cost of the public, with the understanding that, reserving such a number of copies for presentation as my Lords, in communication with the President of the Royal Society, may hereafter determine, the work shall be sold at such a price as may be calculated will repay the cost of printing.

"Their Lordships, however, desire it to be understood that the work shall go forth to the public under the authority of the Royal Society, by the exertions of whose members this important aid to the study of science has been produced."

J. TAYLOR KAY.

IRIDESCENT CRYSTALS.¹

THE principal subject of the lecture is the peculiar coloured reflection observed in certain specimens of chlorate of potash. Reflection implies a high degree of discontinuity. In some cases, as in decomposed glass, and probably in opals, the discontinuity is due to the interposition of layers of air; but, as was proved by Stokes, in the case of chlorate crystals the discontinuity is that known as twinning. The seat of the colour is a very thin layer in the interior of the crystal and parallel to its faces.

The following laws were discovered by Stokes:—

(1) If one of the crystalline plates be turned round in its own plane, without alteration of the angle of incidence, the peculiar reflection vanishes twice in a revolution, viz. when the plane of incidence coincides with the plane of symmetry of the crystal. [Shown.]

(2) As the angle of incidence is increased the reflected light becomes brighter and rises in refrangibility. [Shown.]

(3) The colours are not due to absorption, the transmitted light being strictly complementary to the reflected.

(4) The coloured light is not polarized. It is produced indifferently whether the incident light be common light or light polarized in any plane, and is seen whether the reflected light be viewed directly or through a Nicol's prism turned in any way. [Shown.]

(5) The spectrum of the reflected light is frequently found to consist almost entirely of a comparatively narrow band. When the angle of incidence is increased, the band moves in the direction of increasing refrangibility, and at the same time increases rapidly in width. In many cases the reflection appears to be almost total.

In order to project these phenomena a crystal is prepared by cementing a smooth face to a strip of glass, whose sides are not quite parallel. The white reflection from the anterior face of the glass can then be separated from the real subject of the experiment.

A very remarkable feature in the reflected light remains to be noticed. If the angle of incidence be small, and if the incident light be polarized in or perpendicularly to the plane of incidence, the reflected light is polarized in the *opposite* manner. [Shown.]

Similar phenomena, except that the reflection is white, are exhibited by crystals prepared in a manner described by Madan. If the crystal be heated beyond a certain point the peculiar reflection disappears, but returns upon cooling. [Shown.]

In all these cases there can be little doubt that the reflection takes place at twin surfaces, the theory of such reflection (*Phil. Mag.*, Sept. 1888) reproducing with re-

¹ Abstract of the Friday evening lecture delivered by Lord Rayleigh, F.R.S. at the Royal Institution on April 12, 1889.