ONE HUNDRED YEARS OF MICROSCOPY

The Royal Microscopical Society

By Prof. R. Tanner Hewlett

THE Microscopical Society of London, now the Royal Microscopical Society, was founded in 1839, and it was proposed to celebrate its centenary this October with a special meeting. This function has been postponed for the present, but papers on the progress of microscopy during the last hundred years, contributed to celebrate the occasion, will be published in ensuing numbers of the Society's *Journal*.

In the earlier part of last century, microscopy was beginning to attract considerable attention, and not only among men of science, for public exhibitions with the microscope were given in London about 1833. This development owed much to improved instruments and to improvements in the lenses about this time. The first English achromatic lenses for the microscope were made by Tulley, an instrument maker of Islington, in 1825, at the instigation of a Dr. Gurney. Then in 1830, J. Jackson Lister, father of Lord Lister, devised improved formulæ for "working [achromatic] object glasses of short foci and large aperture, with a view to increase the power and ease of manufacture", and his paper did much to stimulate the production of better microscopes and their more extended use.

In 1839, several votaries of this new science of microscopy lived in Wellclose Square, near Tower Hill, including J. S. Bowerbank, authority on sponges, N. B. Ward, of "Wardian glass-case" fame, Edward Newman, the entomologist, and the brothers Edwin and John Quekett, whose name is perpetuated in the Quekett Microscopical Club. These and several others met at Edwin Quekett's house on September 3, 1839, and on a proposal by Bowerbank decided to form a society for "the promotion of microscopical investigation, and for the introduction and the improvement of the microscope as a scientific instrument"—aims which it has always been the endeavour of the Society and its fellows to fulfil. In December of that year, the Society came into being, with Richard Owen as its first president, Ward as treasurer and Dr. Arthur Farre as secretary. J. J. Lister was one of the original members, and Michael Faraday joined in 1841 and remained a member until his death. The Society was incorporated by Royal Charter in 1868, during the presidency of James Glaisher, and the reigning Sovereign has since been its patron.

Owen delivered his presidential address in February 1841, on "The Structure of Fossil Teeth from the Old Red Sandstone indicative of a new Genus of Fishes (*Dendrodus*)". Of the roll of eminent men who followed Owen as presidents of the Society may be mentioned John Lindley the botanist, Thomas Bell and George Busk, zoologists, W. B. Carpenter, John Quekett the histologist, W. Kitchen Parker, H. C. Sorby the spectroscopist, Lionel Beale, W. H. Dallinger, E. M. Nelson, C. T. Hudson, Lord Avebury, Sir Ray Lankester and Sir J. Arthur Thomson.

During the first forty years of its existence, the proceedings of the Society were published successively in certain journals, but since 1878 the Society has issued its own *Journal*, which in addition to its proceedings, contains abstracts of the world's literature on microscopy. The Society maintains an extensive library and a cabinet of more than 20,000 representative microscopical specimens, including many 'type' specimens of diatoms and other forms of minute life. It also possesses a unique collection of historical instruments.

The following brief survey of communications appearing in the Society's *Journal* will serve to give some idea of the contributions made by fellows to microscopy, though representing but a fraction of the matter contained therein. Reference to articles by living fellows, which have appeared during the last few years, is also omitted, with one or two exceptions.

Dealing first with the microscope and its accessories, an outstanding achievement was the formulation in 1858, with subsequent revisions, of a standard screw-thread for objectives, now universally adopted by makers all over the world. As a result, an objective by any maker will fit the nose-piece of any microscope. The Society has likewise drafted specifications for the sizes of eyepieces and sub-stage fittings which have been generally adopted.

In 1854, F. H. Wenham contributed a paper on "The Application of Binocular Vision to the Microscope", and described his binocular microscope, and J. W. Stephenson described his "erecting" binocular microscope in 1870. T. Maltwood in 1858 designed his "finder" for registering the position of objects mounted on a slide, and the description of the construction of an iris diaphragm was given by J. H. Brown in 1867. A malachitegreen cell for monochromatic illumination was described by J. W. Gifford in 1894, and the glass-rod illuminator by J. W. Gordon in 1907, and Keith Lucas in 1904 designed a stand in which geometric slides replaced the usual planed ones.

Numbers of papers are to be found on microscopical optics, to which E. M. Nelson made notable contributions, and about 1879 the question of lens-aperture and of microscopical resolution occupied much attention, and numerous papers were devoted to these subjects. In that year, Abbe defined "numerical aperture" as we now understand it, and stated that for immersion purposes cedar-wood oil had proved the most suitable fluid.

In 1865, Huggins and Browning first dealt with the application of the spectroscope to microscopy, and later H. C. Sorby contributed much to microspectroscopy, incidentally, in his presidential address to the Society in 1870 surmising the possible existence of "invisible germs", thus anticipating by some thirty years any positive knowledge on ultra-microscopic organisms.

There are naturally many contributions on photo-micrography, commencing with a paper "On the Application of Photography to the Representation of Microscopic Objects" by Joseph Delves in 1853.

As in the "brass and glass" department, as we irreverently call it, so a vast amount of material has been contributed on the biological side. Diatoms, presenting as they do problems in the interpretation of the microscopical image, and as being a most interesting group, both fossil and living, have always been a favourite subject of study, and are dealt with in numerous papers by Wallich, Greville, Kitton, Petit, Flögel and others. The Foraminifera have also been much studied; early papers on the group were contributed by T. Rupert Jones, and more recently by H. B. Brady and F. Chapman, together with the notable papers by F. M. Millett on Malay forms, and by Heron-Allen and Earland on the Selsey, North Cornwall, North Sea and other species. Rotifers are likewise the subject of numerous papers by C. T. Hudson, P. H. Gosse, V. Gunson Thorpe, James Murray, C. F. Rousselet and others. T. H. Huxley contributed a study of the rotifer *Lacunularia socialis* in 1853.

The Infusoria are dealt with by Saville Kent, C. T. Hudson, Dallinger and Drysdale and Dallinger. The latter, in 1880, determined the thermal death-point of monads in natural surroundings to be for the mature forms about 140° F. Dallinger in 1887 also worked on the gradual acclimatization of certain monads to increasing temperatures, and was able finally to maintain them without harm at a temperature of 155° F. E. M. Crookshank and H. G. Plimmer dealt with parasitic flagellated Protozoa. The mites are the subject of a number of papers by A. D. Michael, which deal with their structure and taxonomy and with new species, and Rupert Jones wrote on the Entomostraca and Saville Kent on siliceous sponges.

Parasitology is represented by several communications, commencing in 1849 with one by George Busk on the guinea-worm parasite of man. He remarked that infection is derived from water and that the worm is always female in its attributes; statements that stand to-day, for even now the male is almost unknown.

On the botanical side, contributions on the Bacteria are relatively scanty, probably because microscopy is rather subsidiary to culture methods for their study. There are, however, papers by R. L. Maddox on bacteria in the air and in rain-water and hail, and on lactic ferments, by E. M. Crookshank on Actinomyces and by Cheshire and Cheyne describing *B. alvei*, supposed to cause foul brood of the honey bee. In 1884 Lionel Beale described the microscopical examination of twenty-five samples of Thames mud, taken between Gravesend and Chelsea, for the presence of bacteria, determining their relative numbers at the various localities, and he remarked that if only the vast quantities of water in the upper Thames in time of flood could be husbanded for times of scarcity, there would be ample water to flush London's sewers and to keep the lower Thames from being fouled—surely a presage of the later work of the Metropolitan Water Board.

Many new micro-fungi were described by G. Massee, and other papers on this group were contributed by Miss Lorrain Smith and A. Chaston Chapman. Freshwater algæ are dealt with in many papers by A. W. Bennett and W. and G. S. West, and the bog mosses by R. Braithwaite. There are also many papers on vegetable structure, pollens, cytology and chromosome structure, and W. Carruthers and D. H. Scott dealt with the microscopical anatomy of fossil plants.

There are a goodly number of papers on animal histology, notably by John Quekett, Lionel Beale and C. da Fano, and W. Kitchen Parker contributed several studies on the development of the skull in birds, etc. In 1849, R. Warington described a new medium for mounting organic substances as permanent microscopical objects; this was glycerin, and he outlined the method of sealing the mounts with various varnishes. R. J. Farrants, president in 1861–62, devised the well-known Farrants' mounting medium.

There is no space to record many other important contributions, particularly those on the technical applications of microscopy to iron and steel, clays, petroleum, fabrics and fibres, and others, and to medical science. Many of the subjects referred to in this account are discussed more fully in the papers contributed in honour of the Society's centenary, which, as mentioned, are to be published in the Society's *Journal*.

In conclusion, we may express the belief that the Royal Microscopical Society has throughout its history sedulously pursued studies associated with problems of microscopic structure and function, and has contributed in no small measure to the development of the microscope as a scientific instrument, and to its applications in science and industry.

EDUCATION FOR INDUSTRY*

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THE evolution of industry involves a continual change in the character of the knowledge that must be applied by those engaged in it, if they are to achieve a continually increasing efficiency of production. How important this question of efficiency is to the whole community of an industrial nation may not always be appreciated. The material progress of civilization demands an increasing supply of manufactured products of all kinds. If they are manufactured at home, employment is increased and money is available for circulation. This affects eventually all the community and not merely those workers directly engaged in industry. It is therefore of vital importance that the transformation we speak of as industry shall be conducted with the utmost efficiency, and to achieve this the personnel engaged in it must be most effectively trained; which in its broadest sense means most effectively educated.

Industrial personnel can be divided into two main groups: manual and non-manual workers. The first requirement of the manual worker is practical handicraft skill, and of the non-manual worker specialized knowledge applicable to the function he performs in the particular branch of industry concerned. To satisfy these requirements well-organized schemes of theoretical and practical training must be made available to all those fitted to take full advantage of them.

There are four main classes of entrants into industry, namely, those who enter at the school-leaving age from elementary, junior technical, central and secondary schools; those from secondary schools who have attained School Certificate or Higher School Certificate standard; those who have had university training; and those adults who enter at any age and from any educational level. Of the first three classes, the university group contains the smallest proportion of misfits. At the lowest entry level, economic need and local conditions of employment may, and usually do, determine the choice of vocation. In addition, there is still considerable social prejudice in favour of the so-called 'black-coated' occupations. The importance of vocational guidance in the early years cannot be too highly stressed, and although good work is being done in this direction much more is needed; it should in fact be accepted as a responsibility by every competent teacher. Such acceptance implies, of course, familiarity with local conditions and opportunities. One useful adjunct might be the keeping, from school entry age onwards, of a record of the particular characteristics, aptitudes and preferences displayed by the pupil. Such a record would be of considerable value at the time when discrimination is made between secondary, junior technical and junior commercial schools.

For those entering industry at the lowest stage there is, at present, little conscious preparation for industry from the educational point of view other than that in the junior technical schools. The practical industrial bias given in these schools, for at least the final two years, is of definite advantage. A much greater proportion of junior technical school pupils who enter industry advance rapidly than is the case with their fellows not so educated. Indeed the tendency is for many of them to be recruited to the ranks of foremen, junior managers, draughtsmen and so on, with the result that the equally important field of artisanship is not very well fed numerically from this source. Records of one factory, compiled over a period of years, show that whereas 64 per cent of the entrants from elementary schools became artisans, less than 10 per cent of the entrants from junior technical schools did so, in the same period.

The type of industrial training required for the manual worker who aspires to learn a trade or acquire a craft consists of a long period of practical

* From the presidential address to Section L (Educational Science) of the British Association, delivered at Dundee on August 31.