THE BOTANIC GARDEN, OXFORD*

BY a change of Statute, approved on March 9, the University of Oxford's ancient Botanic Garden enters yet another phase of its history.

The Garden was founded by the Earl of Danby in 1621: it is thus the oldest Botanic Garden in Britain and the sixth oldest in Europe. In that year Danby secured the lease of a piece of swampy water-meadow from Magdalen College and made it over to the University for a physic garden. This lease has been renewed from time to time for more than three hundred years.

Danby first built the wall and gateways, then had the level of the ground raised in an attempt to avoid floods. Some time previous to 1641 he appointed Jacob Bobart gardener on a ninety-nine-year agreement, with benefit of the produce and a payment of £40 per annum for labour and materials. Bobart on his part undertook to keep the garden planted with trees and plants requisite for "the service and use of the said University". It would appear that Danby intended to have a "Botany Professor" also, but the Civil War broke out and funds were short. Morison, first professor, was not appointed until 1669 (*obit.* 1683).

The shortage of funds forced Bobart to support the Garden on what he could grow in it. There is in the archives a rather pathetic appeal (undated) to the Vice-Chancellor from Jacob Bobart jun., who succeeded his father, asking for a salary. He pointed out that the "Exoticks" he cultivated needed special care, and he thought it "a digression, to make Cairfax shine wth the spoils of the Physick Garden, allways having respect to the dignitie of the Universitie".

Bobart the younger died in 1719. The year before there had returned to England Dr. William Sherard, sometime fellow of St. John's, who had been consul at Smyrna. Sherard was a man of means with a considerable interest in botany. He regretted the state of neglect into which the Garden had fallen and entered into negotiations with the University to put botanical studies on a sounder footing. He had a remarkable library and an extensive herbarium. He proposed to found a chair of botany, with £3,000 endowment, nominating Dillenius, a distinguished botanist in his employ, as professor, and to leave his library and collections to the University, if the University would revive the Garden, erect the necessary green-houses and library buildings, and make due provision for upkeep. The negotiations were protracted (Sherard mistrusted early eighteenth-century Oxford) and before they were completed he died (1728). A dispute arose between his executors and the University which dragged on for years, until it was finally settled by an award of Chancery on June 11, 1734. By it the University got the £3,000, the library and collections, and Dillenius became the first Sherardian professor. The University on its part erected the buildings, guaranteed £150 per annum for upkeep of the Garden and appointed a Perpetual Committee, consisting of the vice-chancellor, the proctors, and seven senior resident members on the "Physic Line" to see that the provisions of the award were carried out. The Royal College of Physicians was made visitor.

It is from this award in Chancery that the curators have derived their authority, and it would again become operative should the University at any time cease to maintain the Sherard collections under the custody of the Sherardian professor.

* Substance of an article in the *Oxford Magazine* of March 11, 1943.

It is clear from the early minute book preserved in the archives of the Department that the Perpetual Committee took its duties lightly. It met once a year (with occasional omissions) to approve the accounts and appoint a head gardener. By the beginning of the nineteenth century the Garden had again fallen into a bad state. Its revival owes much to the energy and liberality of Daubeney, Sherardian professor during 1834-67. During his tenure of office the existing range of greenhouses took shape.

In course of time the importance of the Garden as a source of materia medica became less, and its value as part of the University's equipment for the wider study of botany increased. Members of the medical faculty, as such, had less interest in the Garden, and the constitution of the Perpetual Committee was changed (1871). In 1886 an order of the Court of Chancery established a Board of six elected curators, who were given the management of the Garden under the scheme drawn up in 1734. But the same scheme had given the Sherardian professor control of the garden, as is recognized in the statutes defining his duties! Obviously there was need for clarification.

The new Statute, just adopted, makes the professor (at present, Prof. T. G. B. Osborn), *ex officio* a member of the Board of Curators and confirms his duties of 'charge and supervision'. The constitution of the Board remains otherwise unaltered, and the Board as a whole is responsible for the general policy and upkeep of the Garden from the funds which it receives.

In June, 1942, Mr. W. G. Baker, who had been head gardener for more than fifty years, retired, and by good fortune the curators secured the services of Mr. G. W. Robinson, formerly superintendent of Chelsea Physic Garden, to succeed him. With his skill and experience the Garden should thrive and develop.

If by further good fortune some graduate of Oxford should be moved to give to the Oxford Garden only a part of what Cory recently bequeathed to the younger Botanic Garden at Cambridge (see *NATURE* of March 20, p. 328), then indeed the future of the oldest botanic garden in Great Britain would be assured.

ASPECTS OF PHOTOMICROGRAPHY

A SYMPOSIUM on photomicrography was arranged by the Scientific and Technical Group of the Royal Photographic Society and took place at the Society's premises on the afternoon of February 20.

Mr. F. Martin Duncan opened the symposium with a general description of the applications of photomicrography to biological research. He stressed that much good work may be done by means of comparatively simple home-made apparatus. He illustrated the type of equipment he uses for low-, medium- and high-power photomicrography, and dealt with the particular requirements and difficulties of each branch in turn. For low-power work with living specimens a long-extension camera with a short-focus lens is used; it should be mounted on a rigid stand with the axis vertical. The need for rigidity increases with the magnification. For medium powers the camera is fitted to the end of a microscope tube, and for high-power work at a

thousand diameters or more a well-made box camera can be used. For critical work, centring the microscope is most important. Not only should a centring substage condenser be used, but it is also advisable that each objective should be capable of being centred with respect to the remaining lenses in the optical system of the microscope. Most of the double and triple nosepieces sold give unsatisfactory centring of the objectives and cannot be recommended.

Some slides were projected to demonstrate the correct use of filters and choice of negative material, showing the difference in rendering of tone and detail which may be attained by such means. Infra-red technique can sometimes be used with advantage to reveal fine detail in structures that appear dark and opaque in ordinary light. Examples were shown of certain coal specimens, beetles and fleas. In one case the infra-red photograph revealed the presence of some minute parasites on the fleas themselves. The paper was illustrated throughout by a large number of photomicrographs of various subjects of general interest.

Dr. V. G. W. Harrison said that in investigating alloys one of the first tasks is to establish, at all events approximately, the constitution diagram of the system. The means available include the determination of arrest points on cooling curves, thermal dilation curves, magnetic permeability curves, X-ray analysis and photomicrography. None of these is infallible alone, but taken together they are a powerful combination. Dr. Harrison said that his own work has been devoted mainly to the metallography of nickel-iron alloys, which are particularly interesting because the meteoric nickel-irons have a peculiar structure which cannot be reproduced under terrestrial conditions.

Metal specimens can rarely be cut so thin that they transmit light; thus they usually have to be examined under vertical illumination. A specimen is first cut with a hacksaw; one face is filed flat and then rubbed down on successively finer grades of emery. The aim is to finish with a plane mirror-like surface free from scratches and flow marks. There is no royal road to this; care and patience are more important than the exact materials used. The finer grades of commercial emery paper are, however, of little use on account of the grit in them, and better results are obtained by grading 'flour' emery powder oneself and using it wet on an ordinary cork household knife-board. The final polishing is done on a rotating cloth-covered wheel fed with a suspension of a polishing material such as rouge or alumina; chromic oxide gives good results. The surface so prepared is not characteristic of the alloy since it has undergone a certain amount of cold working, and to reveal the true structure of the alloy this layer has to be removed. This is usually accomplished by etching. The etchant used varies according to the chemical nature and physical state of the alloy and the constituents or structure which it is particularly desired to examine. For 10 per cent nickel nickel-iron alloys, 5 per cent nitric acid in water is suitable for most purposes. The depth of etching has to be learnt by experience. Too little etching fails to remove the cold-worked layer and gives poor contrast; too much etching throws the structure into relief and makes focusing difficult in high-power work.

When examined by vertical illumination, constituents that are little attacked by the etchant retain their mirror-like surface and appear bright; the others are dark. Photographically, the images may

usually be treated as black-and-white subjects; nothing looks worse than a section represented in the print by pale washy greys and dirty whites. For this work a medium-speed orthochromatic plate which will stand development to high contrast without fogging is generally suitable. Most of the photographs were taken with apochromatic objectives and light filtered through a blue 'narrow band' filter.

Slides were shown to illustrate some of the changes in structure which occur when natural and artificial nickel-iron alloys are subjected to heat treatment, and it was explained briefly how these visible changes can be correlated with changes in physical properties due to phase changes within the alloy.

Dr. L. C. Martin continued the symposium with an account of the optics of photomicrography. Photomicrography at low magnifications with a field of, say, 18° requires a lens of 'photographic' type, for example, of 2 in. focal length and 'aperture' $F/4.5$. Such a lens may be used for magnifications up to about 35 diameters, if long working distances are no drawback. Ordinary microscope objectives may also be used. The field is then restricted to 6° – 8° , but the aperture may be greater and the definition better. For magnifications of 20 and upwards it is convenient to use a compound microscope. A well-made projection eyepiece does not cause any deterioration in the image yielded by the objective, at least in the centre of the field.

The magnification to be employed depends upon the fineness of detail and the circumstances in which the print is to be viewed. The separation of fine lines such as pearlite will be apparent at a distance between them of 0.2 mm., but this can be brought up to 1.0 mm. with advantage: this entails a magnification of 1,600–3,000 diameters. In general, to show the greatest amount of detail the magnification should be about a thousand times the numerical aperture of the objective. Magnifications higher than this will not reveal fresh detail; the use of lower magnifications may mean that some details escape observation. Greater numerical aperture means better illumination and more detail; but also a more restricted field of good definition and less depth of focus, which is a disadvantage when thick sections are being examined. For routine work it is a good plan to use no greater numerical aperture than is necessary.

Much depends upon the illumination of the object. A great variety of arrangement is possible for opaque objects. For transparent objects, both dark ground and ordinary bright field illumination may be employed. Dark-ground pictures are attractive but more difficult to interpret than those taken with the light field. If the object to be viewed by transmitted light is a narrow opaque strip, the sharpest picture of the boundaries may be obtained in two ways. One can use a broad source of light, such as a window or opal lamp. The disadvantages of this are that the illumination may not be intense enough for photomicrography, and stray light may spoil the image. The latter may be avoided by using a diaphragm. Alternatively, a lens system is made to form an image of the effective source of light in the plane of the object. The angle of convergence of the rays produced by the lens must be as great as the divergence required to fill the aperture of the objective. Dr. Martin then described two optical expedients suitable for cases in which the size of the image of the source is not sufficient to illuminate the required area of the object slide. He stressed that one should never let more light into the system than is required

for the illumination of the minimum necessary area of the object field and for filling the aperture of the objective. In order to control the light, the source and lenses must be correctly aligned.

For transparent objects, when the visibility is due merely to a change of refractive index, the boundary of change may appear dark in the picture unless the aperture of the condenser is reduced. Usually a reduction of the illuminated aperture of the objective to a diameter of about two thirds the full amount is suitable.

Mr. F. J. Pittock concluded the symposium by dealing with the practical application of colour filters to the recording of the image of microscopic specimens by transmitted light. The use of colour filters must take into account not only the colour of the microscopical preparation, but also the relative densities of regions of the same preparation. In the days before the introduction of panchromatic material, the illuminants used were of great intensity and a cooling bath containing a coloured solution had to be introduced to absorb the heat and reduce the brilliance of the light. Other dimming devices were ground glass and 'signal green' glass. It has been known for many years that the resolving power of objectives is much increased if blue or green monochromatic light is used.

Though neutral density filters of colloidal carbon or silver grain cannot be classed as colour filters, they should form part of the equipment of all photomicrographers. Two filters, reducing the intensity one tenth and one hundredth respectively, are recommended for general purposes. There are two reasons for the employment of colour filters proper: first, the resolution is often improved by the use of approximately monochromatic light; secondly, it is usually important that the photomicrograph should show certain areas with greater contrast than is given by differential staining or the density or texture of the material under consideration. By using monochromatic light, chromatic aberration of the lenses is eliminated.

Mr. Pittock exhibited photomicrographs of the developing eye of a pig embryo stained with borax-carmin. On an ordinary plate without filter, the screen sharpness was never faithfully reproduced, whatever the quality of the objective. Exposures on orthochromatic process and panchromatic process plates showed progressive improvement. The introduction of a green filter gave further improvement, and the best result was obtained with the combination of green filter and panchromatic plate. The speed of the plate is generally of little consequence, and a slow plate is therefore preferred because of its superior resolving power.

The question of what is meant by 'contrast' in photomicrography is difficult to answer. Generally, some less important detail has to be suppressed by the use of appropriate filters to give clearer expression to the points of main interest. That is, contrast is reduced in one region and increased in another. If specimens are transparent, this fact should be obvious in the photomicrograph; it is undesirable to give the effect of an opaque mass without internal detail against a white background. Mr. Pittock showed photomicrographs of a section of spruce fir stained green and counterstained red, and explained the difference in appearance produced by the use of blue-green and orange-red filters respectively. The best filters for use with some well-known stains and counterstains were next discussed.

Certain structures are commonly revealed in sections after impregnation with silver salts followed by weak development in a reducing solution. Specimens so made are dark brown or black in colour, semi-opaque and need an orange filter, or even infra-red technique. It is not generally realized that silver-impregnated specimens are amenable to further treatment by any of the colour toning methods recommended for lantern slide-making, with an appreciable increase in transparency.

When objectives giving the utmost resolving power at high magnifications are used to reveal the fine cytological detail of stained sections, the best results are obtained with blue-violet filters and ordinary or ortho-process plates. This was demonstrated by photomicrographs of the pituitary body by yellow-green and by blue light. Mr. Pittock concluded by giving some technical details of the exposure and development of the various photographic plates used.

The papers presented at the symposium will be published in due course in the *Photographic Journal*.
V. G. W. HARRISON.

A GRAIN-BORNE DISEASE OF BARLEY

THE incorporation of barley in bread as a war-time expedient gives added interest to a recent study of the host-parasite relationships of this cereal and *Helminthosporium sativum* P., K. and B. (Mead, H. W., *Canad. J. Res.*, 20, 501; 1942).

Infected barley grains usually show a pale to dark brown discoloration of the adhering lemma and palea. The cells of the host react to penetration by the formation of callosities, and those invaded, either singly or in groups, die and become discoloured, although hyphae may also be present without discoloration. Hyphae may also be present in the cells of the pericarp, and thick-walled resting mycelium may be found on the surface of the tissues or in the intercellular spaces. Many samples have been observed to contain as high as 38 per cent blighted kernels. When the grain is planted the mycelium renews its growth and may infect other cells or form conidiophores. Although mycelium from infected grains may spread through the soil for as much as 2.5 cm., this probably plays little or no part in the infection of seedlings.

At germination, the plumule and the radicle are in contact with the lemma, palea, lodicules and pericarp, any or all of which may be diseased, with the result that infection of the seedling often occurs at the base of the plumule and the radicle. Seedlings usually reach a degree of development because the fungus takes some little time to penetrate to the growing point.

Inoculation of the heads at or immediately after flowering results in the death of the ovaries or the production of only small grains with non-viable embryos. Hyphae may be found as deep as the cells of the inner layer of the pericarp, but they do not seem to penetrate beyond this. Infection 7-10 days after flowering leads to the invasion of the pericarp tissues and the production of shrunken and discoloured kernels, although as microtome sections show, the inner integument, aleurone layer, endosperm and embryo are free from mycelium. Infection 15-20 days after flowering results in the invasion of the lemma and palea, but the pericarp has mycelium