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Wigtown (74). Near Portpatrick, one clump, in 1912.

Lanark (77). Near Kirkfieldbank, plentiful; at Stonebyres, a few.

Peebles (78). In several places near Romanno Bridge; near Broomlee; at and near Slipperfield Loch; several.

Selkirk (79). Near Ashiesteel, one clump, in 1911.

East Lothian (82). Near North Berwick; near East Linton; several.

Midlothian (83). Braid Hills; west of Colinton; Comiston; in fields at Almondbank; by the river at Cramond; at Marchbank; at Bavelaw; in Firth grounds; at Slateford in 1906 and 1913; several in each; and near Gilmerton in immense quantities—the plants, over five feet in height, at one place covering about thirty square yards, at another extending for two hundred yards in an almost continuous strip between two fields.

West Lothian (84). At Carlowrie; west of South Queensferry; two or three.

Fife (85). Near Kilconquhar, plentiful.

East Perth (89). By the Tay below Perth; near Blair Atholl; several.

PHOTOMICROGRAPHY AS APPLIED TO TIMBER STUDY.

By W. S. JONES, M.A., M.Sc. (Plate XIII.)

(Read 12th March 1914.)

Those who have had some experience in the study of the minute structure of timber know all too well the many difficulties of representing by drawing the complex anatomy of dicotyledonous timbers. These difficulties are, without doubt, best overcome by invoking the aid of the camera, and yet how seldom is the art of photography practised in relation to the study of timber structure! Besides being a convenient method of illustration, it is, above all, accurate, entirely eliminating, as it does, the personal element. Imagining the work to be such as can only be conducted in well-equipped laboratories, students leave our colleges for work in forest areas in the colonies and elsewhere deprived of one of the greatest helps in the field of timber

study. Tutors, too, are prone to regard photomicrography as an expensive and tedious business, and are therefore inclined to shun the art. Notwithstanding the prevailing ideas, photomicrography as applied to timber work is an absorbingly interesting and edifying occupation, and withal simple and easily mastered. Writers on the subject are apt to magnify the difficulties and to complicate the apparatus necessary for successful work, thus making the expense, if one accept their estimates, almost prohibitive. Little wonder, then, that few private individuals possess a photomicrographic outfit. Indeed, comparatively few laboratories have such an outfit among their equipment, and where such exists it is often unnecessarily complicated and expensive.

It is with a view to removing some of the misapprehensions regarding this important phase of photography, and to affording simple guidance to those who may require it, that this short article is written.

A comparatively simple, inexpensive apparatus is all that is required, and with it several excellent negatives can be got in an evening. The necessary skill in manipulation is very soon acquired even by those who have no previous knowledge of photography. Neither expense nor difficulty should deter anyone. These observations the writer confidently makes as the result of a fairly wide experience of a simple outfit capable of very good work, and he makes no apology for describing the methods and apparatus which he has for a long time employed.

Preparation of the Timber to be examined.—The timber whose structure it is proposed to study is cut up into convenient cubes and boiled in water for about half an hour. This operation drives out air and softens the blocks. The cubes are then immersed in a mixture of equal parts of glycerine and alcohol. The timber is thus rendered more amenable to further treatment.

Preparation of Sections.—Microtomes specially made for cutting wood sections are very expensive, and for most purposes are unnecessary. Good sections can usually be got without incurring great expense by the use of a suitable hand microtome. The writer uses a microtome which requires the embedding of the material in paraffin

wax. It is desirable, prior to inserting the wax cylinder into the well of the microtome, to make a shallow longitudinal groove in the wax so as to allow the escape of air as the embedded material is pushed in. A further precaution is necessary with this form of microtome. The wax round the upper end of the material should be carefully removed with a sharp knife, at least from the near side (*i.e.* the side which first confronts the razor) of the block. In order to secure good resistance to the razor, the wax on the far side can be advantageously left intact. Other forms of cheap microtomes requiring only the clamping of the wood cubes in position can also be effectively used.

The sections are first placed in strong alcohol in a watchglass, which is then held, by means of a pair of forceps, over the naked flame of a small spirit lamp until the alcohol nearly reaches its boiling point. The air in the section is by this treatment entirely and quickly expelled. Much time is saved by the heating, while the hot alcohol also often removes much of the colouring matter and other substances from the tissues. The sections are then transferred to a watchglass containing pure lactic acid, and held, as before, over a naked flame until bubbles begin to form in the liquid, when the watchglass and contents are removed. Lactic acid, though very seldom used, is a valuable reagent, and, besides having the effect of clearing the sections somewhat, it improves their condition after treatment with strong alcohol. Should the timber be very highly coloured it may, perhaps, be necessary to use some other clearing reagent at the outset, although it may be added that even in such cases alcohol and lactic acid generally suffice.

Staining.—The sections are, after treatment with the acid, transferred to a watchglass containing carboic fuchsin (Ziehl's formula. See Lee's "Microtometist's Vade-Mecum"), where they remain only for a short time. This stain is one of the simplest to use, and one of the most efficient for the purpose of photography. The best strength of fuchsin will be readily ascertained by a few trials. If necessary, add a little dilute alcohol. The sections when stained sufficiently require two or three successive washings in

50 per cent. glycerine. The fuchsin occupying the lumina is thus washed out, and with careful manipulation only the cell-walls are stained.

Mounting of Sections.—After washing, the sections are mounted on a slide in 50 per cent. glycerine, the coverglass being sealed with an easily prepared mixture of equal quantities of gum mastic and paraffin wax (see "The New Phytologist," March 1911). This is a convenient substance for sealing, being very simply applied by means of a slightly heated bent nail mounted in cork. The sections will keep for any length of time, but should there be any conceivable reason for remounting a section the sealing substance can be readily removed.

These operations, apart from the sectioning, although appearing somewhat elaborate, are quickly executed and occupy in all only a few minutes. Moreover, several sections can be treated at the same time.

Microscope.—The magnification desirable for photographing sections of broad-leaved timbers is not usually high. One of from 25 to 120 diameters is generally ample. It is not necessary to possess an elaborate microscope with apochromatic lenses, the ordinary, upright, student's microscope with modern achromatic lenses being all that is required for ordinary work.

Illuminant.—Ordinary coal gas is the most convenient for most workers, and this is quite a satisfactory source of light. A suitable, incandescent, table lamp should be purchased and connected by means of rubber tubing with a gas bracket in the wall or on the bench (Flatters & Garnett manufacture a very convenient inverted lamp with removable chimney). A bull's-eye ($2\frac{5}{8}$ -inch lens) mounted in a ball-and-socket stand should be placed near the lamp, and between it and the microscope, so as to throw the light on to the concave side of the mirror of the latter. The position of the bull's-eye should be so adjusted as to throw the best light on to the mirror, the chimney of the lamp if necessary being removed.

Camera and Accessories.—The writer uses a Browning "Microkam" (lantern size), which he has modified as described below. As the modification adds vastly to the utility of the camera, it is quite worth the few shillings

spent on it. The "Microkam" as sold consists of a well-made, rigid, wooden box, fitted with a hinged dark shutter, and grooved at one end to take the dark slide and focusing screen provided. At the other end is a projecting nozzle intended to fit *into* the microscope tube, but such an arrangement necessitates the removal of the eyepiece, and this greatly reduces the magnification. It is to overcome this drawback that the following modification is desirable (see fig. 1). A short length of thick brass tubing, the outside diameter of which is slightly greater than the milled head of the eyepiece, is fitted to form a collar round the upper end of the microscope tube. The nozzle of the camera must be removed and replaced by another whose internal diameter exactly corresponds to the external diameter of the brass collar fixed to the microscope. By this means the camera can be attached to the microscope without the removal of the eyepiece. This is a great advantage, for the use of the eyepiece obviously ensures a much higher magnification, and compensates for the absence of an extension bellows, while the modification in the camera does not preclude the possibility of working, if desirable, without the eyepiece. It is an advantage to use a screen of ground glass to secure even illumination. A piece the size of a lantern plate answers admirably. It can be fixed underneath the stage by means of an india-rubber band if there be no substage condenser in the way. If the ground glass cannot be so fixed, the screen can be placed with the ground surface downwards on the stage itself. There is little danger of the uneven surface of the glass coming into focus with the section. It is always a safe, and indeed where no eyepiece is used a necessary, procedure to dull the inner surface of the microscope tube by inserting a lining of velvet. To ensure the rigidity of the lining, the velvet is mounted on stiff but flexible paper and rolled into a tube which just fits the microscope tube. The paper, tending, as it does, to unroll, keeps the lining, which, unmounted, would obtrude itself into the field of view, closely applied to the inner surface of the microscope tube. As the camera is firmly attached to the microscope the effect of vibrations is minimised, since the camera and microscope vibrate together. The plates the writer

generally uses are the "Royal Standard" plates by Cadett & Neall.

Exposure.—The slide, when ready, is placed on the stage and the microscope focussed. Great care must be taken to adjust the mirror of the microscope so that the field is perfectly uniformly illuminated; for unless this be carefully done the results will be disappointing. The required portion of the section having been selected, the camera is fixed to the microscope, and the focussing, ground-glass screen placed in position. It will now be found necessary to re-focus so as to have a clear image of the section on the focussing screen. This done, the shutter of the camera is closed, the dark slide slipped into position, and the exposure made. The exposure should, for moderately low magnification, last from two to five minutes, according to circumstances, such as the transparency of the section, intensity of the light, and so on. Immediately the time of exposure has expired, and before closing the dark slide, quickly but gently close down the shutter of the camera. Then push in the sliding face of the dark slide while the latter is still in position. Any modifications necessary to meet special circumstances can, with a little practice, be easily devised.

Developing, Fixing, and Printing.—These operations being precisely the same as in the case of ordinary photography, the reader is referred for guidance to one of the many cheap books now available on the subject. Suffice it to say that, when printing, the part of the negative not required for reproduction should be masked off. Masks are sold by all dealers in photographic requisites in the following two forms: (1) Those which are already cut to shape, and (2) those which can be easily cut into any shape and size. A curved pair of scissors is very useful for cutting circular masks. The mask, when cut into shape, should be stuck on by one corner to the film side of the negative. By this means any number of precisely similar prints can be obtained.

Cost of Apparatus.—All that is absolutely necessary by way of apparatus is included in the following list, with approximate prices appended:—

"Flatters" Microtome . . .	£2 10 0
Knife	0 4 3
Six Imbedding Tubes . . .	0 2 6
Lamp	0 14 6
Bull's-eye	0 11 6
Microscope	7 10 0
Camera, with nozzle, ¹ screen, and dark slide	1 15 0
Total	£13 7 9
Modification, if adopted, about . .	0 5 0

A few inexpensive accessories would obviously be advantageous, but these could be purchased as the work developed.

EXPLANATION OF PLATE.

Fig. 1. Section of camera and microscope showing the modification described in the text. C, camera; S, shutter; E, eyepiece; N, new nozzle; B, brass collar; M, microscope tube.

Fig. 2 shows the general arrangement of the light, bull's-eye, microscope, and camera.

Fig. 3. Photomicrograph, taken with the apparatus described, of cross-section of stem of *Artocarpus integrifolia*, Linn. f.

ADDITIONAL MOSSES FROM WEST ROSS-SHIRE. By JAMES STIRTON, M.D.

(Read 9th April 1914.)

During the last seven years I have spent considerable periods in various parts of the Western Highlands and Islands, mainly for the purpose of investigating the moss-flora of these otherwise attractive regions. Some time previous to this I had become, through correspondence, interested in parts of the east coast of North America under nearly the same latitude as Great Britain. Even at an early stage of this correspondence I was obliged to confess, in spite of adverse criticism, that there were curious similarities in certain divisions of the cryptogamic botany of these opposite shores and, more recently, that there were

¹ Without nozzle the price is £1, 11s. 6d.

FIG. 1.

FIG. 2.

FIG. 3.