Notes on Museum-Methods in use at the Royal Botanic Garden, Edinburgh.

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With Plate III.

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INTRODUCTORY.

It has been the practice in preparing specimens for the Museum of the Royal Botanic Garden, Edinburgh, to endeavour to preserve as naturally as possible the form of the specimen, and to name, where such a course seemed to add to the educational value of the exhibit, the different organs and parts of the specimen. The object has been to facilitate a comparison by students of the specimens exhibited, with the descriptions in text-books and lecture-notes.

A specimen so prepared was exhibited at a meeting of the British Association in 1896, and again in 1901 at a meeting of the same Association some notes on the subject were submitted. Requests have since been received for fuller details; these and the frequent enquiries made by visitors to the Museum for information concerning the preservation of plants for exhibition in museums have prompted the following descriptions of the methods employed.

PRESERVING.

I. General.

In the process of preserving, two stages are to be distinguished —first, killing the plant; second, its subsequent permanent preservation. The method adopted for the latter stage is commonly made to accomplish the former also; the preservative at the same time kills. The two operations may, however, be separate and distinct, but in practice, with some few exceptions, it is not found an advantage to separate the killing and preserving processes, provided always that the preservative kills fairly quickly.

Any method which inhibits the action of putrefactive organisms will, in the simplest sense, preserve plant-structures. A preservative may, moreover, while preventing the grosser changes of

putrefaction, arrest also, to a certain extent, intrinsic decompositions following death. A preservative may alter also, harden, and render firm, or it may be render more soft, the consistency of the plant-tissues.

Upon the prevention of internal changes rests the retention of the natural colours, or, if these be destroyed, the prevention of the formation of discolouring products, while hardening, if it takes place before characters of form have been destroyed, fixes such characters permanently.

The hardening may be due to desiccation either in the air, as happens when specimens are dried, or by the dehydrating action of a liquid medium, or it may result from chemical changes in the plant-substances induced by the preserving medium employed.

Reviewing the results of many experiments, it is impossible to say of any one preserving method that it is the best; the choice of a method must rest not only upon a consideration of the general character of the specimen, but upon a consideration also of any special feature or character the preservation of which may be particularly desired. The separation of such characters into characters of colour and characters of form coincides with the separation of the methods of preserving into two groups—preserving by drying the specimen, and preserving by means of liquid preserving media,

Drying the plant has proved the only method at all satisfactory for preserving the colours of plants, but fails commonly when applied to the preservation of the natural form. Liquid preservatives are invaluable for the preservation of the form of plants, but their use involves a sacrifice of the natural colours.

Again, as preservatives of the form of plants all liquid media are not equally useful, and it is necessary to distinguish those preserving only the form and shape of the separate parts from those preserving also the relationships of the parts to one another. Expressed concretely, the separate leaves on a twig, their shape, substance, and form, may be well preserved in a given medium, but unless there is also preserved the correct angle at which the leaves stand out from the stem and their relationships to one another in leaf-symmetry, then the preservation of the form of the specimen is of a limited kind.

One has to distinguish, then, the preservation of the form of the parts and the preservation of the lie of the organs of the plant.[1]

II. Methods.

The following is a convenient grouping of the methods of preserving here referred to :—

A. *In liquid media.*

1. ALCOHOLIC SOLUTIONS.

a. Alcohol 90 per cent.
b. Alcohol, 50 to 80 per cent.
c. Alcohol and Glycerine.
d. Synthol.

2. AQUEOUS SOLUTIONS.

a. Formaline.
b. Boric Acid.
c. Camphor-water.
d. Salicylic Acid.
e. Fluorides of Sodium.

B. *By drying.*

1. In Air.
2. In Sand.

I will deal with each of these separately:—

Of the alcoholic solutions, 90 per cent. alcohol is the one generally used, and of the aqueous, formaline. The other solutions referred to are some of the less-known preservatives which have occasionally proved useful.

[1] What we in Edinburgh have been in the habit of calling the "lie" of the organs has been termed by Professor Errera, in his report on experiments made at the Institute de Botanique, Brussels, "the attitude" of the specimen. In most of the literature of the subject when a medium is described as preserving well the natural form, the shape of the separate organs is only referred to.

A. PRESERVING IN LIQUID MEDIA.

1. ALCOHOLIC SOLUTIONS.

a. Alcohol 90 per cent.

The alcohol commonly used is strong commercial methylated spirit about 90 per cent. and free from mineral naphtha. As obtained it is somewhat turbid and commonly of a slight brownish colour, and I find that specimens are stained if the preservative is used in this crude state. To prevent this, before being used the alcohol is rendered clear by distillation. The strength of the alcohol in the process is slightly raised, and varies after distillation from 91 to 95 per cent.

Such strong alcohol, perfectly clear, has been found to give by far the best results. It penetrates the tissues rapidly, quickly kills the protoplasm, and very readily hardens, the hardening being due to dehydration. As with other media, the usefulness varies with the class of specimen to be preserved.

Class I.—Herbaceous Structures.

For herbaceous structures generally, leaves, tendrils, and nearly all flowers, alcohol proves of great value, but particularly so where the lie and symmetry of the organs as well as their shape and firmness are controlled by the turgescence of parenchyma-cells rather than by special strengthening tissues. Specimens of the kind killed and preserved in any of the aqueous media become flaccid and soft, and although the separate organs may retain their form, the relationships of the parts are not preserved. Killed in alcohol or by other methods and subsequently preserved in an aqueous medium the results are similar, but killed and also preserved in alcohol such specimens retain permanently the natural shape of the parts and the relationships of symmetry.

Not an unimportant factor in these results is the readiness with which alcohol wets the surface of the specimen, removing from surface-irregularities air, which, if allowed to remain, would interfere with the ready penetration of the medium. More important is its low specific gravity and its power of rapidly dehydrating. Placed in alcohol the specimen as a rule very slowly sinks: it is slightly heavier than the medium. This being so, the

loss of turgescence gradual, and the hardening of the specimen quick, little change of position of the organs results. Whereas when a specimen is placed in an aqueous medium it is from the first evident that the buoyancy of the parts tends greatly to distort its form.

Method of Procedure. — The specimen when gathered is immersed in the preservative before the least flagging or withering occurs. In many cases it is found necessary to carry the jar with the alcohol into the garden or plant-house, and to drop at once the specimen, as it is gathered, into the preservative. In the alcohol the specimen commonly as already stated slowly sinks, but if large quantities of air are present in the tissues it may at first float or only partially sink. It is undesirable that any part of the specimen should be left uncovered, and when the specimen does not of itself sink readily, either a small weight is attached to it by a silk thread to sink it, or it is fastened in some way to the glass support on which it is finally to be mounted and is thus held immersed.

The time taken to effect the hardening varies with the size and character of the specimen. With small specimens a few minutes will suffice; with others several hours will be required; but in all cases when once immersed the specimen should not be removed until it is completely hardened.

As the alcohol enters, the air present in the tissues is driven out, and any colouring substances present are at same time discharged and diffuse in the surrounding fluid. Chlorophyll if present is thus extracted as well as the colours of most flowers, the blue colour of some alone, being to a certain extent retained.

That the bleaching may prove satisfactory the jar containing the specimen is left in a position exposed to strong sunlight, which is most effective, aiding the discharge of the colouring substances and preventing the formation of discolouring decomposition-products, when the specimen is subjected to its action immediately after being immersed in the alcohol.

In the majority of cases chlorophyll is the colour-substance principally discharged. The chlorophyll-solution thus produced, if left exposed to sunlight, decomposes, and the spirit becomes almost clear, but it proves advantage, if well-bleached specimens are desired, to pour off this chlorophyll-solution as soon as the

specimen is properly hardened, and to substitute for it fresh clear spirit. This fresh spirit may become discoloured also, and so from time to time clear spirit must be substituted for that discoloured until a discharge of discolouring substances no longer takes place. The specimen, if then white, is ready for mounting ; if it be dark-coloured and a bleached specimen is required it is treated in one of the ways described below under Bleaching (p. 230).

Class II.—Woody Objects.

Specimens of this kind appear to be equally well preserved in alcohol or in formaline, so that the choice of a preservative rests chiefly upon a consideration of the ultimate method of exhibition. If photoxylin is to be employed in the final mounting, alcohol is used ; if gelatine, then formaline is the preservative chosen.

Class III.—Succulent Objects.

When the object to be preserved is bulky and contains relatively large quantities of water the dehydrating action of alcohol becomes a disadvantage. The quantity of water to be absorbed may be considerable, and its diffusion in the enveloping alcohol being comparatively slow, the specimen may come to be surrounded by an alcoholic solution of low percentage—too weak at first to have any hardening action on the tissues. The absorption of water from the specimen proceeding faster than the process of replacement by the alcohol, the unhardened external portions collapse and the specimen becomes wrinkled on the surface. If succulent specimens are to be preserved in alcohol they must first of all be placed in a weak solution (30 per cent.) and then slowly graded from this to alcohols of greater strength.

Sections of succulent fruits, and even of flowers and other specimens coming under Class I., contract somewhat on the cut surface, the amount of contraction varying with the area of cut surface and with the degree of succulence of the specimen. The curvatures that result may be counteracted if the section is kept flat between two pieces of glass. The section freshly cut is laid upon one piece of glass, a second piece is placed over it,

and the two are then firmly tied together with thin twine. The pieces of glass with the specimen thus secured between them are placed in the preservative and are allowed to remain there undisturbed until the specimen is completely hardened.

Alcohol being extremely volatile, it must always be kept in well sealed jars if its strength as a preservative is to be maintained. Regarding the one disadvantage attaching to its use—viz., the destruction of the natural colours—a compensating feature exists in the readiness with which it bleaches white the majority of specimens. Such bleaching, if the form of the specimen is well preserved, is perhaps more to be desired than the temporary or imperfect retention of colour to be secured in some cases by the use of formaline.

b. Alcohol.—80 per cent., 70 per cent., 60 per cent.

The lower percentages of alcohol are prepared by mixing with water the requisite amount of 90 per cent. alcohol after distillation.

The objection urged against aqueous media that they do not harden delicate specimens applies also to weak alcohol.

Experiments made with alcohols of varying degrees of strength go to show that while the weaker percentages may be employed with some success in preserving certain plants they possess even for these, with the exception of succulent specimens coming under Class III., no advantages over the 90 per cent. alcohol. For the great majority of specimens the weaker alcohol proves unsatisfactory, and the results of experiments with it show that where it is desirable to fix in the best manner possible the natural lie of the parts of a specimen it is not safe to employ alcohol of less strength than 90 per cent.

70 per cent. and 80 per cent. alcohols are useful, however, for the firmer and more woody specimens of Class II., while 50 per cent. alcohol or even 30 per cent. is valuable as a commencing medium for the more succulent specimens.

c. Alcohol and Glycerine—90 per cent. Alcohol 50 c.c., and Glycerine 50 c.c.

This has proved useful for the temporary preservation of material before dissection when the 90 per cent. alcohol alone would have made the material too brittle.

For softening material already hardened it is to be preferred generally to the 50 per cent. water-solution often employed for the purpose. The glycerine tends to keep the material pliable without exerting the macerating action that water under similar circumstances with delicate specimens is inclined to do.

It has been employed with some success for succulent specimens causing less contraction in such than alcohol does alone. For this purpose the following formula is used :—

90 per cent. Alcohol, . .	50 c.c.
Water, ...	50 c.c.
Glycerine, ...	50 c.c.

d. Synthol.

Recently an alcoholic preparation called synthol has been recommended as a preservative for museum purposes.

It is claimed for it that it is a perfect substitute for absolute alcohol, and that it is an excellent dehydrating agent and a preservative of the first order.

From experiments I have made with it absolute synthol appears to act efficiently as a substitute for absolute alcohol.

For museum purposes, used undiluted, it penetrates and hardens delicate tissues rapidly and at the same time bleaches them as effectively as strong methylated alcohol. Diluted with water its action is less rapid, while the weaker percentages, as with alcohol proper, fail to harden. Photoxylin can be used with it as a mounting medium, but gelatine contracts and becomes opaque.

2. AQUEOUS SOLUTIONS.

a. Formalin.

Formol, formalin, formaline are commercial names for a 40 per cent. solution in water of formaldehyde, CH_2O. As a preservative the commercial preparation is used undiluted, or diluted with water to whatever extent required. The solutions which have been found most useful are—formalin 10 parts, water 90 parts ; and formalin 15 parts, water 85 parts. Weaker solutions have been tried, but with them moulds in nearly all cases make their appearance on the surface of the fluid. The weaker solutions prove less reliable the larger the bulk of organic substance

to be preserved relative to the amount of fluid employed. A one per cent. solution will preserve plant-structures for a time, but ultimately moulds invade the preparation, and this happens relatively sooner if any part of the specimen be left exposed above the surface of the fluid. A point of importance is the deterioration of the fluid which in the course of time appears to a certain extent to take place. Formaldehyde gas is extremely volatile, and unless the jars containing the specimens are carefully sealed a weakening of the solution undoubtedly follows. From my experiments it appears that a deterioration may result—firstly, in consequence of the volatile nature of the formaldehyde gas, and secondly, as a result of changes and decompositions which it would seem take place in the presence of organic substances in the fluid itself. This being so, it is not surprising that the weaker solutions after a time permit the growth of moulds.

A note of interest in connection with the presence of acid substances in formalin is contributed by M. Trillat,[1] who points out that commercial formalin may contain as impurities acetic acid, formic acid, and pyroligneous products.

Formalin does not very readily wet the surface of plants, and penetration of the specimen by the liquid I have found to be in consequence comparatively slow. Until penetration is complete, and even for some time after, plants may retain to a certain extent their natural colours. The results of my experiments in this direction are as follows :—

Formalin for Preservation of Natural Colours.

The red, yellow, and blue colours of flowers are better retained than they are in most other media ; but the retention is not permanent. Red and yellow colours are retained longer than blue, but even red—the colour which has proved most permanent —ultimately fades or gives place to a brown if the jar containing the specimen is exposed to the light.

Formalin does not appear to extract chlorophyll, neither does it preserve the green colour, but exposed even to diffused light the chlorophyll is decomposed and the specimen assumes a dull brownish colour, or may, finally, be bleached quite white.

[1] Journ. de Pharm. (5), xxix., p. 537.

In the stronger solutions the fading of the colours is more rapid than in the weaker ; but, as already stated, the disadvantage of the weaker solutions is that they permit the growth of moulds. If formalin is added to sea-water and the specimens are protected from the light the colours of marine algæ are fairly well preserved. These results are in agreement with most of the observations recorded.

White flowers may remain uncoloured, becoming nevertheless, as the fluid penetrates, more or less translucent, as may happen also with coloured flowers and other specimens, or they turn a dull brown colour.

The specimens which show this discolouration are, as a rule, such as would darken if preserved in alcohol ; at the same time, according to Linsbauer,[1] *Lathræa squamaria, L.*, in formalin does not darken so badly as when it is preserved in alcohol, while, on the other hand, I find that specimens of some orchids which in alcohol brown only slightly become in formalin almost black. Formalin is used for many fungi, particularly the more succulent forms, and changes but little the colours of the darker and duller sorts.

Formalin for Preservation of Plant-form.

Formalin fails to preserve the form of many specimens chiefly because it does not harden. Reference has already been made to this defect and to the soft and flaccid character of specimens of Class I. preserved in it. In the weaker (2 per cent.) solutions there is a tendency on the part of the petals of fragile and of fully expanded flowers to drop off after being a short time in the preservative. For succulent plants it presents the advantage that when preserved in it they do not to any extent contract.

For gelatinous or mucilaginous specimens it is valuable, causing little of the contraction and opacity which follow the immersion of such specimens in alcohol. Gelatinous bodies are hardened, swelling or slightly contracting according to the amount of absorbed water originally present. It is advisable to avoid formalin if the specimen to be preserved be one coated in

[1] Verhandl. der K.-K. Zoolog.—Bot. Gesellschaft in Wien, xliv. (1894), Sitz., p. 23.

any way with resin, for I find that the resin is coagulated and that it forms in such cases a white or grey covering over the resinous parts.

Method of Procedure in using Formalin.

The density of the fluid makes it difficult to keep the specimen submerged, and methods such as were described for buoyant specimens in alcohol have usually to be resorted to.

Specimens with waxy coatings are before preservation in formalin immersed for a minute or two in strong alcohol to wet the surface. The alcohol is not allowed to enter the specimen or to act upon it sufficiently to cause contraction of the object; but if the surface be wetted in this way the specimen sinks more rapidly and the penetration of the formalin is facilitated.

Formalin as a Preservative in Collecting.

As a preserving medium for use on excursions and in collecting, the concentrated form in which it can be carried makes it convenient,[1] this particularly so when collecting algæ, where the concentrated formalin is added to the water—sea-water or fresh water according to the habitat of the alga—in the tubes in which the specimens are placed. At the same time, Penzig[2] points out that when collecting abroad it is not so good as alcohol, because with formalin the tin cases commonly employed in work of the kind cannot be used, but glass bottles, heavy and inconvenient in transport, have to be resorted to.

b. Boric Acid.

This is recommended by Chalon[3] as one of the best of a large number of fluids he has tried for preserving botanical specimens. The solution used was a saturated or 3 per cent. aqueous solution, which was improved in some instances by adding 1 to 5 per cent. sodium sulphate.

I find the specimens, as with formalin, become flaccid, particularly those of Class I. Colours remain for some time, but fade when the specimens are exposed to light. Penetration is not very rapid, and there is difficulty at first in getting the specimens

[1] Hornell, Laboratorium et Museum, 1900, pp. 85-89.

[2] Laboratorium et Museum, 1901, p. 19.

[3] Bull. Soc. Roy. Bot. de Belge, xxxvi., Part 2, p. 39.

submerged. For some specimens of Classes II. and III., some tubers and bulbs, it has given good results, and it has, as Chalon points out, the advantage of being practically harmless to work with.

c. Camphor-water.

This is recommended by Setchell and Osterhout[1] for preserving large collections of algæ for several hours if they cannot be studied at once.

The method is to throw on to the surface of the sea-water in which they are left some chips of camphor-gum, which, though sparingly soluble, has powerful antiseptic properties.

On several occasions when collecting sea-weeds, at times when the usual preservatives have not been available, I have found that a liberal use of camphor will prevent the encroachment of putrefactive organisms for a considerable time, but beyond this I have had no experience with camphor as a preservative in museum work.

d. Salicylic acid.

A saturated solution is employed at times, but the preservative is little resorted to, as the specimens become flaccid and soft and in some cases much macerated. Chlorophyll and most other colours are destroyed although the formulæ following have given fair results in the special instances mentioned.

1. For fruits—the amount of glycerine to vary with their relative juiciness :—[2]
   1 oz. salicylic acid.
   5 gallons of water.
   a little glycerine.
2. For dark-coloured grapes :—
   1 oz. salicylic acid.
   8 oz. alcohol.
   2 gallons of water.

e. Fluorides of Sodium.

The fluorides of sodium, sodium-fluoride and sodium-bifluoride have been recommended as preserving fluids for plants and

[1] Bot. Gaz., xxi., 1896, p. 142.
[2] Bailey, Rule-book, p. 187.

animals.[1] Marpmann[2] has recommended sodium-fluoride, 2, 3, and 5 per cent. solutions in water. The bifluoride is also recommended. It possesses greater antiseptic properties than the fluoride. "It is not, in dilute solutions, directly poisonous, and so is pleasanter to work with than formol or sublimate."

I have made experiments with a number of solutions. In all cases the colours of plants fade or are destroyed. The plants become soft and flaccid, and in solutions of less than 10 per cent. fungi may appear on the surface of the fluid, and on the submerged material also.

The corroding action of the bifluoride on glass, even of comparatively weak solutions, prohibits its use as a final preservative in glass vessels.

B. PRESERVING BY DRYING.

1. DRYING IN AIR.

The following are the methods employed in dealing with the different classes of material mentioned.

a. Specimens of branches and twigs which are too large to be preserved in a fluid medium are dried by hanging them in a dry room, or, if the specimen is not too large, it is placed in a ventilated box to protect it from dust, or sand is run around it and the specimen dried in sand (*see* Drying in sand). Where the leaves are known to fall readily after drying the specimen is placed for a few minutes in boiling water before the drying process is commenced.

b. Specimens of woods and the like. Logs of wood which are to be dried and afterwards sawn or prepared as specimens of woods are placed in any dry well ventilated store. The drying should be slow and the temperature even. It is not enough that the store should be warm; unless well ventilated, the wood is liable to rot; again, if the drying is too rapid, the cracks produced are considerable. The logs are laid on their sides, freely exposing both cut ends. Where it is wished to preserve the bark, the logs are laid upon straw or brown paper. To keep free from cracks any special part of the bark I have found it an advantage to make longitudinal incisions at other parts of the circumference.

[1] Merck's Annual Report for 1899, p. 21.

[2] Marpmann, Zeitschrift fur angewandte Mikroskopie, 1899, p. 33. Centralblatt fur Bakteriologie und Parasitenkunde, 1899, Vol. 25, p. 309.

Cracks resulting from shrinkage then follow the lines initiated by the knife. Care should be taken to guard against the attacks of insects. Destructive forms are sometimes present in the logs when they are brought to the museum, and these should be searched for before the specimens are stored.

All dry specimens should be frequently examined, and any showing tunnellings of beetles or their larvæ should be promptly dealt with. If small enough they should be completely immersed in a poison solution. If this is impracticable they should be bathed or painted with the solution until it penetrates the borings completely. A poison solution I have found effective is the following:—

Naphthalene, . .	50 grms.
Corrosive sublimate, .	5 grms.
Methylated alcohol, 90 per cent., . . .	1000 c.c.

Carbolic acid is sometimes added; an objection to its use is that it may stain the specimen somewhat.

c. Dry fruits, roots with mycorhizal coverings, wood attacked by fungi, fungi themselves—particularly the more hard and solid kinds—all dry fairly well. For the majority of these no special method is resorted to. They are suspended in a well ventilated room or are simply laid in an open or ventilated box until dry. Sometimes it is advisable to pin or otherwise fasten the parts in position to prevent warping while drying.

2. DRYING IN SAND.[1]

The method of drying in sand is followed in all cases where the preservation of the colours of flowers is of importance. Some flowers so dried retain their colour if protected from strong light, and certainly look well. Preservation of the form of the flower depends much on the skill of the operator. From the nature of the method considerable shrinkage takes place, and the process consequently is not adapted to the preservation of fleshy forms.

The method I have adopted is as follows:—

A cardboard or paper box, with folding sides is secured and

[1] Errera, Report of Brit. Ass. for Adv. Science, 1896, p. 685. Cornélis, Belgique horticole, 1880, p. 230.

the bottom covered with fine, clean, dry sand to the depth of about an inch. In this the flower to be preserved, from which previously all surface moisture has been removed, is adjusted by sticking the stalk in the sand and heaping the sand around, or in any way that best will facilitate the next operation. This consists of adding slowly more sand, building it up around the corolla, and pouring it into the centre of the flower and around the parts in such a way as not to alter the shape of the flower by the weight of the sand. This is continued until the flower is completely covered. The box is next placed over an ordinary sulphuric acid desiccator and the whole stood on a plate and under a glass bell-jar. The plate with the bell-jar is then placed on the hot-water pipes used for heating the building, or in an oven kept at a temperature of about 40° C. It is left undisturbed for a week or longer, when the box is taken out and the sand is carefully run off by folding down the sides. Considerable care must be exercised in handling flowers so dried, as they become extremely brittle. Any sand that adheres is removed by means of a soft brush or by letting sand fall in a gentle stream from some height upon the specimen. The falling grains, hitting those adhering to the specimen, dislodge them, but at the same time the height from which the sand falls should be adjusted so that the force of the falling sand is not sufficient to break the specimen. Flowers so dried may be kept in any well sealed vessel, provided there is also placed within the jar a small quantity of lime or other desiccator to absorb any moisture[1] contained in the jar.

I have found the cardboard box with folding sides easier to work with than the "cornet" of paper recommended as a receptacle for the specimen and sand during the drying process.

The weak points of the process appear in the shrinking of the parts that takes place, in the difficulty of preserving the natural shape perfectly, and in the impossibility of removing the sand from the nectar surfaces present in most flowers. The adhering of the sand to the cut surfaces makes impossible the

[1] Prof. Errara recommends a glass jar with a wide mouth, the hollow stopper of which is about two-thirds filled with lime kept in position by a piece of skin.

preservation of dissections which shall show the more minute structural features of flowers.

To prevent somewhat the adhering of the sand particles to the surface of the flower, the stirring of the sand with wax, such as a paraffin candle, so that each grain of sand comes to be covered with a thin coating of paraffin, has been recommended.[1]

BLEACHING.

1. General.

The methods following apply particularly to material preserved in alcohol; they may be employed, however, with more or less success for specimens preserved in other media.

The subject for convenience will be considered under the following heads :—

A. Bleaching in 90 per cent. alcohol. The preservative in the case of material intended for alcohol is also the bleaching medium.

B. Bleaching treatment, before preserving, of material known to blacken in alcohol.

C. Bleaching of specimens already preserved, which have darkened under the action of the preservative.

Treatment of the specimens before preserving and likewise treatment after preserving are to be avoided when the simple treatment by alcohol alone can be made to give sufficiently good results.

The reasons for this are—first, treatment other than by alcohol alone has in a greater or less degree a softening and macerating action on the material bleached; and, second, such treatment tends, with an exception in the case of acid alcohol, to render the specimen flaccid. When special bleaching is, however, resorted to, better results are, as a rule, to be obtained by treating the specimens before preservation than can be secured by treatment subsequently of material already discoloured.

When it is known or supposed that a specimen will bleach in alcohol no special treatment is accorded it; if the

[1] Bailey, Rule-book, p. 187.

specimen is known to darken in alcohol it is treated before preservation ; but if placed in alcohol without treatment and subsequently found to need bleaching it is treated by one of the methods given under C. It follows that a knowledge before preserving of the behaviour in alcohol of any particular specimen is a considerable aid in choosing the best method of procedure. No definite rules can be given, but the following statements afford some indication of the class of specimen for which bleaching other than by alcohol alone will generally be found to be necessary.

Specimens usually darkening in alcohol are those whose tissues contain large quantities of tannin, similarly also those in which much resin is present. Thick and leathery leaves and leaves with thick cuticles turn brown as a rule in alcohol, as do also flowers in which brown and yellow colours predominate White flowers, if fleshy and of a waxy appearance, frequently darken ; if the petals are thin they commonly bleach well in alcohol. Leaves, stems, and other parts, of a light green colour bleach white, while those of a darker colour often do not. In the same way young tissues bleach better than older ones. Most seedlings bleach well, the exceptions being particularly some of the Ranunculaceæ and seedlings generally with slightly woody roots, for instance, palms and members of the Cupuliferæ.

Where I have found it possible to institute a comparison of the members of different families, I have found with certain exceptions that the Ranunculaceæ and Cupuliferæ among others stand out as orders the members of which do not readily bleach, while members of the Caryophylleæ, Cruciferæ, Leguminosæ, and Liliaceæ are commonly readily bleached in alcohol alone.

II. Methods.

A. BLEACHING IN 90 PER CENT. ALCOHOL.

Reference has already been made to the bleaching action of alcohol (page 219).

The essential points to be observed to secure success may bear repetition. They are :—

1. The immediate immersion of the material in the alcohol as soon as gathered.

2. The direct and immediate exposure of the jar containing the specimen to sunlight.
3. The employment of clean spirit only.

B. BLEACHING BEFORE PRESERVING.

1. PRELIMINARY AND RAPID KILLING

The darkening in alcohol of many specimens is prevented if they are first immersed in some rapidly acting killing agent. The most important of these are boiling water, boiling alcohol, and boiling acetic acid and alcohol.

a. Boiling Water.

The specimen is immersed in hot or even boiling water for from 1 to 5 minutes, or even, in the case of fleshy or solid specimens, for much longer. The length of time of immersion should vary with the character and consistency of the specimen. Subsequently the specimen is placed in alcohol and exposed to the action of sunlight.

The specimens become soft and flaccid during the process and harden subsequently in the alcohol. In the case of flowers the sap may aggregate below the epidermis in the form of blisters.

b. Boiling Alcohol 90 per cent.

This is employed in the same way as boiling water. The specimens are immersed for a varying time and are then transferred to normal 90 per cent. alcohol. Boiling alcohol penetrates more rapidly than does boiling water, but is not so effective, however, where much tannin is present, and, as with boiling water, blisters may form under the epidermis.

c. Boiling Acetic Acid and Alcohol.

Acetic acid, . . .	10 c.c.
Alcohol 90 per cent., .	90 c.c.

This penetrates rapidly. The macerating action is somewhat considerable if the treatment is other than momentary. Blisters may be produced as in the preceding cases. The bleaching which results is usually perfect.

II. BY SOAKING BEFORE FINALLY PRESERVING IN SOLUTIONS WHICH PREVENT THE FORMATION OF DISCOLOURING SUBSTANCES.

1. Methods which do not render the specimen flaccid.

a. Acid Alcohol.[1]

The plants are placed in strong 90 per cent. alcohol, to which has been added 2 per cent. by volume of hydrochloric acid. They are then exposed as much as possible to sunlight. If the spirit becomes discoloured it is changed, clean acid alcohol being substituted for the discoloured spirit removed. When bleached the specimen is left in the acid alcohol permanently or it is transferred to ordinary non-acid alcohol. In the latter case some specimens exhibit a tendency to darken, but this discolouration is not so great as when the preliminary acid alcohol has been omitted.

The acid alcohol has a macerating action on delicate structures, and the subsequent handling of such is attended with some risk. It should be remembered also, when specimens bleached in this way are subsequently mounted, that photoxylin does not hold specimens to the mounting glass satisfactorily if any acid is present in the final preservative. Specimens, therefore, treated with acid alcohol should be washed free from acid in several changes of non-acid alcohol before being finally mounted if photoxylin is to be employed. Nitric acid and sulphuric acid have been used in the same way but with less success.

b. Potassium Chlorate.

Crystals of potassium chlorate are placed at the bottom of the jar containing the specimen and nitric or hydrochloric acid is added in small quantities, only sufficient to cover the crystals, by means of a pipette, precautions being taken to keep the acid from mixing with the spirit and from coming in direct contact with the specimen.

The chlorine liberated rises through the spirit and has a slight bleaching action. The process is not so effective as that given above.

[1] Hugo de Vries, Berichte du deutschen botanischen Gesellschaft, vii. 1889, p. 298.

2.—Methods which render the specimen flaccid.

Dilute Acid Alcohol.

Alcohol 90 per cent., ...	40 c.c.
Water, ...	50 c.c.
Hydrochloric acid or Nitric acid, . .	10 c.c.

The addition of water to the acid alcohol, while rendering the specimen soft, prevents to a great extent any subsequent browning of the specimen when transferred to 90 per cent. non-acid alcohol for final exhibition.

The specimen is either first immersed in 90 per cent. alcohol for a few minutes to wet the surface and then transferred to the dilute acid alcohol, or the fresh specimen is placed at once in the diluted solution. As in other cases, sunlight favours the bleaching. The macerating action is considerable, and the method should not be employed for delicate specimens. Where the specimens are less fragile and where boiling may be undesirable the results are usually good. Such a solution with nitric acid has been used with excellent results in the case of Musa, specimens of which, owing to the large quantities of tannin present in the tissues, are bleached with difficulty.

C. BLEACHING AFTER PRESERVING.

Specimens which have darkened under the action of the preservative fall into two groups:—First, those we wish to keep hardened in alcohol; second, those which permit a transference to an aqueous medium, softening not being a disadvantage. The methods available in the former case are not so effective as those available in the latter.

1.—Methods which do not render the specimen flaccid.

For these the acid alcohol solution already described is, invariably used. The specimen is transferred to the acid alcohol and the jar exposed to sunlight. The bleaching is sometimes slow, is not always effective, and never so good as when the fresh specimen is placed at once in the acid alcohol before discolouration has taken place.

2.—Methods which render the specimen flaccid.

a. Bleaching Solution.

This is the most rapid and effective bleaching agent. Its macerating action is considerable, and it should not be employed when dealing with the more delicate specimens. The specimen is transferred from the strong alcohol and placed for several hours in alcohol of 50 per cent., from this it is transferred to water, and shortly after to a weak solution of ordinary bleaching powder. This solution is prepared by pouring warm water over bleaching powder and filtering.

After remaining in the bleaching solution for from 5 to 15 minutes, the specimen is transferred to a 2 per cent. by volume solution of hydrochloric acid in water. As the weak acid penetrates, it sets free the chlorine, which is thus brought into intimate contact with the substances to be bleached. If the specimen after some time is not sufficiently bleached it is replaced in the bleaching solution, and similarly a second time transferred to the acid. This is repeated as often as is necessary until bleaching is complete.

After bleaching, the specimen is placed in water, and from this it is graded to 90 per cent. alcohol.

The corresponding hypochlorites of sodium and potassium, "Eau de Labarraque" and "Eau de Javelle," are also powerful bleachers, breaking up on the addition of acid and setting free chlorine in the same manner as the hypochlorite of calcium. These also have a marked macerating action on the tissues.

b. Warm Water and Acid.

Nitric acid or hydrochloric acid 5 per cent.

The specimen is graded from the strong alcohol to water, and is from that transferred to a warm aqueous solution of hydrochloric acid or even to warm water alone.

After some hours it is again transferred by slow grading to strong alcohol and left to the action of sunlight.

The macerating is less than results from the employment of bleaching powder, but the bleaching is not so rapid.

FIXING AND SUSPENDING THE SPECIMEN.

I. General.

In the earliest preparations exhibited in round jars and bottles the specimen was simply placed in the jar, and where necessary loose parts were fastened together and delicate organs supported by tying the specimen with silk thread to glass rods, or the parts of a specimen were pinned together with thin glass rods. Or the specimen was simply suspended by silk thread from the cork or stopper of the jar. One or another or a combination of these methods was used as the requirements of the case seemed to dictate. In this way those morphological features of the specimen that it was desired to direct attention to were brought as much as possible to one side of the jar that they might be more easily seen and less distorted by the convex surface of the glass.

An advance upon this was the method of tying the specimens with silk thread to thin, almost transparent, sheets of mica. Holes were drilled in the mica with a needle and the thread tying the specimen was fastened behind. The mica possessed what proved a great advantage when circular jars were used, considerable flexibility. The mica-sheet was cut as wide or a little wider than the diameter of the jar, so that when placed in position within the jar the specimen attached to it was held by the flexible mica more or less to the one side of the jar and was thus readily seen. Commonly the mouth of the jar was smaller than the body, and in this case by carefully bending the mica a relatively large sheet could he introduced into a comparatively small-necked bottle.

These details are given as the methods are still sometimes resorted to, but as a rule at the present time the specimens are not tied but are fastened by some form of cement, while the adoption of the rectangular form of vessel, in connection with which the support for the specimen need not be flexible—indeed flexibility becomes a disadvantage—has led to mica being replaced by thin sheet glass.

The disadvantages of tying the specimen to the supporting glass are:—1. Great care must be exercised or the specimens are

injured, this particularly so in dealing with material already preserved. 2. The operation takes considerable time. 3. Specimens are liable to be cut through by the thread if they are at all heavy. 4. The thread tying the specimen is visible often, and detracts from the appearance of the preparation.

II. Methods.

I. CEMENTS FOR ATTACHING SPECIMENS TO MOUNTING GLASS.

A. CEMENTS USED WITH ALCOHOL.

1. *For light objects.*

Photoxylin is the cement invariably used with spirit material for light and small objects.

As obtained from Grubler of Leipzig it is a clear, slightly viscid fluid, and is ready without further preparation for use. The advantages attaching to its use are several. Specimens are quickly fastened to the support, and the operation involves little risk of injury to the preparation. Remaining transparent as the cement does, it is practically invisible. Its disadvantages are two. It can only be employed when the preservative used is strong alcohol, and it will not support heavy preparations.

The specimen to be mounted is taken from the alcohol in which it has been hardened and dehydrated, and the excess of surface alcohol is removed with filter paper or blotting paper. It is then placed in position on the glass or mica mount and a small quantity of photoxylin by means of a pipette is dropped upon it at the points at which it is to be fixed. The glass sheet with the specimen attached is then carefully laid in an open trough of 80 per cent. alcohol present in sufficient quantity to cover the specimen. It is left in this for about a minute. The photoxylin sets as a firm transparent jelly, and the mounting glass with the specimen fastened to it is now transferred to a vessel containing 90 per cent. alcohol. From this it may be moved to the exhibition jar containing 90 per cent. alcohol.

After the photoxylin has been applied it must be left to set in the air for a time, varying from a few seconds to as much as a minute, until in fact a slight film forms over its surface. If immersed in alcohol too soon the photoxylin is washed off and it

then congeals in shapeless masses on the surface of the fluid. On the other hand, the specimen removed from the preserving medium is in danger of drying, and a compromise has often to be made between the conflicting requirements of the cement and those of the specimen to be mounted.

2. *For heavy objects.*

Photoxylin will not support heavy specimens, so that resort is had in such cases to gelatine. It is extremely tenacious and will support specimens weighing several pounds if they are glued to the glass support at several points. In alcohol it becomes quite opaque, and its use is limited chiefly to those cases where the fastening cement is hidden behind the specimen. On a white background the cement, even if to a certain extent visible, is not conspicuous. On a black background its conspicuousness is lessened by mixing lamp black with it.

The cement is prepared as follows:—

Gelatine is soaked in water for several hours, the water not absorbed is then poured off and the gelatine heated over hot water. When melted, and of a fairly stiff consistency, it is ready for use.

The specimen should be dried to a certain extent, all excess of alcohol removed, and the glass plate upon which it is to be mounted should be dry and warm. This last condition is secured by holding the glass for a second or two over a gas flame. The cement, used hot, is applied to the specimen, and the latter laid upon the mounting glass so that the cement comes in contact with it and adheres to the warm surface. The cooling of the glass is hastened by running strong alcohol over the specimen from a pipette, which action serves the purpose also of preventing the specimen from drying. When the gelatine has cooled so as to be no longer in a fluid state, the glass plate with the specimen attached is placed in a bath of 90 per cent. alcohol. It is left in this for the gelatine to harden by dehydration, the specimen lying horizontally and putting little strain upon the cement holding it. When quite hardened, the glass with the specimen is lifted out and is transferred to the vessel in which the specimen is to be exhibited.

To fasten with gelatine delicate specimens which would be

liable to be dried by the method just described, resort is had in applying the cement to a pipette surrounded by a hot-water jacket which keeps the gelatine within the pipette in a liquid condition. The specimen is not taken out of the spirit, but is held in position in a dish or trough of alcohol at the bottom of which lies the sheet of glass the specimen is to be fastened to. The pipette, with the surrounding jacket, is brought so that the nose of the pipette touches the mounting glass at the bottom of the trough. Some of the gelatine is pressed out on to the glass and before it coagulates in the alcohol the specimen is placed upon it and is held in position until the gelatine is set firm.

B. CEMENTS USED WITH FORMALIN.

1. *For light objects.*

For light objects, and where the gelatine will be seen, a clear jelly is made from the best French gelatine. The glass plate is warmed and the warm liquid gelatine dropped on the specimen at those points at which it is desired to fix it. It hardens in formalin and remains practically transparent, but readily takes up colouring matters if these have not previously been extracted from the specimen.

2. *For heavy objects.*

Gelatine is used for heavy objects where the cement is hidden behind the object mounted. The gelatine solution employed is the same as is used for heavy specimens in alcohol. The specimen should be dried as completely as possible. Where, as with formalin, the aqueous medium is not inflammable, the glass plate at the points where the cement rests may be heated slightly from below over a gas flame after the specimen has been laid in position

II.—SUPPORTS FOR PREPARATIONS.

Mica is used for round jars, but for rectangular vessels thin sheet glass possesses many advantages. It is cheap, perfectly transparent, can be obtained in any size, and, being rigid, will support specimens of any weight. The mica sheets are of limited size, hardly transparent at the best, and if thin not sufficiently rigid. Opal and blue glass have been used as backgrounds but

not as mounting glasses. With clear glass any background can be used and several may be tried from which to select the best. If opal or blue glasses are used as the support of the specimen, the background becomes part of the preparation, and however unsuited it may subsequently prove cannot be varied. This becomes a disadvantage where the continued bleaching of a preparation already mounted, or its subsequent darkening, makes a change of background desirable.

Where a white or black background is desired, the back of the vessel may be painted the necessary colour. This proves effective, and the cost is considerably less than that which the employment of blue or opal glass as backgrounds involves.

DESCRIPTIVE LABELS.

I. General.

Long descriptive labels are rarely employed, but in every instance an effort is made to indicate concisely the point of biological interest the specimen illustrates.

To facilitate a comparison of the specimens exhibited with the descriptions of text books the names of the different organs are pointed out. This is done in one or the other of the following two ways:—The labels and pointers are attached so that the parts named are pointed out upon the specimen itself, or a photograph or drawing of the specimen is made, and the names of the parts are indicated upon this.

Where the character of the specimen permits its adoption the former method presents the advantage that in a direct manner a distinguishing name is associated with a given organ. The second method, however, where the drawing is made to a certain extent diagrammatic, allows a designated part to be more accurately indicated. Examples of the first method are shown in Plate III. Details of the way in which the method is carried out follow.

II. Methods.

I. Labelling Specimens Preserved in Alcohol or Formalin.

A difficulty which at first prevented the naming of the parts was the want of coloured pointers capable of being bent should the character of the specimen demand it, and which would moreover resist the action of the preserving medium. Thus copper wire, steel wire, and glass rods painted were tried with little success. In time the paint blistered and peeled off. I have now devised a method in which the colouring matter needed to make the pointer conspicuous is protected from the action of the preservative by being placed inside a fine capillary tube. The tubes are made by heating ordinary glass tubing of about $\frac{1}{4}$-inch bore, and when uniformly hot of a dull red colour at the point desired drawing it out to a fine capillary tube. This capillary tubing is broken into suitable lengths, and as required the tubes are filled with any colouring substance that may be considered effective and distinct upon the chosen background.

The backgrounds commonly used are either black or white, and upon these I use vermilion-coloured pointers

Ordinary moist colours mixed with melted gelatine are used to fill the tubes. The mixture, employed warm, flows up the tube for a certain length by capillarity. If pointers of a greater length are required the tubes are filled by means of a rubber pipette sucker fastened to one end of the tube by means of a clamp, or the sucker is held firmly around the tube with the finger and thumb of the left hand while with the right hand the air is expelled. When the rubber sucker is released the colour substance in which the free-end of the tube is steeped is drawn up and fills the tube.

Both the pointers and the labels in the case of specimens preserved in alcohol are attached with photoxylin : when the preservative is formalin they are fastened with the clear dilute gelatine already given as a cement for mounting light specimens in that medium.

II. Labelling Dry Preparations.

In the naming of the parts of dry preparations, the pointers used are the glass tubes already described, or pointers made of

copper wire painted with vermilion paint are employed. The labels and the pointers are attached with a gum made of equal parts of gum-tragacanth and gum-arabic or with the gelatine solution given on page 238.

III. LABELLING MODELS.

The names of the parts of models are attached to pointers made of copper wire. Such pointers, in turn, are fastened to the parts to be named. The cement used for both operations has the following composition :—

Wax cement for attaching names to models.

Beeswax, $\frac{2}{3}$ parts.
Resin, 1 part.

The ingredients are melted together and the cement used warm.

At other times the wire used is pointed and the pointed end driven into the part of the model named. To a small piece of cork or pasteboard fastened at the free end of the wire the name-label is attached with gum or paste.

LUTINGS FOR LIDS OF VESSELS.

I. PERMANENT SEALING.

For permanently sealing the lids to museum jars I have found bichromated gelatine prepared as follows efficacious : —

1 oz. Nelson's Amber Gelatine is soaked in water for several hours ; the water not absorbed by the gelatine is then poured off and the gelatine melted over hot water. When melted, 5 grains. of bichromate of potash are added and the whole stirred.

The melted gelatine is applied with a pipette or glass rod to the rim of the vessel, and the lid, after it has been gently warmed over a Bunsen flame, is laid in position over the mouth of the jar. The gelatine should be fairly stiff ; if too weak when the warm lid is laid on it may run down the inside of the vessel. When the lid has been placed in position, the cement is allowed to cool, and under the action of light it forms a luting insoluble in alcohol or water.

If the lid does not lie evenly on the rim of the vessel the contraction of the gelatine as it dries may crack the lid. To prevent this a cement with more body is prepared by mixing plaster of paris with the gelatine. The plaster fills the interstices between the lid and the rim of the jar. This plaster cement is applied warm in the same manner as the bichromated gelatine cement, excess of cement on the outside in both cases being cleaned off with a knife after it has cooled slightly.

II. FIRM SEALING.

If a firm luting is required, but one which will afterwards permits the removal of the lid, a difficult matter when the lutings given above are employed, the following is used :—

Gelatine, 1 oz.
Paraffin wax, $\frac{1}{4}$ oz.

The gelatine is melted as described in the preceding case ; to the melted gelatine the wax is added and also melted. The two are then beaten together vigorously so as to form as emulsion. The cement is used warm, a layer of the cement being placed on the rim of the vessel, and the lid as before warmed slightly before being placed in position.

III. TEMPORARY SEALING.

For sealing lids temporarily, and as a luting when the jar is not likely to be handled, vaseline presents the advantage that it is clean and easily applied. It prevents, better than any other temporary luting I have tried, loss of spirit by evaporation and offers no difficulty to the ready removal of the lid should this become necessary.

Either of the first two cements may be used for sealing corked bottles. With spirit material the bichromated gelatine has given excellent results. The corks are dipped in the gelatine solution so as to coat them, and when the gelatine has set the corks are driven into the bottles flush with the top of the neck, or if fitting too tightly to permit this they are pared down flush with the top. Any alcohol present is carefully dried off and the surface of the cork covered with an even layer of cement.

If the jar is likely to be subjected to varying temperatures provision should be made for the expansion and contraction of the alcohol, and at the same time a means found by which the loss of spirit by evaporation—it is practically impossible altogether to prevent this—can be made good. Where the vessel is covered by a glass lid or disk a small hole is drilled in the lid, and this hole in turn is covered by an ordinary microscopic cover glass, luted down with vaseline. This permits expansion of the spirit, and relieves the pressure on the luting of the lid. The loss of alcohol that takes place is periodically made good, a small thistle funnel being used to introduce fresh alcohol into the vessel through the small hole provided. In the case of jars and bottles closed with corks, a hole is made in the centre of the cork and a glass tube of small diameter inserted. This takes the place and answers the purposes of the hole drilled in the glass disks.

BUILDING UP OF GLASS VESSELS.

Many of the preparations in alcohol in the Museum are exhibited in vessels built up of pieces of plate-glass cemented together so as to form rectangular, spirit-proof boxes. These vessels are made as follows:—Pieces of plate-glass of good quality are cut the requisite sizes to form the sides and bottom of the vessel, and are then carefully ground along their edges, so that the component pieces, when the box is put together, will fit evenly against one another, leaving no cracks between the joints. A cement is prepared consisting of Nelson's amber gelatine, with bichromate of potash and plaster of paris. The gelatine is melted and the bichromate of potash and plaster of paris are subsequently added, and are stirred into a fairly firm and homogeneous cement which is used warm. A second cement is also prepared, composed of 1 oz. of Nelson's amber gelatine, 5 grains of bichromate of potash, and a few drops of glycerine. Each piece of glass is gently warmed, the plaster cement is applied evenly along the edges to be joined, and while the cement is still warm the glass is fitted in its place to form one of the sides or the bottom of the vessel as the case may be.

A definite order is observed in fitting the pieces together. First, the glass which is to be the back of the finished vessel is

laid flat on a table; the two sides are next cemented vertically right and left of the back glass; the third glass applied is that which is to be the bottom of the finished vessel; and finally the front glass is cemented in position.

When the plaster cement along the joints has cooled and has set firm enough to allow the vessel to be taken up and handled without risk of the pieces falling apart—this is usually after a few hours—the second cement, that without plaster of paris, is run as a luting around the inner angles of the vessel and is also applied as a thin layer over the outside joints. That this may be done successfully the second cement should not be very stiff. Both cements should be applied as evenly as possible, as the subsequent scraping and cutting away of any surplus cement weakens the joints and militates much against the success of the work.

The vessel is placed in a cool room and the cement allowed slowly to dry for one or two days, after which it is placed in strong sunlight until quite dry and until the gelatine under the action of the light has turned a brownish colour. It is perhaps premature to speak of the vessels so made as permanent, but there are in our Museum vessels which were built up thus five years ago which are to-day perfectly spirit-tight.

Much handling of the vessels would appear to be harmful, for some preparations which have been frequently moved have subsequently leaked, and it should be noted, too, that the strength of the spirit within the vessel should be maintained at 90 per cent. if the vessel is to be kept spirit-proof. The alternate drying and wetting of the cement consequent upon an intermittant use of a vessel also causes the cement in course of time to give way and the vessel to leak. Plate-glass or heavy sheet-glass is used, as I find that the thinner sheet-glass is liable to crack under the binding strain it is subjected to as the cement dries and contracts.

The perfectly plane surface of the plate-glass, and the fact that a vessel can be made any required size, are the great advantages of the method, but owing to the cost of the ground plate-glass and labour of grinding the edges square, vessels so made are not cheaper than the cast-glass rectangular vessels to be obtained at the present day.

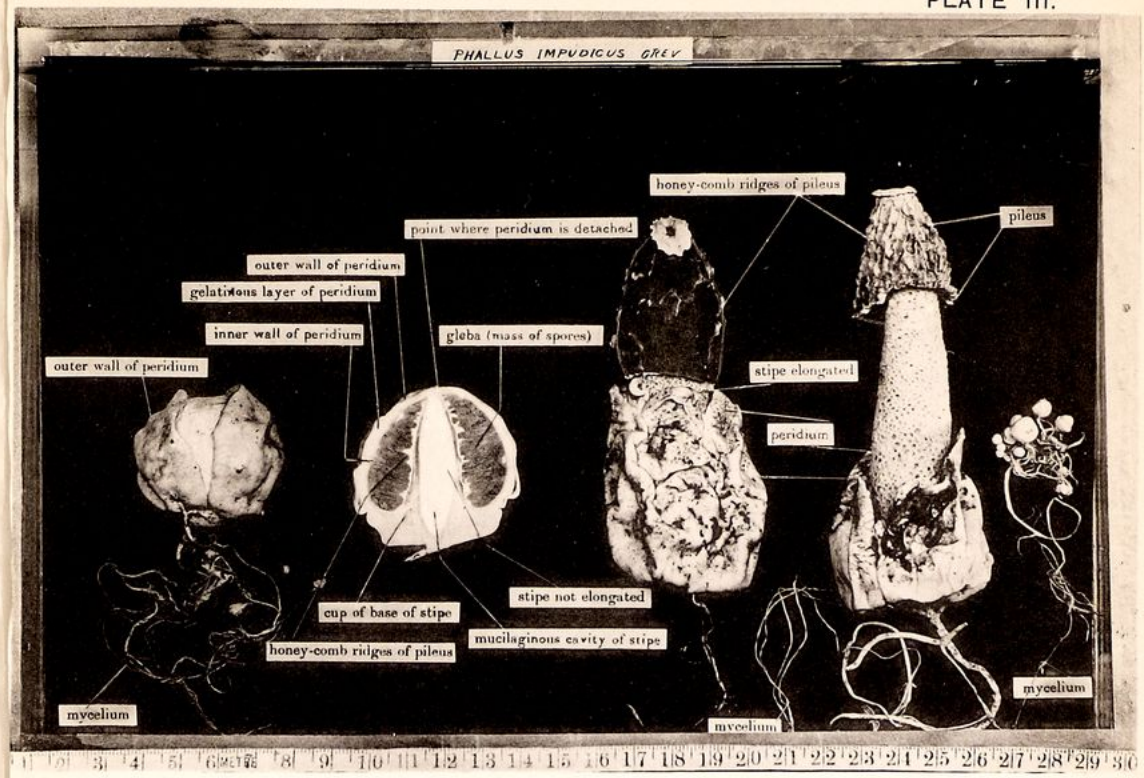
Explanation of the Figures in Plate III.

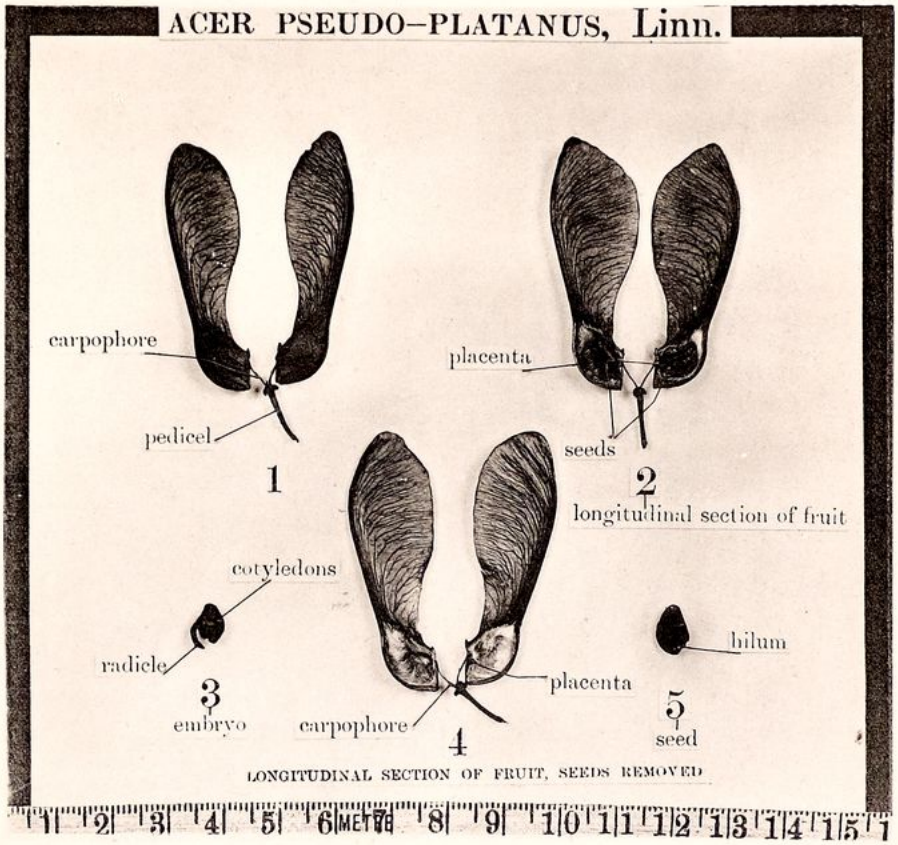
THE FIGURES ARE FROM PHOTOGRAPHS BY MR. T. W. WEST.

Upper figure :—Preparation in 90 per cent. alcohol, exhibited in a rectangular glass vessel. The back of the vessel is painted black, and the names of the parts are attached to a clear glass mount, to which, also, the specimens are fastened. The parts named are pointed out by means of thin glass tubes filled with vermilion injection medium.

Lower figure :—Dry preparation mounted on white card and enclosed in box with glass lid and sides. The small pointers are made of thin copper wire painted with vermilion oil colour.

The scale at the foot of the preparations has been added temporarily to serve as an index to the size of the specimens.


PHALLUS IMPUDICUS GREV
honey-comb ridges of pileus
pileus
point where peridium is detached
outer wall of peridium
gelatinous layer of peridium
inner wall of peridium
gleba (mass of spores)
outer wall of peridium
stipe elongated
peridium
stipe not elongated
cup of base of stipe
mucilaginous cavity of stipe
honey-comb ridges of pileus
mycelium
mycelium
mycelium


ACER PSEUDO-PLATANUS, Linn.
carpophore
pedicel
1
placenta
seeds
2
longitudinal section of fruit
cotyledons
radicle
3
embryo
carpophore
4
placenta
hilum
5
seed
LONGITUDINAL SECTION OF FRUIT, SEEDS REMOVED