Preparing

INSECT DISPLAYS

CANADA DEPARTMENT OF AGRICULTURE

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CONTENTS

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ILLUSTRATIONS

PREFACE

This manual outlines the various museum methods and procedures that may be adapted for preparing entomological exhibits—a phase of exhibition in museums that has not received a great deal of attention up to now. Exhibits of insects, because of their small size, must be displayed in small units for viewing at close range; the need for accuracy in all details presents an important problem. Insects and plant sections must be so prepared that each appears as a replica of the original.

Exhibition work in this field is highly specialized and requires wide knowledge of art, entomology and botany, as well as many specialized techniques. Accuracy of detail and lifelike quality are keys to successful preparation of exhibits. The critical personal touch is necessary to remove the stamp of mass production and raise them to works of art. Good mechanics alone is not enough; originality and inventiveness in tools, materials, and design are needed constantly.

Many museum techniques developed through the years, especially those involving the preparation of herbaceous units, may be adapted for preparing insect displays. Success, however, depends on the ability of the worker to employ these methods skillfully.

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A. A. WOOD

COLLECTING AND REARING INSECTS

In preparing an entomological exhibit, an insect net and killing bottle are essential equipment. Beirne (1) gives detailed directions for collecting and mounting insects for systematic collections. However, there will be little need for standard mounting boards; insects used in exhibits are usually mounted in lifelike positions.

Sometimes it may be necessary to rear larvæ in the laboratory; netted specimens of adult *Lepidoptera,* for example, often lose scales and are not satisfactory for this type of display. This is one case where newly emerged specimens should be used. Bring the larvæ into the laboratory alive with a supply of their host plant. Lantern breeding cages (Fig. 1.) for small larvæ can be made using sheet galvanized metal for the base and a shallow metal can with a friction top with a hole in the center for inserting plant stems in water. A lantern globe fits into a flange about ⅜-inch high around the top of the metal can. Enclose the top of the glass with cheesecloth or screening. This type of cage will hold evergreens fresh for a week (see Fig. 1 p. 7).

Many larvæ may be reared by placing foliage in large vials and loosely plugging the openings with moist cotton. Almost any type of clean container will do if it will confine the larvæ, hold the food plant fresh, retain moisture, and furnish sufficient space for proper expansion of wings. Insects that pupate in the ground will need a layer of soil in the cages.

Refrigeration saves time in rearing insects and especially helps by keeping food plants fresh. It retards surface drying, the main limiting factor in keeping a supply of food. Fresh deciduous or coniferous foliage, layered between sheets of wet paper towelling and placed in a covered crisper, will remain in good condition for a week or two at temperatures a few degrees above freezing.

Larvæ of many insects held for making molds, inflating, or coloring, can be kept in tight containers under similar conditions of temperature. The last two instars of lepidopterous and hymenopterous insects stand refrigeraion better than younger larvæ. Peterson (27) describes various breeding cages and traps for insects.

PRESERVING IMMATURE INSECTS

Preserving insect larvæ has always been a disappointing procedure. Loss of color and form resulting from the various formulæ used have discouraged most workers from using larvæ in exhibitions. Some larvæ when inflated hold their color very well but the form of most is undesirable when conventional methods are used.

There are improved methods for preparing artificial insects but preserved specimens must still represent many forms in exhibits. Following are some approved methods for preserving larvæ.

Dry Mounts

With Formulæ 1 to 3 (p. 60)* specimens may be mounted dry after processing. Newly hatched larvæ are difficult to preserve dry because shrinkage is great; Formula 2 causes less shrinking than Formula 1. Larvæ should be preserved dry for exhibits only if it is impossible to make wax casts.

If Formula 3 (p. 60) is used, place larvæ over one centimeter long in cold water over a slow fire and remove the container when the water reaches the boiling point. After the water cools to room temperature, puncture the larvæ in several places with a fine needle so that alcohol solutions will penetrate.

Do not boil smaller larvæ or pupæ but place them in water at the boiling point and leave to cool to room temperature then pass them through Formula 3. Larvæ or pupæ over one centimeter long should be left in each of the solutions six to eight days, and smaller larvæ or pupæ two to six days. Then take the specimens from the turpentine and let them dry on blotting paper; mount as desired when dry.

Post (28) suggests the following method for dry-mounting larvæ: boil them one-half to one minute in water, remove, and pass through the alcohols. Finally place them in xylol, then pin, and dry. This method preserves *Phyllophaga* larvæ better than Barber's method. *Scarabaeid* larvæ should not be boiled too long; they will suddenly deflate and resist all attempts to bring them back to normal appearance.

Preserving Insect Eggs—Formula 1 or 2 (p. 60) may be used. When the eggs are thoroughly dry, color tint them using pigment mixed in xylol, turpentine, or white shellac. *Do not use water because it will deflate the specimen.* Dipping the eggs in a very thin solution of Formula 45 (p. 70) will impregnate them and make them rigid.

To preserve tent caterpillar egg masses place the twigs with eggs in an oven at 225°F. for 20 minutes. When the eggs cool, impregnate them with a thin solution of cellulose nitrate, Formula 45 (p. 70), or Gelva V 15, Formula 12 (p. 63). Cut off the twig near the egg mass. The shrinkage of the twig will allow the ring of eggs to slide off. To assemble for a permanent display, slip the egg mass over the prepared wax twig before it is built up to full size and model wax around it.

Large insect egg shells may be preserved by blowing as with birds' eggs. Make a small hole in one side of the egg with a small needle and with a blowpipe—made by drawing a small glass tube to a fine point—expel the contents. A short piece of rubber tubing attached to the end of the glass will make the blowing operation less difficult. Hold the tip of the blowpipe either near the hole in the egg shell or insert it slightly. Air forced into the egg will empty the shell.

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*The various formulæ used for preserving insect and plant specimens are listed together from p. 60 to p. 71 in the back to avoid repetition in the text. All will be referred to in the text by number and page only.

Gunder (11) gives detailed instructions for blowing insect eggs using T. M. Blackman's method. One useful point made in this article, is the method of holding the egg while blowing it. If the egg is not attached to something, a minute drop of adhesive can be used to fasten it to a piece of paper. This frees the right hand to operate the blowpipe; the paper with the egg attached is held with forceps in the left hand.

Inflating Empty Larval Skins—Living larvæ may be used. First cut around the anus, freeing the alimentary canal attachment then squeeze gently near the opening to extrude the viscera; with the forceps, carefully remove all body contents.

Place the larva between two pieces of blotting paper leaving the caudal end exposed. Roll the larva gently, pressing at the middle to force the body contents through the anal opening. Repeat the process, pressing at the head until all fat and body fluids have been removed without enlarging the opening in the skin. For all specimens except certain green forms, it is most important to remove all the alimentary canal and contents. Some pale-green larvæ hold their color better if all body juices are not removed.

To dry the skin, Ross (32) suggests using a 250-watt infra-red lamp with ruby red glass and a nickel reflector clamped on a stand. If the skin is held about 2 inches above the center of the lamp and rotated it will dry without scorching the integument or the setæ. This process will not appreciably alter the natural color.

If you use an inflating oven, heat it with an alcohol lamp. Insert the cannula tip into the anal opening and either fasten it with clips or hold it in place with forceps. If you use spring clips, apply vaseline to the glass tip to keep the skin from sticking. Be sure not to pull the skin too far onto the glass. Maintain just sufficient air pressure in the bulb to extend the skin to natural size. One of the most glaring faults of this technique is over-inflation which causes the segments to separate.

Turn the specimen constantly to ensure even drying. When the skin has dried thoroughly remove the cannula. If the skin sticks to the glass, great care must be taken not to tear it; a little moisture may aid removal. After the skin has dried for a day or two, coat the inside with a thin plastic lacquer, Formula 12 (p. 63), injected through the anal opening with a hypodermic needle.

Inflating Larvæ with Wax—A more recent method of preparing larvæ for exhibits consists of inflating the skin with hot wax; it is a modification of the Silver (37) method. It has given better results than the standard procedure above in which the skin is left empty. This method has been used successfully to prepare smooth-skinned species of dipterous, coleopterous, and lepidopterous larvæ and some of the sawflies.

Empty the skin as described above for inflation. Use larger cannulæ made from ¼-inch glass tubing. Fasten the watch spring clips to the tubing with fine annealed wire. Melt a mixture of 1 part pure white beeswax and 2 parts paraffin wax in a double boiler. Tint the wax with artists' tube colors, blended and thinned with turpentine to match the basic body color of the larva. Draw hot wax into the cannula for half its length. When the wax has cooled, slip the skin over the glass tip and fasten with clips. Attach the cannula to the cautery set.

Hold the wax-filled end of the cannula over the inflating oven in such a position that all the wax will liquefy without the larval skin becoming too hot. Regulate the pressure in the bulb to force the wax into the skin, gently filling it to natural size. Then immediately dip the specimen and the glass tip in cold water.

Bend the specimen to any desired lifelike position as soon as you remove it from the glass or place it in warm water until the wax softens sufficiently. Do the shaping before the skin dries. Fill the hole left in the wax by the cannula and shape the integument to a natural poise.

To pest-proof the skin, treat it with a weak solution of mercuric chloride, Formula 10 (p. 62). When thoroughly dry, dip it in a very thin Gelva solution, Formula 12 (p. 63); this will seal and strengthen the specimen. The skin should not show more than natural glossiness; usually two thin coats give better results than one heavier one. After each dipping, roll the specimen about on porous paper to get rid of excess plastic lacquer. If the skin needs coloring, do this before treating with plastic.

Liquid Preserving

Specimens processed by the following methods must be kept in liquid preservatives. Kahle's fluid, Formula 6 (p. 61), is used chiefly to preserve larvæ permanently.

Place the larvæ in cold water and bring them slowly to a boil. Leave them over the heat until the body begins to straighten, but not until the segments separate. Allow the water to cool to room temperature before transferring the larvæ to the preserving fluid.

Craig's method of preserving color in larvæ, Formula 5 (p. 61) appears to hold some colors well. A series of fifth-instar larvæ of the tomato hornworm was successfully prepared by this method.

Post (28) offers the following method for avoiding bubbles in vials. Form a blunt plug of good-quality absorbent cotton by twisting it between the thumb and the forefinger. Saturate the plug with the solution and insert it in the full vial. Fill the space above the plug and insert the cork. The plug should fit the vial snugly. Any bubble formed between the plug and the cork cannot reach the specimen.

To make sure corks remain firmly in vials, lay a fine insect pin along the side of the cork as it is pressed in; this allows air to escape. Remove the pin and twist the cork to fill the groove left by the pin. The cork will be held in by the vacuum formed.

Preserving Larvæ in Gelatin (13)—Kill the specimens by dropping them into boiling water. Then place them in Formula 6 (p. 61) for 12 hours. Wash the material in tap water until all traces of the odor of the fixative have disappeared; this may take 24 hours. Keep in 3 per cent formaldehyde-distilled water until ready to mount in gelatin.

Remove the specimens and allow them to dry for a few minutes on a towel. Cut cards to fit the vials and attach the specimens with Duco cement.

Insert the mounts in the vials and fill with hot gelatin, which is prepared as follows: Dissolve 5 gm. of bacteriological gelatin in 100 ml. of distilled water. Heat until it becomes clear. Stir in 20 drops of 40 per cent formaldehyde. The solution hardens slowly. When it has set, cork the vials and seal them with two or three coats of Duco cement.

Gelatin mounts are superior to mounts in liquid preservatives because the specimens do not move around in the vials and there is little loss from evaporation. The reaction of the gelatin and formaldehyde produces a permanent gel that will not melt in hot water. The jelly-like material in the vial acts as a shock absorber for the mount.

PRESERVING ADULT INSECTS

Adult insects pinned and dried in the usual way will not last long in exhibits. It is necessary to preserve them in such a way that colors will not fade, that the specimens will remain free from pest attack and be strong enough to withstand the vibrations of moving or shipping. A few of the techniques used for preserving in color are briefly noted.

Lepidoptera—Large-bodied moths should not be dried and mounted in exhibits without suitable processing. They are subject to attacks from pests and become greasy. To avoid greasiness, cut a slit along the underside of the abdomen and clean out thoroughly, removing as much fat as possible. Swab dry with bits of absorbent cotton and apply arsenical soap, Formula 11 (p. 63), to the interior, working it up through the thorax. Insert a manikin of cotton, filling the cavity. Mount the specimen in a lifelike position and allow it to dry.

When the wings are in a position so that the bottom sides will not show in the exhibit, coat the underside of the specimen with white shellac to strengthen it; pay particular attention to the bases of the wings and the undersides of the body, head, and leg attachments. Coat the antennæ with thin white shellac or plastic lacquer and apply a second coat to the bases.

To reduce fading of colors in moths and butterflies, paint the scales. It is better to use fresh specimens but it is possible to restore faded ones this way. You can probably do the finest work with an airbrush. Mount the specimen on a base with supports against the undersides of the wings to protect them from the blast of the airbrush. Use masks to work out the color pattern, and spray. Claude E. Johnson, formerly preparator in the National Museum of Canada, prepared a polyphemus moth by this method. This specimen has held colors well although exposed to light for several years.

You may also brush in colors using the transparent oil colors for slide and photograph tinting. Thin the pigment with xylol and allow it to run into the scales.

Orthoptera—The following method can be used to preserve grasshoppers satisfactorily. Immerse living specimens in Formula 8 (p. 62) for one day. Cut along one lateral abdominal suture and remove all viscera with fine forceps. Insert wads of absorbent cotton and rub the walls of the cavity and up into the head until the swabs come away clean and dry. Brush thinned arsenical soap, Formula 11 (p. 63), over all of the interior. Insert a cotton manikin to fill the cavity.

Close the incision, mount in the desired position, and let it dry thoroughly. Dip in a very thin Gelva solution, Formula 12 (p. 63), at least twice which will impregnate and hermetically seal the specimen. Liquid cellulose nitrate or acetate may be used, but has not the penetrating quality of Gelva. This method holds the colors and greatly strengthens the specimen.

For green katydids, place freshly killed insects in Formula 8 (p. 62) for one day and then treat them in the same manner as grasshoppers.

Coleoptera—With large beetles, remove the viscera through an incision in the underpart of the abdomen. Insert absorbent cotton saturated with arsenical soap, Formula 11 (p. 63). When dry, dip the specimen in thin Gelva solution, Formula 12 (p. 63), to impregnate and seal.

Small Soft-bodied Insects—Use Formula 2, (p. 60), for insects whose abdomens will remain plump. The method works well for larvae and midges and other small, soft-bodied adults that are to be mounted in lifelike positions.

COLLECTING AND PRESERVING PLANTS

The reproduction in wax or plastic of insect injury to plants often makes it necessary to collect insect-injured plant series to be used as patterns in copying the injury on artificial reproductions. The natural material may be mounted as scientific specimens on botanical mounting sheets, or small twigs and leaves may be mounted on filing cards and completely covered with scotch tape.

Collecting

Choose plants typical of the species. Bend tall specimens several times, or cut out sections of the stem to conform to the size of the mounting sheets. Always leave roots attached. Be careful with the artistic arrangement of plants before drying, so that the appearance of the finished mount will be satisfactory.

Arrange the plant in the press as soon after collecting as possible. Fold a sheet of porous paper, such as newsprint, and place the plant inside, paying particular attention to arrangement of leaves and flowers. Place the folded paper, with the plant inside, between driers in the press. Leave the plant in the paper until dry, so that the driers may be changed without disarranging the specimen. Pressure should not be too great when plants are first put in the press; it may be increased when they become partially dry and there is no danger of crushing soft parts.

After the day's collecting, if plants have been put in the press in the field, re-arrange any parts needing attention. Place a few ventilators between driers.

Figure 1
Cage for rearing larvae.

Figure 2
Mounted herbarium specimen with label.

The first 12 to 24 hours will determine the quality of the pressed plant. Rapid drying preserves natural colors. Change the driers several times during the first day or two as they absorb moisture from the plants. Used driers may be dried in an oven or in the sun.

To hasten drying, place the press where there is good circulation of air; leave it in the sun, or hang it over some source of heat.

Mounting

When the plant is thoroughly dry, mount it permanently on a botanical mounting sheet. If the plant is not longer than the sheet, mount it straight in the center; if it is longer, place the root toward the lower left corner and the top diagonally toward the upper right. Attach the plant to the mounting paper with narrow strips of mounting tape, using sufficient points of attachment to hold all parts of the specimen. Attach the label in the lower right corner (Fig. 2).

A useful method of mounting is to coat a sheet of glass with Gelva solution, Formula 12 (p. 63), lay the specimen on and when it is well coated on the underside transfer it to mounting paper. Advantages of the method are neatness, strength, and the absence of mounting tape covering parts of the plant. Should it be necessary to remove the specimen, acetone will dissolve the adhesive.

Preserving Green Colors

In Liquid—Methods of preserving green colors in plants and foliage, and also the various colors of fruits are given in Formulae 20 to 27 (pp. 65 to 67). Formula 20, the boiling treatment to replace the natural greens with copper acetate, gives very good results when the specimens are stored permanently in liquid.

Dry Preserving—Green colors may be preserved in plants by using Formula 28 or 29 (p. 67). The specimens may then be pressed and mounted.

PLASTER MOLDS

To reproduce plants and certain immature forms of insects in wax and plaster, it is necessary to prepare molds of the originals from which to make casts. The various plasters and methods of making plaster molds are discussed.

Characteristics and Uses of Plaster

Calcined gypsum, commonly called plaster of paris, is calcium sulphate-hemihydrate ($2CaSO_4.H_2O$). Variation in color of the gypsum rock determines the shade of the finished plaster, which may vary from white to gray. When water is added to calcined gypsum, it recrystallizes back to hydrated rock. This chemical reaction produces heat in the plaster as it sets. The heat of the mold indicates the time to remove it from the object being treated. Each type of plaster has a definite setting time, which may be controlled by adding accelerators or retarders to the water.

The plaster generally used in Canadian museums is Hammer Brand Molding Plaster, formerly known as Hammer Brand FF, a Canadian brand. The company states that this plaster is processed to the same specifications as Red Top White No. 1 Molding Plaster of the United States Gypsum Company. The latter company processes a wide range of plasters suitable for different types of work which you may also buy from local dealers. Some of these plasters are described below:

USG Red Top White No. 1 Molding Plaster—This is the standard form of plaster of paris and is the general-utility plaster used in many casting shops. The dependable uniformity in fineness of grinding and setting characteristics makes it suitable for molds, plaques, and general work.

USG Red Top Superfine Gypsum Casting Plaster—This plaster has a finer grain than the above, giving smoother castings and excellent detail. It is ideal for modelling.

USG White Art Plaster—This plaster was designed especially for castings that are to be painted or that require a hardened, smooth-textured finish. Adding a surface-hardening ingredient minimizes paint absorption yet sacrifices none of the smooth-working qualities. To obtain the best and most uniform surfaces, dry these castings rapidly in circulating warm air. Trim and sand the castings before drying.

USG No. 1 Casting Plaster—This plaster was developed recently for use when unusual surface density and hardness are desired.

USG No. 1 Casting Plaster (Special)—This plaster excels in structural strength. A lower proportion of water is needed, giving greater strength and hardness. Castings are uniformly hard from core to surface.

USG Pattern Shop Hydrocal Plaster—This plaster is moderately low in setting expansion, giving accurate dimensions. The material sets gradually, has a long period of plasticity, does not get too hard, and can be carved. The normal mixture is 100 parts of plaster and 50 to 54 parts of water by weight. Setting time is 20 to 35 minutes. The setting expansion is 0.00125. Compressive strength dry is 3,200 pounds per square inch.

USG Hydrocal A-11—This is a high-strength gypsum cement with a low setting expansion and is suitable for making hard, tough models of uniform and stable dimensional accuracy. It sets rapidly after the setting actions begins. It is recommended for pouring or slurry casting technique. The normal mixture of this plaster is 100 parts of plaster and 40 to 42 parts of water by weight. The setting expansion is 0.0004. When set, its compressive strength is 4,500 pounds per square inch.

Coecal Plaster—Coecal plaster, a Canadian dental plaster, is excellent for fine work. It takes only 1 part water to 3 parts plaster by weight and has a compressive strength of 7,000 pounds per square inch after setting for 22 minutes. To produce best results, the plaster should be sifted into the water, allowed to stand one minute, then spatulated to a creamy consistency. Vibrating the mix improves surface density and strength. It is usually possible to remove a mold after 20 minutes. Coecal plaster is more expensive than white molding plaster but it gives finer definition and allows wax casts to free perfectly from the mold using only hot water as a separator.

Preparing Molds

Plaster may be used for molds, casts, and carved models, or as one of the ingredients in mâché when making bases. The proportion of water in the mix affects the hardness, strength, density, and porosity of the mold or cast. To obtain more uniformity in mold texture, precisely weigh or measure the ingredients and carefully record notes on the results obtained.

Test for the correct amounts of plaster and water for particular plasters. For example, a good technique for hard molds is to use as little water as possible to form a mix that will pour. Whenever possible, it is best to use the normal setting time for each particular plaster. If in special work it becomes necessary to speed up or slow down the period of plasticity, or free-flowing state, add accelerators or retarders to the mix. A little glue added to the water will hold back the setting; common salt (sodium chloride) or potassium sulphate dissolved in the water will cause plaster to set more quickly. Accelerators in the plaster, however, will make molds more brittle.

A mold is like a photographic negative. It is made to obtain a negative of an object from which to cast a positive, thus obtaining a detailed replica of the original form.

Piece Molds—Those requiring more than one piece or section, must have enough pieces so that the cast can be freed; undercuts in a mold will lock the cast permanently.

54899-0—2

Fruit and Vegetable Molds—An apple, if not misshapen, usually releases freely from a 2-piece mold. A potato tuber, however, because of its uneven shape and deep eyes, requires three or more pieces. A material is needed for shaping around objects before making molds; the best material is water clay. A mixture of clay and sand that has gone through a brick or tile machine works well; it is not too sticky. Storing clay in a tight metal box with a little water in the bottom will keep it soft indefinitely. The following method of preparing a piece mold of a potato tuber in plaster will serve as an example. First if there is dust or soil on the potato skin, wash it thoroughly. Decide which side is to show in the exhibit, and where it will be best to join the several mold pieces and then:

1. Roll out a piece of clay to slightly more than half the thickness of the tuber. Lay the tuber on the clay, keeping uppermost the side to be featured in the exhibit. Mark on the clay around the tuber with a scalpel point and cut out the section, leaving a cavity that will fit the tuber. Line the clay cavity with thin, soft paper to keep it from sticking to the tuber.

2. Sink the tuber into the clay slightly more than half way. Model the clay smoothly against it, being careful not to cut the skin.

3. Cut a strip of thin card about two inches wide and long enough to reach around the tuber. Leave ½ inch of clay all around between the card and the tuber. Apply vaseline to the inside of this band, pin the overlapping ends, and press it into the clay. This will act as a dam to contain the poured plaster that will form the first section of the mold (Fig. 3, left).

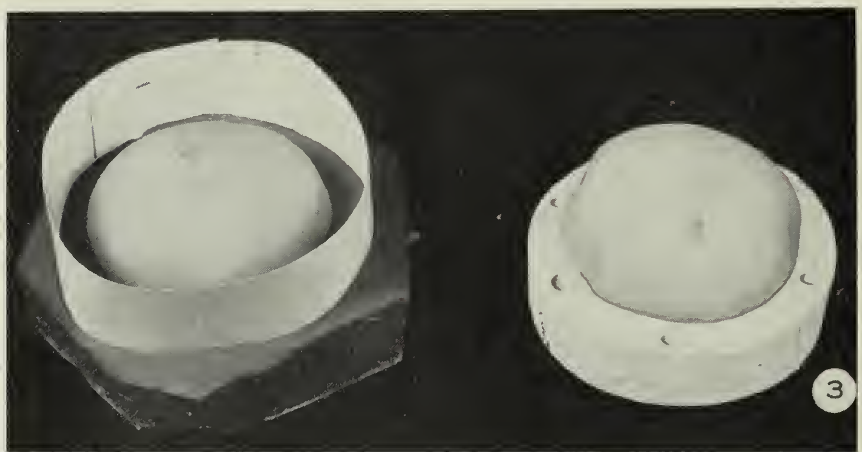

Figure 3
Left, potato tuber in clay with dam.
Right, first section with holes drilled for keys.

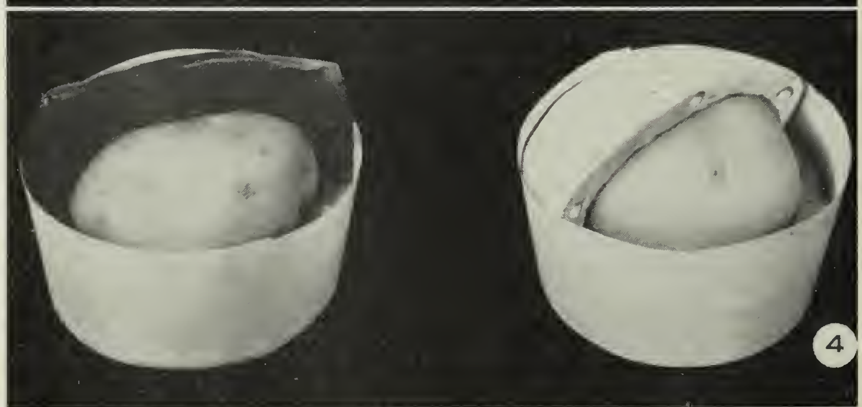

Figure 4
Left, mold ready for second pour.
Right, mold ready for third pour.

Figure 5
Open mold showing pouring opening and holes for holding staple

4. Pour water (about 4 ounces for an average tuber) into a flat bowl and sift in twice the weight of plaster, more or less, depending on the type of plaster used. Let it stand for one minute, or until the water seeps throughout the plaster. Stir carefully to avoid trapping air bubbles until a smooth, creamy consistency is obtained. Use a brush and apply a thin coat of plaster over the exposed part of the tuber. This will avoid bubbles when pouring the balance of the plaster to a thickness of about $\frac{3}{8}$ inch. Keep the plaster uniformly thick for each section of the mold. A thick area of plaster is likely to form a chalky surface on the mold.

5. After the plaster sets (when it becomes warm), remove the paper dam and the clay from the tuber which remains fast in the plaster. With a $\frac{1}{4}$-inch bit, make six hemispherical cavities in the plaster around the tuber to form keys for the next pour. This ensures perfect alignment with other pieces of the mold (Fig. 3, right).

6. Apply a thin film of vaseline to the edges of the mold section, working it well into the key holes. This acts as a separator for the next pour of plaster. Pin a strip of card, with vaseline on the inside, around the mold section, and insert a clay dam to expose half of the portion of tuber that was not in the first mold section (Fig. 4, left).

7. Paint plaster over the exposed area of tuber and pour the second section. When this section becomes warm, remove the paper and the clay dam. Drill holes for keys in the newly exposed edge and apply vaseline. Place a vaselined strip of paper around the mold making it ready for the third pour (Fig. 4, right).

8. Pour the third section and when the plaster is warm trim all sutures until clean lines appear at the joins. Release the mold from the tuber by wedging a knife blade into the joins until they separate; the pieces can then be lifted off.

For a subject that will be fastened to the back of a display unit, carve a $\frac{1}{2}$-inch hole through the underside of the mold for pouring the wax. On each side of this hole, bore a small hole to carry a wire staple for supporting the finished wax cast in the display case. Bind the two small sections of the mold together with fine wire to protect the edges of the join (Fig. 5).

Two-piece Leaf Molds—For leaf molds, Coecal plaster lasts longer and gives better definition than white molding plaster. It takes only a small amount of the material to face the molds; ordinary white plaster may be used to build up the necessary bulk to give it strength and support.

To be efficient, leaf molds should fit a hand press (Fig. 6, p. 13), used for casting and made of uniform size with tin forms. For molds $2\frac{1}{2}$ by 5 inches by $2\frac{1}{2}$ inches high, cut two pieces of tin $15\frac{5}{8}$ inches long, one of them $1\frac{1}{4}$ inches wide and the other $2\frac{1}{2}$ inches wide. Cut a wood block to the above mold measurements. With a mallet and a vise, bend each tin strip separately around the block, overlapping the ends at the join (Fig. 6).

Select leaves with strong varietal characteristics, of normal size, and as fresh as possible. Leaves will stay fresh for a week or more if layered between wet paper in a tightly covered metal box and refrigerated at a few degrees above freezing. To make the molds, roll out a sheet of soft clay, cut it into pieces a little larger than the bases of the tin forms (do not use

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clay that is too sticky) and press a form lightly on the clay to mark the area within which the leaf or leaves are to be placed. Apply vaseline to the insides of the tin form.

When a single large leaf is used, place the petiole at one end of the mold. If you are making several small leaves in one mold, arrange them side by side with the petioles all one way. Model the clay under the leaves to support their natural shapes. Do not press the leaf or leaves into the clay but make sure all edges are in contact with it or plaster will run under when poured. If the leaf surfaces are soiled with clay, swab them clean with water. Place an elastic band or a cord around the narrower form, press it evenly into the clay.

Paint Coecal plaster quickly over the leaf surface to exclude air bubbles. Pour on about $\frac{1}{4}$ inch of Coecal plaster and fill the form with white plaster (small molds may be made entirely of Coecal). Just before the plaster begins to set, stroke off the top level with the tin form.

Remove the plaster from the form after it has set. Remove the clay from the leaf *very carefully* so as not to loosen any leaf surface from the plaster. Should this happen, you must fasten the leaf to the plaster evenly or a thick spot will result on the cast; thin a little bookbinders' paste with water and slide it in between the leaf and the plaster with a fine brush. Press the thumb on the leaf back of the loosened area to avoid lifting more leaf surface.

See that all the leaf edges are free from plaster that may have run under. Drill depressions for keys with a $\frac{1}{4}$-inch bit and apply vaseline to plaster surfaces with which the next plaster pour will come in contact.

Apply vaseline to the insides of the $2\frac{1}{2}$-inch-wide tin form and fit the form around the first piece of the mold surrounding the leaf, to contain the second pour of plaster.. Make sure the bottom of the tin form is even with the bottom of the plaster block and tie the form with wire or cord so that it fits tightly against it. Treat this second block the same as the first; after levelling the top, let stand until it sets.

When the plaster becomes warm, remove the tin, trim the join if necessary, and tap the mold along the join so that it may be pried apart with a knife. Remove the leaf from the mold, wipe any bits of plaster from the face, and bind the two halves together with fine wire to dry (Fig. 7.).

To make plaster molds for thin leaf casts, especially when the undersides will not show, use the following procedure. Remove the leaf from the mold piece after the first pour. Paint the plaster surface with a separator, Formula 32 (p. 68). Place the wide tin form in position and finish as described above. Cut a groove for the midrib wire in the under half of the mold.

Molds of Larvae—Thoroughly remove chemicals from preserved larvae before molding. It is much better to use living larvæ; any distortion in a preserved one will show in the mold. One of the difficulties is to keep the specimen from collapsing while making the mold. To obtain best results with large larvæ, place the living larvæ in cold water, bringing them slowly to a boil. Allow the water to cool with the larvae in it. Injecting absolute alcohol hypodermically through the anus will also harden the larvæ. Very small larvæ are best killed with ether.

Coecal dental plaster works well for molds of larvae. Cut a narrow strip of thin cardboard, apply vaseline to one side, overlap the ends and pin. Shape this dam so that it will surround the larvae evenly, and press the edge of the paper into a smooth piece of clay or plasticine. Pour plaster to fill the dam and level off the top, teasing any surface bubbles to the edge with a pin. With forceps, pick up a larva and, beginning at the caudal end, carefully lay it on its back in the plaster, sinking it evenly halfway. With the point of a pin, even the plaster where it touches the sides of the specimen. Allow the plaster to set, remove the paper dam, trim the plaster where necessary, and drill holes for keys.

Paint a thin film of vaseline on the mold edge and pin another dam around the mold. It is now ready for the second pour. Cover the larva with a thin coat of plaster, blowing to rid the surface of bubbles, and then pour the rest of the plaster; alternatively the larva may be painted lightly with thin plaster and the pour made.

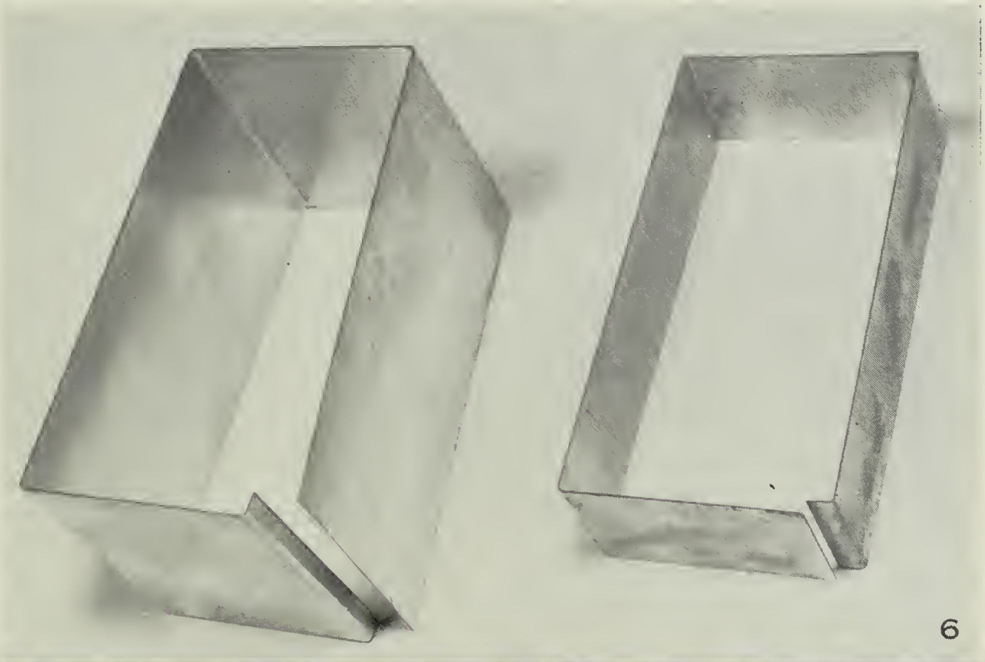


Figure 6
Tin forms for leaf mold.

Figure 7
Plaster mold of leaf.

When the second pour has set, separate the mold by wedging it apart with a knife. Scribe a fine channel with a scalpel point from the head to the edge of the mold to allow air to escape when injecting hot wax. Carve a funnel-shaped opening in the caudal end of the mold for injecting the wax.

Preparing Plaster Slabs

Use two pieces of plate glass and four spacer blocks of the required thickness. Mix plaster free of bubbles and to creamy consistency. Pour the plaster on one of the pieces of glass, to slightly more than the thickness desired. Make a high ridge down the middle so that the second piece of glass, when pressed on the plaster until it rests on the spacer blocks, will not trap air bubbles. No separator is needed. Allow the plaster to set fully before sliding the glass off. Cut and shape the slabs soon after freeing. When dry, they may be impregnated with thin Gelva solution, Formula 12 (p. 63). These slabs are useful for mounting small insects and showing life histories in exhibits.

FLEXIBLE MOLDS

Latex Molds: Description and Uses—Latex is made from the milky juice of rubber trees. For molds, natural latex is processed in such a manner that it will dry or vulcanize without heat. It is one of the best mediums for flexible molds, giving even better definition than plaster. Another advantage over plaster is the absence of troublesome flanges resulting from joins. It is not always possible to eliminate the flanges on wax casts made from plaster molds; with rubber molds the only openings are at the back where they do not show.

Preparing the Latex Mold—The following is the procedure for preparing a latex mold of a potato tuber. Prepare a base on which to mount the potato tuber. The tuber needs to be mounted so that all the skin is exposed; the latex must not be touched with the fingers when it is drying. For a medium-sized tuber, cut a piece of galvanized iron sheeting 2 by $2\frac{3}{8}$ inches. Trim one end to conform with the contour of the underside of the tuber. Bend the opposite end of the sheet to make a right-angled flange $\frac{3}{8}$ inch wide. Tack the sheet to a wooden block big enough to hold the tuber firmly when mounted on the tin.

Cut two pieces of 18-gauge wire 2 inches long, and solder them vertically to the free end of the tin; keep them $\frac{7}{8}$ inch apart and projecting $\frac{3}{4}$ inch above the tin. Besides acting as a support for the tuber, these wires will leave two holes in the mold for receiving a wire staple when casting; it is used to fasten the cast in a display unit.

To complete the base, cut a $\frac{3}{4}$-inch cork stopper in half lengthwise and fasten one half to the metal between the wires with Duco cement. Leave the small end up and trim to fit against the tuber. The cork forms

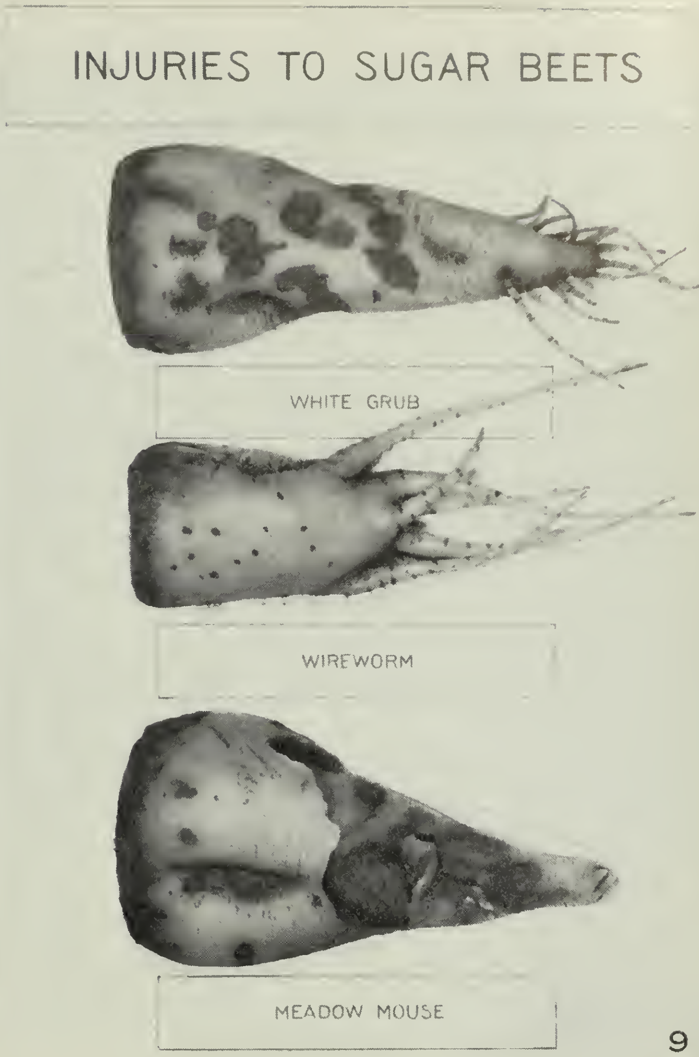


***Figure* 8—Rubber mold in plaster jacket showing treatment of undercuts in a sugar beet.**

***Figure* 9—Exhibit of injuries to sugar beets. The lower model was cast hollow from the rubber mold illustrated in Fig. 8 (Displayed in Science Service Building, Ottawa.)**

a hole in the bottom of the mold through which to pour the casting medium (Fig. 10, left). Press the two projecting wires into the tuber until the metal sheet comes in contact with the skin, but without cutting it (Fig. 10, right).

Use only a 1 per cent aqueous solution of ammonia for thinning; do not dilute latex unless it is necessary to pour or spray it. Between coats, brushes may be left in the ammonia solution or in a 10 per cent solution of soap flakes in water. After applying the coats of latex soak the brush in carbon tetrachloride and remove the latex by scraping should it become fllled with partly dried rubber.

No separator is needed when applying latex to a potato tuber; it is applied directly to the tuber. Six coats should be sufficient depending on the thickness of each.

Apply the first coat evenly with a soft bristle brush or your finger over the entire surface, and about one inch down the tin and the cork. Drying time between coats depends on the thickness of the coat applied. To determine when to apply the next coat, press a hard object into the drying latex. If the impression disappears, the rubber is dry. Should the mark remain, let the rubber dry longer. Apply additional coats similarly, making each coat even with your finger. Allow two or three days for final drying; pull out the wires and the tin, leaving the tuber on the mold.

The next step is to prepare a plaster jacket, or "mother mold". This is a 3-piece jacket to support the latex mold for casting in it. Cover the mold with moist tissue paper and with the pouring hole at the top and the tuber still inside, embed the mold to half its depth in moist clay (Fig. 11, left). Cut a strip of thin cardboard wide enough to be level with the highest part of the mold when the cardboard is pressed into the clay. Apply vaseline to the inner side of the carboard, overlap the ends and pin to form a ring large enough to expose $\frac{3}{8}$ inch of clay all around the mold. Push the cardboard into the clay. Cut a thin strip of clay and press it upright against the mold to act as a dam to retain the plaster when poured on half the surface of rubber above the clay base. It is now ready for the first pour (Fig. 11, right).

Pour the plaster. When it sets, remove the paper containing-ring and the clay dam. Bore four hemispherical holes in the edge of this section of the plaster mold and apply vaseline as a separator. Place a strip of vaselined paper as before around the rubber mold (Fig. 12, left). Pour the plaster for the second section. When it has set, remove the strip of paper and peel off the clay. Drill holes as before in the edges of the two sections and apply vaseline as a separator (Fig. 12, right).

Place a paper dam around the mold, exposing the rubber that has not yet been covered. Pour the plaster for the third section. When it sets,

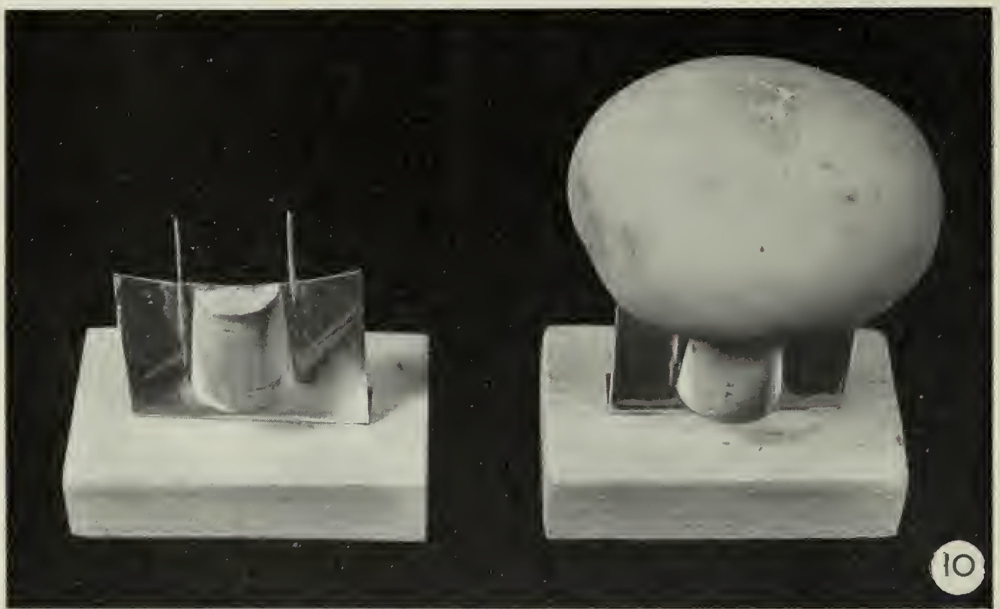


Figure 10
First stage in preparing a rubber mold.
Left, tin on wood base with wires for mounting tuber.
Right, tuber mounted ready for applying latex.

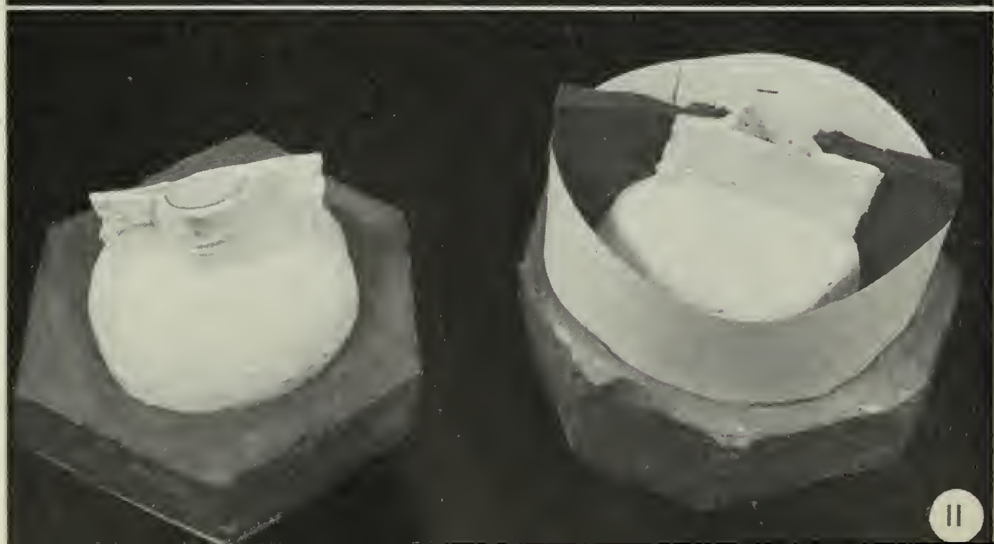
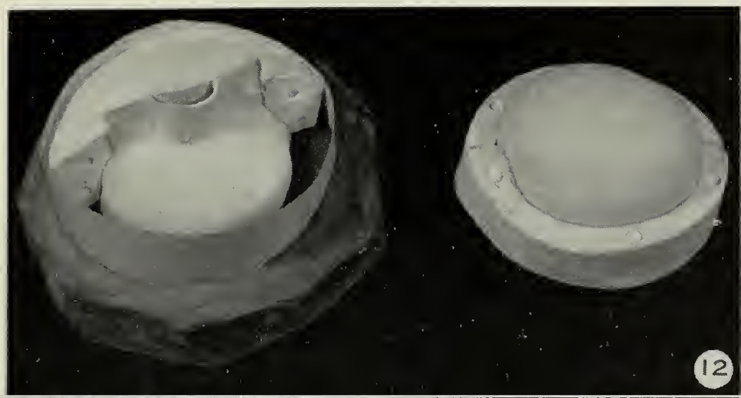


Figure 11
Left, rubber mold on tuber embedded in clay.
Right, ready for first plaster pour for the mother mold.



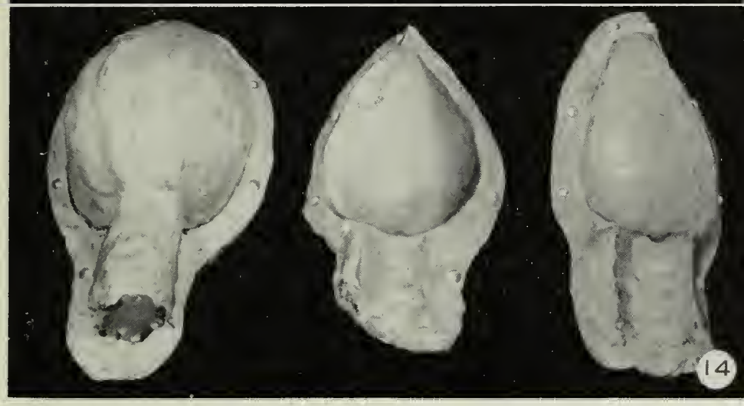



***Figure 12*—Left, mold ready for second pour. Right, with keyholes for third pour.**

***Figure 13*—Left, plaster jacket complete. Right, rubber mold is removed from tuber.**

***Figure 14*—Rubber mold of cabbage head filled with plaster to prevent shrinkage in storage. Plaster jacket in sections.**

***Figure 15*—Plaster casts showing one enlargement from a rubber mold.**

remove the rubber mold (which is still on the tuber) from the plaster jacket. The rubber mold and the plaster jacket are now complete (Fig. 13, left). Dust talc over the outside of the rubber to prevent it from sticking while it is being removed; this is important. Remove the mold from the tuber (Fig. 13, right).

Place the two small sections of the plaster jacket together over that part of the rubber mold on which they were made. Fasten the plaster sections together by bending a wire around them. Fit the large plaster section into place taking care not to buckle the rubber. Then with a wire around the whole jacket, fasten it together. If storing the mold, fill it with liquid plaster to avoid shrinkage (Fig. 14).

No reinforcements are necessary for small rubber molds. Pre-shrunk flannel or absorbent cotton is best for medium-sized molds and moistened burlap for large ones. When casting mâché from a rubber mold, moisten the face of the mold with water to which has been added 1 per cent water softener, a detergent. Separators are needed when casting latex positives from latex negatives. To prevent sticking, dust talc on the face of the mold or apply shellac.

Do not use oily lubricants on an object from which a latex mold is to be made; latex swells if added over oil. Latex molds last about 10 years if properly stored. Keeping them in a cool, dark place adds to their usefulness. They shrink some and become hard in 15 to 20 years.

Reid (31) has recently perfected a new method of preparing latex casts from plaster molds. Latex called CA-132 is thoroughly mixed with filler CA-132, and allowed to stand twelve to twenty-four hours to rid the mix of air bubbles. Increasing the proportion of latex results in a rubbery casting; increasing the proportion of filler produces a heavier more rigid casting. Plaster piece-molds are made in the usual manner, having the pouring hole at the highest point. Place a ring of clay around the hole to form a reservoir and make an air hole just outside this ring.

The moisture in the casting material is absorbed into the plaster mold, drawing with it fine particles of the latex compound which are deposited upon the face of the mold, giving perfect detail. These build up on each other, and in about thirty minutes form a skin about $\frac{1}{32}$ to $\frac{1}{16}$ inch thick (which is sufficient for most castings). Keep the mold filled until the desired build-up is attained on the face of the mold.

Clean any partly-set casting material from the pouring hole and the air vent. Pour out the remaining liquid part of the casting compound and store if desired for future use. Invert the mold to drain overnight then pry it apart, leaving the cast in one half of the mold. The cast is quite rubbery at this stage and is easily deformed if handled. If this occurs, restore its shape by blowing gently through the pouring hole. Allow the exposed surface of the mold to dry for about four hours before removing from the other half of the mold. Suspend the cast by a string tied around the pouring nipple for twenty-four hours to dry completely.

This latex may also be used for preparing rubber molds by von Fuehrer's method. Von Fuehrer (45, 46) also had instructions mimeographed dealing with construction and uses of flexible molds in which he described his discovery of a method to enlarge rubber molds.

Enlarging Rubber Molds—Enlarging rubber molds by soaking them in oil makes it possible to obtain enlarged casts of various objects, keeping details and proportions correct. Use of this procedure rather than the usual method of preparing enlargements by modelling would save much time.

To enlarge a rubber mold submerge it in kerosene for 24 hours, or until it distends fully. If it is removed from the oil before it distends completely, the proportions will not be correct. The degree of enlargement at one time is about 60 per cent. Rubber molds treated with heavier oils lose their toughness and tear easily. If kerosene, gasoline, or carbon tetrachloride is used for enlarging, the enlarged mold retains more of its original strength.

By the time the mold has fully enlarged it has lost its elasticity and acquired a metallic quality, but is still tough enough to use. Drain all oil from the mold and place it in cold water to become more rigid.

Casting in Plaster from Enlarged Molds—The mold shrinks when removed from the oil bath. Casting materials should therefore be ready so that casting may be done as quickly as possible. Pouring fine sand around a very small mold may hold it in shape but larger ones may need a thin coat of quick-setting plaster poured on the outside.

Do not apply the first coat of plaster with a brush but flow it into place because the mold is very tender. Be careful not to trap air bubbles in the plaster. A second rubber mold may be made over the plaster cast and be enlarged by the same method. This technique of enlarging the rubber mold and casting in plaster may be repeated until the desired size of model is obtained (Fig. 15). The larger the rubber mold, the thicker it must be.

A rubber mold may also be enlarged by dipping it in benzene, and then exposing it to benzene fumes by placing it on a glass platform just above the liquid in a tight jar. This method gives about 50 per cent expansion in six to seven hours. Contraction, however, is more rapid than in the kerosene-enlarged molds. Have the casting plaster ready to use immediately when the mold is removed from the benzene jar.

Gelatin Molds—This is a quick method of preparing a flexible mold when only a few casts are needed. It produces fine detail and may be used over a rough, uneven subject.

Fasten the object over which a mold is to be made to a base so that it will not float when the mold material is poured over it. To contain the getatin as it is poured, make a form of cardboard around the model, sufficiently rigid to hold its shape and place. Leave a space of about ¾ inch between the form and the subject. Use casting gelatin that is sold to plasterers for making ornamental molds.

Wet the gelatin in a 90 per cent water and 10 per cent gelatin solution by weight adding as a preservative 1 per cent of zinc sulphate or 1 fluid dram of phenol per gallon of gelatin. Use 10 to 20 per cent of the liquid with the gelatin by weight. When thoroughly wetted, heat it in a steam- or a water-jacketted kettle to not over 140° F until the gelatin has melted. Before pouring, raise the temperature until the gelatin liquefies. Allow time for bubbles to rise, skim them off and pour the gelatin over the subject filling the form.

When the mold has cooled, remove the cardboard form and slit one side of the mold to release the subject. With a soft brush, carefully paint on two or three applications of 5 per cent formaldehyde solution if hot wax is to be used in casting. Formaldehyde-hardened gelatin cannot be remelted.

Make a removable plaster jacket around the mold and obtain desired casts as soon as possible; formaldehyde will act on the gelatin and make the surface granular in a few days.

METAL MOLDS: for casting leaves in plastic

Metal molds are sometimes used in casting deciduous leaves in plastic. The technique of making and using such molds is discussed briefly. As with plaster, metal molds may be made of one or both leaf surfaces.

Preparing Impressions of Both Leaf Surfaces—Make a 2-piece plaster mold as described for leaf molds (p. 11). Prepare a wooden frame without a bottom, about one inch longer and wider inside than the mold, and as high as the double mold. Place one section of the plaster mold on a sheet

Figure 16
Impression in molders' sand from mold on leaf.

of glass, with the leaf impression up, and arrange the wooden frame around it, leaving equal spaces on all sides. Use fine molders' sand. Moisten the sand enough that it will hold together when pressed between the thumb and finger, yet will still crumble. Sprinkle sand on the face of the mold and fill in around it, packing tightly. Press the sand firmly into the plaster impression and continue packing in sand until the frame is full. Scrape the top level with the frame. Holding the frame and the glass together, turn them over and slide the glass off. Remove a little sand at the edges of the mold and lift it out carefully without disturbing the impression (Fig. 16).

The sand impression is now ready for the first pour. Babbit metal or antimonial lead may be used. Babbit metal is cheaper and gives good results. Heat the metal in an iron ladle over a gas flame but *do not let the metal become too hot;* some of the alloy will be burned out and the mold will show porous areas on the surface. Skim off the sludge. Test the molten

Figure 17
Metal mold complete.

metal for casting temperature by dipping a piece of white paper into the melted metal momentarily. The paper should not burn, but turn yellow. *Be careful that no free water comes in contact with the molten metal or it will explode.* Pour the metal on one section of the impression, beginning carefully at the base and filing the cavity left by the plaster mold.

Let the metal cool and remove it from the sand. Repeat the above operation with the other section of the plaster mold and the two sections of metal will fit together as did the plaster mold (Fig. 17).

Caution: Any disturbance of the impression of the plaster mold in the sand, before or during casting, will prevent the two pieces of the metal mold from fitting together.

***Figure 18*—Metal mold is smoked to form a separater for the second pour.**

Preparing Impression of One Leaf Surface—Make one half of the metal mold exactly as described above, using the section of plaster mold of the desired surface.

When it is cold, smoke the impression surface by holding it over a burning cotton cloth previously saturated with turpentine (Fig. 18) This will act as a separator when the pour for the next section is made.

Cut a strip of asbestos paper twice as wide as the height of the metal section and bind it around the metal, leaving the smoked impression up. The asbestos will contain the molten metal until it cools. Be sure the metal section is cool and dry; then pour the metal, filling the asbestos ring. *Never pour molten metal on a hot mold surface because it will stick.*

Casting in Sheet Plastic from Metal Molds

Metal molds will not give the minute detail obtained by casting liquid plastic from plaster molds. However, where large numbers of leaves are needed, as in group exhibits, casting sheet plastic from metal molds is fast and useful.

Casting Plastic Leaves from a Cold Metal Mold—Use molds that have been prepared by the method described under the above heading "Preparing Impression of One Leaf Surface".

Cut a piece of sheet cellulose nitrate, .005 or .001 inch thick and slightly larger than the mold. Place it in a cold bath, Formula 46 (p. 70). When the sheet becomes rubbery, remove and wash it quickly in cold water. Quickly remove all water, using absorbent cotton. Complete removal of water is important to prevent defects in the cast. Place the sheet between the two halves of the mold, with the keys matching, and clamp the mold in a vise until the plastic has set. Fifteen minutes or more are necessary. Trim the edges of the impression. If it is difficult to follow the edges on the clear cast, spray paint lightly on one side to bring out the detail.

Casting Plastic Leaves from a Hot Metal Mold—Use iron tongs to hold the two halves of the mold together to keep the section in alignment and act as a handle to remove them from a boiling water bath. Tongs must be large enough to fit either end of the mold when the two sections are together. Solder the jaws of the tongs to the mold sections while the mold is closed and the keys registering perfectly. Cut a piece of sheet cellulose nitrate or acetate slightly larger than the mold, and place it on the leaf impression. Over this lay a piece of thin rubber (cut from a tire inner tube to the size of the plastic sheet) place the other half of the metal mold in position and clamp the mold shut. Place a ring tightly over the ends of the tong handles to hold the mold shut. Immerse the mold in boiling water until the plastic becomes soft. Then clamp the mold in a vice for ten seconds, change ends and clamp again. Glycerin in a double boiler with sand in the bottom section of the boiler will provide greater heat.

Casting Plastic Leaves from a Metal Mold in a Hydraulic Press—A hydraulic press with controlled pressure from 10,000 to 30,000 pounds per square inch is needed. Leaf casts of good detail are rapidly produced. Tool out a channel for the midrib wire in the under section of the mold, place a wire in the groove and put the mold on a hot plate. Place tenite plastic in sheet or granular form over the impression in the mold over the wire, close the mold and position in the hydraulic press. While in the press, the plastic becomes softened to such a degree that it flows into all details. The wire for the petiole and midrib will be firmly embedded in plastic.

CASTING IN WAX

Casting in wax plays an important part in preparing exhibits. Fruit, vegetables, and the larvae of insects reproduced by this method are more lifelike than when cast in plastic or plaster. Foliage also may be successfully cast in wax; fewer molds are needed because it is possible to alter the shape of casts after they are made. Casting in wax involves making a mold or negative of the original object and pouring wax into it to obtain a positive.

Fruits and Vegetables in Wax

The proper separator to release wax casts from plaster molds should be chosen. No separating agent is needed for molds made with Coecal plaster heated in water but one should be used for white molding plaster. Use Formula 37 (p. 69).

Melt pure, refined white beeswax in a double boiler. Turn the heat to low when the wax has melted. Tint the hot wax by thinning tube oil color with turpentine and stirring it into the wax. Formerly balsam was added to beeswax to temper the casts and make them less brittle; but, contrary to expectations, as the casts aged the balsam-treated wax became more brittle than untreated wax. Before casting, check the following points and little difficulty should arise: adjust the room temperature to 80° F, and the wax temperature to 158° F; soak the plaster molds for at least 30 minutes in water held at 128° F. If the molds are made of white plaster, add the soap solution a few minutes before casting. Have a supply of special staples ready to anchor one in each cast. For a small cast such as of an apple or a potato, make the staple from a 3-inch piece of 18-gauge wire (bend the ends at right angles to the center part). The crosspiece of the staple should be $\frac{7}{8}$ inch long. Apply shellac to the crosspiece and bind cotton around it.

Casting Solid—To cast, remove the mold from the hot water and swab the inside with cheesecloth dipped in hot water and wrung out. Insert the prongs of the staple from the inside of the mold through the holes prepared to receive them, leaving the cotton-wound crosspiece projecting into the mold $\frac{1}{4}$ inch or more to make sure that the staple will be well anchored in the cast. Assemble the mold hot and, with a ladle large enough to fill it in one pour, fill the mold. It is usually necessary to add a little wax as it cools.

Casting Hollow—The procedure for casting hollow is the same as for making a solid cast up to the time the mold is filled with wax; wait a moment and then pour out nearly half. A good way to judge the quantity removed is to pour it back into the ladle. Stop the hole with a cotton plug held by the thumb and rotate the mold in every direction; the wax will cool in an even layer over the entire mold. Open the hole from time to time during the early part of the rotation to allow heated air to escape. Continue rotating for a short time after no liquid is heard when the mold is shaken.

Release solid or hollow casts when the wax has set but is still rather warm. Remove the wire holding the mold pieces and pry the pieces apart slightly with a knife to loosen them from the cast. If a small cast sticks in a piece of the mold, hold the cast in the hand between thumb and fingers and just above the palm. Tap the mold gently with a wooden mallet or a small hammer; this will usually release the cast. A slight flange is left on the cast where the mold pieces join. Remove this while the wax is still warm, with a spatula, modelling tool or other instrument. If any disfigurement remains, dip your finger in carbon tetrachloride and rub it along the tooled area. Do not remove any wax from either side of the flange. Rest the cooling wax cast on two wooden blocks, with the staple between, until the wax is cold.

To make a hollow cast that will be viewed from all sides, fill one half of the mold with wax and replace the other half. Rotate until the wax sets. Even with this method it is necessary to make a small hole in the mold which you can open occasionally to release hot, expanded air; otherwise it will force its way out between the joints and ruin the cast.

Causes of Difficulty in Casting in Wax

- If the cast sticks to the mold, the wax or the mold is too hot or the mold has not been thoroughly soaked.
- If there are cracks in the cast, a draft chilled the mold on one side while the wax was cooling.
- Pits in the surface of the cast are caused by droplets of water left on the mold.
- If there are waves on the cast, the mold or the wax has been too cool, or the wax has not been poured fast enough.

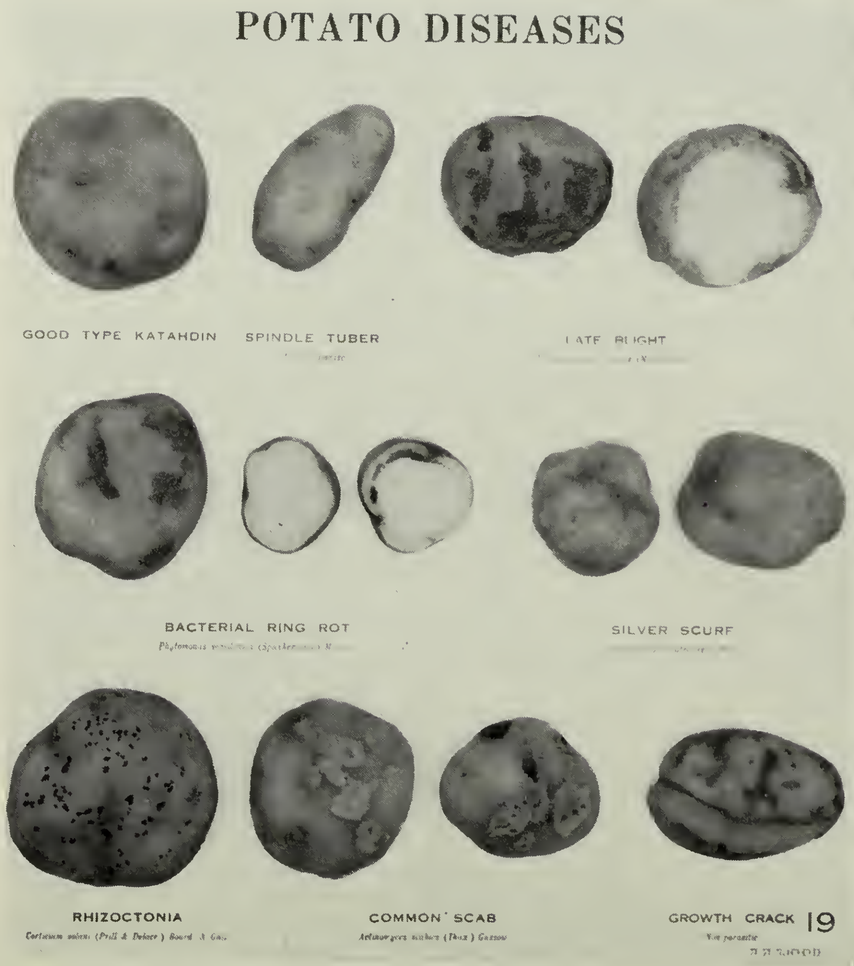


Figure 19—**Exhibit of potato diseases. Tuber cast hollow from rubber molds. (Displayed in Science Service Building, Ottawa.)**

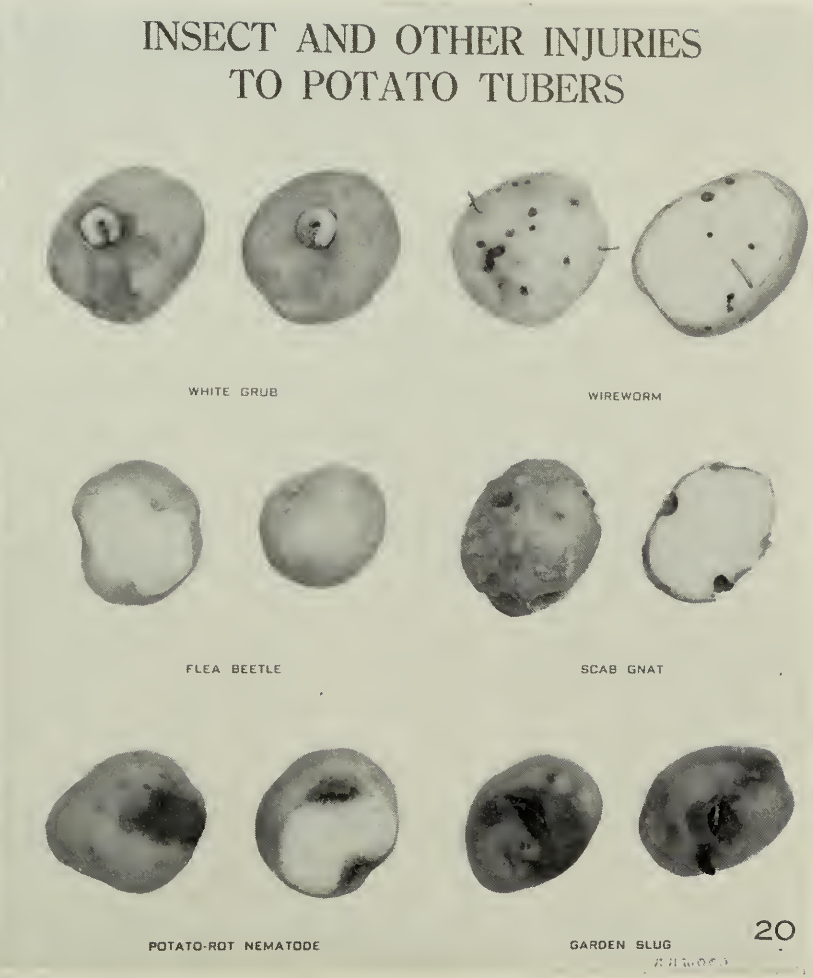


Figure 20—**Exhibit of insect and other injuries to potato tubers. Cast hollow from plaster molds. (Displayed in Science Service Building, Ottawa.)**

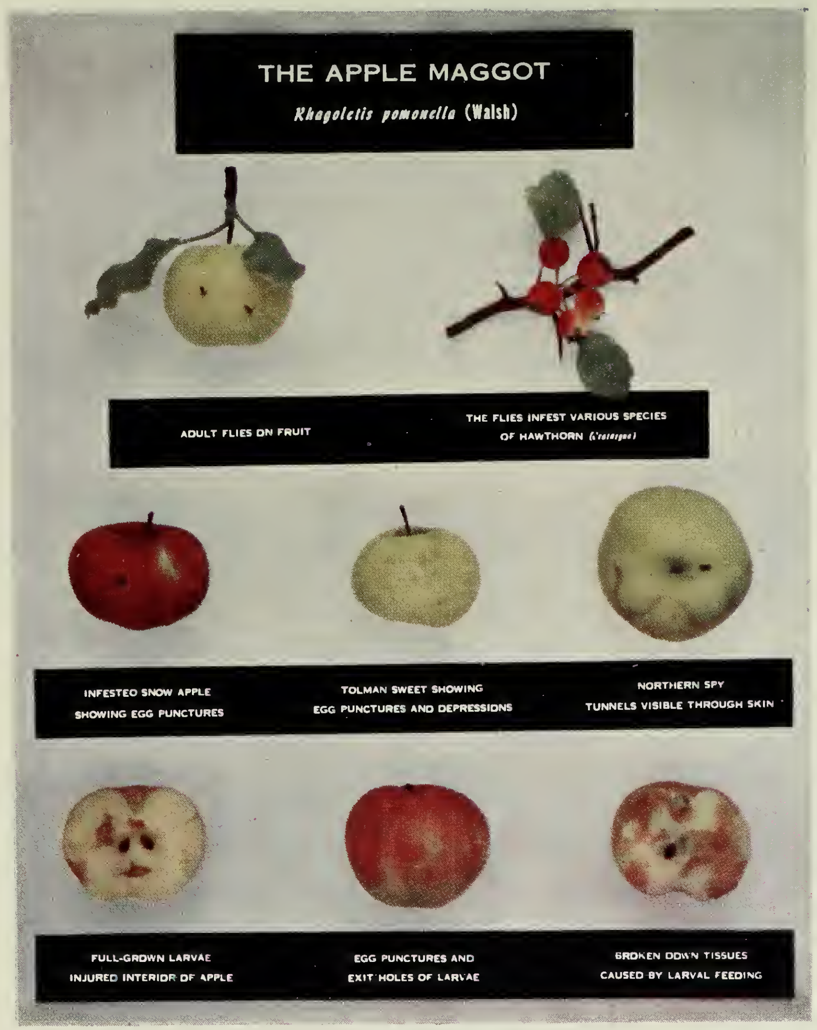


Figure 21—Exhibit of the apple maggot. Cast hollow from plaster molds. (Displayed in Science Service Building, Ottawa.)

Figure 22—Exhibit of some pests of the tomato. All in wax. (Displayed in Science Service Building, Ottawa.)

Leaves and Petals in Wax

Presses are used to make leaves in wax by pressure. To reproduce a branch in wax, it is not necessary to use as large a series of leaf molds as for casting in plastic. You may choose a few sizes and alter their shapes after casting.

The press discussed is essentially the same as that described by Rowley (35) except that the handle hinge has been changed to eliminate excess sliding of the top section of the mold when the lever is worked (Fig. 60, p. 73).

The sub-base is $4\frac{1}{4}$ by 12 by $\frac{3}{4}$ inches. On this is screwed the base, $3\frac{1}{4}$ by 10 by $1\frac{1}{8}$ inches. The basal ends of two $\frac{3}{16}$-inch drill bits, are sunk into the base, allowing the tapered butts to project $\frac{3}{8}$ inch. Two $\frac{1}{2}$-inch bolts come up through one end of the base.

The upper lever is made adjustable to fit molds of varying thicknesses by hinging it to a block of the same thickness ($1\frac{1}{4}$ inches) which works up and down on the two $\frac{1}{2}$-inch bolts. Four wing nuts on the bolts regulate the height. Pointed bolts on each side of the lever hold the upper half of the mold in place. A template of sheet metal fits over the two drill points in the base. This template is used when boring holes in the bottom of the mold.

To adjust the press, place the mold on the base with the two drill points fitting into the holes. Lower the lever, with the mold between the two horizontal bolts, and adjust the wing nuts until the lever rests evenly on the mold. Tighten the two bolts on to the sides of the mold while holding the lever down tightly with the chest.

Taper wires for the midribs by tying a number together and dipping the tips in acid for a moment; use hydrochloric acid for iron wire and nitric acid for copper and monel wires. Tin copper wires or verdigris will form on them. After dipping the wires in acid, wash and dip them in molten solder. Wipe them quickly with waxed cloth to smooth the solder. A

Figure **23—Wire and cotton on leaf mold ready to cast in wax.**

Figure **24—Wax leaves. Left, as leaf comes from the press. Right, the edges trimmed**

***Figure* 25**
Rolling to thin the edge of a wax leaf.

section of metal pipe will hold solder at melting temperature over a gas jet. Dip the wires in shellac and cover them thinly with absorbent cotton.

Keep the room temperature at 85° F, the wax at 162° F, and the water for soaking molds at 130° F. Such high temperatures are necessary in casting leaves because the thin film of wax cools much more rapidly than the bulk wax poured in casting heavy objects. Soak the molds in hot water for 30 minutes, remove, and blow the moisture off the faces of the mold. Fasten the mold in the press. Lay a thin film of cotton over the midrib groove, with the fibres crosswise. Place the wire in the midrib groove with about one third of its length from the base and over the cotton. Apply another sheet of cotton over the entire impression, keeping it away from the keys and the edges of the mold beyond the impression. Use a maximum of cotton (Fig. 23). Quickly pour hot wax over the cotton and immediately bring down firmly the lever with the upper half of the mold. Raise the lever and usually both halves of the mold will come up together. If they do, pry them apart and remove the cast (Fig. 24, left). Before casting the next leaf put the mold back in hot water or close it on a pad of cheesecloth previously soaked in hot water.

As it comes from the press the cast leaf has a waste margin which must be trimmed. Trimming is simple for leaves with a plain edge but one that has serrations must be carefully notched as in the cast. Different edges require different methods in shaping, but the pattern must be followed exactly using fine scissors, razor-blade splinters (narrow cutting edges of the blade) in holders, or a warm notching tool. Make all cuts firmly against the impression; any parts of waste edge left will show especially if the leaf is sprayed for colour (Fig. 24, right).

Thin the cut edge of the leaf with a modelling tool, either a small wooden cylinder rounded at the end or the head of a hat pin. The latter tool is more apt to cause gloss (Fig. 25.).

Causes of Difficulty in Casting Leaves in Wax

- If casts stick to the mold, the mold has not been thoroughly soaked, or the mold or the wax was too hot.
- If casts are imperfectly filled out, too little wax was poured on the mold, or the cotton was wet.

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- Pits on the cast surface are caused by some water left on the mold.
- If wires pull out, the cotton was not firmly attached to the wire with shellac, or the cotton on the wire was wet.

Larvae in Wax

Immerse the molds in hot water for thirty minutes with the water temperature at 130° F. Heat the wax to 160° F; it cools much more rapidly when small amounts are used. Hang a pipette in the hot wax. Remove a mold from the hot water, blow water from the inside, and fit the two halves together, holding them tightly between thumb and fingers. Take up enough wax in the hot pipette to fill the mold, and inject it quickly. Release the cast in a very few minutes. Before the wax cools, carefully remove the funnel-shaped piece of wax on the pouring end of the cast (made by the injection opening) and the flanges on the sides. Use a lens for final shaping (Fig. 26.) Some casts of larvae may be improved by removing the head and substituting natural ones that have been dehydrated and impregnated with wax by boiling gently. A portion of the skin with the six legs may also be used in this way.

A Note on Plaster Casts—If a separator, Formulae 32 to 36 (pp. 68 and 69), is used, it is possible to release plaster casts from plaster molds that have no undercuts. Plaster casts are easily chipped, but you can strengthen them in a thin solution of Gelva, Formula 12 (p. 63).

CASTING IN PLASTICS

The Walters Method

Description and Uses—The plastic used is cellulose nitrate or cellulose acetate. Both celluloids are inflammable but the nitrate requires greater care in this respect; the acetate is more difficult to handle in other ways. Dissolve pieces of the cellulose sheets in amyl acetate or butyl acetate and keep the jars stoppered tightly to prevent evaporation. To retard setting, add 20 per cent diacetone alcohol to one of the solvents. Acetone dissolves celluloid, but is apt to leave a foggy film and cause weaker casts.

Paint the plastic solution on plaster molds that have been sized with glue. Release the molds by soaking them in cold water to soften the glue. This method of casting produces sharp detail, casts have a lifelike texture and are pliable and strong. Walters (48), commenting on the use of plastic in casting, draws attention to the importance of correct colour tints and degree of translucence to give a natural appearance to the finished cast. He accomplishes this by adding the correct tint to the translucent medium that form various layers applied in building up the cast.

The method has been adapted, especially at the Chatham laboratory to reproduce deciduous foliage and, to some extent, hairless larvae. Whole onion plants have also been cast successfully. Plastic casts obtained have proved much superior to those made with wax both in detail and in durability.

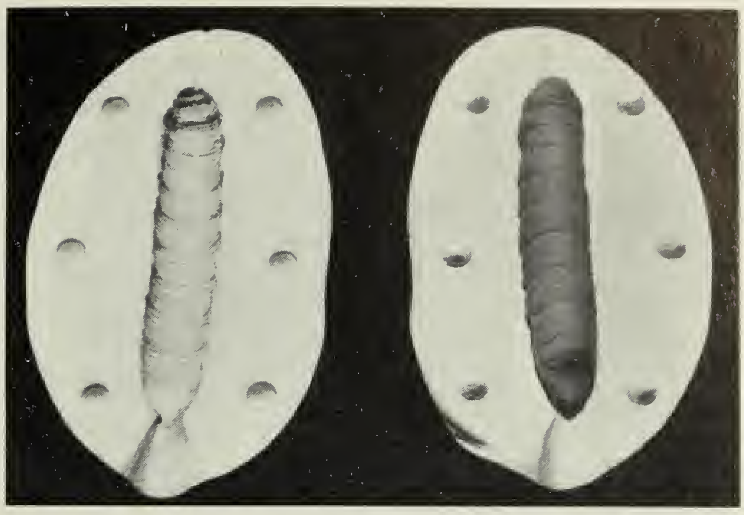

Figure 26
Wax larva cast in plaster mold.

Preparing Waste Molds of Leaves in Plaster—It is important to use plaster giving a hard, dense surface. Probably the best Canadian plaster available for this work is Hammer Brand Molding Plaster. In preparing leaf molds, use fresh crisp leaves whenever possible. Lightly coat the reverse side of the leaf with plaster and let it set. Add successive thin coats to avoid flattening any parts of the leaf. When sufficient plaster has been applied, turn the leaf over and lay it on a sheet of soft water clay. The plaster on the back holds the leaf in its natural shape until the mold is made.

Build up the clay along the edges of the leaf until a complete, narrow, flat border is formed. Pour water into a flat mixing bowl and sift in white molding plaster until it stands dry above the water. Use enough plaster to make the mold according to the size of the leaf, and about half as much water, by weight, as plaster. While the water is seeping through the plaster, use the thin portion around the edges to paint the entire leaf surface, thus avoiding air pockets between the leaf and the plaster. Mix the plaster in the bowl carefully without stirring in air. Pour the plaster over the leaf and on the narrow, flat border of clay. Have the plaster sufficiently thick so that it will not run on the surface of the mold. Large leaves such as corn or tobacco need reinforcements of string, cheesecloth, or wire through the mold. Allow the plaster to set. Trim the edges where necessary to form a smooth, narrow border around the impression. Remove the leaf and let the mold dry thoroughly.

Size the mold on the impression and the narrow border with three coats of 20 per cent liquid glue. Stop when the first sign of gloss appears on the dry surface. Remove any spots of gloss with a swab moistened with water or acetic acid. Let the mold dry for one week after sizing.

Casting Leaves with Liquid Cellulose Nitrate—When casts are to be made that will be viewed with transmitted light, any thick areas on the cast will show darker. Before sizing the mold, speckle it with India ink to make it easier to apply coats of even thickness; the spots will show through the first few coats (Fig. 27, upper).

To prepare the casting medium, use Formula 45 (p. 70). When the cellulose has dissolved completely, mix in the pigments. Use only high-grade artists' oil colors as they come from the tube without thinner. About

2 per cent pigment to dry weight of cellulose makes an average mixture. Do not add too much pigment to the medium because shrinkage in drying intensifies the color. If the plastic lacquer is cold, warm it gradually to 70° to 75° F; then it will spread more evenly.

Make small trial casts until the desired color is attained. Remove the cast as described later, and compare it with the natural leaf or a color sketch. When the color in the trial cast is satisfactory, mount it on a card together with the tints of liquid plastic used.

Practically all leaves have contrastingly colored midribs. Build these up with a number of light coats first. This may be accomplished by using masking tape. Lay a strip on each side of the groove and paint the liquid right over it. Remove the masks after each coat; the drying plastic will pull loose if you don't.

When casting the underside of a leaf with prominent midribs and veins, make sure that the grooves in the mold do not become bridged over. If they do, clean them out and start over because bubbles are sure to form under this condition. Better results will be obtained in this type of casting if you store the mold in a confined space between coats. This procedure produces better detail in casts that have decidedly uneven surfaces. As mentioned above, there is always danger of bubbles forming when casting a leaf with prominent narrow veins. When this trouble is expected, after the last coat is applied place the case on the mold in an air-tight box without solvent to dry slowly for three weeks. This treatment reduces the chance of bubbles forming in the cast. Partly open the box cover and leave the cast in the box for another week, then remove and dry thoroughly.

Dry casts of small leaves with normal veins in an open room free of drafts. Do not dry casts between coats in the sun or in currents of air.

Figure 27
Upper, plaster waste mold speckled with ink to aid in applying even coats of liquid plastic. Lower, plastic cast on the mold.

Do not allow a coat of plastic to dry too much before applying another or the cast may lift from the mold in places, leaving flat areas in the impression.

After applying the preliminary midrib coats, paint a coat of light green plastic over the entire mold surface then alternate with several deeper shades to give a lifelike appearance to the cast. When stickiness has disappeared from each of these coats, mask and paint another midrib color. Continue this until the midribs are just dense enough that the darker colors painted on them will not show through the finished cast. Then apply the blade colors over all finishing with a light tint.

In applying the coats, be careful not to wipe the high areas too thin. If the join with the midrib is too sharp, stipple with solvent to soften the effect. The period between coats varies and must be judged by the condition of the preceding one; apply another coat when the surface is no longer sticky. The cast must not dry too much before all the coats are completed. Turning the molds continually on an inclined turntable causes the plastic lacquer to lie evenly and not run into depressions, as often happens when the mold is left flat. To keep the plastic from flowing, molds may be turned upside down between some of the coats. When too much plastic flows into depressions, stipple it out with the brush while applying the coat.

When it is necessary to leave an unfinished cast overnight or for a few days, place it in an air-tight box with a little amyl acetate in an open dish to prevent the cast from drying. Too much solvent in the dish will cause the plastic to run. All stickiness should leave the cast before it is put in the box because it will not dry in it.

Releasing and Cleaning the Cast—Place the thoroughly dried cast and mold in cold water overnight. Remove the gloss from the last coat of plastic, while the cast is on the mold, with a natural-bristle toothbrush using ground pumice and water. The water softens the glue and allows the cast to be lifted from the mold. Brush off bits of plaster that have pulled from the mold using a brass brush such as is sold for cleaning suede shoes. The cast may appear clean when wet but have white spots of plaster showing when dry. If repeated brushings do not remove all the plaster, brush over with Formula 47 (p. 71), which makes the plaster transparent. Trim the waste plastic around the edges of the impression.

Retouching and Shaping—Leaves coming from the molds are usually complete and do not need added coloring. If retouching is needed, it is best to use Formula 48 (p. 71).

Properly made molds of leaves should produce casts that need no shaping. When necessary, you can reshape leaves in hot water. Then holding the leaf in the desired shape, immerse it in cold water. When cold the cast will retain the altered shape. Soften large leaves with steam applied through a hose to limited areas. It may be necessary to bind casts of large leaves to forms and steam them to shape, leaving them in position to cool. Cloths dipped in very hot water and applied to small areas will soften them sufficiently for shaping. Plastic casts changed in shape without using sufficient heat may return to the original form.

To remove gloss from the surface of a cast leaf, dip a brush in benzene, rub it on a cake of beeswax, and paint the glossy surface.

Figure 28—Exhibit of cabbage insects. In cellulose nitrate. (Displayed in Entomology Laboratory, Chatham, Ontario.)

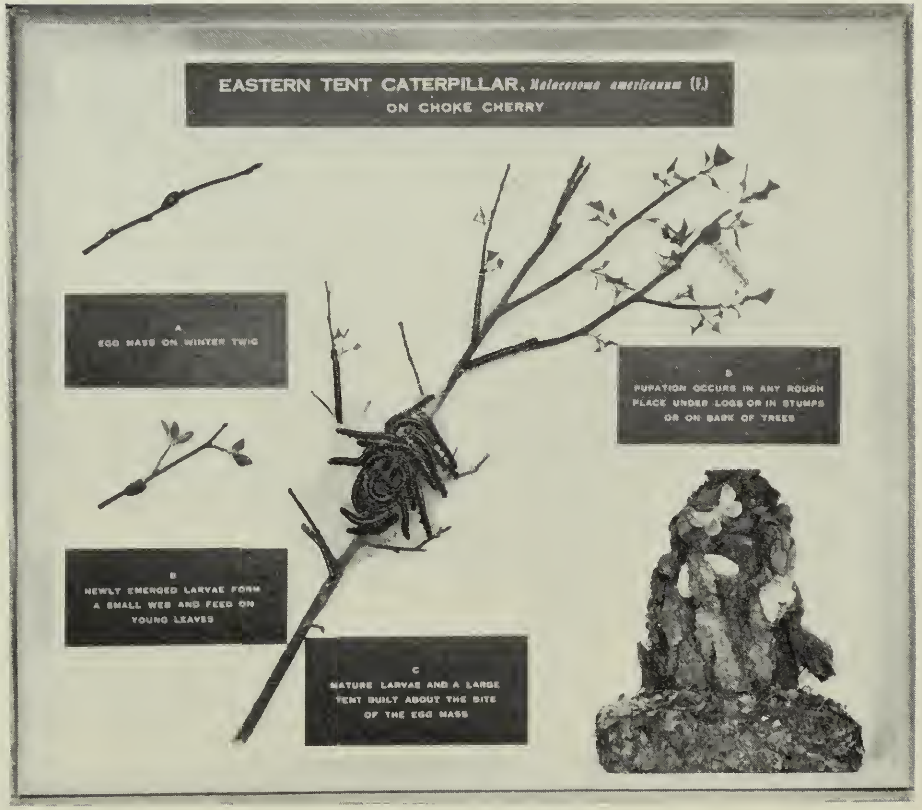

Figure 29—Exhibit of eastern tent caterpillar. Foliage in cellulose nitrate; branch in wax; larvæ inflated empty. (Displayed in Forest Insect Laboratory, Sault Ste. Marie, Ontario.)

Figure 30—Exhibit of the spinach leaf miner. In plastic. (Displayed in Science Service Building, Ottawa.)

Figure 31—Exhibit of the tomato hornworm on tobacco. Foliage in cellulose nitrate; eggs and larvæ in wax. (Displayed in Science Service Building, Ottawa.)

Casting in Plastic from Rubber Molds—Walters' method of casting leaves with liquid cellulose nitrate from rubber molds has been used with good results. Latex takes finer details than plaster and eliminates the extra work of removing plaster from the cast; it can be removed without a separator. The method has its limitations, however. It is more applicable to small leaves, because these may be fastened more securely than large ones to bases to counteract curling caused as the plastic dries and shrinks.

To avoid flat places on the mold, pour a "pancake" of plaster on glass. Lay the leaves in rows on the plaster but be careful not to trap air under the leaves. Make sure that all edges are in contact with the plaster. Let the plaster harden. Make the rubber mold in one sheet; no separator is needed.

Paint the coats of latex directly on the leaves and surrounding plaster, making the coats uniformly thick over the entire mold. Let each coat dry before applying the next one. While the second last coat is still tacky, sprinkle a layer of glass fibre or absorbent cotton on the mold for reinforcement; the final coat over this acts as a bond. Allow at least three days for drying before releasing the mold.

Before casting, tack the mold all around the edge on a thick plywood board; this avoids curling while the plastic cast is drying. Casting proceeds in the same manner as with plaster molds (Fig. 32.).

Cold Press Casting of Leaves and Petals

This method has been practised in several museums. Clear cellulose acetate sheet was used as the casting medium by some, but for large leaves or petals cellulose nitrate sheet makes stronger casts.

Preparing the Molds—Hang the leaves or petals individually in a row by running pins through the bases, exposing the undersides. Mix plaster, and paint these surfaces with successive coats until the plaster holds the leaves firmly in position. When the plaster has set, remove the leaves or petals. Roll out a sheet of soft water clay. Lay the plaster mold, from which the leaf or petal has been removed, face up on the clay. Model around the mold to form a smooth edge on the clay. Follow this procedure through the series. Place a dam or form around each mold to contain the plaster that will be poured.

Apply a separator, Formula 32 (p. 68), to the plaster. Paint thin plaster over the mold to exclude air bubbles and pour additional plaster to a depth of 1 inch. When the plaster has set, separate the pieces.

Casting—Prepare a lump of plasticine a little larger than the mold. Press the face of the last section of the mold poured into the plasticine until a good impression is formed. Cut a piece of cellulose nitrate sheet, .005 or .010 inch thick, slightly larger than the mold. Place it in a cold bath, Formula 46 (p. 70). When the sheet is limp and rubbery, dip it in cold water and quickly remove all water with absorbent cotton. *This is important.* Any water left on the plastic will cause defects on the cast. Place the sheet of plastic over the impression in the plasticine and press

Figure 32
Rubber mold for casting leaves in liquid plastic.

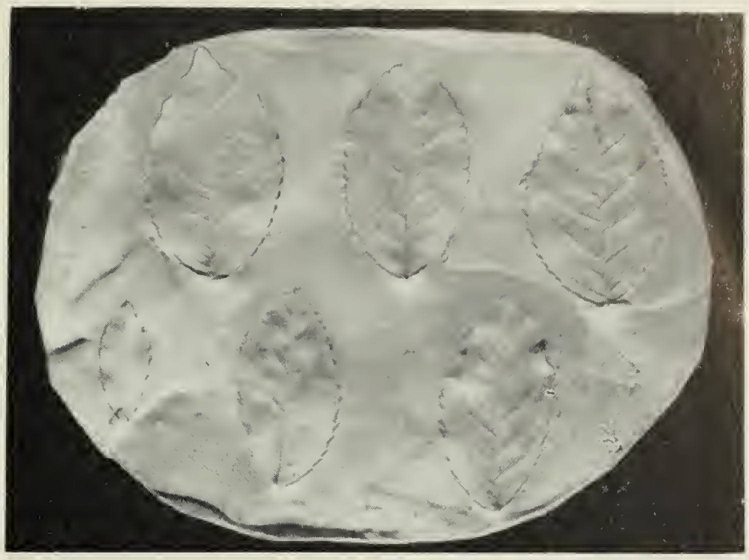

Figure 33
Cold-press casting in plastic. Plaster mold, plasticine, and cast leaf.

the mold firmly into it. Lay a weight on the mold and allow it to set; time needed is usually about fifteen minutes. Trim the waste edges. If the cast is a petal, it is ready for coloring. With leaf casts, fasten a plastic-coated wire on the back of the midrib base with Duco cement to form the petiole (Fig. 33.).

To color this type of cast, use artists' tube oil colors thinned with spirits of turpentine. If no gloss is desired, add 25 to 50 per cent carbon tetrachloride to the turpentine. With casts having sharp details, the pattern may be worked out with an airbrush by spraying across the cast surface, just striking the high parts. Iridescence may be attained by laying one color over another. Do not use vermilion or the cadmiums if translucency is desired.

A Plastic Material for Cold Molding

Methyl methacrylate comes in liquid, granular, and sheet form. The addition of a plasticizer such as dibutyl phthalate forms a paste that can be molded. The resulting medium has a white, marblelike translucence. This material is useful in building up thick midribs in plastic leaf casts.

Casting Foliage for Miniature Groups

Rowell (34) used type metal or stereotype plates for mold material. He sketched the leaf pattern on the metal face and worked out details with engraving tools. A separator was applied and the cast made in liquid cellulose nitrate, which was released from the mold by soaking.

The Harvard College forest models in the Petersham, Mass., Forestry Museum made by Theodore Pitman are excellent dioramas. Copper wire was twisted together to form branches of trees, and the long ends were bound together by wrapping wire around them to form the trunks. Needles and leaves were made of sheet copper by photo-engraving process, soldered to wires, and twisted into the branches. The branches were dipped in molten solder to stiffen, and colored by hand painting and spraying.

Embedding in Plastic

This method may be used for displaying preserved biological materials. The embedding medium is a syrup of polyester resin. The catalyst may be one of several chemicals; Ward's catalyst for their monomer (Bio-plastic) is tertiary-butyl-hydroperoxide. Adding the catalyst to the monomer causes it to jell, bringing about the process of polymerization. It is later cured by heat to give a hard, clearer-than-glass plastic in which the specimens are embedded.

Much has been published on this method and the techniques involved need not be discussed here. Ward's (51) gives the results of a wide range of experiments, both of embedding in plastic and of casting from flexible molds. Special treatments for various subjects are described. Apparently insects were the most difficult. Fessenden (8) dealt very thoroughly with the preserving of natural color in plant specimens mounted in plastic blocks. The Castolite Company (6) in their instruction manual have explained the simple method of embedding in plastic without heat and the professional method with heat. The publication also describes the casting of solid subjects in plastic from flexible molds. Raizenne (30) adapted the method to display deciduous leaves.

PAINTING AND ASSEMBLING

Painting

Correct color and texture are important features of plant and insect exhibits. The form and detail are obtained by careful casting, but faulty finishing may ruin an exhibit. Use good artists' oil paints in the painting process.

Painting 3-dimensional objects is very different from painting on a flat surface. Shadows in pictures are fixed, but insect and plant exhibits must be colored so that the lights used to display them produce the highlights and shadows naturally. All colored objects, when placed in display cases, tend to appear darker; it is important to use tones that are not too dark.

Fresh insect or plant material from which molds are made is seldom available by the time casts are ready for painting. It is imperative, therefore, to make good color sketches from the subjects while they are still in a fresh, natural condition. Make the sketches in oil paints if oils are to be used to color the exhibit.

When it is feasible to use the airbrush it is possible to obtain more lifelike results. This is especially true with thin leaves; transmitted light brightens them and shows brush marks if they are hand-painted. With all subjects, it is well to use paint sparingly. An object that looks painted never duplicates the original.

Beeswax dissolved in benzene or xylol and lightly tinted and sprayed on painted wax casts of fruit will give them greater depth of color. Adding a little Damar varnish to the solvent produces a glossy effect on the cast.

Many special color textures may be obtained. For example you can duplicate the flaky effect on the skin of new potato tubers by painting a coat of liquid plastic on a rubber glove. When it dries, stretch the glove and the film of plastic will crack and curl. Apply the flakes to the surface of the potato while the paint is still tacky.

Assembling Plant Parts

Before molds can be made of a plant, it must be taken apart to prepare molds of the individual parts. The drawings and color sketches made at this time determine the accuracy of the final assembly. In plant sketches give the general outline of the plants, positions of leaves, and distances between them. A convenient method of identifying positions of leaves on a plant sketch is to number them clockwise or counterclockwise around the stem.

A Potato Plant—A potato plant will serve as an example. Assume that all the wax leaflets are cast, shaped, colored, and lying in position on the original sketches of the compound leaves. The terminal leaflets will have wires long and strong enough to support the lateral leaflets. File flat areas on the rachis wires for attaching the wires of the lateral leaflets; flatten all wire ends of the leaflets parallel with the leaf blades and bend to fit the central wire for soldering.

Solder all leaflet wires to the rachis wire, beginning with the first pair below the topmost leaflet. Place the rachis wire in a vise. See that the flat areas on the wires make even contact then apply soldering flux, Formula 19 (p. 65), to the wires and solder quickly. The heated areas of the wires must be cooled immediately or the heat will travel through the wire and melt the wax. To cool quickly apply wet swabs of cotton or pour a spoonful of cold water over each join.

Tint beeswax pale green and build up the rachis by applying successive layers of hot wax with a spatula. Model the rachis making smooth connections with all petioles. Model the characteristic grooves on the rachis surface using a specially shaped scribing tool. To prepare this tool, flatten the end of a wire and file it to make a template to conform with the pattern on the original stalk. Scribe the rachis while the wax is warm but not too soft.

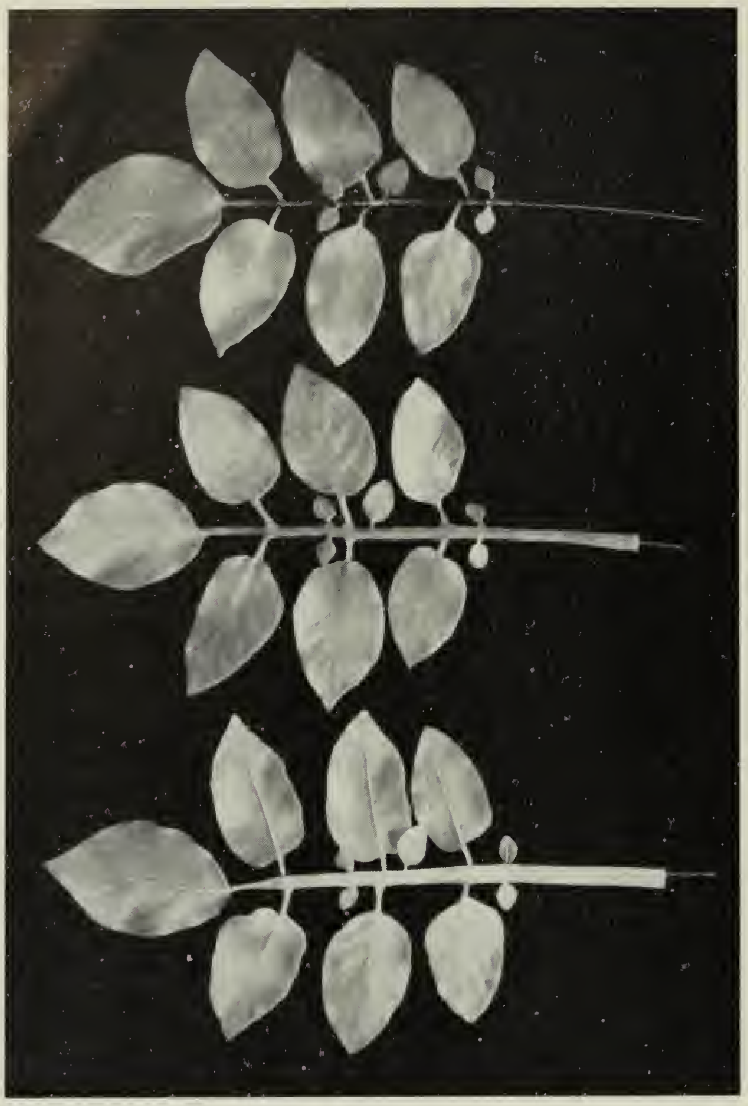

Figure 34
Compound leaf.

Upper, potato leaflets soldered to central wire.

Center, leaf stalk modelled in wax.

Lower, stem and midribs masked for spraying leaf blades.

Spray the entire compound leaf with pale, greenish yellow as a ground color. When the paint is dry, cut masking tape to fit all midribs, petioles, and the rachis. Fit these in their exact positions before further spraying (Fig. 34).

Spray all the leaf surfaces with the blade color, leaving the undersides slightly lighter. It is good practice to test the density and evenness of the spray by holding the leaf between the eye and a light. To blend colors, remove all masks and spray the entire leaf *very lightly* with the last color used. A pale green tint of paint sprayed lightly will represent the bloom usually seen on plants. Dip a bristle brush in white cotton flocks and stipple the freshly painted surfaces to duplicate pubescence.

Cut a piece of 12-gauge galvanized wire for the plant stalk and taper one end for the top. File flat areas for the compound leaf attachments. Locate the points of attachment from the drawing prepared from the original plant stalk. Apply shellac to the wire and wind it tighly with cord, keeping it away from the flat areas; this will act as a bond for the wax modelling. It is easier to model wax over this wire before attaching the compound leaves. In order not to lose the points of attachment, solder a section of a common pin at the upper edge of each flattened area. Model hot wax over the wire to the size of the original stalk.

Cut a section of wax away just below each pin marker. Beginning at the top, solder each compound leaf in place and model over the joins with tinted wax. Prepare the winged flanges of the stalk by using Japanese paper dipped in pale green wax. Cut narrow strips from this, fold them sharply lengthwise, and cut narrower strips from the folded edge. Cut grooves in the wax with a scalpel point and insert the strips, building up against them to restore the original shape. A final light spray finishes the coloring.

Insect injuries and other fine hand painting should be done under a lens. When the painting appears satisfactory through the lens, there should be very few brush marks noticeable with the naked eve.

Branches of Trees—Green sections of tree trunks or heavy tree branches usually crack badly near the cut ends while drying. This may be overcome by coating the ends with melted beeswax and making a fresh cut above the wax when the wood has dried.

When assembling exhibits of tree branches in permanent cases, it is often difficult to attach small ones to the back of the display case. Make special drills by grinding sewing needles of various sizes to drill points. Use a speed drill with a foot control so that both hands will be free; fasten the drill head to a small bench vise. Hold the branch against the drill point to drill the holes.

Arrange the branch in the case and push a pin through each hole to mark for drilling in the back of the case. Drill the holes with the same size of drill as was used for the branch. Push the pins in the branch through the

Figure 35
Exhibit of insects on a hill of potatoes. Prepared in wax by casting and modelling. (Displayed in Entomology Laboratory, Chatham, Ont.)

holes in the back and clinch them into the wood. The pin heads in the branches can be hidden by paint or covered with bits of bark.

Fruit and Vegetables—Casts of small fruits and vegetables are temporarily mounted on wooden blocks for coloring and storing. Two holes are bored in the blocks for inserting the staple prongs.

To assemble the finished casts in a display unit, make a template of thin cardboard to fit inside the unit. Mark the label positions on the template and place the models on blocks in the arrangement they are to have in the finished exhibit. Mark around each block on the template and for each item use the following procedure.

Remove a cast from a block, cut a paper the size of the top of the block, and mark the positions of the two holes. Lay this paper within the outline of the block on the template and mark for the two holes. When ready to attach the models, first fasten the labels, from measurements on the template, with bookbinders' paste. Then lay the template in place and punch through the pairs of hole marks into the case back to mark for drilling. Drill all holes with a drill the size of the staple wire. In the back of the case cut a slot between each pair of holes to receive the wires when clinched to hold the casts. For soil profiles made over wood and mâché forms, fasten with two screws through the back of the case.

Mount photographs in exhibits by applying bookbinders' paste over all the back surfaces of the prints to keep air from getting under the prints and buckling them during weather changes. A photographer's rubber roller is a useful tool for obtaining an even contact of photographs and labels in the cases.

PRESERVING CONIFEROUS FOLIAGE

Fortunately, it is not necessary to reproduce artificially the foliage of coniferous evergreens. A recent technique by Raizenne (29) retains the needles on the twigs almost indefinitely. After treatment, painting will restore the natural color.

Soft needles of spruce or balsam in the new spring growth do not process; after curing they will shrink and curl as they dry. To overcome this disadvantage, duplicate the new growth artificially or use older needles of the proper size and depend on coloring to simulate the new growth.

Ethylene Glycol-Gelatin Method—Select branches of suitable size and shape and process them as soon as possible after cutting. Pines, balsams, and other evergreens with a high pitch content should have the surface pitch removed before treatment. Thoroughly wash all frass, webs, and dirt from evergreens with severe insect injury before they go into the glycol bath. Any substances left on the needles when the branch is dipped in gelatin will be sealed in, causing roughness over the foliage. Submerge the branches for two weeks in the ethylene glycol solution, Formula 30 (p. 68); remove excess preservative by shaking gently. Dip several times in the gelatin solution, Formula 31 (p. 68), while it is still warm. Shake the foliage well after each dipping to remove excess film between needles.

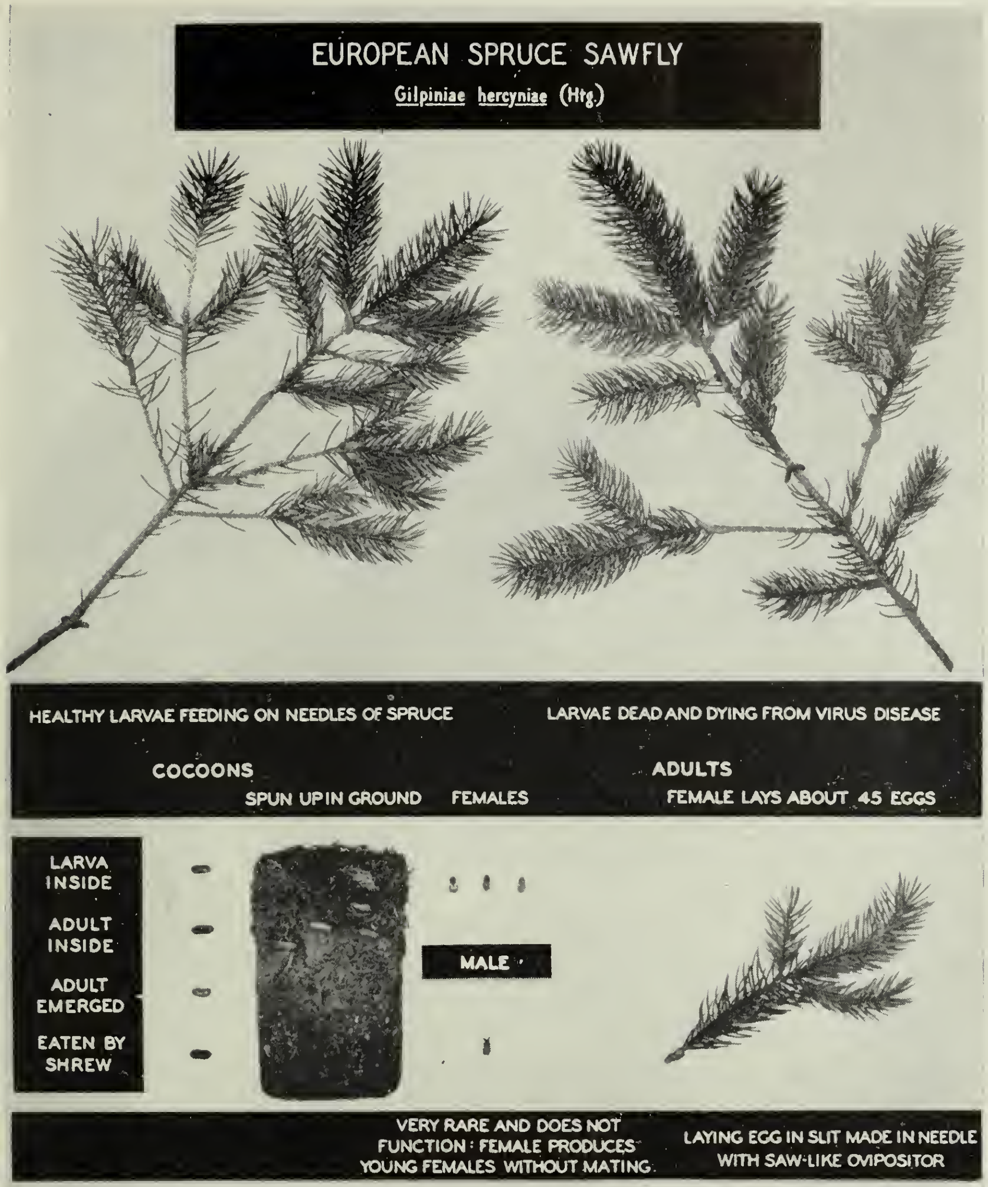

Figure 36—**Exhibit of the European spruce sawfly. Preserved foliage, colored. (Displayed in Forest Biology Laboratory, Fredericton, New Brunswick.)**

With evergreens having closely set needles, it is necessary to separate the needles after each dipping so that they will not stick together. When two needles dry in contact, you will tear the gelatin coat when separating them.

Allow a few days to dry and then color the needles with oil paints to match the prepared color chart. Use thin oil paint and with a fine sable brush paint each needle individually. Starting at the base of the needle make each stroke continuous to the tip. The bloom effect may be obtained by spraying with a pale paint mix.

If the needles are not firmly attached after processing, it is the result of one of two things: either the branches were not treated in the glycol bath soon enough after cutting or not enough gelatin was deposited over the needles.

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Mr. Emil Sella, Natural History Museum, Chicago, processes his evergreens with glycerine and restores the color with an airbrush, removing color on the branches with a brush and turpentine. This method of coloring may be used for group work, however hand painting of small sections to be viewed closely will produce finer results.

Glycerin-Shellac Method—Other methods of preserving evergreens are available. Mr. D. M. Blakely (in litt.), Cranbrook Museum, Bloomfield Hills, Mich., using an acetone-alcohol and glycerin-formaldehyde method, processed a black spruce tree in a habitat group which was very successfully mounted in a museum, but was too fragile to ship.

Processing Larch Branches—The glycol method does not work well on larch. The leaves are held firmly in the fascicles, but they curl and shrink. Select branches with mature leaves. Place them in glycol solution and agitate the individual branches until the leaves separate in the fascicles. Leave them in a natural position for two and a half weeks.

Remove the branches from the preservative, shake each well, and dip in warm gelatin solution while still wet. Remove the excess gelatin by striking each branch gently on paper. Dip one branch at a time and shape it before the gelatin dries and seals the needles together.

Use an air hose with a pressure of about 25 pounds with a circular motion on each fascicle until the needles stand free from one another. Separate needles that stick together. When the gelatin solution has become cooler and the branch partly dry, dip it again taking care not to melt the first coat. Repeat the air hose treatment and pin in position on a sheet of soft plywood, cork, or corrugated paper. Separate any needles in contact and allow the whole to dry thoroughly. After the branches have dried, spray them with gelatin twice more to strengthen the fascicles.

More natural foliage may be made artificially from thin sheets of plastic cast in color. Cut needles individually, assemble them in fascicles and fasten to the branches with "Duco" cement.

BUILDING ENLARGED MODELS

For exhibiting certain insects, it may be necessary to prepare enlarged models. These appear as seen through a microscope with all external parts highly magnified. This is the only graphic method for exhibiting small insects other than using enlarged drawings or photographs. Make models from suitable materials such as plastic, plaster, wax, wood, or metal; in each case the medium or media chosen must be suitable to portray the several parts of the insect.

The detailed procedure that follows is an example; it was used to prepare an exhibit of the wheat stem sawfly for the Empire Exhibition in London, England, in 1949 (Fig. 37.).

An Exhibit of Wheat Stem Sawfly—To avoid making molds and casts for the enlarged stems of wheat, a medium of the correct size, $\frac{3}{4}$ inch in diameter, was found in tubes and solid rods of cellulose butyrate. On these it was

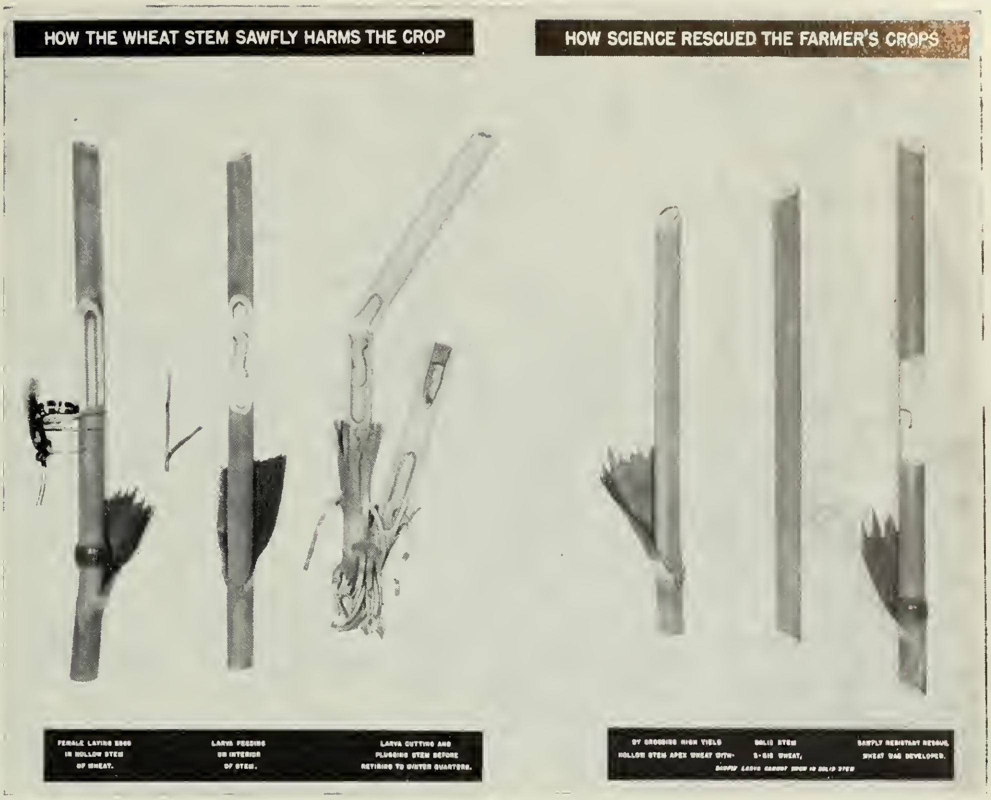

Figure 37
Exhibit of the wheat stem sawfly. Models enlarged six times. Made of cellulose butyrate. (Displayed at Permanent Canadian Exhibition, London, Eng. for some time after 1949.)

possible to model furrows imitating those on a wheat stem. These furrows were longitudinal in groups of two to four fine ones alternating with a deeper one; a short length of the material was used for a trial modelling of the surface texture.

The Stems—You use six tubes and two solid rods of cellulose butyrate for modelling the six wheat stems that appear in the exhibit. Cut the tubes and rods to the desired lengths and leave $\frac{1}{2}$ inch to spare on each one for later trimming. This practice will also allow cutting of the striæ—which is described later—to reach the ends.

To form a node, the swollen joint on a stem, cut two sections from a spare piece of tubing; make one piece $1\frac{1}{4}$ inches long and the other $1\frac{1}{8}$ inches long. Split each down the side and place them in hot water to soften. Apply "Duco" cement around the tube where the node is to appear and place the longer section from the hot water around the tube on the "Duco" cement. Fill in the gap caused by spreading of the section with a piece of the same material. Repeat with the shorter section, placing it over the first. When the adhesive has hardened, grind to the shape of the original node.

Model the striæ, the fine longitudinal grooves on the stem, directly on the plastic stems. A standard 10-inch file has striæ properly spaced to represent the pattern on a wheat stem enlarged six times. To make a holder, or sled, for the cutting tool and a base to guide it, proceed as follows:

Nail two boards 2 by 20 by $\frac{5}{16}$ inches to a base board $4\frac{5}{8}$ by 20 by $\frac{3}{4}$ inches, leaving a slot in the center into which the butyrate tube fits snugly. Gouge a hollow in the base where the node will rest. To make the sled, which will hold the cutting tool, fasten a piece of wood 3 by $5\frac{1}{4}$ by $\frac{3}{4}$ inches with glue and screws on the edges of two blocks, each $1\frac{5}{8}$ by 3 by $\frac{3}{4}$ inches. Fasten a 10-inch file horizontally on the end of the sled with four small screws. The bottom edge of the file should lie about $\frac{3}{4}$ inch from the bottom of the sled runners which rest on the outside edges of the baseboard.

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Screw a stopper on the end of the base to hold the plastic tube from slipping endwise. Fasten the base on the bench, pointing away from you.

With the plastic tube in the slot, grasp the sled with the file on the side next to you, and tipped so that the corner rests against the plastic. With a firm, continuous stroke, pull the file the full length of the stem. Turn the plastic tube after each stroke so that all the spaces between the striæ are equal.

***Figure 38*—Tool for scribing striæ on enlarged plastic models of wheat stems.**

Now cut the deeper, longitudinal furrows, mentioned above. With a fine-pointed scalpel, cut a groove in the plastic tube where it rests in the slot; use the wood against which it rests for a guide. Turn the tube after each groove is cut and continue around the tube. Make these grooves about $\frac{1}{4}$ inch apart, but vary the spacing slightly.

With the striæ now completed, cut the stem ends to shape and slice out sections of the stem to expose the interior as illustrated in Fig. 37. Using a $\frac{1}{16}$-inch steel bit in a speed drill, model the texture of exposed interiors and the cut ends. With the bit held vertically, draw it over the surface of the area being shaped. If the drill is held lightly, its slight bounding motion will form small pits in the plastic which will then resemble the natural texture. Heat the modelled stems in hot water and bend them to the desired shapes; holding them in correct position, dip them in cold water until they set.

The Leaves—Cut a leaf section from a wheat stem, and separate the blade from the sheath. Flatten them under a sheet of glass. Draw enlarged patterns from them (Fig. 39A). Fasten a sheet of cellulose acetate 0.002 inch thick over the patterns and, with a sharp-pointed tool, scribe the outlines and all striæ appearing on the pattern. Cut out the two sections and sandpaper both sides of each lengthwise to make the proper texture. Bind the sections in position temporarily around a piece of $\frac{3}{4}$-inch rod of butyrate. Place the leaf and rod in hot water until they are well heated and then dip them in cold water while they are still bound on the rod. Remove them, lap the edges slightly, and fasten the sheath with ligule to the blade with

"Duco" cement. Joining these two pieces, one with a straight edge and the other with a concave edge, causes the leaf blade to stand out from the stem as in nature (Fig. 39B.).

The Stubble—The surfaces of pieces of tubing used to represent stubble have no striæ; they are just sandpapered lengthwise to remove gloss. Cut triangular sections out of the bases of tubes used for stubble so that the remaining points, when pressed together, will form rounded ends. Heat the bases in hot water and bend the points until all the cut edges join. Fill any gaps with butyrate chips softened in a flame.

To form roots for the stubbles, rip pieces from a plastic rod to the approximate sizes of the roots required. Dip them in acetone and scrape to shape. Attach the roots to the stems by boring holes to fit the root bases and insert the roots. Build up around the root bases with thick liquid butyrate. Model all cut edges and exposed interiors of the stubbles as described for stems.

Sheaths on dry stubble are usually badly worn by wind; this condition must be simulated in the enlarged sheaths. Make them from a 0.005-inch sheet of cellulose nitrate that has been scribed for striæ and painted with brownish yellow acetone. This colors and withers them in one operation. Cut out the sheaths then shape and fit them as previously described.

Coloring the Stems, Leaves, and Stubble—Coloring of the models is very important. This is best accomplished by spraying, using masks to cover parts not to be colored in the first spraying. Cut pieces of masking tape to fit all cross sections of stem ends, openings made to expose interiors, and the light areas at the bases of the leaves. This way you expose only the exteriors of the stems and the portions of the leaves and sheaths to be colored green.

For coloring enlarged stems and leaves in plastic when color has not been incorporated into the medium, best results are obtained by applying the color with an airbrush. Lay one tint over another to give a more lifelike appearance. Mix three tints from tube oil colors—a pale green for the first coat, the full blade or stem color next, and last a bluish white—the last represents the bloom, a light powdery-appearing effect found on many plants. To thin the paint, use Formula 43 (p. 70). Hold the airbrush well away from the object and at right angles to it. Apply the various coats one after the other without waiting for the previous coat to dry. When the paint is dry, remove all masks and spray the exposed interiors lightly with sap green and white tint.

Spray the stubble white, and then yellowish brown, made by properly blending yellow ochre, zinc white, and raw umber. The bases of all stems and stubble that will be covered by sheaths may be left uncolored.

The Female Adult Sawfly—This model was made mainly by modelling with liquid plastic over a plaster core and using wire reinforcements for the antennae and legs. The construction proceeded as follows:

Model the head, thorax, and abdomen in one piece from white beeswax, working directly from the microscope or an enlarged drawing. Make a 2-piece plaster mold from this model and from the mold cast the body of the enlarged model in plaster. Run a 16-gauge wire through the center of the cast from the head through the ovipositor. Leave a length of wire with which to mount the model. When the plaster cast is dry, paint it with black cellulose nitrate until no white plaster shows. Paint the color pattern on the black plastic with yellow liquid plastic.

Cut monel wires for antennae from 0.018-inch wire and for legs from 0.022-inch wire. Coat the wires with tinted liquid cellulose nitrate thick enough to model antennae and legs. For the spines near the joints of the legs, use sections of entomological pins. Drill holes in the head and thorax to receive the antennae and legs.

Mount the natural wings on a microscopic slide and project them to the correct magnification on a card. Trace the wing margins and the venation pattern. Fasten a piece of cellulose nitrate, 0.005-inch thick, over the wing outlines and trace them with a sharp-pointed tool. Cut out the four wings and paint the grooved sides with black India ink. Before the ink dries, wipe the plastic, leaving ink in the grooves only. Mix oil paint to match the wing tint, add a drop of essence of pearl to give slight iridescence, and spray lightly on both sides of the wings. Attach the wings to the thorax with "Duco" cement. Mount the model on the stem by boring a hole through it to carry the wire protruding from the ovipositor. Adjust the antennae and legs and fasten them in the holes prepared in advance (Fig. 40.).

The Larva—Model the larva in wax from microscopic examination or enlarged drawings. From the wax model make a 2-piece plaster mold, and from the mold cast in wax the several larvæ needed. Secure proper-sized spines from cactus leaves or a similar source and insert them in the casts for setæ.

Assembling the Parts—To attach a leaf to the stem, apply "Duco" cement to the inside of the sheath and bind it in place on the stem with a cord. Let it dry thoroughly. To fasten a wax cast of a larva in the stem or stubble, embed entomological pin points in the stem at the point of attachment, place a piece of cotton saturated with "Duco" cement between the pins, and press the larva firmly into position. Distribute frass made of tinted plastic sawdust around the larvæ. For the plug in the end of the stubble section, showing the position of the overwintering larva, use cork covered with brown-tinted plastic sawdust.

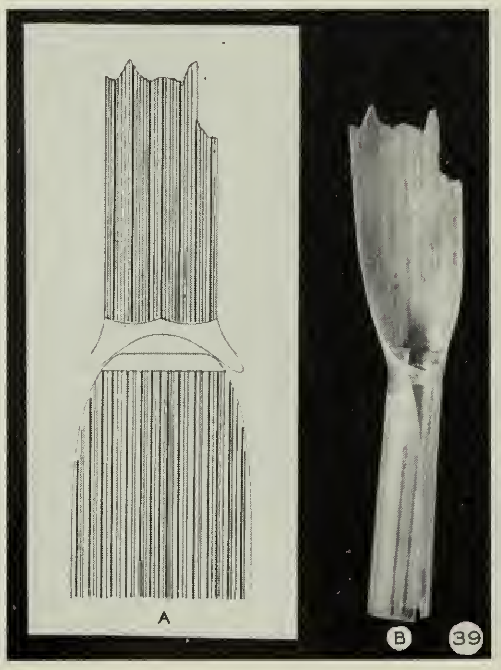


Figure 39
Left, enlarged pattern of section of wheat leaf.

Figure 40
Model of the wheat stem sawfly in plastic.

To fasten the exhibit in the case, make two rectangular staples for each stem, the middle section of the staple is $\frac{7}{8}$ inch across. Cut two grooves in the underside of the stem deep enough to anchor the staples, with the middle cross section in the holes. Fill the grooves over the staples with liquid cellulose butyrate. The two prongs of each staple go through the back of the case. The base of this exhibit measured 20 by 27 inches.

Animated Models

Construction of enlarged models opens a large field for mechanically minded operators, especially for making animated models. Carmel (5), of the Cranbrook Museum, Bloomfield Hills, Mich., constructed three animated fireflies, enlarged 17 times. By means of a synchronous motor and a series of cams operating microswitches, the abdomens of the fireflies were illuminated in proper sequence of timing. Balsa wood, plastic, and metal were used. He also made a model of a blue-bottle fly, enlarged 46 times, that showed the halteres in motion while the case lights were on.

Uses of Glass in Model Making—Von Fuehrer (47) used blown glass to make insect models; legs and antennæ were strung in segments on wire. Glass takes paint and plastic coating satisfactorily.

AIRBRUSH TECHNIQUE

An airbrush is almost indispensable for preparing exhibits. Wax and celluloid leaves painted with a standard brush appear uneven and blotched when viewed by transmitted light. With the airbrush, it is possible to apply successive light tintings to ensure even coverage and proper color tones. It is ideal for applying the ground color on wax fruit but not altogether satisfactory for spraying preserved evergreen foliage because it is not feasible to mask the branches. Painting the branches the same as the needles with the airbrush, will result in some loss of natural tints from the bark when the paint is removed.

Types and Performances—Wold, Paasche, and Thayer and Chandler are three popular makers of airbrushes (Fig. 62, p. 74); these brushes have been used in museums, some preferring one and some another. With the Paasche ABG and the Wold BBF brushes, you can use thicker oil paint which is an advantage when producing special finishes with talc, soil, or flocks on freshly painted surfaces. Small airbrushes made to use water colors may prove difficult to use when applying oil paints. Low surface tension in oil paint allows the paint to run through the paint slot and hang on the tip of the cup. If the paint is too thin it will be blown off and spatters the work; if it is too thick, the paint slot is not kept full and the spray stops. Only experience will show the operator how to mix oil paint suitably for use in airbrushes.

If you use oil paints, buy the best artists' paints and thin when needed with Formula 42 or 43 (p. 70). Strain the oil paint used in airbrushes but use paint as it comes if mixed thick for special uses, as mentioned above; spatulate it on a palette and when the paint runs sluggishly from the spatula, it is in proper condition for spraying.

Before attaching the airbrush to the hose, blow the hose out well to remove any dirt or moisture. Check the needle point to see that it is in perfect condition. Never leave an airbrush for more than a few minutes before cleaning. Flush it with turpentine or carbon tetrachloride until all paint residue is removed.

Air Supply—A constant air supply adjustable from 25 to 30 pounds pressure is desirable. An electric compressor unit with capacity in this range will give the most satisfactory results. Open the drainage valve periodically to blow out accumulated water and dirt from the tank. Check the oil level in the crankcase and oil the motor bearings at regular intervals. When a compressor unit is not available, a cylinder of compressed, liquid, carbonic acid gas may be used. With most cylinders, it is necessary to have a reducing valve to control the working pressure. When reducing pressure, it is important to reduce the pressure at the cylinder first. For detailed instructions in airbrush technique, consult Kadel (15) or Tobias (40).

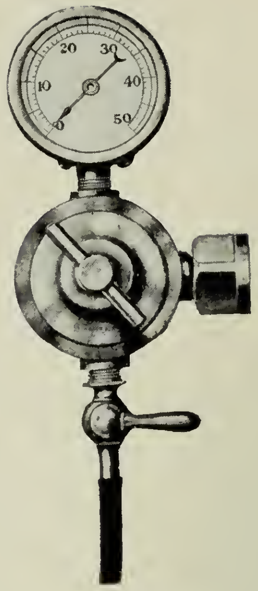


Figure 41—
Gauge for liquid carbonic gas outfit.

BUILDING INSECT DIORAMAS

More and more museums are using dioramas to portray subjects in their natural habitats. These exhibits produce the illusion of a view through a picture window. Up to now, dioramic exhibits have mainly portrayed large species of animal life; little has been done to adapt the method to exhibit insects. An insect group must necessarily be small so that the habitat does not dominate the exhibit. By carefully choosing subjects successful groups may be prepared. The method would be useful for portraying severe outbreaks by insects such the armyworm and the Japanese beetle.

General Principles—In such a group the foreground, consisting of actual insects or reproductions of them and the injury they do to plants, blends with a curved, painted background suggesting the area of infestation. To be successful the groups must depend entirely upon illumination from within the case; it should be stronger than room light to prevent reflections.

It is impossible to give any illusion of distance in too small a case. No attempt should be made to build an insect diorama with a depth of less than 42 inches. For correct perspective the ratio of depth to width should be 6 to 10. Place the horizon line at eye level at a height of about five feet. The glass front should be smaller than the background to hide the ends and top of the painting and also to avoid distortion of the background. The glass should slope slightly outward at the top to eliminate reflections.

Base and Foreground—The base should slope slightly upward toward the back so that it will more readily blend into the background.

Prepare soil surfaces as follows. Build a wooden form, cover it with galvanized wire screen, and model the soil contours with mâché (any one of Formulae 38 to 41, pp. 69 to 70). Sterilize the natural soil to kill insects or bacteria that may be present. Sprinkle the soil with 5 per cent glue water and mix thoroughly until it is slightly moist but will still crumble. Apply a liberal coat of liquid glue to part of the base and sprinkle the moistened soil evenly over the glue; press firmly and add more soil until no glue shows through. Continue until the entire base is covered, and then sprinkle lightly with soil. When it is thoroughly dry, remove soil that is not attached. Sometimes it is necessary to glue on a second coat of soil to form a perfect coverage. To make cracks in the soil use an excess of water in the soil before fastening it to the base. Duplicate the moisture line on soil profiles by spraying with paint thinned with boiled oil and turpentine.

Choose subject matter for the foreground and arrange it so that it will blend into the background with no break. A photograph of the completed exhibit should appear as a single unit, showing no break between foreground and background.

Background—Use a sheet of galvanized iron in constructing a small group. Nail it to a wooden frame of the correct contour; the metal should form an even sweep all the way from near the front toward the center back with no undulations. Nowhere on the background should there be flat areas, yet the curve should not be part of a circle. If the sides and the center back are not curved and are connected by curved areas close to the corners, distortion will occur on the sides and the back; in fact, the center will appear to bulge. Use long curves as indicated in Fig. 42.

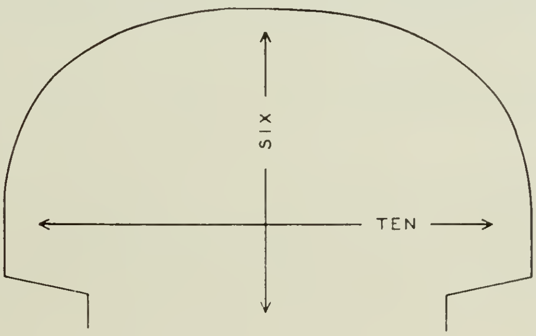
Clean the metal surface with vinegar and water, and then apply three coats of flat, pale blue paint. On this, sketch the scene and paint it with oil colours. To obtain true tones, paint the background under the type of lights to be used in the finished exhibit. Objects should be less than life-size, even where they occur near the foreground. If the background should appear too cold when finished, spray lightly with rose madder.

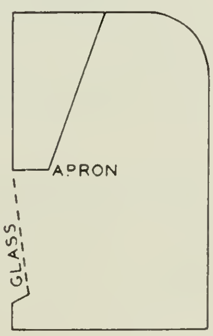
View Window—To achieve greater illusion of distance and perspective, limit the size of the front glass. Cut off from view the edges of the sides and the top of the background so that nothing extraneous obstructs the line of vision. Use an apron, as indicated in Fig. 42 right, inside at the top of the glass to further restrict the line of vision at the ceiling.

Figure 42
Plan of diorama unit.

Left, proportions of the base.

Right, end elevation.

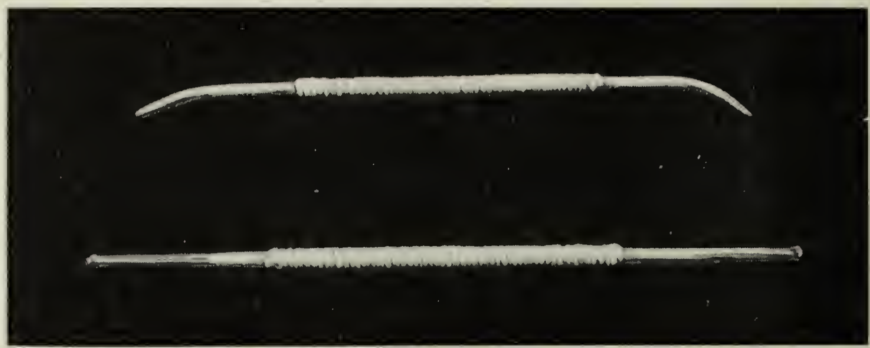




Lighting—Arrange the lights so that no shadows are cast on the background. Accomplish this by using a wide area for light sources and having the lights shine through ground glass. It is better to place the lights in a separate, ventilated unit; fluorescent lights will reduce heat.

Leaves from Paper—When large numbers of leaves are needed it is best to use metal molds but paper-based leaves may be used in dioramas that have sufficient depth. Use cream, double-faced, crepe paper sized with thin, liquid cellulose nitrate, Formula 45 (p. 70). Cut leaf blades from original patterns, lay them on blotting paper, and form the veins with a veining tool, copying the pattern of the natural leaves. With an embossing tool, rub between the veins to shape these areas. To make this tool, solder ball bearings of two sizes on a metal rod, one on each end. Wind string on the center of the rod and lacquer it for a handle (Fig. 43.).

Figure 43 **Tools for modelling paper-based leaves. Upper, veining tool. Lower, embossing tool.**



Attach tapered wire coated with liquid plastic to the back of the midrib, and then shape the blade as desired. Dip in hot, colored wax and twirl rapidly by the wire to remove excess wax. To keep the wax from spattering, tie a paper collar around the top of the pot. Almost any type of leaf may be made by this method.

Although not dioramas, two 8-foot groups were made illustrating damage and control of the pale western cutworm and the clear-winged grasshopper on wheat for the World's Grain Show at Regina, Sask., in 1933. These were constructed in cellulose nitrate, one of which is illustrated in Figs. 44 and 45.

DISPLAY UNITS AND LABELS

Display completed exhibits in closed units to protect them from dust, breakage, and insect attack. Also, the exhibit must be securely fastened for shipment. It is necessary, therefore, to provide a case that is attractive in design, that has a glass front; there must be a dustproof base or a back on which to fasten the exhibit.

Display Units

Display units may be of various designs and sizes to suit the exhibits. Most exhibits made at the Chatham laboratory were mounted in standard units of two sizes, 16 by 19 by $3\frac{1}{4}$ inches and 18 by 21 by $3\frac{1}{4}$ inches. They

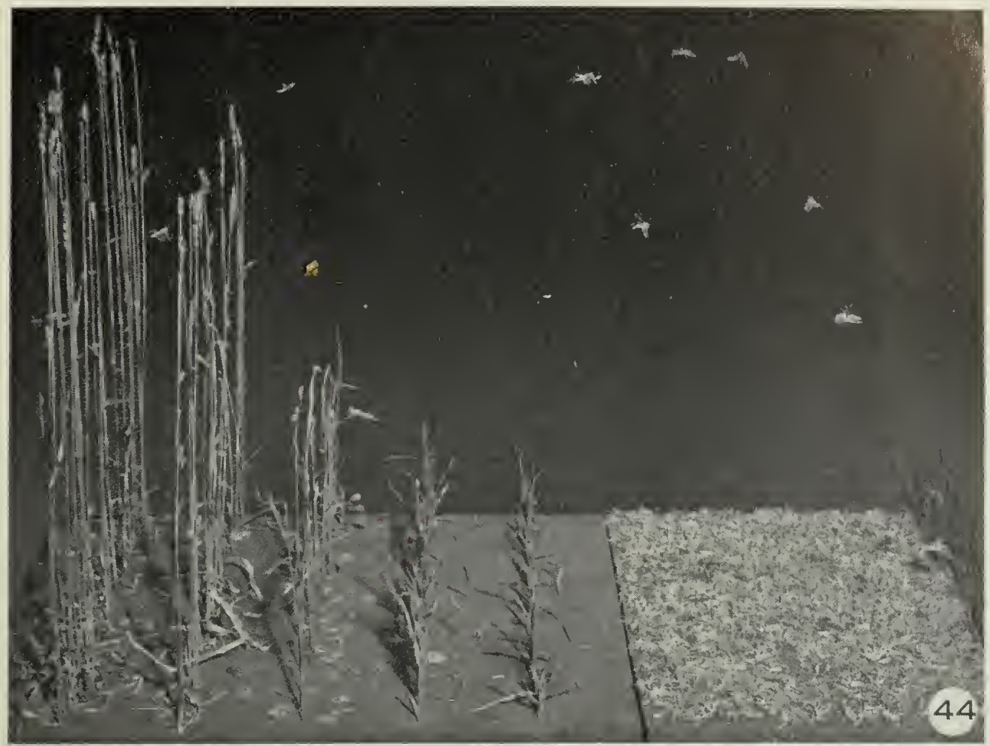


Figure 44—Injury by the clear-winged grasshopper to Marquis wheat, and egg bed in sod. Plants in cellulose nitrate. (Displayed in National Museum of Canada, Ottawa.)

Figure 45—Grasshoppers emerging from sod, and control in wheat with poisoned bait. Plants in cellulose nitrate. (Displayed in National Museum of Canada, Ottawa.)

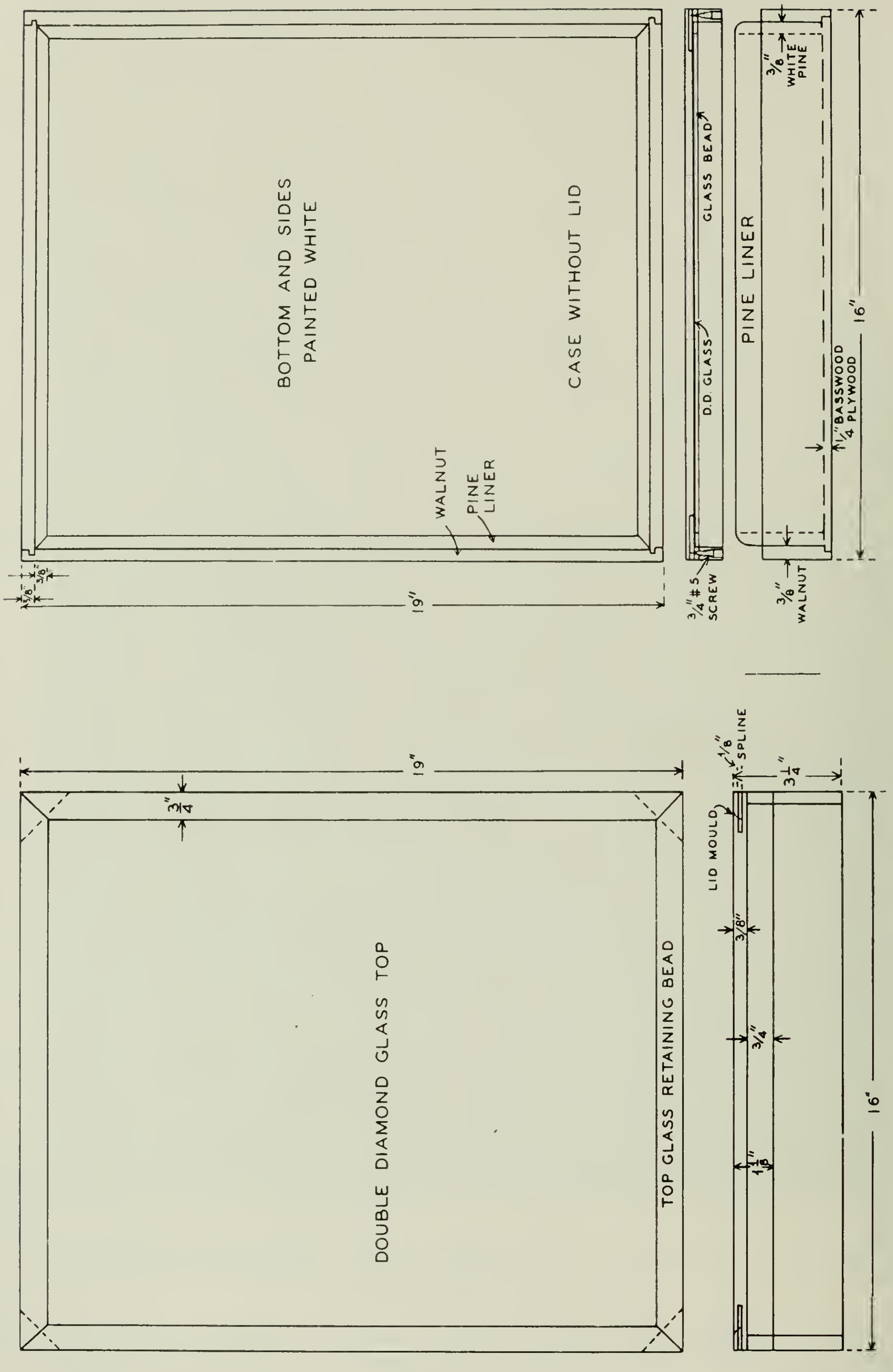


Figure 46—**Plans of walnut display cases with glass tops.**

are made of solid walnut with basswood-plywood backs and glass fronts. A pine interliner, covering the joints on the ends and sides inside made by the glass front, makes the case practically dustproof. Interiors are painted with three coats of flat white enamel to which you add enough permanent blue to give a very pale, blue-white finish. It is difficult to obtain a white enamel that will not turn yellow in an air-tight case. It helps to leave the fronts of the cases partly open for a week or two to dry the enamel thoroughly. This allows a scarcely visible film of dust to form on the white paint. Remove all dirt before attaching labels; if attached with bookbinders' paste they will curl while drying if the surface is not clean.

Nicholls (24) recommends the following finish for the outside of walnut cases. Brush on one coat of walnut paste wood filler; before this dries, rub off the excess across the grain with a coarse cloth. After the filler has dried for 24 hours, brush on one coat of Hippo oil. After another 24 hours, sand lightly with 4-zero or 6-zero sandpaper. Apply a second coat of Hippo oil and let it dry for 24 hours. Rub the final coat smooth with fine steel wool and apply a coat of hard wax (Fig. 46).

Large display units for full-size plants may be patterned after those in use at the Royal Ontario Museum of Zoology and Palaeontology, Toronto. The display part of the unit is 30 inches each way with glass on three sides and top. The back is of plywood, covered inside with unbleached linen. It is mounted on a base 36 inches high (Fig. 47, p. 54).

A small glass unit for displaying a single fruit or vegetable would consist of five pieces of plate glass, four of which are slotted into a wooden base and the fifth piece forming the top. A case for a large potato requires two pieces of plate glass $3\frac{1}{2}$ by 8 inches, two pieces $3\frac{1}{2}$ by $7\frac{1}{2}$ inches, and one piece 8 by 8 inches. All exposed edges are smooth-polished; all the edges to be cemented are rough-ground.

For the wooden base, use one piece of solid wood 10 inches square by $\frac{3}{4}$ inch thick with shaped edges. Four binder posts, $\frac{3}{16}$ by 4 inches, and felt washers for the posts are needed. Bore $\frac{1}{4}$-inch holes near the corners of the 8- by 8-inch glass top so that they will come just inside the glass sides. Bore similar holes through the wooden base to match these. Enlarge these holes in the bottom of the base to accommodate the lock screws. Rout out a $\frac{1}{4}$-inch slot all around the wooden base to fit the four sides of the glass case. Cement felt washers under the heads of the binder posts, and around them where they go through the glass (Fig. 48, p. 55).

To assemble the side pieces of glass, make a 3-sided form on a square of $\frac{3}{4}$-inch plywood. Cut and grind the glass accurately. Clean the edges to be cemented with amyl acetate. Apply two coats of "Duco" cement to each surface of glass that will come in contact. Wedge three of the glass pieces against the form to hold them square while drying. It is easier to handle the fourth piece separately. Hold it in place with a wooden block clamped to the form. When the cement on the sides has hardened, cement the top in place (Fig. 49. p. 55).

Figure 47

Museum display unit.

Mount the subject on the wooden base, using the staple that is anchored in the wax cast. Place a little latex on the bottom edges of the assembled glass and insert in slots. Run the four binder posts through the holes and secure the lock nuts in place.

Labels

Labels, bearing captions, are necessary in displays. The choice of labels may add much to the attractiveness and value of exhibits. White paper turns yellow in time. Labels prepared photographically and having white lettering on a black background are most satisfactory. This type of label needs no border and may be trimmed with a paper trimmer or a razor blade. A razor blade makes a cleaner edge, especially if a sheet of glass is placed beneath during the cutting.

Labels for exhibits prepared at the Chatham laboratory were made at the Bio-Graphic Unit, Science Service, Ottawa. Parker (25) contributed the following on the method. Labels are prepared entirely by mechanical

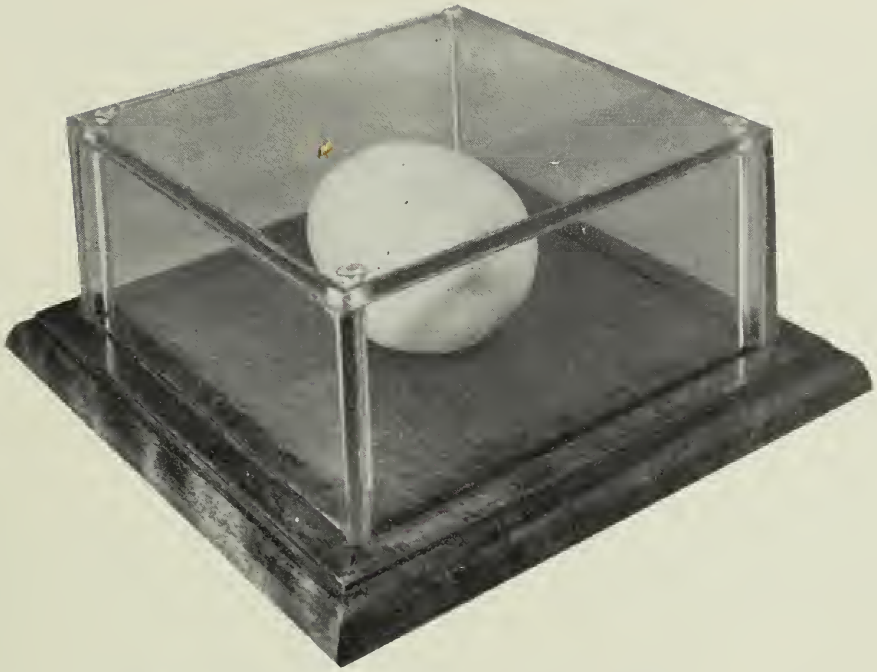


Figure 48—Special display unit for a small exhibit.

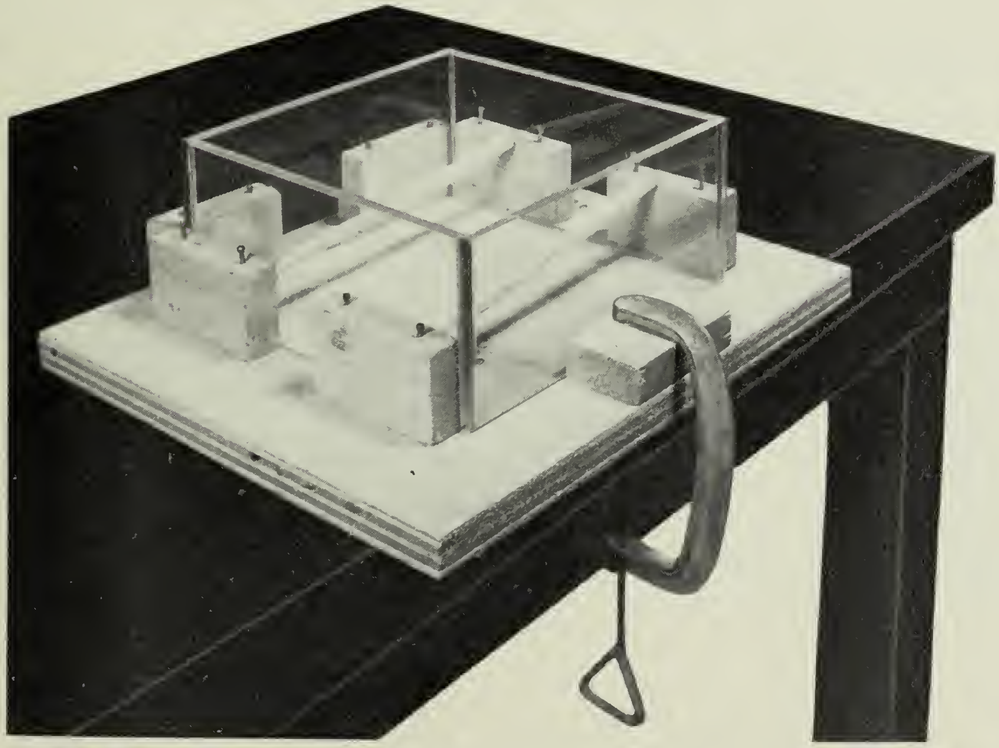


Figure 49—Method of assembling plate glass in unit shown in Fig. 48.

means with either the Coxhead-Liner machine (Ralph C. Coxhead Corporation, 720 Frelinghurpen Ave., Newark 5, N.J.), or typeset, depending on the number of words in the caption and size of letters required. Further photographic processing produces a set of captions suitable for use in exhibits.

First prepare a layout indicating the number of captions, wording, type font required, and relative positions. If possible, remove from the layout all main captions calling for larger type which are to be prepared from Coxhead-Liner type, if this is not possible, prepare a separate list. Typeset remaining captions which contain a large amount of text and call for smaller type.

Coxhead-Liner Composition—The Coxhead-Liner (Fig. 50), a comparatively recent development, prepares proofs of type in a wide variety of styles and sizes. Its main components are a chamber containing photographic paper, developing and fixing tanks, an exposure aperture, a spacing dial, and a large plastic disk marked with the letters and numbers of one style and size of type around its outer edge (Fig. 51).

In operation, a selector knob brings each letter or number into position for exposure on the 35-mm. paper tape. When you depress the exposure key, the paper automatically advances a preset letter-spacing distance. Exposures are made and the paper tape rolls through almost as quickly as the operator can select letters. A line-length dial controls the length of line within a variable setting.

The paper tape passes through the processing tanks and emerges from the machine producing continuous line of lettering. The letters are ideal for reproduction; they can be enlarged up to 15 diameters without fuzziness or distortion. More than 50 styles and sizes of type are available, you simply change the master disk in the machine to use them.

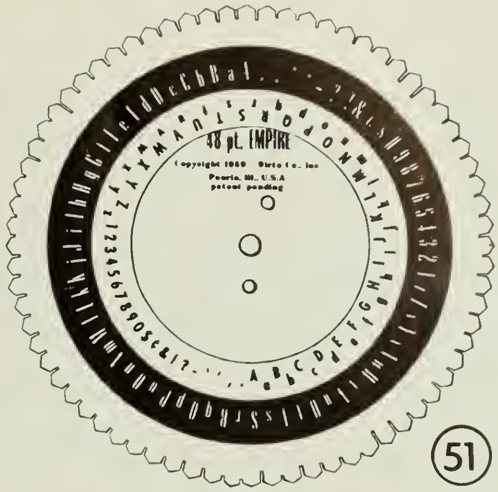
Eighteen-point Gothic copperplate is used to prepare main captions, which are enlarged photographically to 36-point; sub-captions usually remain in 18-point. When short sub-captions are prepared by the Coxhead-Liner method, the 18-point Gothic copperplate is reduced photographically to 14-point (Fig. 52.). Set all scientific names appearing in main captions in 30-point Lydian cursive, later reduced to 24-point (Fig. 53.).

A 3-line main caption containing a scientific name in the second line is set in 18-point for the first line, 30-point for the second, and 18-point for the third; these will appear on the exhibit label as 36-point, 24-point, and 18-point, respectively. The Coxhead-Liner provides Gothic copperplate in 14- and 18-point, and Lydian cursive in 30-point only; larger or smaller letters of each of these styles must be obtained photographically.

Typesetting—Subcaptions, each comprising a large number of lines, are set in 14-point Gothic copperplate and will appear in this size in the exhibits. When subcaptions prepared by this method contain scientific names, underline each name (Fig. 54.).

Prepare enough copy to fill a galley, make proofs and proofread. Make necessary corrections and pull final proofs on reproduction paper with a suitable surface for further photographic processing.

(50)



(51)

EDL 12 POINT

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HIS SMALL INSECT
EUROPE ABOUT 19(
ABIES BALSAMEA (
THE BARK AND SH

(54)

BALSAM WOOLLY APHID

Adelges piceae (Ratz.)

ON BALSAM FIR

THIS SMALL INSECT WAS ACCIDENTALLY INTRODUCED INTO CANADA FROM EUROPE ABOUT 1900 AND HAS KILLED LARGE QUANTITIES OF BALSAM FIR ABIES BALSAMEA (L.) MILL., IN THE MARITIME PROVINCES. IT FEEDS ON THE BARK AND SHOOTS BY INSERTING A LONG SLENDER TUBE BETWEEN THE CELLS. A SALIVA IS INJECTED WHICH CAUSES ABNORMAL GROWTH OF TWIGS ('GOUT DISEASE') AND FORMATION OF A HARD, BRITTLE TYPE OF WOOD ('REDWOOD').

(55)

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(56)

Figure 50—The Coxhead-Liner photo-lettering machine.
Figure 51—The Coxhead-Liner Typemaster.
Figure 52—Gothic copperplate in the various sizes used.
Figure 53—Lydian cursive, actual size and reduced.
Figure 54—Proof of monotype, actual size.
Figure 55—Completed caption ready for photocopying.
Figure 56—Completed caption as used in exhibits.

Preliminary Photocopying—Photograph the Coxhead-Liner single-line strips, enlarging or reducing on the negatives as needed. Prepare prints from these negatives for the artist's use.

Artwork—The layout, which was cut apart to facilitate preparation by the two methods, is temporarily re-assembled. The contact prints from the Coxhead-Liner strips and the typeset proofs are now trimmed and mounted for photocopying; each caption is set up as a separate unit. At this stage, all letters are black on a white background (Fig. 55.).

Final Photocopying—Place the completed captions layouts in position on the copy board of the camera. Arrange to use as much of the film area as possible and make negatives.

Direct Positive Prints—Direct positive prints can be made directly from the negatives; the image is transposed to white letters on a black background during processing. Direct positive paper is light in weight and it is usually necessary to mount the print on a cardboard base for use in the exhibit.

Contact Prints—To make contact prints, the image must be transposed before the prints are made. Expose the final negative on a second piece of film, which results in a positive with opaque letters on a clear background. Contact prints prepared from this positive reverses the letters to white on black. Captions produced in white letters on a black background (Fig. 56.) give greater contrast and legibility.

***Figure* 57—Shipping cases with buffers of foam-rubber.**

SHIPPING

Living Insects—One of the greatest difficulties in shipping living insects is to keep food plants fresh in transit. It is safe to ship larvæ feeding on coniferous foliage in breeding cages (Fig. 1, p. 7). Fill the water container with absorbent cotton before adding water, to avoid leakage. Tie the chimney, wrap each cage in newspaper and pack in excelsior or shredded or crumpled paper. You can ship a few small larvæ in large test tubes, supplied with evergreen twigs; wrap the cut ends in wet cotton. The tubes should be stoppered with plugs of wet absorbent cotton.

Dead Insects—Use a wooden box with a deep, firm pinning medium securely fastened in the bottom. With pinning forceps, pin the specimens into the box. Place a sheet of cardboard over the pin heads, and then pack cellucotton above it to hold the cardboard against the pins. Wrap the box in paper to keep dust out, then in cotton, and pack it in excelsior in a carton labelled "Fragile".

Evergreen Foliage—If no preservative is at hand, ship coniferous foliage fresh from the tree, packing it as described for deciduous foliage below. However, evergreen foliage should be partially preserved as soon as it is cut from the tree. Place it in Formula 30 (p. 68) for one week and then wrap it while it is still wet in cheesecloth saturated with the same solution. Wrap in plastic sheeting and pack in moist moss. Be careful not to crush the needles and keep the branches in their natural shapes.

Deciduous Foliage—Ship deciduous foliage fresh from the tree. Wrap the cut end in wet absorbent cotton or cheesecloth. Wrap the entire branch in wet cheesecloth, cover this with damp paper, and enclose the whole in a plastic wrapper. Pack the parcel in wet moss in a carton. If the branch must be kept for some time before shipping, before the leaves wilt place the branch in 5 per cent formaldehyde. Never put deciduous foliage in Formula 30.

Fruit and Vegetables—Choose specimens that have no injuries to the skin other than the damage to be shown. Wrap each item individually in wax paper and pack in excelsior in a wooden box.

Completed Exhibits—Glass-topped cases containing exhibits should always have adequate packing material on all sides between them and the wooden shipping box. An excellent shipping box for glass-topped cases was designed by Mr. C. F. Nicholls, Entomology Laboratory, Belleville. It is made of ½-inch fir plywood with sheets of 1-inch foam rubber surrounding each case. Thin wallboard dividers between the cases keep the weight of one case from resting on another.

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FORMULAE

The formulæ for preserving insect and plant specimens are listed together here to avoid repetition in the various sections of the manual. They are referred to in the text by formula number and page. Numbers in brackets relate to References (see p. 80).

Preserving Larvae Dry

1. Barber's Method (28)—Kill in 80 per cent alcohol to which benzol, carbon bisulphide, or some other fat solvent has been added at 1 part of solvent to 10 parts of alcohol. Allow average specimens to remain in this solution at least 24 hours; larger insects and those with softer bodies should remain 72 hours.

Change to 95 per cent alcohol and leave for 24 to 72 hours.

Dehydrate in absolute alcohol containing a piece of limestone to take up moisture.

Transfer to xylol and dry on plaster blocks. Puncture large specimens to facilitate dehydration.

Shrinkage may be reduced by placing the specimens in cold water over slow heat and bringing it to the boiling point. Remove the specimens from the heat and allow to cool to room temperature.

Larvæ preserved by this method may be mounted on pins.

2. Preserving Small Soft-bodied Insects (12)—The following solution is suitable for either soft-bodied larvæ or adults:

Ethyl alcohol	85 cc.
Formaldehyde (10 per cent)	15 cc.
Glycerin	5 cc.

Place living or newly killed specimens directly into the solution and leave as long as desired but at least 24 hours. **Specimens that will later be boiled in caustic should not be placed in this solution because it contains formalin.**

When pinned specimens are wanted, dehydrate by placing them successively in 85 per cent, 95 per cent, and absolute alcohols, then in xylol, leaving them 10 minutes in each.

Specimens need not be removed from the vials to make changes to different solutions. Drain off the liquid with a small-tipped pipette. While the specimens are in xylol, position them if they are adults on folded strips of filter paper; place the wings in contact with the paper. Remove specimens and paper gently and allow to dry.

3. Alternate Method for Preserving (28)—This method preserves larvæ so that they may be pinned or used out of preserving liquid. The color is lost but may be partially restored by using Formula 4.

Pass the specimens through alcohol, 60, 70, 80, and 90 per cent, and absolute, in turn, then through the following solutions:

2 parts absolute alcohol, 1 part xylol
1 part absolute alcohol, 1 part xylol
1 part absolute alcohol, 2 parts xylol

Xylol
2 parts xylol, 1 part turpentine
1 part xylol, 1 part turpentine
1 part xylol, 2 parts turpentine
Turpentine
Leave specimens in each solution for six days.

4. **Staining Dry Preserved Larvae** (28)—Prepare the stain with an oil paint that is soluble in xylol. Dehydrate the specimens with Formula 3. Have the stain rather concentrated and transfer the specimens to it. Leave them in the stain two or three hours. Very oily specimens will not absorb stain and must be hand-painted. Do not use water colors; the specimen will shrink as soon as it comes in contact with water.

Preserving Larvae in Liquid

5. **Craig's Solutions** (origin unknown)—This solution preserves colors of larvæ very well.

Solution 1.	Formaldehyde (40 per cent)	200 cc.
	Potassium nitrate	15 gm.
	Potassium acetate	30 gm.
	Water	1000 cc.
Solution 2.	Sodium chloride	saturated solution
Solution 3.	Potassium acetate	60 gm.
	Potassium nitrate	30 gm.
	Water	1000 cc.
Solution 4.	Potassium acetate	100 gm.
	Glycerin (chemically pure)	250 cc.
	40 per cent formaldehyde	5 to 10 cc.
	Water	1000 cc.

Depending on its size, the carefully washed specimen remains in Solution 1 for one to five days. Extraction of formaldehyde and development of gross color are usually completed in Solution 2 in one to three days. In Solution 3, the time needed for complete development of colors in fresh specimens is two to seven days. The specimen is placed in Solution 4 for permanent storage.

6. **Kahle's Fluid** (19)

Ethyl alcohol (95 per cent)	15 parts
Formaldehyde (40 per cent)	6 parts
Glacial acetic acid	1 part
Distilled water	30 parts

Preserving Adults

7. **Formalin-chloroform for Preserving Reds, Yellows, and Browns** (28)—Saturate a vial of 10 per cent formalin with an excess of chloroform. Shake the bottle two or three times a day for a week. Pour off the saturated solution and add the specimens.

8. Preserving Browns and Greens in Cicadidæ and Orthoptera with Formalin (28)—This method was used by the late W. T. Davis, Staten Island Museum.

Green preserves much better in insects soaked in formalin with about 16 to 18 parts of water for a few days than in specimens not so treated. Place newly collected insects in formalin, pour off after a few days and replace the cork in the bottle; this will keep the insects in a moist condition. If the formalin is not too strong, the insects will remain pliable; it is possible to stretch and arrange the legs as if the insects had been dead only a few days.

9. Degreasing Insects—Large-bodied moths, especially Sphingidæ and Saturniidæ, often become greasy some time after mounting. To avoid spreading of the grease, remove the viscera through a slit on the underside of the abdomen. Swab out with cotton and paint the inside with arsenical soap (Formula 11, p. 63). Fill the cavity with a twisted, tapered plug of cotton and draw the edges of the incision together.

To degrease an old specimen, Ward's suggests the following procedure. Pin the specimen so that the wings are tilted, and with an eye-dropper allow carbon tetrachloride to run slowly from the base of the wing to the tip. Place a small ball of cotton near the tip of the wing to collect the carbon tetrachloride, save and use again until it becomes saturated with grease (when it turns yellow).

Peterson (27) mentions having success with a variation of Valentine's (44) method for removing grease from larvæ, nymphs, and pupæ that are to be dried. Kill the specimens in an ethyl acetate killing bottle and place directly into ether. Several changes are necessary until no yellow shows in the liquid; it will take two to several days. After all the fat has dissolved, remove the specimens one at a time and place them on absorbent paper under an electric light bulb in a gooseneck desk lamp. The heat evaporates the ether and slightly inflates the specimen; too-rapid evaporation may burst them. Leave under the lamp until all the ether has evaporated. If removed too soon, the specimen will shrink. A shrunken specimen can be restored if returned immediately under the lamp. Suspending the specimens on wire screen in the ether should prevent the grease from penetrating the specimen.

10. Keeping Dried Specimens Free of Pests—Use mercuric chloride dissolved in ethyl alcohol in a glass container. Thin the solution until a black feather dipped in it will not show a white deposit. **This chemical is a very dangerous poison and must be handled with great care.**

Insects not heavily covered with scales or hair may be dipped; others should be carefully moistened with a soft brush. Place the label "Poison" on the container and brush, and use them for nothing else. Do not mount the treated specimen in a display unit for some time because the fumes will turn white paint yellow.

Some German entomologists have used pure lindane in alcohol with success; they claim it will last longer than other materials tried. It is lightly sprayed over mounted insects and inside the cases.

Marioni (21) states that a small cellophane envelope containing 0.5 gm of BHC mixed with geraniol, placed in a case of insect specimens and pierced with a pin, will protect the contents from attack by insects for three years; specimens in an unprotected case in the same room were completely destroyed and numerous psocids, lepismids and adults of *Anthrenus* spp. were present.

11. Preserving Fresh Specimens (14, p. 346)

White bar soap, soft	2 pounds
Powdered white arsenic	2 pounds
Subcarbonate of potash (potassium bicarbonate)	6 ounces
Camphor	5 ounces
Alcohol	8 ounces

The soap used should be best quality laundry soap of such composition that it can be reduced with water to any degree of thinness. Do not use soap that becomes jelly-like when melted. Slice the soap and melt it in a small quantity of water over a slow fire and stir occasionally to prevent burning. When melted, add the potash and stir in the powdered arsenic. Next add the camphor, which should be dissolved in the alcohol at the beginning of the operation. Stir the mass thoroughly, boil it down to the consistency of thick molasses, and pour it into an earthen or wooden jar to cool or harden. Stir it occasionally as it cools to prevent the arsenic from settling to the bottom. When cold, it should be like lard or butter. To use, mix a small quantity with water until it resembles buttermilk and apply with a common paint brush. Use this mixture to treat the body cavities of large Orthoptera and Lepidoptera, and larvæ from which the viscera have been removed.

12. Impregnating Dried Insects—The synthetic resins "Gelva" and "Alvar" may be used successfully to impregnate dried insects; "Alvar" is stronger than "Gelva" but has an amber tint, "Gelva" is colorless. Dried insects or plaster casts may be immersed in very thin solutions of either.

To dissolve, place the resin in alcohol and heat in a water bath until it has liquified completely. Do not tighten the lid while the container is being heated. Add more alcohol when the resin has dissolved to make a thin solution for impregnating.

For adhesive purposes, an average solution consists of 25 per cent resin by weight. To mend wood, saturate both sections and let dry. Apply a second coat and let it dry. Soften the adhesive with alcohol and press the parts together.

13. Metal Plating Insects (36)—Formula 1: To one pint of orange shellac add ¼ pint of wood alcohol and mix thoroughly. Attach No. 20 or other small copper wire to the article to be plated and dip in the solution for one minute. Remove and shake off the surplus shellac, then fill an ordinary insect powder gun with gold bronze powder and spray, covering the shellacked surface well.

Formula 2: Especially for insects, make a thin solution of shellac by adding wood alcohol. Place the insect on wires as in Formula 1 and spray with this solution, using a common throat atomizer. Make a solution by dissolving nitrate crystals in a liquid composed of 6 parts of 95 per cent alcohol and 4 parts of distilled water. Dip articles in this liquid for a moment and then remove and expose them to fumes of hydrogen sulphide for five or ten minutes, or until they turn to a silvery gray. If they are not evenly covered, remove, dry, dip again, and return to the fumes. When the insect is evenly covered with a silvery gray finish, it is ready for the bath.

The following bath is used for both formulae. Dissolve 1 pound of copper sulphate in 2 quarts of warm water and add 2 ounces of sulphuric acid; add slowly and stir constantly. Place the solution in a glass jar. Use two 2-volt dry cell batteries in parallel. Connect several feet of fine iron wire to the negative side of the battery, and to the other end attach the article to be plated. The wire serves as a resistance wire. Attach fine iron wire to the positive side of the battery and attach to it a sheet of copper 3 by 4 inches for the anode. Leave the article in the bath for 12 to 24 hours or until the plating is heavy enough.

If the deposit is loose or grainy, use more resistance wire; if too slow, use less wire but a slow deposit gives best results. If the article has spots not plated, gild them carefully and return it to the bath until plated. Finish the articles with such plating or bronze with gold or silver, or paint with oils or enamel. To produce a metallic finish in colors, use combinations of gold and silver for green, gold and copper for red. It takes practice to master this coloring. After articles have been plated with copper, they may be plated with silver by the "Electro" process in common use but a cheaper process is as follows: use 60 grains of silver chloride, 300 grains of cream of tartar, and 120 grains of common salt. Mix well and reduce to a fine paste with distilled water; cover articles with this paste and let dry, rub off with powdered chalk and polish. It takes a great deal of practice to use this process efficiently.

Alcohol: Uses and Diluting

14. Dehydrating Alcohol (28)—By using anhydrous copper sulphate, water can be removed from alcohol. Heat the copper sulphate in a pan until the water is driven off and it becomes white. Place this in a receptacle or alcohol. It will turn blue again as it picks up water. By repeatedly heating the copper sulphate, the alcohol may be kept almost completely dehydrated. About one third of the container of alcohol should be kept filled with crystals. (For exact dilution table, see Bolles Lee (19), p. 45).

15. Testing Strength of Alcohol (28)—Post obtained the following hints from J. Douglas Hood, Cornell University. If the solution is known to be relatively free from oils, glycerin, and substances other than alcohol and water, a sufficiently accurate determination may be made by a simple specific gravity test. Take up a minute quantity of the liquid in a finely pointed pipette and force it slowly into an alcohol of known strength. If observed against the light it will be seen to sink or rise, depending on whether it is heavier (weaker) or lighter (stronger) than the liquid in which it is being tested. Differences as little as 5 per cent in water content may be readily detected. The method is particularly valuable when the amount of liquid available is too small to permit the use of a hydrometer.

16. Diluting Alcohol—Using 95 per cent alcohol, fill a graduate flask to the number of cubic centimeters equal to the grade of alcohol desired and fill up to the 95 cc. mark with distilled water. To make 75 per cent alcohol from 95 per cent alcohol and water, pour 75 cc. of 95 per cent alcohol into a graduate and fill to 95 cc. with distilled water.

17. Attaching Gummed Labels to Glass (38)—To attach gummed labels to glass slides or bottles, apply a drop of alcohol to the non-gummy side to make the label lie smoothly without wrinkling. Partly attached labels may be refastened by the same method.

Soldering to Reduce Heat

18. Bismuth Solder (35)

Lead	3 parts
Tin	5 parts
Bismuth	8 parts

This solder has a low melting point, which may be lowered further by adding mercury or cadmium. Use it to solder the wires in small leaves to those in the branches, where normal soldering heat might run up the wires and melt the casts.

19. Soldering Flux for Cleaning Subject before Soldering—Cut hydrochloric acid by placing pieces of sheet zinc in the acid. **Do not inhale the fumes.** For fine work, use jewellers' solid-core solder.

Preserving Leaves, Stems, Fruit, and Vegetables in Liquid

20. Copper Acetate (Boiling) for Preserving Green Colors in Plants (10)—Securing a permanent approximation of natural color in green specimens is often desirable, and can be accomplished by boiling the specimens in copper acetate solution. To make **stock solution** add copper acetate crystals to a 50 per cent solution of glacial acetic acid until no more will dissolve. To make **solution for treatment,** to 1 part of the stock solution add 4 parts of water. The treatment is as follows:

- Heat the solution for treatment to just below boiling. While heating, place the material to be treated into the solution. At this temperature the green of the chlorophyll breaks down and a yellowish green or brown color appears. As boiling continues the green color of the copper acetate replaces the yellowish green or bleached foliage.

- The treatment may take 3 to 15 minutes. Fleshly parts may take about 30 minutes. When the proper intensity of color is reached, remove the specimen from the hot solution.

- Thoroughly wash the specimen in tap water.

- After washing, place in a weak solution of formalin made by adding 5 parts of 40 per cent formalin to 95 parts of water. The strength of the solution may be reduced to 3 per cent.

- After the specimens have been in the formalin solution for several weeks, replace the solution at intervals of several weeks until it remains clear. Red usually disappears and there is no known good method to preserve it, but all shades of green and yellow are well differentiated by this method.

21. Copper Chloride (Cold) for Preserving Green Color in Plants (10)—The following solution is valuable for preserving green, yellow, and red colors.

It is much more easily handled than the copper acetate solution and the specimens are not boiled.

Alcohol (50 per cent)	90 cc.
Formaldehyde (40 per cent)	5 cc.
Glycerin	2.5 cc.
Glacial acetic acid	2.5 cc.
Copper chloride	10 gm.

Place the plants in the solution for several days. The full green color is reached in two days by delicate plants and in three to ten days by harder plants. Dry herbarium specimens treated by this method before pressing retain their color indefinitely.

22. Preserving Fruit (10)—The various colors of fruits may be preserved, at least partially, by placing the fruits permanently in the following solutions.

- For peaches, apricots, quinces, cherries, green and yellow pears, white raspberries, green and yellow grapes and white currants:

Sulphurous acid	1 pint	(0.568 l.)
Water	8 pints	(4.544 l.)
Alcohol	1 pint	(0.568 l.)

- For gooseberries, blackberries, red and yellow apples, red and black cherries, red and black currants, red and black grapes, dark-coloured plums, and red and black raspberries:

Boric acid	1 lb.	(453.6 gm.)
Water	45 lb.	(20.61 l.)
Alcohol	5 pints	(2.74 l.)

Dissolve the boric acid in the water and then add the alcohol. If the fluid is not clear, allow the suspended material to settle, decant, and filter.

23. Bleaching Woody Material (10)—To bleach woody roots or stems and twigs of woody plants, place the specimens in 1 per cent sodium bisulphite solution in jars. Add a little citric acid until a strong odor of sulphur dioxide is given off. Leave the specimens in the solution for several weeks, until it becomes discolored. Replace the solution until discoloration is not noticeable. More delicate specimens may be bleached in the solution for one or two hours and permanently preserved in 3 to 5 per cent formaldehyde.

Preserving Red in Fruits and Vegetables

24. Vacha's Formula 14A (43)—Useful for preserving red:

Cobalt nitrate	15 gm.
Stannic chloride	10 gm.
Formaldehyde (40 per cent)	25 cc.
Water	2000 cc.

This solution may be used for preserving strawberries, Bliss Triumph potatoes, and other red fruits and vegetables. Thoroughly wash the specimens in cold water, place them in jars, and submerge them in the solution. Keep them in the solution for at least two weeks; discard the solution and replace it with a holding solution, Vacha's Formula 14B, as follows:

Formaldehyde (40 per cent)	10 cc.

Ethyl alcohol (95 per cent)	10 cc.
Sulphurous acid	30 to 50 cc.
Water	1000 cc.

25. Vacha's Formula 2 (43)—Useful for preserving red raspberries and red plums:

Potassium bisulphate	40 gm.
Oxalic acid	20 gm.
Formaldehyde (40 per cent)	30 cc.
Glycerin	50 to 150 cc.
Ethyl alcohol (95 per cent)	25 cc.
Water	1000 cc.

Place the specimens in the solution for about five days to three weeks, and then in a holding solution, Vacha's Formula 14B.

26. Preserving Red in Fleshy Plants (43)—Vacha's Formula 41 is suitable for preserving red in materials that are fleshy and soft and have a tendency to break up:

Ethyl alcohol (95 per cent)	254 cc.
Formaldehyde (40 per cent)	54 cc.
Copper sulphate	0.5 gm.
Water	2500 cc.

Place the specimens in the solution for 24 hours to several days. As soon as the red becomes dense, remove the specimens, wash them thoroughly for several minutes in running cold water, and place them in a holding solution of Vacha's Formula 14B.

27. Hesler's Solution for Preserving Insect Injury on Fleshy Plants and Fruits (28)—The San Jose scale and the pear psylla were preserved in the following solution. There was little loss of color or shrinkage in insect injury to prunes.

Water	4000 cc.
Zinc chloride	200 gm.
Formaldehyde (40 per cent)	100 cc.
Glycerin	100 cc.

Preserving Color in Plants for Mounting

28. Preserving Plant Material before Pressing (28)

Glycerin	50 parts
Acetone	25 parts
Alcohol (95 per cent)	25 parts

After specimens have been in the solution two or three days, they may be pressed and mounted. The plants remain green and pliable.

29. Preserving Green Plants (16)

Alcohol (50 per cent)	90 cc.
Formaldehyde (40 per cent)	5 cc.
Glycerin	2.5 cc.
Glacial acetic acid	2.5 cc.
Copper chloride	10 gm.
Uranium nitrate	1.5 gm.

For yellowish green plants the amount of copper chloride may be reduced by half, especially for Spirogyra, young corn plants, the young needle clusters of larch, and the like.

For general laboratory use, plant materials are merely dropped into the solution and stored until needed. Some delicate forms are ready for study in forty-eight hours. Generally, however, the color change in most plants is less rapid, and three to ten days are necessary to complete preservation.

Herbarium dry mounts made from specimens preserved in this solution withstood fading, although exposed in a south window for eight months. Plants preserved in this solution may also be kept in a 4 per cent formaldehyde solution.

30. Preserving Evergreen Foliage (29)

Ethylene glycol	65 parts
Water	34 parts
Carbolic acid or formaldehyde (40 per cent)	1 part

This solution has a specific gravity of 1.029, and penetrates better than other solutions. Leave freshly cut evergreens in the solution for two weeks.

31. Fixing needles (29)

Gelatin	4 sheets
Water	12 ounces
Glycerin	3 cc.
Carbolic acid	A few drops

Dissolve the gelatin in cold water. Warm the solution and add the glycerin and the carbolic acid. Dip the branches as they come wet from the glycol solution. Two or three dippings are necessary; shake the branches well after each dipping.

Separators for Plaster Casts from Plaster Molds

32. Stearic Acid and Kerosene (41)

Stearic acid	¼ lb.
Kerosene	1 pint
Aerosol O.T. 100 (Dioctyl sodium sulfosuccinate)	1 oz.

Shave the stearic acid into flakes and mix the three ingredients. Bring to the boiling point, but heat the mixture with care as it is very inflammable. Stir well. Paint a very thin film while the solution is warm. If brush marks show, thin with kerosene.

33. Petroleum Jelly (41)

Petroleum jelly	1 part
Kerosene	2 parts

Blend by heating and stir well.

34. Beeswax and Carbon Tetrachloride (7)

Yellow beeswax	1 part by weight
Carbon tetrachloride	9 parts by weight

Heat the carbon tetrachloride with the wax in it until the wax dissolves.

35. Banana Oil and Acetone (7)

Banana oil	3 parts by weight
Acetone	1 part by weight

This dries quickly on the mold.

36. Benzene and Paraffin (7)

Benzene	5 parts by weight
Paraffin	1 part by weight

This may be thinned by adding more benzene.

Separator for Wax Casts from Plaster Molds

37. Castile Soap

Liquefy 2 ounces of castile soap by boiling in 30 ounces of water to form a stock solution. Add 3 teaspoonfuls to each gallon of water in which white plaster molds are heated.

Base Construction

38. Papier mâché (7)

Wet paper pulp	1 part by weight
Water	3 parts by weight
Plaster of paris	8 parts by weight
Hot glue (consistency for cabinet work)	1 part by weight

Macerate paper such as old newspapers in boiling water. When the fibres have separated, squeeze some of the water from the paper and add the hot glue. Stir into a soft, sticky mass. Add the plaster and squeeze through the fingers to break all lumps. Use as soon as possible after making. The surface may be kept moist by covering with a damp cloth. The mixture adheres firmly, sets in three hours, and becomes firm as wood.

It is best to make a new mass each time it is needed, but it may be kept for a time by adding a few drops of glycerin and methyl salicylate, phenol, or sodium fluoride, and storing it in a tightly sealed jar.

39. Coarse Papier Mâché (7)

Felt building paper	Whiting
Dextrin	Plaster of paris

Macerate the paper in boiling water. Dry-mix equal parts of the plaster and whiting. Mix dextrin syrup (equal parts of dextrin and water boiled) with equal parts of the damp paper and the plaster-whiting mixture. The mixture should set in less than one hour. To retard setting, add more dextrin syrup and whiting; to hasten setting, add more plaster and dextrin.

40. Dextrin Mâché for Touching up Tree Bark (4)

Dextrin	4 parts
Water	4 parts
Boil and add paper pulp	5 parts
Manikin sawdust	1 part

Mix the following thoroughly before adding to the above:

Whiting	7 parts
Plaster	7 parts

Stir all ingredients together until a smooth mass results.

41. Asbestos Mâché

Ground asbestos	5 parts
Plaster of paris	1 part

Mix the asbestos and plaster thoroughly, then add 10 per cent glue until a smooth medium like thin putty is obtained. When the mâché is dry on the base, paint it with 20 per cent glue.

Thinners for Airbrush Oil Painting

42. Turpentine-Linseed Oil Thinner

Pigment as it comes from the tube	1 part
Spirits of turpentine	2 parts
Linseed oil	1 part

43. Turpentine-Carbon Tetrachloride* Thinner

Spirits of turpentine	2 parts
Carbon tetrachloride	1 part
Damar varnish	A few drops

For less gloss, use less turpentine and varnish.

* If desired, the very toxic solvent carbon tetrachloride may be replaced by methyl chloroform (1,1,1, trichloroethane).

Preserving Natural Soil Units for Bases

44. Preserving with Lacquer Cotton—Dissolve lacquer cotton with acetone or butyl acetate and pour the solution over a small soil area in the field. When dry, lift the shallow section out intact. If acetone is used as a solvent, it will set under water, or under wet conditions. Acetone sometimes leaves a fog; if this happens, remove it with butyl acetate.

Methods for Casting in Plastic

45. Casting in Liquid Cellulose Nitrate (48)

Amyl acetate, technical grade	5 parts by weight
Cellulose nitrate	1 part by weight

Dissolve the cellulose nitrate in the amyl acetate. Two or three days are required to dissolve the cellulose, with occasional stirrings.

46. Softening Cellulose Nitrate Sheets (26)

Acetone	60 per cent by volume
Water	40 per cent by volume

Immerse the sheet of cellulose nitrate in the solution until it is rubbery.

47. Rendering Bits of Plaster on Plastic Casts Transparent (48)

Benzene	5 parts
Linseed oil	1 part

Brush over the bits of plaster on the casts that cannot be removed by brushing. They will become inconspicuous.

48. Retouching Plastic

Toluene	5 parts by weight
Ethyl cellulose	1 part by weight

Dissolve the cellulose in the toluene and tint with oil colors.

EQUIPMENT AND MATERIALS

Some exhibits may be prepared with a minimum of equipment, but appropriate tools greatly facilitate the work and produce higher-quality results. "Sources of Equipment and Materials" (p. 77), gives a ready index to supply houses. Commonly used items are listed below.

Laboratory Facilities

Compressed Air—A cylinder of liquid carbonic acid gas is suitable for operators working away from the laboratory, or when doing a limited amount of spraying. Electrically driven compressors are much preferred for continuous use.

Fume Hood or Exhaust Fan—Fumes from solvents used in plastic casting may be very objectionable and some may be harmful.

Benching—Work benches of two heights, 30 inches and 36 inches, are desirable. These should be supplied with outlets for water, gas, compressed air, and vacuum.

Lighting—Lighting is very important. A room with north windows is best for color work; use daylight bulbs.

Storage Space—Without proper temporary storage facilities, it is difficult to care for unfinished material. Ample drawer space of different depths should be available.

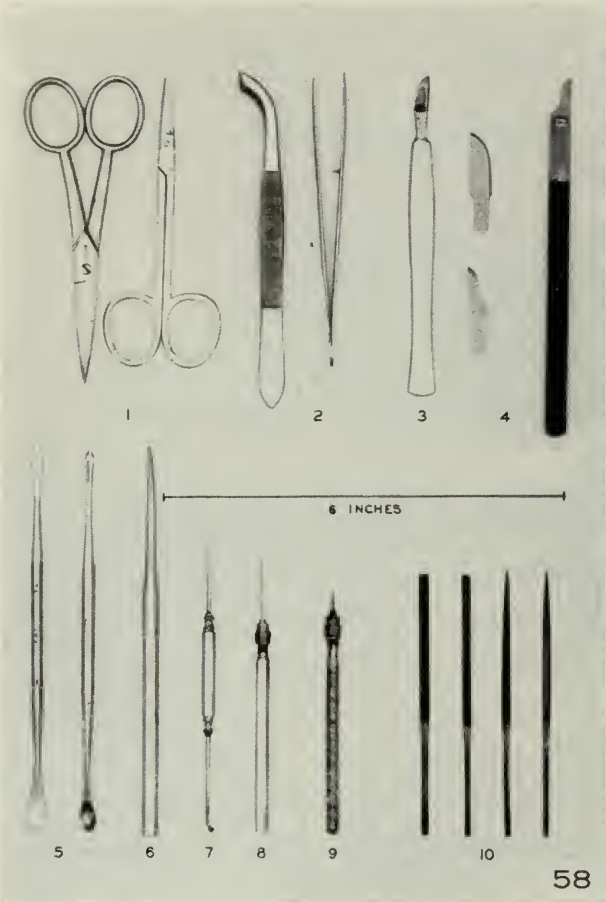
Mold Making

Equipment

A set of flat enamel, earthen, or glass bowls for mixing plaster
Boxwood modelling tools, steel rules
Metal ladle for babbit or antimonial lead
Tools such as shown in Figs. 58 and 59 (see p. 72).

Materials

Molding plaster, dental plaster, and dextrin
Water clay and plasticine



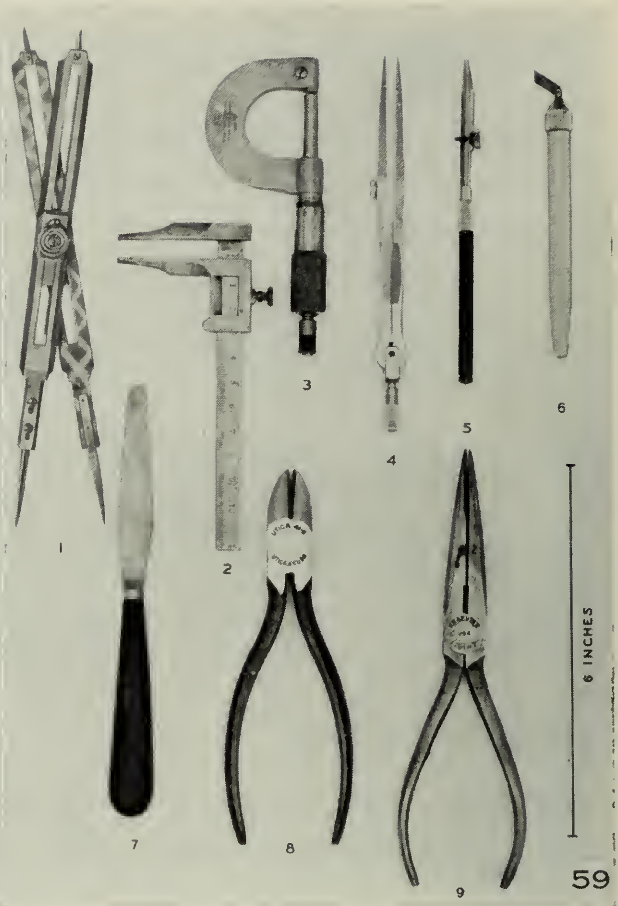


***Figure 58*—(1) Scissors, (2) forceps, (3) scalpel, (4) combination knife, (5) wax spatulas, (6) dental probe, (77 spoon and seeker, (8) dissecting needle, (9) holder for razor-blade splinter, (10) Swiss pattern files.**

***Figure 59*—(1) Proportional divider, (2) caliper, (3) micrometer caliper, (4) dividers, (5) ruling pen, (6) swivel stencil knife, (7) flexible spatula, (8) cutting forceps, (9) long-nosed cutting pliers.**

Castile soap, borax, alum, and talc
Tin for leaf mold forms
Liquid latex and ammonia for dilution
Water-white kerosene for enlarging latex molds
Gelatin for molds
Babbit metal or antimonial lead for metal molds
Molders' sand

Casting in Wax

Equipment

Electric hot plate, Bunsen burner, and alcohol lamp
Enamel double boilers for melting wax, enamel pan for heating plaster molds in water
Water pitchers and ladles for wax
Pipettes
Wax press for casting leaves (Fig. 60.)

Materials

Pure white beeswax, paraffin wax
Castile soap

Long-fibred absorbent cotton and cheesecloth
Annealed iron, copper, and monel wire
Stearic acid for a separator

Casting in Plastics

Equipment

Small brass brushes for removing bits of plaster from casts
Air-tight box for holding unfinished casts over noon hour or night to retard drying
Tray of brushes in solvent for applying liquid plastic (Fig. 61.)

Materials

Cellulose nitrate and cellulose acetate sheets for preparing liquid plastic and for casting in press molds
Ethyl cellulose in low-viscosity, granular form, to be dissolved in toluene for retouching plastic casts
Cellulose butyrate tubes and rods for model making
Crystals of "Gelva" and "Alvar", synthetic resins for impregnating plaster casts
Tenite pellets and sheets for thermocasting
Methyl methacrylate for building up thick midribs in large leaf casts
Solvents: amyl acetate, butyl acetate, ethyl acetate, acetone, diacetone alcohol, and toluene

Art Work

Equipment

An airbrush that will produce a fine line as well as a wide spray is very useful (Fig. 62, p. 74).
Binocular microscope, hand lens, and mounted, adjustable, rectangular swivel lens

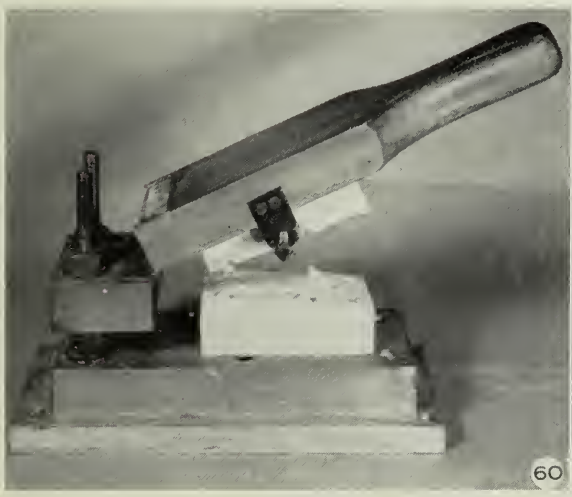


Figure 60—**Hand-press for casting leaves.**

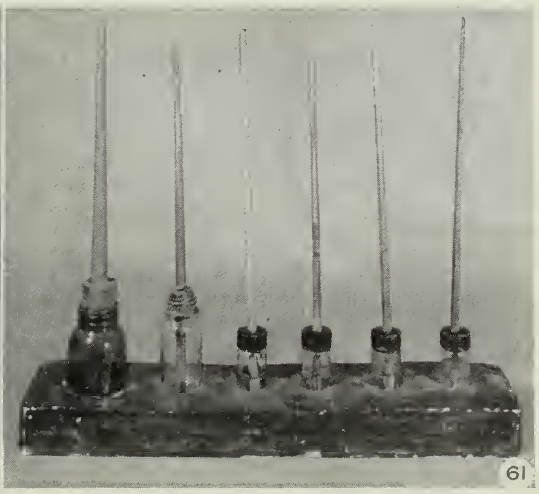


Figure 61—**Tray of brushes in solvent for casting in liquid plastic; the stoppers are fixed to the handles.**

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Figure 62
Airbrushes.
Left, Wold
Center, Thayer and Chandler.
Right, Paasche.

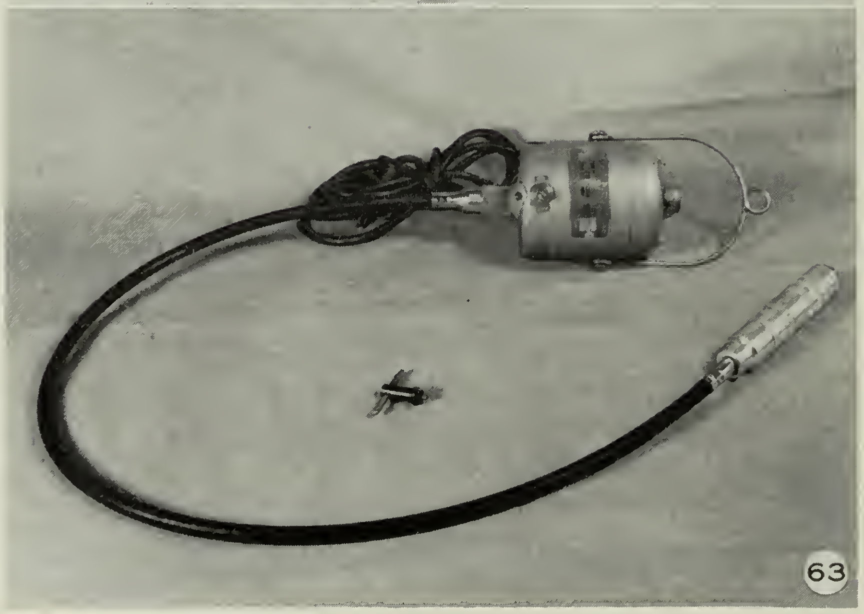

Figure 63
Electric drill with flexible shaft and grinder.

Drafting board, T-square, and ruling pens
Artists' sable brushes for oil paint, Nos. 00 to 10, and white bristle brushes with unpainted handles for plastic casting, Nos. 3 to 10.

Materials

Artists' tube oil colors with thinners: rectified spirits of turpentine and carbon tetrachloride
Artists' dry paints in various colors
Tracing paper

Assembling Exhibits

Equipment

Electric soldering iron with $\frac{1}{4}$-inch point; high-speed electric drill with flexible shaft, and chuck taking drill bits and attachments from zero to $\frac{1}{4}$ inch (Fig. 63.)

Materials

Adhesives: "Duco" household cement, "Ambroid" cement, "Kodak" rapid mounting cement, book-binders' paste, liquid glue, gum tragacanth, and gum arabic
Jewellers' solder
Zinc sheet and hydrochloric acid for soldering flux
Ground asbestos for mâché mix

Collecting Insects

Equipment

Insect net, killing bottles, glass jars, and tins for carrying living and dead insects in the field; lantern breeding cage for rearing larvæ in the laboratory (Fig. 1, p. 7).

Inflating Larvae

Equipment

Double-bulb cautery set to ensure steady air pressure within the skin (Fig. 64, p. 76).
Alcohol lamp and tin box with opening on one side for inserting the skin while drying. (This improvised oven should be soldered to a wire frame to hold it above the flame. An infra-red lamp may be used in place of the alcohol lamp and the oven.)
Fine curved and straight forceps, dissecting needles, glass cannulæ (small glass tubes drawn to fine points), clips made from watch springs fastened to the cannulæ with silk threads

Collecting Plants

Equipment

Trowel for securing roots with plants
Oval tin box about 16 inches long with a long, tight-fitting, hinged door, keeping plants fresh between sheets of wet paper (Use shoulder straps for carrying vasculum)
Two slatted wood frames, 12 by 17 inches with metal slots through which to pass webbing straps for pressing the plants (Fig. 65, p. 76).
Porous felt paper, 12 by 17 inches, for absorbing moisture from the drying plants, ventilating with sheets of corrugated paper between the porous felt paper sheets
Good grade bristol board or 56-pound ledger paper cut to 16⅝ by 11½ inches for mounting dried plant specimens. Mounting tape may be gummed paper, cloth, or transparent plastic; "Gelva" solution may be used for mounting. Herbarium labels are white, gummed paper about 2¼ by 4 inches, usually having headings similar to the following:

Family ....
Scientific name ....
Common name ....
Locality ....
Habitat ....

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Date .... Det. ....
No. .... Collector ....
See mounted specimen (Fig. 2, p. 7).

Preserving Plants

Materials

Acids: glacial acetic, hydrochloric, oxalic
Gelatin and formaldehyde
Copper acetate, copper chloride, and copper sulphate
Potassium bisulphate, zinc chloride, cobalt nitrate, uranium nitrate

Miscellaneous

Equipment

Small bench vise, hand saw, hack saw and blades, hand drill and bits
Emery wheel, oil stone, screwdrivers, hammers, chisels, smoothing plane, tri-square, files, countersink

Materials

Ethyl alcohol, methyl alcohol, benzene, ether, chloroform, carbon tetrachloride, xylol

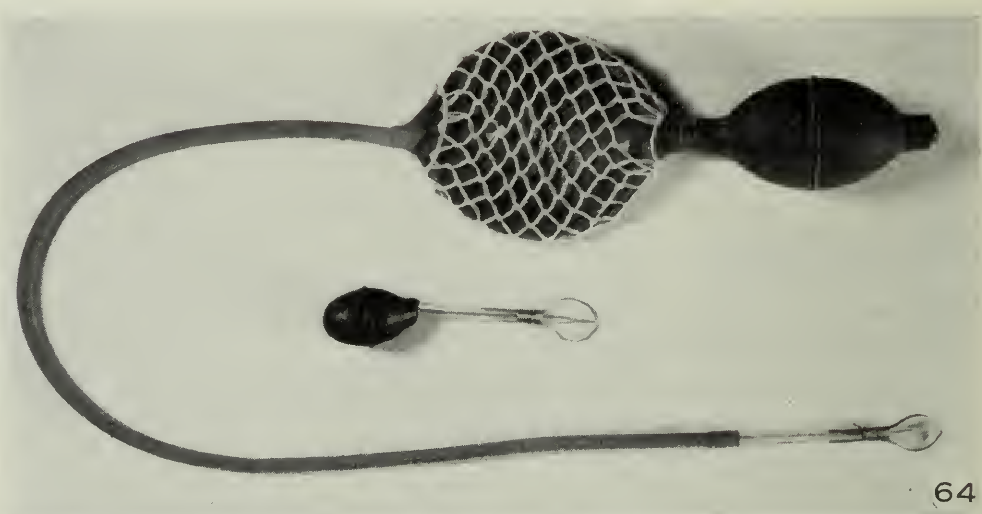

***Figure* 64** **Cautery set and glass cannulae with spring clips for inflating larvae.**

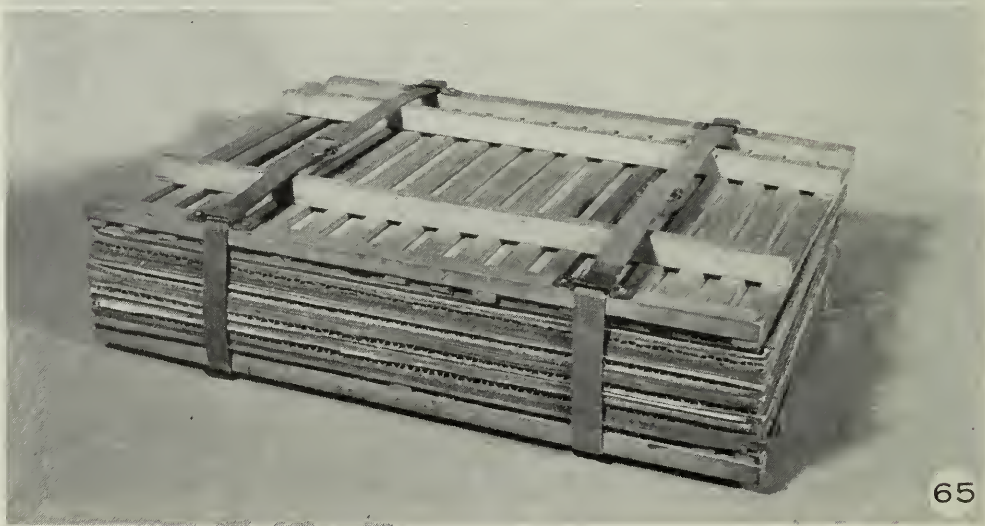

***Figure* 65** **Plant press with driers and ventilators.**

APPENDICES

A—SOURCES OF EQUIPMENT AND MATERIALS

(The number or numbers after each item refer to the appended list of supply houses.)

EQUIPMENT

Air compressor 45, 77
Airbrush 2, 9, 61, 75, 82

Bits 45, 77
Botanical driers and ventilators 21, 40
Bowls, enamel 45
Bowls, glass 45
Brace 45, 77
Brushes, brass 45, 77
bristle 9, 10, 47, 66
sable 9, 10, 47, 66
Bunsen burners 45, 77

Caliper, graduate 47, 48
micrometer 47, 48
Carbonic acid gas unit 70
Cautery set 18, 21, 37, 40, 81
Chisels 45, 77
Countersink 45, 77

Dividers, pointed 47, 48
proportional 47, 48
Double boilers 45
Drafting board 47
Drills, hand 45, 77
speed 45, 77

Emery wheel 45, 77

Fan, exhaust 34
Files, flat and 3-cornered 45, 77
Swiss pattern 49
Foam rubber 42

Gas burner 45, 77
Glass blowing, tools for 33

Hammers 45, 77
Hot plate 34

Insect net 18, 21, 37, 40, 81

Ladles, for metal 14
for wax 45, 77
Lamps, alcohol 18, 21, 37, 40, 81
desk 34
infra-red 34
Lenses, pocket 5, 47
swivel rectangular 5, 47

Micrometer, caliper 47, 48
Microscope, binocular 5
Modelling tools 9, 10, 18, 21, 37, 40, 81

Needle holders 18, 21, 37, 40, 81

Oil stove 45, 77

Pan for heating molds 45
Pens, ruling 47, 48
Pipettes 18, 21, 37, 40, 81
Pitchers 45
Plant press 21, 40

Rules 45, 47, 77

Saws, hack 45, 77
hand 45, 77
Scalpels 18, 21, 37, 40, 63, 81
Scissors 18, 21, 37, 40, 63, 81
Screw drivers 45, 77
Soldering iron, electric 45, 77
Spatulas 18, 21, 37, 40, 63, 81
Specimen hangers, Schrosbree 56
Square, T 47
Tri 45, 77

Thermometers 18, 21, 37, 40, 81
Trimmers, paper 32
Tweezers 18, 21, 37, 40, 81

Vasculum 18, 21, 37, 40, 81

Diacetone alcohol	Formaldehyde ....
Dibutyl phthalate	Methyl hydrate ....
Ether	Toluene ....
Ethyl acetate	Turpentine, spirits of ....
Ethyl alcohol	Xylol ....

B—SUPPLY HOUSES

1. Acme Paint & Varnish Co. Ltd., New Toronto, Toronto, Ont., and Montreal, Que.
2. Airbrush and accessories supply houses
3. Ambroid Co., 305 Franklin St., Boston 10, Mass.
4. American Anode Corp., 60 Cherry St., Akron, Ohio.
5. American Optical Co., Buffalo 15, N.Y.
6. Anthony-Foster & Sons Ltd., 294-306 Church St., Toronto, Ont.
7. Armstrong Cork Insulation, Adhesive Div., 522 King St. W., Toronto, Ont.
8. Arthur Brown Co., 2 West 46th St., New York, N.Y.
9. Art Metropole, 36 Adelaide St. W., Toronto, Ont.
10. Art supply houses
11. Ash-Temple Dental Supplies, Box 249, London, Ont.
12. Bookbinding houses, or No. 2863 Swift Canadian Co., Toronto 9, Ont.
13. British Drug Houses (Canada) Ltd., Toronto 14, Ont. (through local stores)
14. Builders' supplies
15. Canadian Durex Abrasives Co., Brantford, Ont.
16. Canadian Gypsum Co. Ltd., 170 Bloor St., Toronto 5, Ont. (through local builders' supplies)
17. Canadian Industries (1954) Ltd., Box 10, Montreal, Que.
18. Canadian Laboratory Supplies, Ltd., 3701 Dundas St. W., Toronto 9, Ont.
19. Carver Hydraulic Press Co., New York, N.Y.
20. Cave and Co. Ltd., 567 Hornby St., Vancouver 1, B.C.
21. Central Scientific Co. of Canada Ltd., 146 Kendal Ave., Toronto 4, Ont.
22. Claremont Waste Mfg. Co., Claremont, N.J.
23. Colonial Kalonite Co., 2212 Armitage Ave., Chicago, Ill.
24. Corning Glass Works, Corning, N.Y.
25. Corn Products Sales Co., 333 N. Michigan Ave., Chicago, Ill.
26. Crystal Glass and Plastics Ltd., Queen's Quay, Toronto, Ont.
27. Dental Co. of Canada Ltd., 229 College St., Toronto, Ont.
28. Dow Chemical Co., Midland, Mich.
29. Drugstores
30. Dry goods stores
31. Du Pont Co. of Canada Limited, 80 Richmond St., Toronto, Ont.
32. Eastman Kodak Co. Ltd., Rochester, N.Y.
    Canadian Kodak Co. Ltd., Toronto, Ont.
33. Eisler Engineering Co., Newark, N.J.
34. Electrical supply stores
35. Ettl Studios, 227 W. 13th St., New York, N.Y.
36. Favor Ruhl & Co. Inc., 425 South Wabash Ave., Chicago, Ill.
37. Fisher Scientific Co. Ltd., 904 St. James St., Montreal, Que., and 245 Carlaw Ave., Toronto 8, Ont.
38. Foundries
39. Furane Plastics Inc., 4516 Brazil St., Los Angeles 39, Cal.
40. General Biological Supply House Inc., 761-763 E. 69th Place, Chicago, Ill.
41. General Latex and Chemical Corp., 666 Main St., Cambridge, Mass. (Canada), Montreal, Que.
42. Goodrich, B. F., Rubber Co., Dunker Bldg., Kitchener, Ont.
43. Greening, B., Wire Co., Hamilton, Ont.
44. Gypsum, Lime and Alabastine Co., Paris, Ont.
45. Hardware stores
46. Hercules Powder Co., Wilmington 99, Del.
47. Hughes-Owens Co., 527 Sussex St., P.O. Box 77, Ottawa, Ont.
48. Instruments Ltd., 240 Sparks St., Ottawa, Ont.
49. Jewellers' supplies
50. Jones and Son, Bedford, Que.
51. Knob-Loch Co., 4726 Arthington St., Chicago, Ill.
52. Latex Laboratories, 2336 N. Hoyne Ave., Chicago, Ill.
53. Lowe Bros. Co. Ltd., 263 Sorauren St., Toronto, Ont.
54. Mailloux, J. E., Ltee, St. Jean, Que.
55. Mearl Corp., 153 Waverly Place, New York, N.Y.
56. Milwaukee Pub. Museum, Milwaukee, Wis.
57. Monsanto (Canada) Ltd., 183 Front St., Toronto 2, Ont.
58. National Drug and Chemical Co., London, Ont., and Montreal, Que.
59. National Lead Co., Chicago, Ill.
60. Ontario Steel Products, Plastic Div., Gananoque, Ont.

61. Paasche Airbrush (Canada) Ltd., 864 Pape St., Toronto, Ont.
62. Perma-Flex Mold Co., 243 Fifth St., Columbus 15, Ohio.
63. Physicians supply houses
64. Polymer Corp. of Pennsylvania, Dept. SM, Reading, Penn.
65. Popper, Leo and Son, Importers, New York, N.Y.
66. Professional Art Products Co., Dept. SM, 8455 Wabash Ave., Chicago, 5, Ill.
67. Robbins, Jim, Co., 130 Stephenson Highway at 14 Mile Rd., Royal Oak, Mich.
68. Rohm and Haas Co., Washington Square, Philadelphia 5, Penn.
69. Shawinigan Chemicals Ltd., Chemical Div., Shawinigan Falls, Que.
70. Soda fountain supply houses
71. Soden, P. N. and Co. Ltd., 1498 Yonge St., Toronto, Ont.
72. S. S. Rubber Co., 314 N. Michigan Ave., Chicago, Ill.
73. Stationery stores
74. Tennessee Eastman Corp., 360 N. Michigan Ave., Chicago, Ill.
75. Thayer and Chandler, 910 W. Van Buren St., Chicago, Ill.
76. Tile yards
77. Tool shops
78. United States Gypsum Co. (through local dealers)
79. United States Plywood Corp., Dept. SM, Weldwood Bldg., 55 W. 44th St., New York, N.Y.
80. Ward's Natural Science Estb. Inc., 3000 Ridge Rd. E., Rochester, N.Y.
81. Wills Corp., Rochester 3, N.Y.
82. Wold Air Brush Mfg. Co., 2173 N. California Ave., Chicago, Ill.

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* See also: Harvey, J. K. Improved technique for inflating and mounting insect larvae. Can. Ent. 89 : 280-283. 1957.

D—GLOSSARY

A

Accelerator—A substance used in the water for a plaster mix to shorten the setting time.

Adhesive—Adhering, sticky.

Airbrush—An instrument for spraying paint on a surface.

Air compressor—A unit to pump air into a storage tank to supply a continuous flow of air at a given pressure regulated by an air gauge.

Alvar—A synthetic resin soluble in alcohol.

Anhydrous—Lacking the water of crystallization (applied to minerals).

Anther—The essential part of the stamen which contains the pollen.

Anode—The positive pole of an electric source.

Antennae—The jointed feelers on the heads of insects.

Apron—A projection on the inside top of a diorama to cut off view of ceiling join. See Fig. 42, p. 49.

Armature—A framework to strengthen a model.

B

Binding post—One of the metal posts holding the sheets in place in a loose-leaf binder.

Blade—The expanded portion of a leaf.

Bloom—The delicate, powdery coating on surfaces of many plants such as plums, grapes, and cabbage.

Blowpipe—A small glass tube drawn to a fine point, with rubber tubing attached to one end; used to empty egg shells.

Buffing plastic casts—The act of removing gloss from the casts with a brush and ground pumice.

Bunsen burner—A kind of burner consisting of a straight tube, 4 or 5 inches long, with small holes for entrance of air at the bottom. Illuminating gas is also admitted at the bottom; a mixture of gas and air is formed which burns at the top with a feebly luminous but intensely hot flame.

C

Calcined—Reduced to powder by heat.

Calyx—The outer set of floral envelopes of a flower.

Cam—A projecting part on a wheel to impart an alternating motion.

Cannula—A glass tube drawn to a fine tip.

Catalyst—As used for embedding in plastic: a chemical compound that initiates the process of polymerization, by which the liquid plastic becomes solid.

Caudal—Of, or pertaining to, the cauda or the anal end of the insect body.

Cautery set—As used for inflating insects, a hand blower giving a continuous stream of low-pressure air; the first bulb is the "pump" for putting air in the second bulb, which is balloon-like and covered with net.

Cc.—The volume contained in a cubic centimeter (one centimeter high and one centimeter on each side).

Celluloid—Usually a plastic that has been plasticized with camphor.

Compound leaf—A leaf consisting of two or more leaflets.

Coniferous—Cone-bearing; evergreen.

Corolla—The leaves of the flower within the calyx.

Crisper—An enclosed container refrigerated at above freezing to hold vegetation fresh.

D

Dam—A barrier around a subject to contain plaster or other molding material.

Deciduous—Having leaves that fall in autumn.

Dehydrate—Deprive of water.

Diorama—A self-lighted display group with a foreground of reproduced subjects and a curved, painted background. It is used to represent out-of-doors scenes.

E

Eccentric wheel—A wheel with an offset axle and an arm to change rotary into backward and forward motion.

Emboss—To cause to stand out; to model between veins in paper leaves, causing the veins to stand out in relief.

Enlarged model—A scale model made larger than the original.

Essence of pearl—A medium made from fish scales, using a plastic base.

Extrusion of plastics—Pressing plastics by machine into tubes, rods, and various patterns.

F

Fascicle—A close cluster.

Filament—The stalk of a stamen in a flower.

Fistular—Cylindrical and hollow like onion tops.

Flocks—Finely cut cotton, wool, or plastic thread used to form pubescence on wax plants.

Flower stalk—The stalk that holds the flowers; the peduncle.

Fusible—Capable of being melted by heat.

G

Gamopetalous—Having united petals.

Gelva—A synthetic resin soluble in alcohol.

H

Halteres—Movable filaments or balancers in Diptera, one on each side of the thorax and representing the hind wings of 4-winged insects.

Head capsule—The sclerotized portion of the head of an insect.

Herbarium—A systematically arranged collection of plants.

Hydraulic press—One with the force exerted by liquids.

Hydrometer—An instrument for determining the specific gravity of fluids.

I

Impregnate—Infuse an active principle into.

Inflation of larvae—The emptying and drying of larval skins and filling with air to distend them to natural size.

Integument—The body wall (of an insect).

Internode—The part of a stem between the nodes, joints, or leaf attachments.

J

Japanese paper—A thin, tough, long-fibred paper made in Japan.

K

Killing bottle—A stoppered bottle having a lethal poison in the bottom such as cyanide, ethyl acetate, or carbon tetrachloride.

L

Lacquer—A varnish consisting of shellac dissolved in alcohol, or plastic dissolved in a solvent.

Latex—The milky juice of plants; for molds, a liquid preparation from the juice of the rubber tree to dry in the air.

Leaf blade—The expanded part of a leaf.

Ligature tube—A vial of soft glass that can be sealed with a blast lamp after insertion of a specimen and preserving fluid.

Ligule—A membranous appendage at the summit of a leaf sheath of grass.

M

Manikin—In museum work, an artificial filling for an insect or an inner reinforcement for a hollow, plastic cast.

Masking tape—Sticky paper or cellulose tape used for masking when spray painting.

Micrometer caliper—An instrument for measuring minute distances or thicknesses.

Monomer—In embedding, a liquid, plastic syrup. Adding a catalyst brings about polymerization.

Mother mold—A sectional mold of plaster around a flexible mold to hold its shape during casting.

N

Node—A knob on a root or a branch; the point from which leaves arise.

O

Oscillate—To swing back and forth; vibrate.

Ovipositor—A pointed, tubular organ with which female insects deposit eggs.

P

Papier mâché—Molded paper pulp. Ground asbestos and plaster may be used in place of paper.

Period of plasticity—In plaster, the period of free flowing.

Petal—A leaf of the corolla.

Petiole—The continuation of the midrib of a leaf, or leaflet which is attached to the rachis.

Pipette—A glass tube with a narrow tip.

Pistil—The seed-bearing organ of a flower.

Plant drier—Felt paper used in a plant press to absorb moisture.

Plant press—Two slatted wood frames with straps around them to press plants.

Plaster jacket—A sectional mold of plaster around a flexible mold to hold its shape during casting.

Pollen—The fertilizing powder contained in the anther.

Polypetalous—Having the petals separate.

P.s.i.—Pounds' pressure per square inch.

Pubescence—The fine, soft hairs on plants.

R

Rachis—The central stem in a compound leaf to which the leaflets are attached.

Receptacle—The axis or support of a flower.

Replica—A copy of an original.

Retarder—In plaster mix, a substance put in the water to slow the setting time.

R.p.m.—Revolutions per minute.

S

Scribe—To make lines with a pointed instrument.

Segment—Of an insect, one of the rings that compose the body.

Separator—In molding and casting, a substance applied to plaster to prevent the second pour from sticking, or to prevent wax from adhering to a mold.

Seta—A stiff hair or bristle.

Sheath—The base of a leaf when surrounding the stem, as in grasses.

Size—To glaze or coat with glue, starch, etc.

Soil profile—A vertical section of soil to show types of soil or insects in the soil.

"Spaghetti" insulation—A small, fabricated tube used as insulation in radio work.

Spatula—A knifelike implement with a broad, flat, more or less flexible blade for mixing drugs, paints, etc.

Specific gravity—Relative density.

Sludge—In casting, the scum forming on melting metals.

Slurry—Mixed plaster thin enough to pour.

Solvent—The component of a solution that dissolves the other component or components.

Stalk or *stem*—The axis of a plant; the part that bears all the other parts.

Stamen—The fertilizing organ of a flower.

Stipple—To dot.

Stipule—One of the appendages at the base of the leaf in many plants.

Stria—A slight furrow or ridge.

Suture—A line of junction between two parts.

Swiss pattern file—A miniature file used by watch makers.

Synchronous motor—An electric motor with a set speed, as in clocks and record players.

T

Template—A pattern or gauge.

Turbine—In airbrushes, a wheel that spins by air pressure.

Turntable—A revolving platform.

U

Undercut—A cavity with overhanging edges; any part of a subject in which a rigid mold will lock.

V

Vasculum—A kind of case or box used by botanists for carrying specimens as they are collected.

Viscera—The soft, interior organs of the body, especially of the abdomen.

Vulcanize—In latex molds, to dry the medium.

W

Waste mold—A plaster mold that is used once and discarded.

Water clay—Usually a clay with a mixture of sand that may be softened with water.

E—INDEX