ESPECIALLY FOR FIELD COLLECTORS

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THE PRESERVATION OF LEPIDOPTEROUS LARVÆ USING THE INFLATION AND HEAT-DRYING TECHNIQUE

by H. E. HAMMOND

INTRODUCTION

The preservation of lepidopterous larvæ by the inflation and heat-drying method is the method adopted when specimens are required for cabinet display or in making up life-history cases and is particularly useful for those who wish to study the color and superficial structural characteristics of the larvæ. This method, too, is a very great help to the field-worker for, as his collection grows, he absorbs a great deal of knowledge and except in the case of critical species, he is enabled to name promptly most of the species already encountered. Apart from this, the formation of a well-preserved and neatly mounted collection of larval skins is a real asset to the appearance and value of his collection of imagines giving, as it does, a wider and more interesting aspect to the whole.

The preservation of skins by this method takes but little longer than does the setting of imagines and the whole process can be completed in a matter of minutes with the resultant mount ready for the cabinet.

It is to be regretted that the preservation of larvæ is not more universally practised and the object of this paper is to explain and illustrate a simple method, in the hope that others will be encouraged to take up this absorbing work.

A number of the more critical species need to be bred to make certain of larval identity for very few can claim to identify larvæ of more than a fraction of the species. This alone makes the project well worth the effort and if one adds to this the increase in botanical knowledge which must automatically be acquired it can give the thoughtful student a great deal of pleasure and profit.

My own collection has been formed over many years and now embraces about 90% of the British species. To effect this I estimate I have, to date, preserved some 25,000 specimens and many collaborators and institutions are the richer by drawing on the surplus. This does, I am informed, give me the experience necessary to try to pass on to others what I have learned of the subject.

Before passing on to the main part of this paper I must make one remark. Do please pay strict regard to detail; it is so important, I want to stress the point. Success does so much hinge on care.

Apparatus

This is neither bulky nor expensive and the handyman can easily construct some of it. It consists of the oven, spirit (alcohol) lamp or bunsen burner, glass blowpipe jets, rubber inflator, silk or cotton covered copper wire, pins and a few miscellaneous items to be mentioned later.

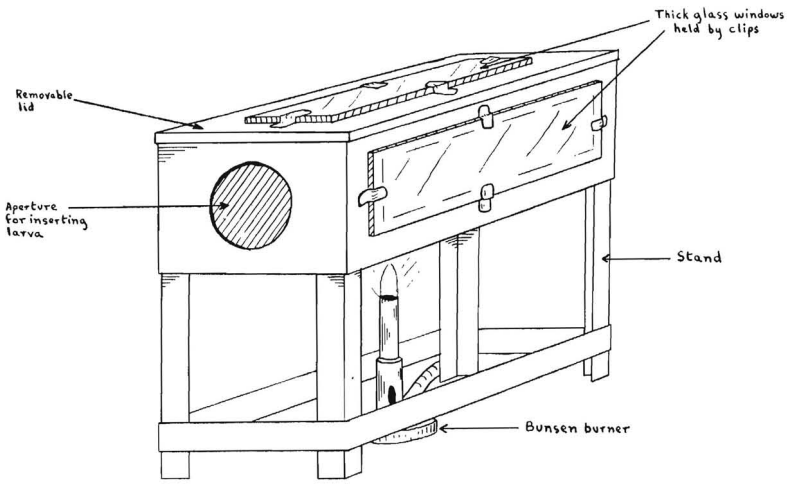

Fig. 1. Hammond-pattern drying oven, heated by a Bunsen burner.

1. The Oven.

I use one type only - a rectangular box with a removable lid. It is made of aluminium to avoid rust, but a box made from stout tinplate will answer as well. A suitable size is about 7 inches (18 cm.) long x 4 inches (10 cm.) wide x 2½ inches (6 cm.) deep. This will accommodote all larvæ likely to be dealt with unless it is desired to preserve some of the very large tropical species. At one end is cut a circular aperture for admission of the skin. The aperture should be be about 1¼ inches (3.5 cm. approx.) in diamter. In the lid is cut an aperture 5 inches (12-13 cm.) x 1½ inches (4 cm. approx.), and in the sides similar apertures 5 inches (12-13 cm.) x 1 inch (25-30 cm.). Over these apertures are placed pieces of glass slightly larger than the aperture. These are held in position by clips of brass or other soft metal. It is necessary to ensure that glass and metal fit perfectly to avoid loss of heat. I advocate a fairly loose lid, for occasionally a skin may pop off the jet and speed in recovery is essential; a few seconds' contact with the oven base will ruin a good skin. If a piece of non-ferrous gauze is fitted at about ¼ inch (4 mm.) from the oven base it will minimize the possibility of damage if recovery of the skin is reasonably prompt.

The drying oven is placed on a stand which may be another box cut to a suitable size and trimmed neatly to make a framework. If a spirit lamp is used for heating it must be protected from draughts, but *must* have ample ventilation or it will continually be extinguished or get over-heated and burst into flames. With a bunsen burner, the stand will need longer legs.

An ordinary cocoa can or similar container can be used with or without the lid in place of a more complicated oven. An aperture must, of course, be made at one end. The chief disadvantages of this form of oven are a tendency to overheat and the impossibility of watching progress without continual withdrawal of the skin for inspection; with the glass windows perfect observation and control is possible. Flat metal or fine wire gauze (not zinc, which melts over a flame) can be used as a substitute, but drying takes much longer and burnt fingers are usually a further penalty.

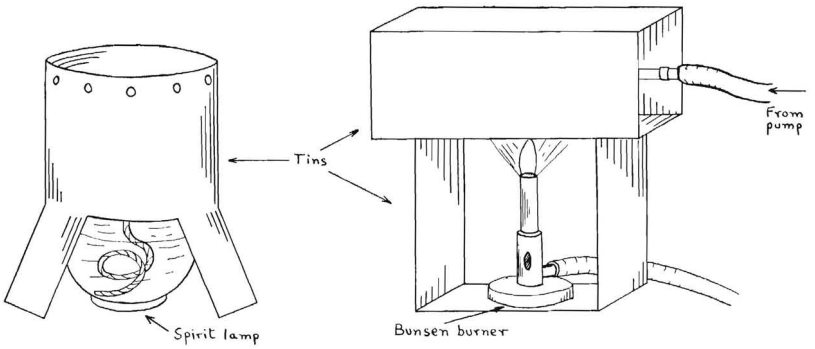

Fig. 2. Alternative drying ovens.

2. Source of Heat

For speed in operation and complete control of the heat a bunsen burner is much to be preferred, but as many would-be enthusiasts are relegated to the garden shed for "blowing" their larvæ, a spirit lamp can be used effectively in such circumstances. It is necessary, however, to use either a somewhat smaller oven or compensate for the gentler, but less easily controlled heat, by using a lamp of suitable size or, in the case of large ovens, to use two lamps. Temperature, of course, must be constant and not allowed to rise or the skins will be discolored or scorched. With the oven I use (as described) in conjunction with a bunsen burner, I have the top end of the bunsen burner 2 inches (5 cm.) from the oven base and after igniting the gas, adjust the flame so that its tip *just touches* the oven base without any lateral spreading. After reaching maximum heat at this adjustment I can do a hundred skins, if necessary, without even looking at the flame. Any other oven would, of course, need a different flame adjustment but very little variation would be needed for oven of comparable size and thickness of the metal used.

3. The Glass Blowpipe.

A stock of various sized jets should be available if many larvæ are to be prepared. Many dealers in scientific apparatus will supply these cheaply but they are extremely simple to make. Take a piece of glass tubing about 8-10 inches (20-25 cm.) in length. Hold this centrally over a bunsen flame until soft, continually rotating it to keep the jet central to the tube. When it is sufficiently hot draw the two ends gently and steadily apart, when the heated portion will narrow to a fine waist. After cooling, mark with a fine file and snap into two portions. If the two ends are rough, hold *for a second only* in the flame to smooth them. A longer period will close the jet and make it useless. If any jets get broken they may be re-drawn by placing two together— end to end — in the flame until red hot. The two ends will adhere, when one may be drawn out. The other piece will need to be fused to a piece of waste tubing when it, too, may be re-drawn.

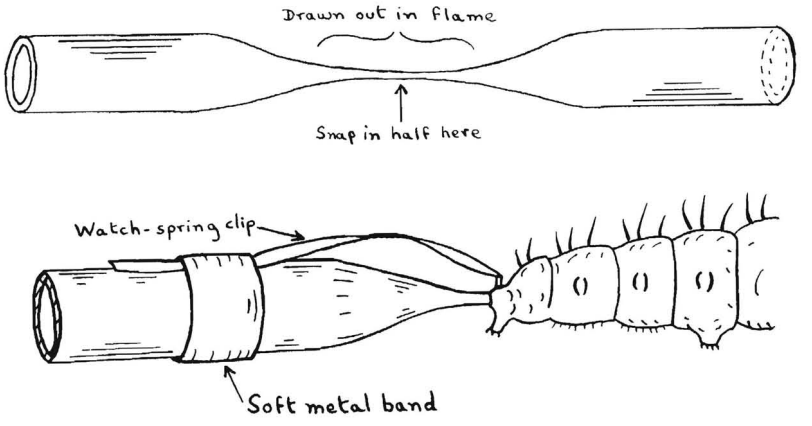

Fig. 3. Above, making the jets: glass tube drawn out in flame to narrow waist. Below, the method of attaching the spring clip to the glass jet, to hold the caterpillar skin firm during inflation and drying.

A point to remember is that the longer the portion which is actually heated, so the longer and finer will be the resultant nozzles. Onto the tubing slide a metal band and insert a piece of watch-spring to act as a clip to secure the skin to the jet. In practice I find that a piece of fine copper wire wound around the tube and clip is most effective in holding them in position. Before these are assembled the watch-spring should be made red-hot at one end and about 1/8 inch (3 mm. approx.) bent at right angles. In the tip of the short piece thus formed a V-cut should be made with a fine file so that it fits snugly on the tip of the glass jet. Only heat the extreme end of the spring or the temper of the whole will be lost.

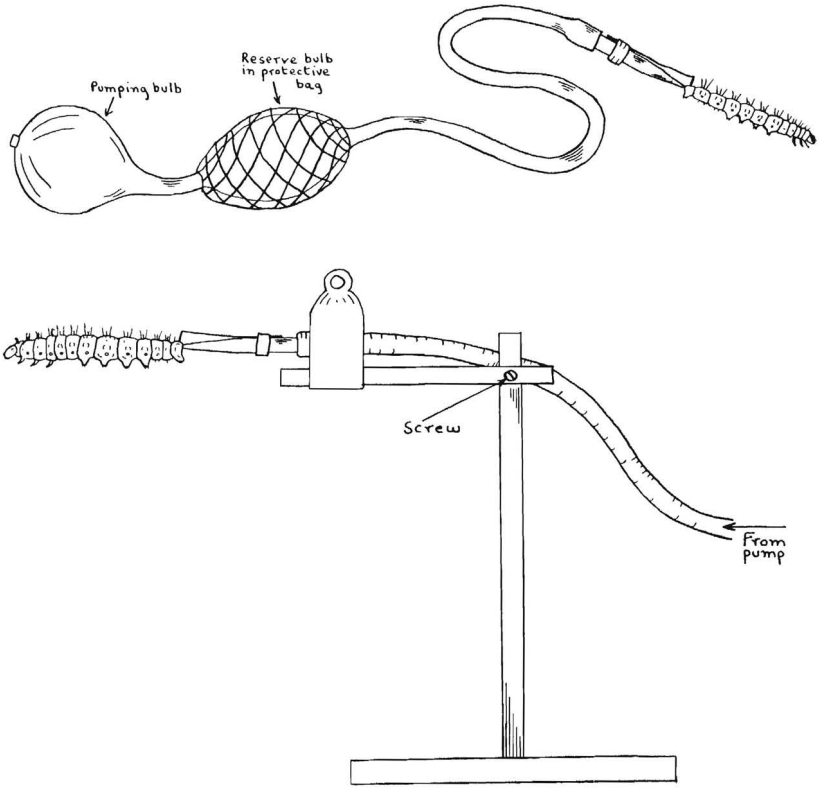

Fig. 4. Above, the arrangement of the double-bulb pump. Below, the apparatus for supporting the jet.

4. The Inflator.

If a sufficiently long blowpipe is used, the skin can be inflated by mouth. I do not recommend this as the pressure is, naturally, intermittent and moisture is apt to enter and delay the drying. A far better method is to purchase a rubber double bulb of the type used for throat sprays. Most drugstores stock them or will obtain one at a small cost. A medium size is best, and make sure it is of good quality with the reserve bulb of fine, flexible rubber. These bulbs are made in segments and are apt to split at the joints. They can be repaired with self-adhesive rubber strips as used for bicycle tire repairs, but I prevent splitting by removing the net protector and affixing strips of the rubber along all the seams prior to use. A good quality bulb thus treated will last for years and do thousands of skins if not ill-treated. It should never be exposed to high temperatures and if allowed to get very cold will turn hard but can be easily softened if gently warmed prior to use. Of

course, if anyone wishes to go in for a pressure bottle worked off the water faucet, or even to the length of purchasing an electric diaphragm pump, it would make mass-production easier but will not give such good results owing to a lesser degree of control.

5. Other Apparatus.

You will also need a small glass jar to hold spirit, setting needle, forceps, scissors, a few small wooden rollers of various sizes (about 6 inches (15 cm.) long and the thickness of pencils or smaller — a graduated one is, perhaps, better), silk or cotton covered copper wire, entomological pins, a sheet of cork for use when mounting, blotting paper, a tube of glue (not gum), vaseline.

6. Support For The Jet.

When doing several larvæ it is helpful to use a support to hold the jet and skin whilst drying, thus leaving both hands free to prepare the next skin for drying. A simple piece of apparatus is all that is needed. A piece of wood about 6 inches (15 cm.) square for the base, with a central upright piece and an arm secured horizotally on a line with the oven opening is all that is necessary. The jet may then be clipped to this with a largish spring paper clip. Mine is rather more ambitious as it is of metal and the horizontal arm slides up and down the upright and is secured with a wing nut and bolt, and the arm is made in two pieces with universal joints to allow the jet to be manipulated to any angle.

7. Killing Agent.

Larvæ may be killed in the cyanide bottle or by dipping into spirit. Alcohol of good strength is excellent but I simply use methylated spirit (wood alcohol) and find it perfectly satisfactory. It is quick in action and being so cheap can be replaced often, thus avoiding the use of a soiled fluid. The larvæ should be removed as soon as dead and placed to dry on blotting paper. This applies particularly to the hairy species for, if wet when the larval contents are being removed, the hairs are more liable to fouling.

Selection of Suitable Larvæ

The caterpillar must be mounted to look as natural as possible. This can only be done if a suitable specimen is chosen. No matter what care is taken during inflation, a success cannot be made of a larva molting, and nothing looks worse than an oversized, balloon-like object. Some caterpillars assume different markings at each instar (between each molt) and you may wish to show the changes; but if only one specimen is required, it is best to wait until the final larval molt and "blow" it about one day after it has recommenced feeding. Never, on any account, attempt "blowing" just before the molt or just before pupation, for the outer skin, which is all we

require, is then not only lacking in color, but is extremely thin and even if successfully emptied, always distends in an unnatural manner.

The exceptions to this are the larger Hawk-moths and other very large species. Unless it is absolutely necessary to show the final instar it is by far the best to "blow" these larger species in the penultimate larval instar, for if one wishes to have a neat mount it is almost impossible to avoid stretching the skin in the heat when fully grown. Should it be necessary to preserve these large species when fully grown I do not use the normal oven but stand a metal box of suitable size upright over the flame and suspend the skin in it. By so doing a minimum of air-pressure is required to keep the skin shapely and thus much of the oversize is obviated. It does, of course, take longer to dry out.

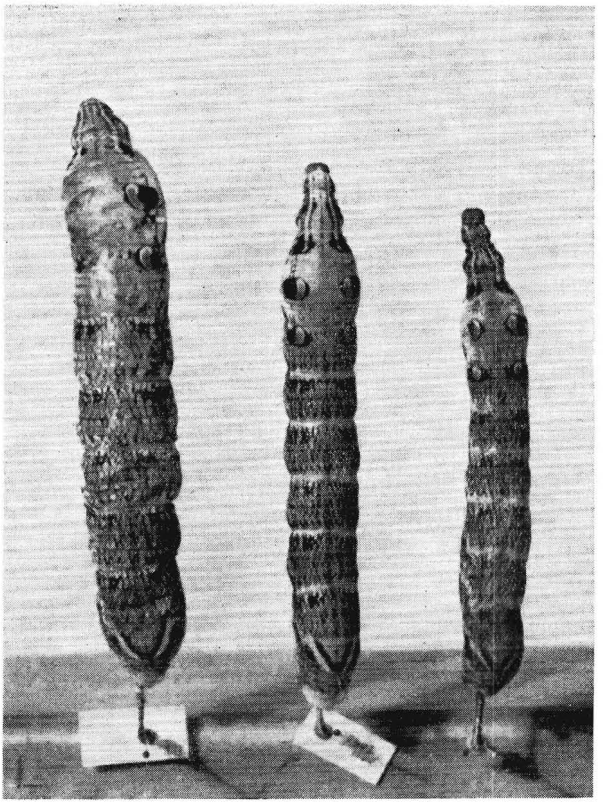

Fig. 5. Examples of over-inflated (left), correct (center), and under-inflated (right) larval skins. All are *Deilephila elpenor* L. (Sphingidæ), and the left larva was remarkable in lacking a left eye-spot and in having segmental abnormalities on abdominal segment V.

The hairy species are worth spending more time on. If the skin is placed in a very hot oven the hairs are liable to curl in the heat. This can be avoided if the operator has patience enough to start off the drying in a cold or cool oven and allow it to heat up as drying continues. The same remark applies to a number of the fawn and light brown Geometridæ, which often turn red or pink if placed in a hot oven; by the exercise of patience in starting off with a cool oven, better results are obtained. Should these skins turn reddish do not discard them, as they almost invariably tone down after a few weeks in the cabinet.

The green larvæ also pose a problem, as they almost certainly will lose all or most of the color, generally when emptied, and of course heat aggravates it. I will deal with this later.

Emptying the Skin

Place several thicknesses of blotting paper on a perfectly flat surface and on this lay the dead larva *on its back*, with the anus away from you. I stress *on its back*, because no larva is hairy underneath (the side we are about to roll), and the colors we wish to retain, those of the back and sides, are in this way less likely to be damaged, while the larval liquid has more chance of getting away freely.

With the forefinger on the roller, gently press the abdominal contents towards the anus, so that a little pressure is evident at the anal opening. With the needle carefully prick the slightly protuding gut, which will give the liquid a chance to escape and thus avoid bursting the skin. Move back the roller about one quarter the length of the larva and *gently* roll towards the anus. this will start the contents emptying. Again move the roller back, this time halfway towards the head and once more roll to the anus. The third time go right back to the head and roll yet again. The great secret of success is to do this very gently. Do not attempt it in one or two rolls but start by giving half a dozen gentle rolls; this will give you the touch needed to retain the colors. Neither is it necessary to extract every atom of moisture; far better to leave the skin a little too moist than too dry to begin with.

In all probability the entire digestive tract will come away with simple rolling; should it not, however, seize the protruding part at the anus and gently draw it out with the forceps, whilst holding the skin in the left hand; it can then be snipped off as near the head as possible. If it is allowed to remain within the skin it will contract in drying and show as a dark blob through the skin. Avoid allowing any moisture to touch the setæ of a hairy larva.

The larval skin is now ready for inflation and drying, but before proceeding further make sure the oven is sufficiently hot. The insertion of a finger into the round aperture will, with practice, be a good guide to this. A moderate heat is required.

Too high a temperature will scorch or discolor the skin whilst, if too low, the job can become tedious. The safest plan is to regulate the heat so

that a small skin, e.g., a fully grown *X. fluctuata* (Garden Carpet) is thoroughly dry in about 2 minutes, a medium one, e.g., *B. brassicæ* (Cabbage Moth) in 4 minutes, and large ones, such as the Hawk-moths, is approximately 8 minutes.

With practice, a good average working speed is 10 to 12 skins an hour, including emptying, fixing to blowpipe, and drying. Never empty more than one skin at a time as they dry out quickly and then, especially if small, become difficult to fix satisfactorily to the jet.

Fixing to the Blowpipe

Take the skin between the thumb and forefinger of the left hand with the anus away from you and the anal claspers facing you so that the merest trifle of the anal end of the body is visible. Moisten the end of the fine nozzle of the blowpipe with the lips or with the merest suspicion of vaseline and carefully insert it into the anus for not more than 1/8 inch in the case of very small larvæ and proportionately more for larger skins, according to the size of the opening; with the spring clip secure the smallest possible portion of the V-shaped anal flap so firmly that the skin will not blow off when inflated. Two clips are sometimes needed for the larger species. If two are used, endeavor to secure the skin to the rear of the anal claspers.

Never insert the jet further than is necessary as it makes it more difficult to be removed after drying and is liable to split the skin or remove a patch of pigment.

Inflation and Drying

Give a gentle squeeze to the inflator. If properly secured, the skin will fill out to its former natural size. Be careful not to use too much pressure or a distended skin will result, which cannot be rectified. At the same time do not allow the skin to droop or sag. Insert the inflated skin into the oven and continue to blow only just strongly enough to keep the skin in a natural position until it remains as you require it without further pressure.

Owing to the impossibility of removing the head contents by rolling, this part and the first segment are always the last to dry, and a good test to find out if all is thoroughly dry is to remove the skin from the oven and gently touch the head from in front, with a finger or the setting needle. If all is as it should be the whole skin will be rigid. If the head is still moist and further drying is necessary, a slight movement will be noticed.

When dry the caterpillar is ready for removal from the jet. Whether moisture or vaseline has been used, a skin will occasionally stick to the glass; this may be cured by adding a spot of benzine to the offending part, which will loosen it in a few seconds. It also helps when removing the skin from the jet when several skins are to be blown, to use several blowpipes and allow each to get cold before removing the skin, thus allowing the hot glass to shrink.

Occasionally a skin will, when inserted into the oven, decide to be awkward and curve sideways into a semi-circle. This unpleasing attitude may be remedied by removing from the heat whilst still flexible, and by touching the convex side of the skin on the hot oven the convex side will be slightly shrunk and the skin straightened. Do this several times along the length of the skin if necessary. Never do this after the skin is hardened but first relax the skin by suspending it (still on the jet) in hot water. Then re-inflate and shape as above. Relaxing in hot water may also be done with older skins providing no punctures exist in the skin. If punctures or cracks exist, leave well alone, especially if it is a rare species. When relaxing older skins add a few drops of carbolic acid to the water to kill any mould spores which may be lurking and awaiting a chance to start growth.

Tinting

I am not in favor of painted larvæ; they do not please the eye at all, and water-colors invariably cause distortion of the skin. Very few larvæ, however, lose sufficient color to make them unsightly. The chief offenders are the green species and usually the color can be satisfactorily restored without causing offence to the fastidious. Use no water at all but employ dry pigment dissolved in spirit. The dyes used by the ladies for household articles will serve but are not very lasting. A substance known in Britain as chrysodine, used by anglers to dye blow-fly larvæ for bait, is very satisfactory and is usually obtainable from fishing tackle stores. This substance (or similar) should be dissolved in a little spirit and kept as stock. It is very strong, and a few drops should be suitably diluted to the appropriate tint, as needed.

This dilute dye will run smoothly and being transparent will not obscure any important characteristics but it will stain any white surface if allowed to spread. I have tried out many substances but always come back to chrysodine. Some skins need a second application after an interval. In the case of very hard chitinous skins the dye tends to run into beads. Lay on plenty, leave until it begins to dry, and then go over the skin with a tuft of cotton-wool. Sufficient will remain to effect a pleasing finish. If a skin takes too much color or is too deep in tone when stained it may readily be toned down or completely removed by the application of clean spirit. I do not recommend internal coloring; the result is usually a patchy mess.

Mounting for the Cabinet

Wire or fine twigs form the simplest and probably the best style of mount for cabinet use. If twigs are used, push a pin through one end and glue it firmly *before* mounting the skin. It is also necessary to see that the twig conforms to the underside contours of the skin and it should fit neatly betweeen the legs and claspers. If wire is used, it is only necessary to twist one end round a pin, bend the wire to shape, and glue the larva to the wire with a suitable adhesive. Data labels are then added and the mount is ready for the cabinet.

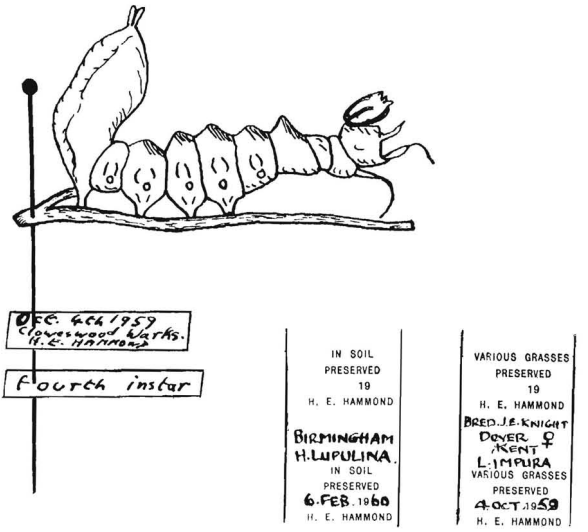

Fig. 6. Upper left, sketch of the bizarre larva of *Stauropus fagi* L. (Notodontidæ) mounted on a twig which is supported on a pin. Lower right, sample portions of data-label strips, showing printed blanks above and, below, completed labels ready to go on pins under larvæ.

Labelling

Labelling is undoubtedly the most important part of any collection of scientific objects but is so often regarded as unnecessary or at best, by careless folk, as a necessary nuisance. Someone once said "a good collection consists of a series of labels illustrated by specimens." This is more true today than ever it was. Fortunately I learned this early and have always labelled my specimens accordingly. Of course, styles of labelling must suit the individual but all relevant facts should be shown. I have all my labels printed as 4-line and specify plenty of spare space at the top and bottom to allow for any additional information to be written in. I carry a large assortment such that when a good number of species feed on any particular pabulum, I have the foodplant name printed individually. It all saves time and adds neatness to the label. The very minimum information shown is: locality with county, district, state, or whatever is needed; name of species, name of foodplant, date of preserving, and of course the name of the person preparing the specimen. If the name of the breeder or captor is different from the preparator, this can also be added at the top or bottom of the label or on the reverse. These 4-line labels can be cut into two if required, and placed on the pin so that both can be read without handling the specimen. Where a specimen is bred *ab ovo* I indicate this by simply adding the female sign after the locality name. I also carry a stock of labels which do not indicate the foodplant, for use with specimens which have fed on the less common plants. Written details should be done with a fine nib, using a permanent black ink. Some col-

lectors' labels are a model of neatness but some, alas, are untidy and illegible and written with ink which fades; they are but little credit to the owner.

Mounting for Life History Cases

A life history display, showing not only the full series of stages but also a sample of the food plant with the larva mounted thereon in a feeding or resting attitude, is a great improvement in the usual cabinet series. Either natural or artificial twigs, leaves, or grasses may be used.

Acknowledgements

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My special thanks are due to the Amateur Entomologists' Society (London) who have permitted me to use the photographs and extracts from my original paper "Preserving Caterpillars — How to "Blow" and "Pickle" Larvæ Successfully." This paper is still available as Leaflet No.20 from the A.E.S., 1 West Ham Lane, London, E. 15, at the modest price of 1s.2d. post free (U.S. 15 cents).

16, Elton Grove, Birmingham, 27, ENGLAND

MAINE BUTTERFLY SEASONS — GOOD OR BAD?

by A. E. Brower

The request for information on the poor collecting seasons for Lepidoptera concerns directly a subject in which I have been interested and in which I have been keeping some records for the past tweny-nine seasons in Maine. Any statements comparing seasons need to be based upon comparative knowledge over a considerable period of time. When Henry David Thoreau travelled through Maine over one hundred years ago, making detailed observations on the life he saw, he remarked on the great dearth of wild flowers and animals in the climax forest which dominated the greater part of Maine. He also noted the rapidity with which *Aster, Solidago,* Fireweed and some other genera came in on land cleared of the forest, and that insects were common with the flowers. Much of the cleared land became farm and pasture land, but great areas were heavily cut, often devastated by fire, and left to nature. The timber cut reached a maximum in 1909. The mantle of soil recently spread by the last ice sheet was probably already becoming low in lime and some other elements when the land was cleared. These elements and the