be a much more versatile tool for the task. A large standard pin (e.g. no. 4) bent at an obtuse angle (Fig. 4) provides an inexpensive tool, instead of a second pair of forceps, to help in holding the specimens or the wings during pinning and setting. It is important to use a pin that is not too fine because the point may catch and rip into the wings too easily.

Setting triangles (Fig. 5). Triangles are used to hold the wings in place once they are spread. They are made with a point punch (of the type commonly used for mounting small insects) from moderately thick, very smooth or glossy card and inserted no more than half way up on short pins. We use two sizes of triangles [7 mm long with pointed end (Fig. 17) and 10 mm long with truncate end (Figs. 10–12)] for different sizes of microlepidoptera. We mount them on pins no. 00 cut down to 1 cm in length (trimmed the same way as the minutens). Do not use minutens for mounting triangles because they are too fine to insert easily into the relatively thick card stock of the triangles. When mounting triangles, check that the side with rough edges (produced by the punch on the underside of the paper) is turned upwards (check with a magnifying lens if necessary). If this simple precaution is not taken, much damage to the wing scales will occur because of the rough edges of the triangles. As for minutens, a large supply of mounted triangles should be readied, pinned in shallow boxes. Triangles are re-used indefinitely or until they become loose on the supporting pins.

Pinning pad. White cotton fabric folded several times into a pad about 1 cm thick and 10 cm × 10 cm makes an ideal surface to pin microlepidoptera. The fabric must be as soft as possible. This surface prevents specimen compression when pinning and the fabric fibres tend to hook the moth claws, thus reducing slippage. Avoid paper towels of any kind, they are usually too rough. The thickness of the pad must be greater than the length of the minutens so that the pad does not have to be lifted up when pushing the minutens through the specimens.

Humid container. This serves to hold pinned specimens to prevent them from drying while they await setting. If this precaution is not taken, the smaller microlepidoptera will begin to dry in a mere few

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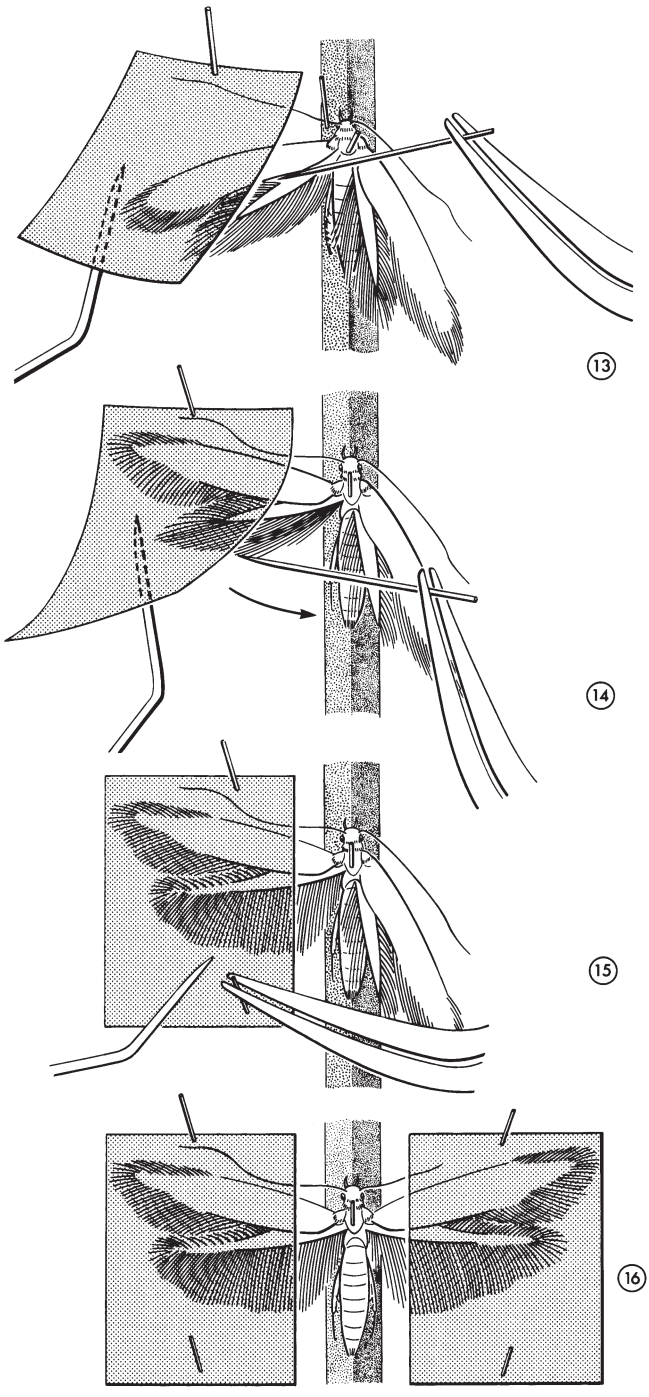
FIGS. 9–12. Setting with the point method. **9,** Inserting the specimen into the groove with the wings partly opened; **10,** Moving one set of wings forward with the point-holding pin; note the antenna held in position with a minuten; **11,** Setting the wing into position with the mounted point while holding it with the bent pin; **12,** Repeating the operation with the other side.



minutes in dry air and become difficult to spread by the time one gets to the last few of a batch. The container is simply made from a plastic petri dish or similar small plastic dish or box with a loosely fitting lid. The bottom of the dish is lined with wetted tissue or filter paper. A small plastazote pad serves to hold specimens. In very dry conditions, the inside of the lid may be *lightly* misted to increase ambient moisture in the container (too much moisture could drip on the specimens).

PINNING AND SETTING

For best results (and less eye strain) the pinning and setting operations should be done with magnifying lenses or under a low-power stereoscope (up to about 5×).

Pour the freshly killed moths on the cotton pad and pin them. Insert the minuten through the center of the mesothorax (mesoscutum) or at the suture between the mesoscutum and mesoscutellum (the mesoscutellum is the roughly triangular or diamond-shaped area behind the center of the mesothorax). Try to keep the pin in line with the center of the thorax, otherwise the wing muscles may become transfixed, which renders spreading more difficult. To ensure that a specimen is squarely pinned, apply very slight pressure on its dorsum with the tip of the bent pin (or another curved forceps) to prevent the body from rolling sideways while the minuten is inserted into the mesothorax (Fig. 7). The minuten must be inserted far down so as to leave no more than about 2 mm protruding above the moth, enough to manipulate it comfortably with forceps (Fig. 8). Of course, the height of specimens with unusual structural modifications such as long palpi recurved over the body or thoracic crests should be adjusted appropriately in order to leave sufficient minuten length for the forceps; such specimens may require longer (untrimmed) minutens.

Place pinned specimens in the humid container. Prior to this, if one wishes, the wings may be partly opened by gently blowing on them from behind the moth with a slight puff of breath. Before proceeding with setting, another series of specimens is transferred to the killing tubes. Hence, there will be specimens ready for pinning when the first batch has been set. We usually proceed in batches of no more than 15–25 moths.

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FIGS. 13–16. Setting with the paper method. **13,** Moving one set of wings forward with a minuten while lifting the paper strip with the bent pin; note the minuten holding the antenna; **14,** Combing the fringe; arrow indicates direction of combing movement; the combing minuten touches the tip of the fringe lightly; **15,** Pinning the paper strip down to secure the wing into position; the minuten holding the antenna may be removed as it is usually no longer necessary; **16,** Set specimen.

Take specimens out of the humid container singly for setting. If the wings are still closed, gently blow on them from behind, then insert the specimen into the groove (Fig. 9). Lift the wings and partly push them forward with the tip of the closed curved forceps inserted beneath the wings. Tuck the legs into the groove. With a minuten position the antennae so that they form a widely obtuse V, holding them temporarily by placing minutens behind their base. If the fringes are matted, lift the wings a little and comb the fringes by brushing them with the tip of the triangle's pin in a movement going from the apex of the wings toward the body.

To fix the wings into position, we use two different procedures.

(1) Points method (Figs. 10–12). This method may be a bit faster than the paper method (see below). Although excellent, it sometimes gives slightly inferior results, and makes it more difficult to set the antennae properly.

Using a mounted triangle, bring one pair of wings forward by pushing on the hind margin of the forewing with the tip of the pin. Usually, if this movement is delicately executed, both wings will move together because of the coupling. Do not pierce the wings. While holding the wings into position with a slight pressure of the bent pin held in the other hand, put the triangle on top of the wings as close to the apex of the hindwing as possible and push it down sufficiently to immobilise the wings. The triangle must lie flat against the wing surface and must not be pressed down too strongly or it will leave a mark. It may be necessary to adjust the position of the hindwing slightly, which sometimes will be a little too far back or too far forward. One or more triangles may be added to better hold the wings of larger or broad-winged microlepidoptera or to prevent them from curling up.

Repeat the procedure for the other side. To prevent set specimens from hindering hand work over the spreading box surface, it is best to proceed in transverse rows instead of filling one groove after another.

For someone having difficulty using both hands simultaneously, the following variation may be applied: using a mounted triangle as outlined above, move a pair of wings only halfway forward then insert the triangle over the wings just sufficiently to prevent the wings from slipping back but ensuring that they can still be moved; with a minuten move the wings into their final position (the wings should stay in place) and with the forceps maintained closed, gently push down the top of the pin holding the triangle until the wings are flat. Positioning of the wings in this way may have to be done in several stages for some specimens. The other hand may hold the spreading box. With this variation, one can proceed by filling one groove after another if desired.

(2) Paper method (Figs. 13–16). The second procedure uses small

strips of thin, translucent setting paper and is essentially similar to the standard technique used to spread larger Lepidoptera on a normal setting board. The paper strips are held down with 0.20 minutens. This technique can yield the finest specimens because the entire surface of the wings is held flat, and the antennae can be set properly with ease. It is a little more cumbersome and may take a little more time depending on individual ability. In our own experience, however, it takes about the same amount of time as the triangle technique, if one has prepared and has ready the necessary materials, such as pre-cut pieces of setting paper and minutens.

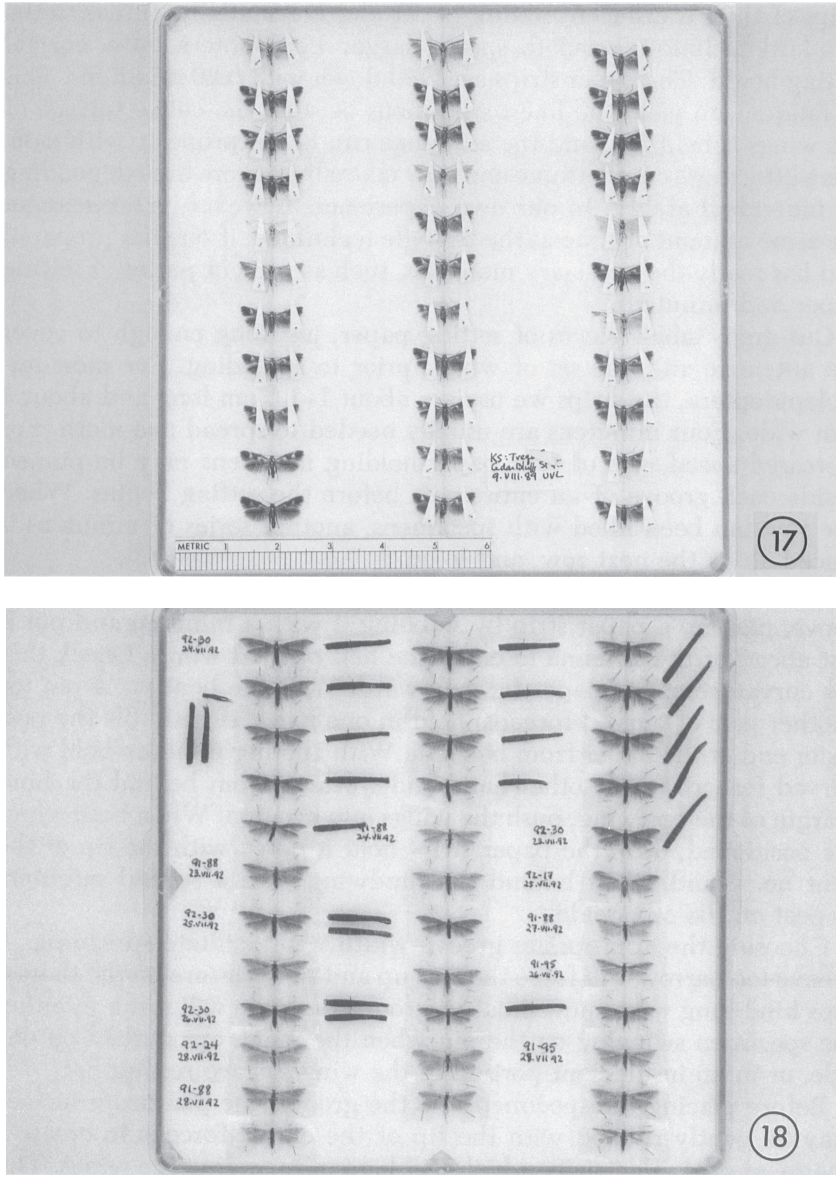
Cut many small pieces of setting paper, just long enough to cover the antennae and one set of wings, prior to spreading. For most microlepidoptera, the strips we use are about 1–1.5 cm long and about 5 mm wide. Four minutens are usually needed to spread one moth. For increased speed, sets of four paper-holding minutens may be pinned beside each groove of an entire row before the setting begins. When one row has been filled with specimens, another series of minutens is placed along the next row, and so on.

After pinning the moth and having set the antennae as described above, pick up a paper strip by stabbing it with a minuten and pin it just ahead of the antenna to cover the half-opened wings. Check that the curvature of the paper faces upward. With the bent no. 4 pin (or another pair of curved forceps) held in one hand, slightly lift the posterior end of the paper from beneath. With another minuten held with curved forceps in the other hand and working from behind the hind margin of the forewing, push the wings into position. When both wings are positioned, drop the paper strip, hold it down with the tip of the bent no. 4 and pin it behind the hindwing with a second minuten. Repeat on the other side.

Choosing the appropriate groove width will facilitate spreading. A groove too narrow will force the legs up and put pressure on the thorax, thus hindering wing movement. A groove too wide will result in either the specimen swinging on the pin when the wings are pushed on one side, or in an insufficient portion of the wing surface resting flat.

Before placing the specimen into the groove, the plastazote surface may be gently rubbed with the tip of the closed forceps to create a charge of static electricity which will help in spreading the wings. This is not necessary, however, if one is using the paper strip method, and it is not recommended with very small microlepidoptera such as nepticulids because the charge will be too strong and may push the wings up vertically.

With a fresh, fully relaxed moth and some practice, the whole operation of pinning and setting takes no more 30–60 seconds. With



FIGS. 17–18. Examples of filled spreading boxes. **17,** Point-set specimens; **18,** Paper-set specimens (larval cases beside reared specimens). Scale in cm.