Field Studies 5 (1980) 307-321

BIOLOGICAL ILLUSTRATION: A GUIDE TO DRAWING FOR REPRODUCTION

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> "... only remember this, that there is no general way of doing *any* thing; no recipe can be given you for so much as the drawing of a cluster of grass."
>
> J. Ruskin, *The Elements of Drawing*, Letter II, 1857.

INTRODUCTION

GOOD illustrations impart information which cannot readily be conveyed by words, and their attractive and decorative qualities enhance the appearance of the printed page. This paper is intended to help any biological artists whose work involves the preparation of black and white drawings for reproduction, and who need some guidance in technique and presentation. A recurrent theme will be seen to consist of the links between the original subject, the drawing, and the method by which it will be reproduced.

All drawing involves a degree of selectiveness on the part of the artist—the limitations of flat white paper and a penful of black ink impose their own restrictions. In addition the biological illustrator has the ability (and obligation) to select particular aspects of the organism in question for special emphasis, whether it be the general growth form of a typical oak tree, or some detail of a hair on a joint of an insect's leg.

Successful selection generally requires some degree of technical understanding of the organism being illustrated, and this is best achieved by close collaboration between the biologist and the illustrator. The artist will be helped to interpret unfamiliar structures correctly, and the biologist will be less likely to expect impossible feats of drawing.

Diagrammatic v. naturalistic representation

For any drawing to be a success, the artist should always be influenced by the original inspiration or purpose for undertaking the work. In biological illustration this means the suppressing of one's own exuberance in dwelling on beautiful but perhaps irrelevant detail where this detracts from the aims of the drawing as a whole, but without losing one's enthusiasm for the subject. It is a delicate balance.

Illustrations can vary from a thumbnail-sized outline to a complete page of detailed naturalistic observation of a particular individual specimen, and each can be appropriate to its purpose.

A diagrammatic illustration is one where extreme selectivity is used, its purpose being generally to show some aspect of structure or relationship of parts, but without any attempt to portray true-to-life external appearance. In contrast, a naturalistic drawing contains details (for example of texture, light and shade) which help to convey the actual appearance of the organism.

In *British Water Plants* (Haslam, Sinker & Wolseley, 1975), drawings approaching

each of these extremes are used with good effect. Very small simplified drawings help the user of the key to see instantly the difference between the contrasted leads; only the relevant part of the plant is drawn with no distracting peripheral detail, and the reader's attention is directed to precisely the part that matters and not to anything else. Sometimes these differences are quite subtle: simplification should never be equated with haste or inaccuracy.

20. Stipules oblong or triangular,  fewer than 100 ultimate leaf segments **R. peltatus**

Stipules round or oval,  up to 150 ultimate leaf segments 21

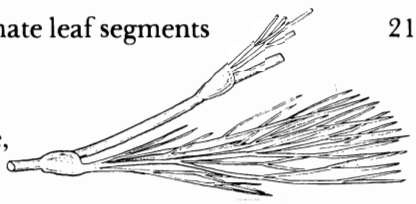
21. Dissected leaves narrow-obconical in outline, segments sub-parallel 

FIG. 1
Small drawings interspersed with text of key, taken from Haslam, Sinker and Wolseley (1975).

In addition there are more detailed illustrations of complete plants, so that the user, having worked his way through the key, can be reassured that he has in fact correctly identified his plant. Here the more naturalistic approach is appropriate as the purpose now is to check the identity of the plant in its entirety.

Gestalt

Economical diagrams and the fullest naturalism are to be understood as extremes with an infinity of gradations in between; all should involve accurate delineation. However, in the production of a naturalistic drawing, mere accuracy alone is not sufficient. To some extent the artist assembles the observed units (leaves, legs, etc) into a coherent entity which will still look complete and alive. This process involves a scarcely definable quality—the essence of the species—which is appreciated through thorough examination of a number of specimens, and is effected by sympathetic and sensitive draughtsmanship. Without labouring the philosophical component, this may be compared with the concept of *Gestalt* as applied to flowers, or fruit (see discussion by Arber, 1950, p. 144), but with a shift in application from an organ-*Gestalt* to an individual species-*Gestalt*.

The treatment of variation

If an illustration is intended as an aid to indentification it must present an impression of a truly typical example of the species as a whole, without any of the peculiarities or deviations exhibited by separate individuals of that species. Should these peculiarities involve say withered or damaged foliage, then it may be quite acceptable to replace them by intact substitutes which must then be drawn so as to be compatible with the rest of the plant. Often however the problem is that of real biological variation within the species, more than can be covered by one approximation to an "average" example, and it becomes necessary to illustrate several individuals to cover the diversity of morphology encountered (Fig. 2).

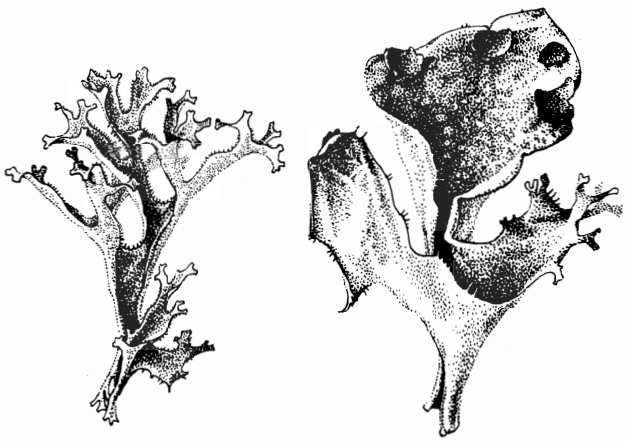


FIG. 2
Two specimens of the lichen *Cetraria islandica,* collected from the same wood near Kongsvinger, Norway (Nat. size).

Working from dried or preserved material

Living or fresh material is not always available, and the biological illustrator must often work from preserved and perhaps dried specimens. These introduce problems of distortion, shrinkage etc., which vary greatly with the group of animals or plants in question. To some extent this can be remedied by wide experience of drawing living organisms, and a pressed plant can be restored to some degree of vitality through a correct understanding of the sequence of leaf attachment, vein structuring and so forth. Entomologists working with anaesthetised or mounted specimens will see wings, legs and antennae in very "unnatural" positions, and their correct disposition can only be appreciated by watching the living beasts walking, eating or flying.

The artificial appearance of preserved specimens can sometimes be put to advantage, as we may only be concerned with say the pattern of spots and bands on a moth's fore wing, and this may be of greater value taxonomically than the living insect's posture. The shape of plant leaves is usually better displayed in a two-dimensional pressed specimen than in the original three-dimensional example where they are seen in full perspective.

The source of illustrations and copying

Finally, when working, use as much source material as possible, (whilst remembering the need for conservation) as one must distinguish between the idiosyncracies of the individual and the characteristics of the species. **The source must be actual specimens, and not other people's illustrations.** Quite apart from matters of copyright and professional ethics, it is almost impossible to maintain the integrity of the species-*Gestalt* from copy to copy, and errors creep in during the copying process which makes such derivative drawings almost useless.

Black and white reproduction processes

The guidance here is concerned only with drawing in pure black and white. This is because it is the most straightforward (and least expensive) for the printer to reproduce. In addition it encourages the artist to produce a clear, precise image

which is more suitable for a scientific illustration than a blurred mass of pencil lines, however beautifully and sensitively executed.

The printing processes most commonly used nowadays—offset lithography and (decreasingly) letterpress—cannot produce anything other than black (or whatever colour is used instead by the printer) marks on the paper; intermediate greys (or their coloured equivalents) as such do not exist. An outline of how the appearance of such intermediate tones are rendered is given below.

In the case of lithography the ink either adheres to greasy areas or is repelled by water-moistened non-greasy areas. With letterpress or relief printing the ink sticks to any part of the block which has not been hollowed away out of reach of the ink-bearing roller.

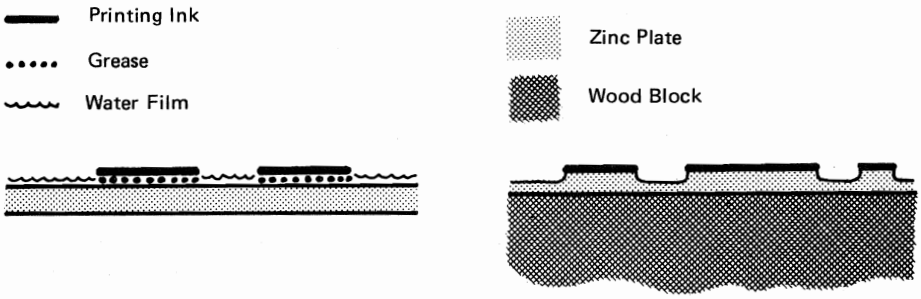


FIG. 3
(a) photolitho, ink transferred to paper via roller (offset).
(b) letterpress, ink transferred directly to paper.

In order to render the intermediate tones, the black areas have to be interspersed with white. This can be achieved by using a variety of lines, tones and dots. Mechanically, an illusion of continuous gradation of tone can be produced by passing light from a photographic negative of the original (pencil drawing or photograph) through a screen or regular grid of black lines intersecting at right angles. This is so constructed that the more light passes through a given cell in the grid, the larger a corresponding black spot appears on the finished article. Examination of a newspaper photograph for example will show that a pale grey area is made up of a number of small black dots, and a darker area is made from larger ones, which can eventually occupy the whole of their alloted cells and appear to merge to make a continuous black.

For a fuller discussion on this subject (and many other aspects of printing) see Jennett (1973).

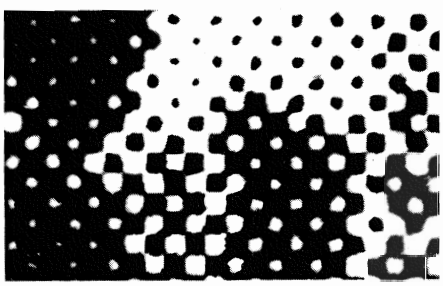


FIG. 4
Part of a photograph reproduced by photolithography to show the effect of the half tone screen (×60).

A Practical Guide to Black and White Drawing

Dots, lines and tones

Every mark on the page should be placed there for a purpose: it is for the artist to choose what kind of line or dots will convey the maximum amount of information economically. The following guide may help in choosing suitable techniques for differing problems, but it is not intended as a list of recipes to be followed slavishly—there may be other solutions as well as those given here.

Pure line drawing

In drawings involving only lines, some indication of form and distance can be shown by varying the thickness of the line used. Where a very light line is required (see problems of very thin lines below), a dotted line can be used instead. Thicker lines may be used to indicate parts in shadow nearest the viewer, thinner ones lighter parts or those more distant from the viewer. Thinner lines can also be used for superficial detail secondary to more important structural form (see Fig. 8a).

Tone

This is used to indicate light and shade, and hence to convey an illusion of solidity. Tone can also represent texture, and to a limited extent, colour (Fig. 5).

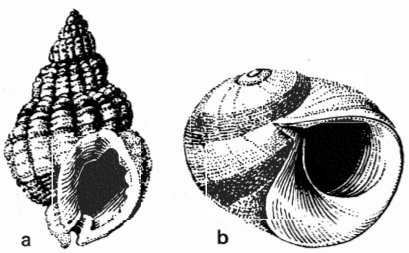


Fig. 5
Form, texture and colour. (a) ribbed shell of *Nassarius incrassatus*, with dull red bands (×3); (b) smooth shell of *Littorina mariae*, light yellow with red-brown bands, inner surface of aperture very smooth and white (×2).

It is always best to show the light falling on the object from the top left. Adopting this convention*, will help to reduce the ambiguity of convex or concave surfaces and furthermore gives an appearance of tidiness and consistency throughout the work (see Figs 6 and 7).

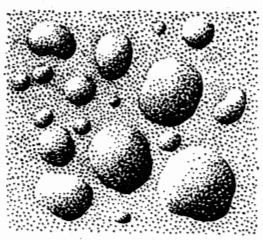


Fig. 6
Blisters?

*Gombrich (1972, p. 229) notes that psychologists have found that Western observers, in the absence of other visual clues, interpret tonal patterns in a manner compatible with the light coming from the top left, probably because this is the most convenient position when drawing or writing with the right hand.

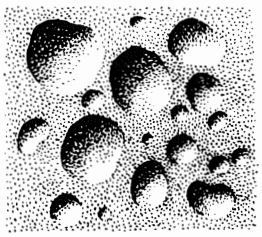


FIG. 7
Emmenthal? This is fig. 6 printed upside down.

Dots

Dots (or stippling) are an extremely effective and adaptable method of rendering tone, and generally reproduce well (see Figs 2 and 8b).

Hatching

Parallel line hatching should be executed extremely carefully to look satisfactory. It is usually best to follow some structural feature of the subject (e.g. figs 8c and 8d), rather than to let the lines cut across in a direction unrelated to structure (Fig. 8e).

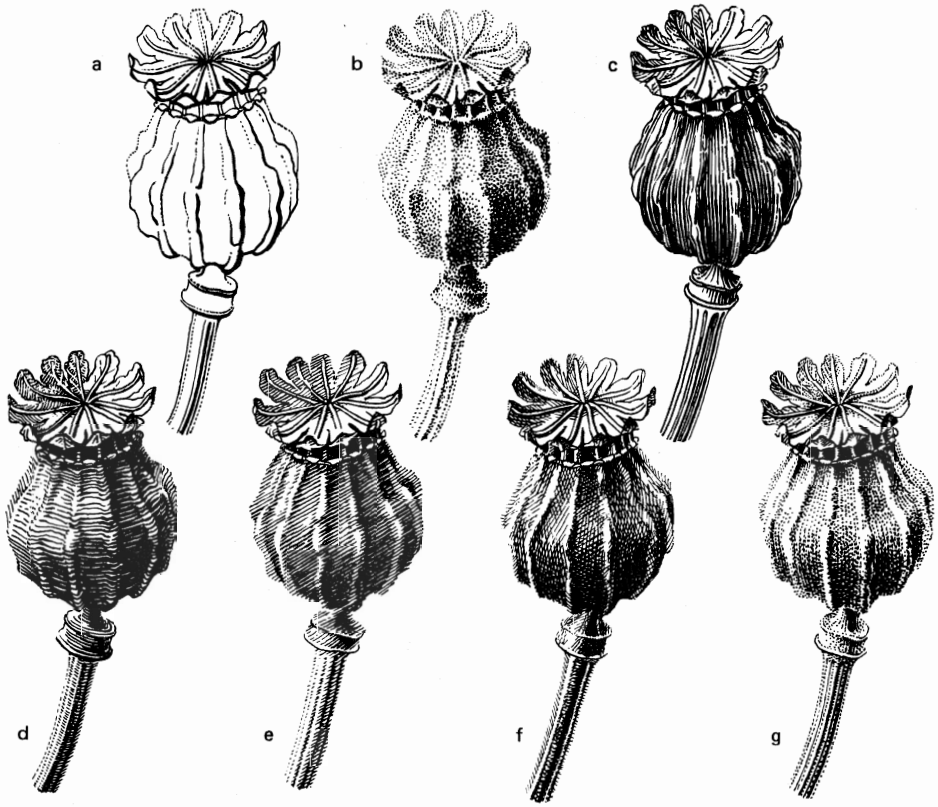


FIG. 8
Drawings of fruit of the opium poppy, *Papaver somniferum* (a) pure line; (b) stipple; (c) hatching parallel to main axis of form; (d) hatching at right angles to main axis of form; (e) parallel hatching with direction not related to form; (f) cross-hatching in two and three directions; (g) combined dots and lines.

Cross hatching is technically very demanding and consequently seldom looks good; it should be used with extreme discretion. If it is really necessary for the desired effect, it is best to avoid lines crossing at right angles or nearly so (Fig. 9b), as the resulting grid pattern can be too obtrusive. Hatching in three directions is even more demanding and consequently is probably best avoided (Figs 8f and 9c).

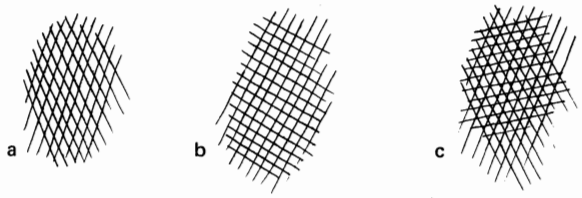


FIG. 9
Cross hatching (a) more or less rhomboidal cells; (b) more or less square cells; (c) lines in three directions, note the very small size of many cells.

Parallel line hatching tends to give the impression of a smoother surface than stippling (see Figs 5 and 8).

Artificial tones and tints

These are available in transfer form and are suitable for maps and diagrams where a precisely even result is required. There is a great variety of lines, hatchings, dots and patterns. When making your selection, choose tints which differ clearly in tone (hold them at a distance and view them through half-closed eyes), not just the shape and size of their component marks. In particular, note that the use of diagonal hatchings of similar thickness and spacing but facing in opposite directions (Fig. 10) make a poor contrast because of their similarity in visual weight.

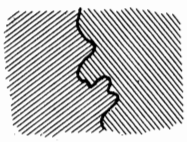


FIG. 10
Artificial tones of the same weight, differing only in the direction of the lines.

TOOLS AND MATERIALS

Pens for drawings

The ideal pen for drawing has a pointed flexible nib. With this the thickness of the line can be varied with pressure according to the requirements of the drawing. (Fig. 11)

FIG. 11
Line drawn with a flexible pen (Gillott 404).

In this respect the tubular type of pen has a distinct drawback as it is designed to produce lines of constant thickness. Thicks and thins can thus be achieved only by changing pens—disastrous in mid-line (Fig. 12a) or by returning to a line and very carefully adding an extra thickness to it (Figs 12b and c).

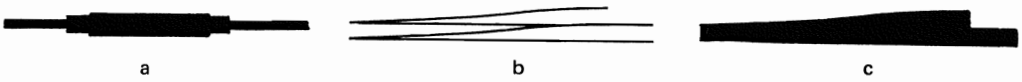


FIG. 12
Varying the width of a line with a tubular pen; the outlines of the two strokes used in (c) are shown in (b).

The actual choice of pen is personal to the user, but particularly satisfactory results can be obtained from mapping pens or Gillott 303 nibs. Some people may find that they need practice in handling a fine flexible nib if they are unused to it, but the results will be worth the trouble. Do not use rough or soft textured paper even for practice as discouraging splutters or a nibful of paper fibres will result.

Mapping pen nibs have special holders made for them. They produce extremely fine lines, but are not supplied with any reservoir to control the flow of ink. Gillott 303 nibs fit into standard pen-holders—if the holder does not have a reservoir built in, a clip-on one can be bought (Fig. 13). In either case the reservoir is adjusted so that its tip barely comes in contact with the nib about 3 or 4 mm behind its tip. Try always to keep the pen clean—it will work better. Before ink dries hard, rinse the pen in water and wipe it dry, but if it has hardened, then the ink should be soaked off in a proprietary pen cleaner or in warm water with liquid detergent until it has loosened. This may take some hours.

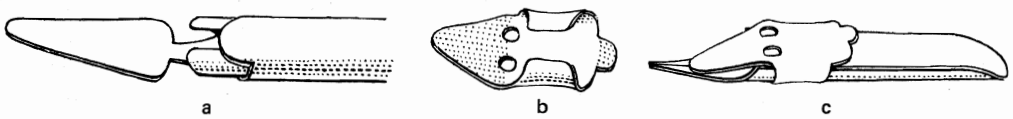


FIG. 13
(a) pen-holder with built-in reservoir; (b) clip-on reservoir; (c) nib (inverted) showing reservoir in position.

Pens for maps and diagrams

For maps and formal diagrams a line of constant thickness is, however, highly desirable, so the tubular type of pen is ideal here. For greater clarity and a more interesting appearance, use more than one thickness of line where appropriate (according to ISO standard 3098 these should increase in thickness by factors of x 1.5). Ruling pens can be used with a ruler for straight lines, or attached to a specially adapted compass, but they are much less satisfactory for freehand lines. One advantage of a ruling pen is that the thickness of the line can be adjusted before the line is started, but care is needed to maintain an even thickness when the pen needs to be refilled.

Pencils

Most people prefer to make an indication of the main lines of their drawing before committing themselves to ink. Therefore it is best to use one that is hard enough to be a sharpened to a very fine point (a knife is better than a pencil sharpener, with fine emery paper for its final point), and soft enough not to leave an indented line in the paper when used with light pressure. A 3H is usually satisfactory on Bristol Board, but use a softer pencil on a softer-surfaced paper (e.g. an H on cartridge paper). It should then be removable with an india rubber.

Brushes

Indian ink ruins good brushes, so try to find one that is past its best, or cheap. For white paint use a fine sable brush (essential for making small corrections to ink lines, or drawing white lines and dots on a black background), size 0 being the most useful. White paint does not improve a brush either, so try to keep one specially for the purpose, and remember to use separate water-pots for black and for white.

Paper

The most reliable paper for pen and ink drawings that are to be reproduced is Bristol Board. It is available in various thicknesses (referred to as 2-sheet board, 3-sheet board etc.) and broadly speaking, thicker paper is better for larger drawings, to discourage creasing. Bristol Board has a hard smooth surface. In theory one can remove an error by gently scraping it with a sharp clean razor blade and then burnishing the scraped area smooth again with a hard, smooth implement. This does not always work in practice as the new surface tends to be more porous than the original one so that new ink sometimes spreads slightly. One may prefer to correct errors with white (see below) as an alternative. Other good quality papers may be suitable according to the preference of the artist, and tracing films (such as UNO or Permatrace) may be useful for tracing maps. All paper should be kept flat in a dry place.

Spare paper

This has three main functions, (i) to put under the artist's hand to protect the drawing paper from the merest suspicion of grease—which would repel ink; (ii) to try out the pen each time it has been dipped in ink to make sure that it is not over-loaded and has not picked up any fluff or fibres, and (iii) to experiment with patterns of lines and dots before committing oneself to the final drawing.

Ink

This should be fixed (i.e. waterproof) Indian ink. It is often too thin (when newly bought) or too thick (when old). If it is too thin, lines will be grey, not black; the ink will tend to be sucked into the fibres of the paper (even Bristol Board) and lines will be blurred. The cure: time, and some exposure to air. If the ink is too thick, it will clog the pen and dry up in mid-line. The cure: if it is slightly too thick, add a *very* small amount of distilled water; if it is actually lumpy, then throw it out.

White paint

This is often the best substance for removing unwanted ink marks (see above, under brushes). Process White gives the densest cover, while Designers' Gouache (Winsor & Newton) is suitable, but two coats may be needed to cover black ink.

Typists' correcting fluid (such as Tipp-Ex or Instant Paper) provides a much better surface for re-drawing in Indian ink than the water-based paints referred to above, so it may be used for eliminating small unsatisfactory areas of drawing where new lines are to be substituted. Note however that large areas painted thickly are inclined to crack, and that the brush provided in the bottle is unsuitable for making small and precise marks. In addition these compounds are spirit-based and dry out very quickly, and so should not be used with a good brush.

Light box or tracing table

This is an extremely useful item to possess. A rough drawing placed on top of the box can be seen through a sheet of Bristol Board or other paper laid over it. Selected lines of the drawing can then be traced on to the top sheet of paper. Alternatively several rough drawings on separate pieces of paper can be arranged (or turned over to reverse a drawing if desired) until they fit the space given for the illustration, and drawn on a piece of Bristol Board laid over them. A window can be used as a substitute for a light box, with sticky tape to counteract the effects of gravity.

Linen tester

This can be used to measure the thickness of lines (see below, Lines for diagrams and maps).

Proportional dividers

This is a very useful tool if the drawing is anything other than the same size as the subject (Fig. 14). If the final printed illustration is to be a moss magnified say, ×5, and the drawing is to be done $1\frac{1}{2}$ times the size of the printed illustration, then the moss is to be drawn 7.5 times natural size. The proportional dividers are set so that the distance between one pair of points is 7.5 times the distance between the other pair of points.

FIG. 14
Proportional dividers.

LIMITATIONS IMPOSED BY PRINTING TECHNIQUES

It is customary for the artist to make the drawing larger than the final printed illustration, as reduction in size makes irregularity of line less noticeable. Drawings are best made between 1.25 and 2 times the final printed size; ×1.5 is the most usual, but check with the editor of the publication before starting work, as different publishers have different requirements. If possible, it is helpful if a set of drawings is done to the same scale, so that they can all be reduced by the same amount. The reduction of the drawings is done photographically, so unless precautions are taken, some loss of detail may follow. It is not the artist's aim to produce a mechanically perfect drawing (which would be lifeless), but to avoid disappointment in the printed results, it may be helpful to bear in mind the following recommendations.

Lines

Lines should be carefully and firmly drawn, even if they are fine, and any variation in their thickness should as far as possible be intentional. It is not possible to give a precise figure for minimum line thickness for reproduction (as processing conditions vary considerably) but the lines reproduced at their original size and reduced to 2/3 in Fig. 15 may serve as a guide (and see Appendix A, p 320).

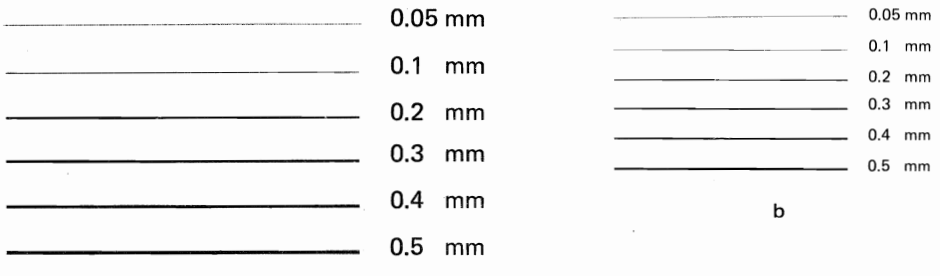


FIG. 15.
Black lines, (a) actual size, with width in mm; (b) the same as (a) but reduced to 2/3 linear

From this it will be appreciated that a line which wavers in thickness may be in danger of disappearing in places when reduced. If you want a line which is so thin that it runs the risk of breaking in this way, consider making it dotted.

Similarly, a white line between two areas of black cannot be infinitely thin (Fig. 16).

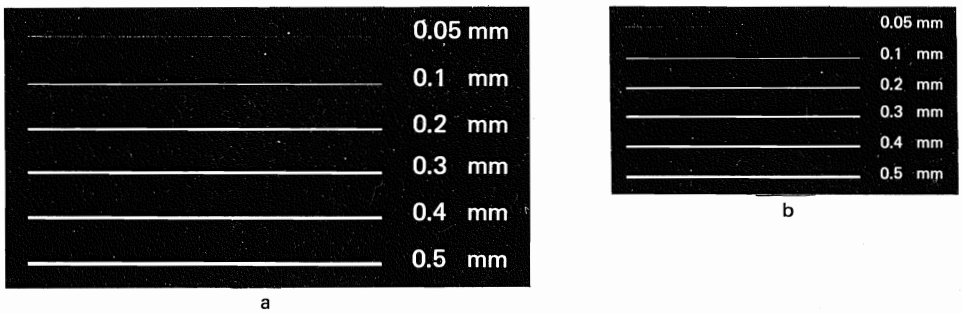


FIG. 16.
White lines (a) actual size, with width in mm; (b) the same as (a), but reduced to 2/3 linear.

A related problem (encountered especially with hatching and drawing very thin stems) is that of two lines locally coalescing (Fig. 17).

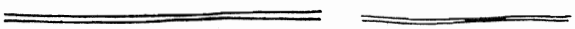


FIG. 17.
"Parallel" lines (a) drawn carelessly; (b) as they would probably appear after reduction, with filling where they come close together (both enlarged).

When drawing evenly-spaced lines of increasing thickness to make a gradation to a darker tone, it will be found that there comes a point when the white lines between the black ones are too thin to be sure of appearing, so the answer is to keep the white lines the same thickness but to increase the black ones. When lines cross, as in cross-hatching, the size of the cells formed between the lines is as important as the thickness of the lines themselves (see Fig. 9).

Lines for diagrams and maps

Before deciding on which thickness of stylus pens to use, first find an example in a recent number of the journal in which you wish to publish, where the weight of the printed lines seems satisfactory. If possible, measure the thickness of the lines (using

for example a linen tester fitted with a graticule or fine scale) or match the lines visually against those shown in Fig. 15. If you plan to draw your figure say ×1.5, then you must multiply the measured thickness by this factor and select pens of the nearest size. Small deviations from your calculated thicknesses will not matter, since the printed line will not be exactly the width you expect anyway, and you can always indicate the final size (after reduction) to the printer on the drawing.

Dots

Similar conditions apply to dots as to lines. It is better to make a light tone from small dots which are reasonably widely spaced than from very small ones which may not appear at all. Like lines, dots should each be placed carefully because there is a danger that when they are reduced and the spaces between them become correspondingly smaller, groups of individuals may join together to form unpredictable and unintentional dark lumps in an otherwise light area (Fig. 18).

FIG. 18.
Dots may merge to form clumps if they are too close together.

To make a gradation from light to dark, draw small well-spaced dots, then small closer dots, then larger dots, then start to join dots together to make an irregular vermiculate pattern, and finally surround white areas entirely to make white dots on black (Fig. 19).

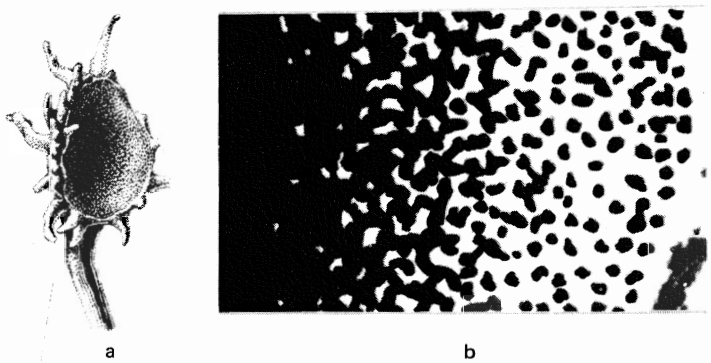


FIG. 19.
(a) Fruit of the lichen *Cornicularia normoerica,* drawn ×7.5, reduced here to 2/3 linear (i.e. to ×5); (b) part of (a) enlarged a further 8 times.

Black versus white

It is essential when drawing for reproduction, that:

the black should be really black
the white should be really white

Preparation of Artwork for the Printer

It is advisable, before starting work on illustrations, to check whether the editor or printer has any special requirements. This section offers some general guidance.

Lettering

This can be done with a very clean stencil, or with Letraset or a similar product. Draw guide lines *very lightly* (transfer letters will come off if you try to rub the lines out), and take care to space the letters well (Fig. 20). When using tracing paper or film it is a great help to place a sheet of graph paper underneath, both for spacing and alignment. Some printers ask that they, and not the artist, should insert the lettering. In this case the lettering may be typed on an overlay to show where it is to be put.

OIL OIL not OIL

Fig. 20.
The spaces between the letters should *appear* equal.

Lines and symbols

Lines used in labelling should not be confused with those of the drawing or diagram. If the line is to end in a dot, draw this first, followed by the line—it is much easier. Dots, arrows, triangles and other symbols can be drawn using Linex or other stencil templates, or can be obtained from Letraset, Arcal etc., transfer sheets, always remembering to allow for reduction. As with lettering, the printers may prefer to insert all symbols themselves.

Marking the illustration for the printer

Remove all unwanted pencil lines, and put the author's name and figure number on the back together, optionally, with the artist's name and address.

Write TOP at the top, even if you think this is obvious, and add any other instructions to the printer which may be necessary (e.g., "reduce to 66%", or draw a line and "reduce to 75 mm"). These notes and markings can be written in BLUE pencil on the drawing itself (in the margin), or on a transparent overlay sheet of tracing paper. (Fig. 21). For extra protection a drawing on which much time has been spent can be mounted on card and can be provided with a protective sheet of good brown wrapping paper in addition to the overlay.

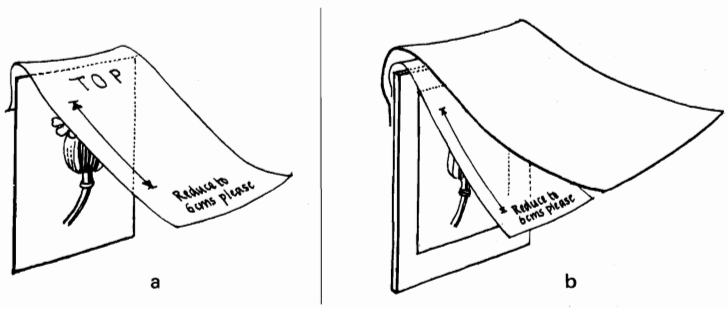


Fig. 21.
The finished artwork (a) unmounted, with tracing or layout paper overlay; (b) mounted, with overlay and protective covering.

Careful presentation of your work should, one hopes, encourage other people to treat it with respect.

ACKNOWLEDGEMENTS

We would like to thank all those who have helped us in clarifying our thoughts in this paper, and to acknowledge especially the advice offered by Anne Bebbington, Marilyn Crothers and Pat Wolseley. Our thanks are also due to the Experimental Cartography Unit of NERC for assistance with figs 15 and 16.

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APPENDIX A

Notes on text figures

Figs 2, 5, 6, 7, 8, 17b, 19a and 21 were drawn with a mapping pen. Figs 9, 13, 17a and 18 were drawn with a Gillott 303, and 11 with a Gillott 404. Figs 3, 12 and 14 were drawn with a tubular pen.

All drawings were made 1.5 times the final printed size, and most have some corrections in Process White or typists' correcting fluid.

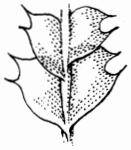
The lettering (except for Fig. 21) was done by the printers.

In Figs 15a and 16a the thicknesses given are those of the lines as supplied to the printers, and are not necessarily the widths reproduced in this copy of the paper.

This paper is printed by offset-lithography.

Appendix B

Some technical problems in pen drawing

PROBLEM	EXAMPLE	SUGGESTION
large smooth surfaces	caps of some fungi	use tone sparingly; dots may be easier than lines as these may have to be very long and evenly drawn
translucent subjects	some seaweeds, moss and liverwort leaves.	use tone lightly; dotted lines can be useful 
thin subjects	grass stems	often impossible to suggest tone as lines too close together; lines of different thickness can be used 
thin subjects whose section is not round	sedge leaves and stems	draw magnified section 
hairy subjects	particularly objects covered in fine white hairs	usually no option; if scale allows them to be shown draw hairs as fine black lines 
very small subjects and details of larger subjects	diatoms; seeds of some plants	never hesitate to magnify and indicate scale (often a good idea to show line or shape to represent actual size); add magnified details to a drawing of the whole specimen when possible
complicated subjects with too much small three-dimensional detail	complete moss tufts	avoid if possible! A detailed drawing is often confusing and a simplified one meaningless. Consider a photograph
coloured subjects where colour is important	fungi; insects	good verbal description; some indication of dark and light areas can be shown; care should be taken not to confuse these with the tones of light and shade
spirals; geometric shapes	gastropod shells	check drawing in a mirror; this often reveals faults that were not noticed while working
intricate symmetrical subjects	butterflies	draw one half accurately, trace with finely sharpened HB or H pencil onto tissue paper; lay tracing pencil-side down beside first half and draw over lines