A COMPUTER-ASSISTED METHOD FOR PRODUCING ILLUSTRATIONS FOR TAXONOMIC DESCRIPTIONS

L Bouck, D Thistle

VIE ET MILIEU, 1999, 49 (2/3) : 101-105

A COMPUTER-ASSISTED METHOD FOR PRODUCING ILLUSTRATIONS FOR TAXONOMIC DESCRIPTIONS

L. BOUCK, D. THISTLE

Florida State University, Department of Oceanography, Tallahassee, FL 32306-4320, USA

TAXONOMY
ILLUSTRATION
COMPUTER

ABSTRACT. – The traditional method for producing taxonomic illustrations requires the preparation of inked copies of pencil originals. These individual figures are then grouped into plates for publication. We describe an alternative, computer-based approach. In a preliminary step, a pencil drawing is digitized and imported into an illustration program. The program's tools are then used to trace the image. Each figure is stored as a separate computer file. To make a plate for publication or a slide for presentation, several figures are combined. The approach has several advantages. (1) It is easier to master than the pen-and-ink method. (2) Figures can be manipulated electronically, so the size and orientation of a figure is infinitely adjustable, providing great flexibility in the preparation of plates. (3) Multiple "originals" can be printed. (4) Mistakes can be corrected easily.

TAXONOMIE
ILLUSTRATION
ORDINATEUR

RÉSUMÉ. – La méthode traditionnelle pour réaliser les illustrations en taxonomie consiste à encrer des copies d'originaux au crayon. Ces figures séparées sont ensuite groupées en planches pour la publication. Nous décrivons une approche alternative utilisant l'ordinateur. Dans une étape préliminaire, un dessin au crayon est numérisé et importé dans un logiciel d'illustration. Les outils du logiciel tracent ensuite l'image. Chaque figure est stockée dans un fichier séparé. Puis on groupe plusieurs figures pour constituer une planche à publier ou à présenter en diapositive. Cette approche présente plusieurs avantages : 1, elle est plus facile à maîtriser que la méthode au crayon et encrage ; 2, les figures peuvent étre traitées et retouchées de sorte que l'on peut ajuster une taille et une orientation adéquates de manière infinie, ce qui donne une grande souplesse lors de la préparation des planches ; 3, de multiples « originaux » peuvent être imprimés ; 4, les fautes peuvent se corriger facilement.

INTRODUCTION

The traditional method of preparing species descriptions requires the preparation of figures for publication (Mayr & Ashlock 1991) by arranging original drawings into plates and tracing them onto velum with pen and ink. We found inking the figures to be the limiting step in our taxonomic work. We turned to illustration software as a possible solution and found that we could produce figures of a quality equivalent to that of the pen-and-ink method. Below, we outline the methods we use, discuss their advantages, and report potential pitfalls.

METHODS

Scanning the original

Our approach requires that the original pencil drawings ("drawing" always refers to the pencil rendering) first be digitized. We use a Hewlett-Packard ScanJetIIcx scanner and Adobe Photoshop® 3.0 for this step, but any scanner and software can be used that have previewing features that allow the image ("image" always refers to the computer rendering) to be resized and permit optimizing the contrast and brightness of the image. After some preliminary experimentation, we select settings that provide sufficient detail but allow the digitized image to be stored on a 1.4 MB floppy disk so it can be transferred from a central scanning station to our working computer. In particular, we select black-and-white (1 bit) scanning, set the resolution to match that of our laser printer, set crop marks to include the drawing but exclude as much bordering white space as possible, and reduce the image size to 80 % or less. We then save the image in a format (TIFF) recognizable by our illustration software. If the original drawing is larger than the scanner can accommodate, we make separate scans of different sections of the drawing, with care to be consistent in the reduction of the image (*e.g.* all scans reduced to 60 %), and piece them together in the illustration software.

Creating an illustration file

A tracing of the image can begin once the image file is imported into the drawing software. Two types

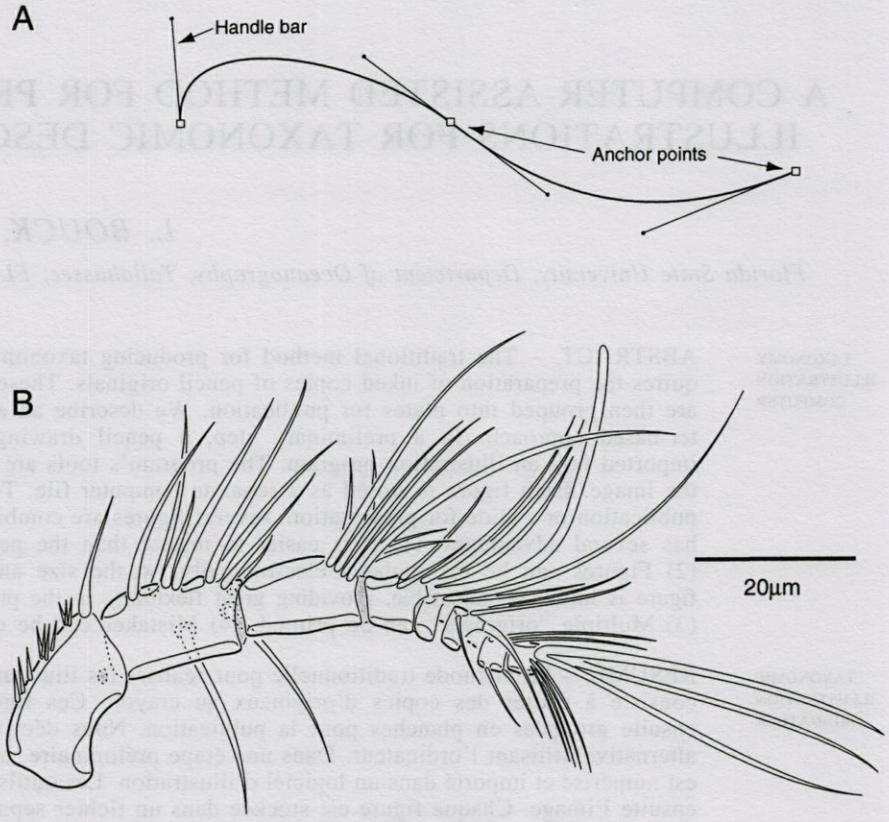

Fig. 1. – A, Vector curve with the anchor points and handle bars used to manipulate its shape; B, antennule from a female harpacticoid copepod illustrated with Adobe Illustrator® 7.0.

of drawing software are available, vector-based programs (*i.e.* illustration software), which represent lines by means of equations, and bitmap-based programs (*i.e.* painting software), which represent lines as groups of pixels (Adobe Systems Incorporated 1997). The use of vectors, rather than a bitmapped computer representation, creates smooth curves that can be adjusted in several desirable ways. For example, line widths can be altered, and the size of a figure (both on screen and printed) can be changed without creating the jagged edges characteristic of bitmapped images (Alspach 1997). We use Adobe Illustrator® 7.0, but any vector-based software with the capabilities discussed below could be used (*e.g.* Corel Draw® and Freehand®).

Illustration software allows different elements of an illustration to be placed on separate "layers" within the file. The final image prints as a single unit, but the manipulation of multiple parts of the image is greatly facilitated by the layering feature. We create a file in our illustration software such that one layer contains only the scanned TIFF image and serves as a template. To facilitate tracing, we set the options of the template layer such that the scanned image (1) is dimmed, (2) will not be printed, and (3) cannot be changed. We create a tracing of the template on as many additional layers as necessary.

Tracing the template

We trace the template by creating curves with the illustration software, in turn by setting anchor points and manipulating the lengths and angles of accompanying handle bars (Fig. 1A). The portion of the image on the screen is enlarged or reduced as needed before a curve is drawn. We select options in the software that produce curves with rounded ends and corners that resemble those made with a pen. If dashed lines are needed (*i.e.* to show underlying structure), the dashing option in the software can turn a solid line into a series of dashes. The technique can take a novice 5-10 hours to master.

Several conventions used in taxonomic illustration can be implemented easily in vector software, often with results superior to those possible with pen and ink. For example, different line widths are used traditionally to convey structural information (e.g., in harpacticoid copepod drawings, the outside of the cuticle is represented by the thickest lines and the inside edge of the cuticle by thinner ones; *e.g.* Huys 1987, Fig. 3A). Illustration software includes a larger selection of line widths than is available in pens. Also, if all the curves of a given thickness are made on a single layer, their width can be changed quickly (Ahmed Ahnert, pers. comm.). For example, if the thinnest curves are too thin, the layer with those curves can be selected while other layers are locked, all thin curves can be selected with two keystrokes, and the width can be increased.

By convention in taxonomic illustration, when one feature lies above another, the lines representing the lower feature are broken in the vicinity of the upper feature (*e.g.* Huys 1987, Fig. 2C). These line breaks can be produced by creating a white halo around the

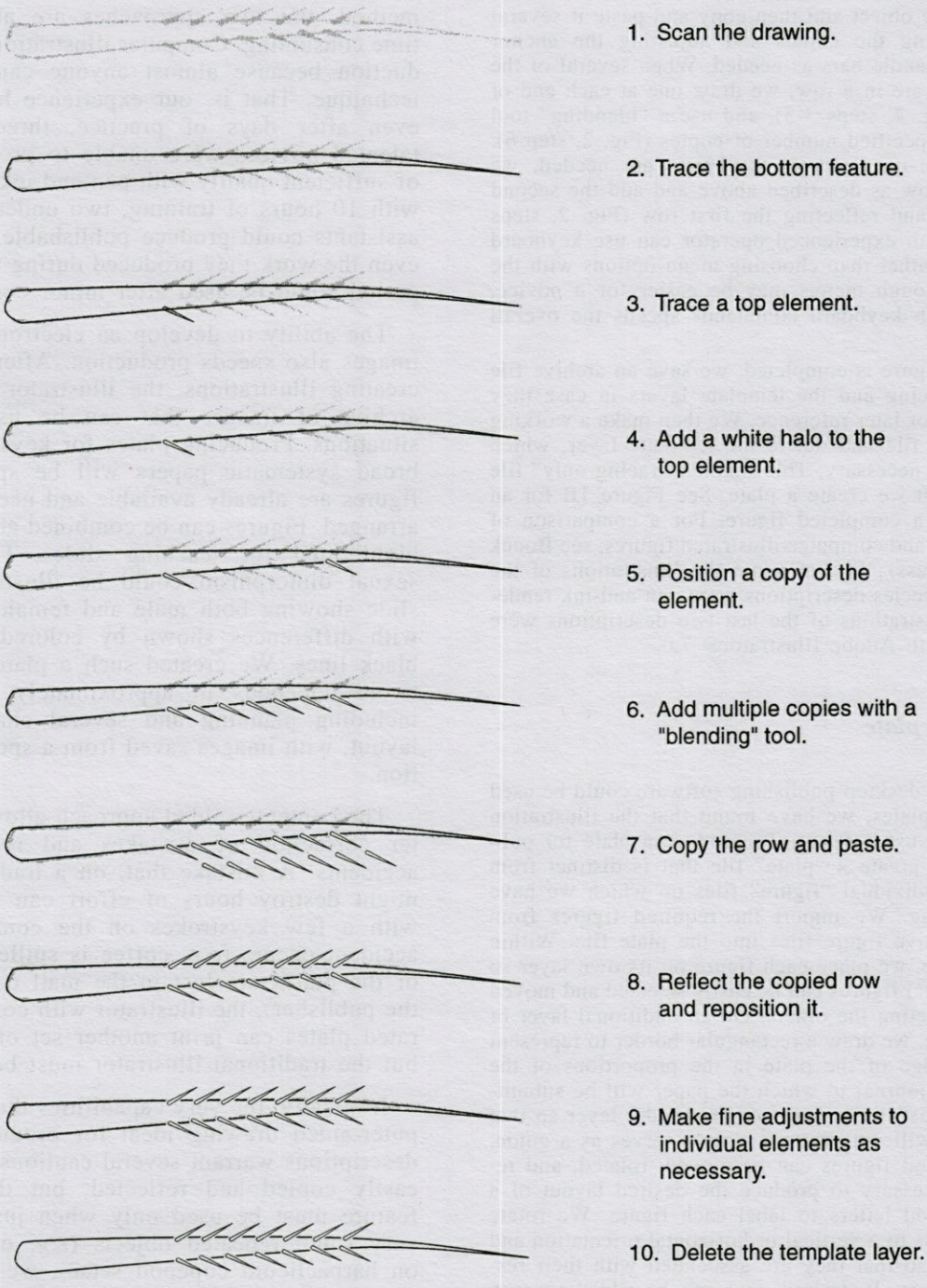

Fig. 2. – Steps used in tracing a template with several time-saving techniques demonstrated.

top feature (Ahmed Ahnert, pers. comm.). When this top feature is placed onto another feature, the white halo acts to create gaps at the intersections of the two features (Fig. 2, step 4). When several copies of the same feature are added to an existing structure, this technique is faster than drawing the underlying structure with many short lines (*e.g.* Fig. 2, steps 4-8).

Taxonomic illustrations frequently require the addition of visual texture, which is traditionally represented by stippling (*e.g.* Huys 1987, Fig. 3D). Illustration software can produce a great variety of textures, which can be added to images easily. When a region to be shaded is enclosed by a curve, we select the curve and fill it with the appropriate shading. If a region to be shaded is not defined by a closed curve, we enclose it by drawing a curve with the line color set to "none" and fill it with the appropriate shading. As the size of the area to be shaded increases, shading with illustration software becomes increasingly more efficient than stippling.

Illustration software can speed drawing in additional ways. When several of the same type of object occur,

we draw one object and then copy and paste it several times, rotating the copies and adjusting the anchor points and handle bars as needed. When several of the same object are in a row, we draw one at each end of the row (Fig. 2, steps 3-5), and use a "blending" tool to fill in a specified number of copies (Fig. 2, step 6). When mirror-image rows of objects are needed, we create one row as described above and add the second by copying and reflecting the first row (Fig. 2, steps 7-8). Also, an experienced operator can use keyboard commands rather than choosing menu options with the mouse. Although menus may be easier for a novice, working with keyboard commands speeds the overall process.

After a figure is completed, we save an archive file with the tracing and the template layers in case they are needed for later reference. We then make a working copy of the file and delete the template layer, which is no longer necessary. This smaller "tracing-only" file is used when we create a plate. See Figure 1B for an example of a completed figure. For a comparison of pen-and-ink and computer-illustrated figures, see Bouck *et al.* (in press); in that paper the illustrations of the first three species descriptions were pen-and-ink rendered; the illustrations of the last two descriptions were produced with Adobe Illustrator® 7.0.

Creating a plate

Although desktop-publishing software could be used to produce plates, we have found that the illustration software we use suffices. To produce a plate for publication, we create a "plate" file that is distinct from the many individual "figure" files on which we have been working. We import the required figures from their respective figure files into the plate file. Within the plate file, we place each figure on its own layer so that individual figures can be easily selected and moved without affecting the others. On an additional layer of the plate file, we draw a rectangular border to represent the outer edge of the plate in the proportions of the page of the journal to which the paper will be submitted. We adjust the options for the border layer so that the outline will not print; it simply serves as a guide. The individual figures can be moved, rotated, and resized as necessary to produce the desired layout of a plate. We add letters to label each figure. We rotate the scale bars to a vertical or horizontal orientation and move them so that they are associated with their respective figures. If desired, text can be added to each scale bar (both horizontally and vertically), indicating the scale within the figure itself rather than in the figure caption. If cropmarks are desired, the bordering rectangle can be changed to print as cropmarks.

RESULTS AND DISCUSSION

Perhaps the most important benefit of illustration software is that it speeds the production of figures and plates. If all goes well with both the computer-aided method and the pen-and-ink method, the two approaches are about equally time consuming. Computer illustration speeds production because almost anyone can master the technique. That is, our experience has been that even after days of practice, three artistically talented novices were unable to produce figures of sufficient quality with pen and ink. In contrast, with 10 hours of training, two undergraduate lab assistants could produce publishable figures, and even the work they produced during their training period could be used after minor corrections.

The ability to develop an electronic library of images also speeds production. After a period of creating illustrations, the illustrator develops an archive of images that can be used in other situations. Producing plates for keys, reviews, or broad systematic papers will be speeded when figures are already available and need only to be arranged. Figures can be combined and key points highlighted for teaching slides. For example, sexual dimorphism could be illustrated with a slide showing both male and female appendages with differences shown by colored rather than black lines. We created such a plate for harpacticoid copepods in approximately 15 minutes, including planning and several changes to the layout, with images saved from a species description.

The computer-aided approach allows much faster correction of mistakes and recovery from accidents. A mistake that, on a traditional plate, might destroy hours of effort can be "undone" with a few keystrokes on the computer. If an accident occurs (*e.g.* coffee is spilled on a plate or the plates are lost in the mail on the way to the publisher), the illustrator with computer-generated plates can print another set of "originals," but the traditional illustrator must begin again.

Ironically, the very capabilities that make computer-aided drawing ideal for producing species descriptions warrant several cautions. Objects are easily copied and reflected, but the reflecting feature must be used only when justifiable. For very small repeated objects (*e.g.* ornamentation on harpacticoid copepod setae), we use the "reflect" tool to speed illustration as described in the methods (Fig. 2). We perform the operation at a very high magnification, check the results against the template, and adjust objects as necessary. It is our experience that figures with reflected elements can, with these precautions, be as accurate as those created with pen and ink at a smaller scale.

An additional potential source of difficulty is resizing figures. For example, a figure can be accidentally resized independently of its scale bar. Also, resizing is not automatically proportional; specific procedures must be followed to make it so. We recommend care in use of the "scale" tool,

as several small errors may accumulate, escaping the attention of the user. Despite the care required, the ability to resize figures easily is an advantage over the traditional pen-and-ink method.

Because failures of power and computer system must be guarded against, work should be saved often during a session and backed up on removable media at the conclusion of a session. Because a floppy disk is generally too small to hold a work in progress that contains both the template and the overlying curves (sometimes as large as 4.6 MB), a large-capacity, removable media device (*e.g.* a Zip™ drive) is an important component of a computer system to be used for taxonomic illustration.

ACKNOWLEDGEMENTS. – This work was supported by ONR grant N00014-95-1-0750 to D. Thistle. The encouragement of M. Schratzberger and discussions with A. Ahnert, D. Danielopol, and G. Paterson were much appreciated. The comments of A. Ahnert, P. Leitman, K. Suderman, A. Thistle, and R. Wetzer improved the manuscript.

LITERATURE CITED

ADOBE SYSTEMS INCORPORATED 1997. Adobe Illustrator 7.0 User Guide. Adobe Systems Incorporated, San Jose, California : 362 p.

Alspach T 1997. Illustrator 7 Bible. IDG Books Worldwide, Inc., Foster City, California : 964 p.

Bouck L, Thistle D, Huys R. Systematics and Phylogeny of *Zausodes* C. B. Wilson (Copepoda, Harpacticoida, Harpacticidae), including three new species from the northern Gulf of Mexico. *Bull nat Hist Mus Lond (Zool)* (in press).

Huys R 1987. Studies on the Cylindropsyllidae (Copepoda, Harpacticoida). 1. The status of *Leptastacus laticaudatus* Nicholls. *Zool Scr* 16(2) : 155-166.

Mayr E, Ashlock PD 1991. Principles of Systematic Zoology. McGraw-Hill, Inc., New York : 475 p.

Reçu le 30 novembre 1998; received November 30, 1998
Accepté le 19 janvier 1999; accepted January 19, 1998