

"Digital inking": How to make perfect line drawings on computers

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Abstract

A fast and accurate way for making perfect scientific illustrations is described. A pencil drawing or a photo is scanned. The resulting file is imported into Adobe Illustrator and the line drawing is made using a WACOM Intuous digitiser board. After the habitus and detailed drawings have been made, the plates can be arranged using the same software. Lettering and arrows can be placed very quickly on the plates. The plates can be exported as graphic files for printing or further manipulation.

Keywords: methods, scientific illustrations, digital inking, computer

Introduction

Making line drawings on a computer with a digitiser board has many advantages, e.g. is possible to draw perfect lines. Graphics software, such as Adobe Illustrator has certain settings which generate smooth lines as if made with a French curve. Thus shaky lines known from inking on drafting film become a thing of the past. Another important advantage is the possibility to correct parts of the drawing. Trying this on drafting film is very difficult or impossible. With this excellent possibility of correction, the drawings on the computer can be made by technical staff or even inexperienced volunteers. Afterwards the systematist can easily correct the parts that are not drawn perfectly. Small details or confusing areas in the pencil drawing, such as dense fields of setae, can be enormously (up to 6400%) enlarged on the computer screen, whereas in the traditional ink drawing magnifying glasses are needed to be able to draw these details correctly.

After making the detailed drawings these can quickly be arranged into plates; each detail can be scaled to the preferred size or rotated. As Adobe Illustrator drawings are in a vector format, the lines will not become rough after enlargement of the drawing, as occurs with bitmap graphics.

Scalebars can be adjusted, lettering and arrows can be added very quickly. If desired the habitus drawing can be shaded, after importing the drawing into Adobe Photoshop. For publication these plates

can be exported to a variety of file formats, burned on a CD-ROM and sent along with the manuscript to the editor. There is no danger that valuable illustrations might get lost in the mail.

This new method is much faster than the traditional way of making illustrations. However, it takes some time to learn the software, as this is packed with options and the few functions needed for our purpose are sometimes difficult to find within the complex software. This paper gives step by step instructions about how to make the final drawing with a computer.

Material and Methods

A Dell Inspiron 7500 computer was used. Any notebook or desktop computer with at least a 700 MHz processor and an USB port can be used. A digitiser board, WACOM Intuous 2 DIN A3 (currently about 900 Euros; smaller boards are available at a lower price), was connected to the USB port (Fig. 1). The standard inking pen from WACOM was used.

The pencil drawings were scanned with a conventional HP scanner, larger drawings were scanned by a 3.3 megapixel digital camera (black and white photo setting).



Fig. 1: Setup of digital drawing equipment. On the left a notebook computer, on the right a WACOM digitiser board with two different pens.

Adobe Photoshop 6.0 was used for scanning and improving the scanned pencil drawings. Habitus drawings can be shaded with Adobe Photoshop. The line drawings were made with Adobe Illustrator 10.03. The selection of menu levels is shown in the following text as hyphenated expressions in brackets. The use of keyboard shortcuts is much faster than using the mouse and so these shortcuts are given in brackets.

The procedure introduced here is, of course, also possible with software other than that from Adobe. Macromedia Freehand and Corel Paint and Draw probably possess equivalent functions, though commands and tool names will be different. The procedure has been described using Adobe software because this is what was available. The same applies to the operating systems MS Windows, Apple Mac OS, Unix and Linux.

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Step by step guide

Preparation

1. Prepare the pencil drawings with the microscope. If the drawing is larger than DINA4 reduce the size with a Xerox machine in case you don't have a large format scanner or digital camera with high resolution to scan large sized drawings or (analogue) photos.
2. Scan in the illustrations using Adobe Photoshop: (File-Import-Scanner) Open the file menu and

import an original (pencil) drawing from a scanner. If you are using a digital camera, copy the image file to your hard disk (see camera manual). TIFF and jpg formats (in highest quality) are recommended.

3. In order to increase the contrast use (Image-Adjust-Autocontrast) (Fig. 2). Save the file and quit Adobe Photoshop.
4. Open Adobe Illustrator and attach the WACOM board to the computer (depending on the operating system and the connection between the digitizer board and the computer, you might need to connect the board before booting). Open a new document (Ctrl N or File-New-Enter); name it now or later when you save your drawing for the first time.
5. The following windows of Illustrator are needed: Tools (Windows-Tools) (Fig. 3a), Layers (F7 or Windows-Layers) (Fig. 3b), Attributes and Strokes (F10 or F11 or Windows-Attributes) (Fig. 3c) and the Navigator window (Shift-F6) (Fig. 3d). It is better to arrange these windows on the right of the screen as the left side of the screen is needed for drawing.
6. Follow the next steps to define the following recommended line types or load the predefined lines makro (see below):

Outline

- a) open Actions in the Level menu window (Fig. 3: arrow); click on the folder icon in the action window (Create New Set) to create a new set; name it "drawing" (Fig. 4a).
- b) (Create New Action) (Fig. 5), name it "outline" (Fig. 5a); assign to function key ("F2", select "Shift" and "Control") (Fig. 5c); press "Record" (Fig. 5d).
- c) fill in "Stroke" (in F10 window); weight "1 pt" (Fig. 4c); select "Cap" "round" (Fig. 4d); "Join" "Round Join" (Fig. 4f).
- d) Stop recording the line definition by pressing the black square (Fig. 4f).

Outline dashed

- a) (Create New Action), name it "outline dashed"; assign to function key ("F3", select "Shift" and "Control"); press "Record".
- b) fill in "Stroke" (in F10 window); weight "1 pt"; select "Cap" "round"; "Join" "Round Join".
- c) select "Dashed line" insert "3 pt" in "dash" and "2 pt" in "gap".

d) Stop recording the dashed line definition by pressing the black square.

Seta

a) (Create New Action), name it "seta"; assign to function key ("F5", select "Shift" and "Control"); press "Record" (Fig. 4).

b) fill in "Stroke" (in F10 window); weight "0.5 pt"; select "Cap" "round"; "Join" "Round Join".

c) Stop recording the seta definition by pressing the black square.

Seta dashed

a) (Create New Action), name it "seta dashed"; assign to function key ("F7", select "Shift" and "Control"); press "Record".

b) fill in "Stroke" (in F10 window); weight "0.5 pt"; select "Cap" "round"; "Join" "Round Join".

c) select "Dashed line" insert "2 pt" in "dash" and "1 pt" in "gap".

d) Stop recording the seta dashed definition by pressing the black square.

Seta dotted

a) (Create New Action), name it "seta dotted"; assign to function key ("F10", mark "Shift" and "Control"); press "Record".

b) fill in "Stroke" (in attributes and stroke window, F10); weight "0.5 pt"; select "Cap" "round"; "Join" "Round Join".

c) select "Dashed line" insert "0.5 pt" in "dash" and "1 pt" in "gap".

d) Stop recording the seta dotted definition by pressing the black square.

By using the function keys, the line types can be changed very efficiently.

7. Save all line definitions by selecting the folder icon "drawing" in "Actions", click then on the small arrowhead just below the closing-x (Fig. 3e), then (Save Actions) (only in Illustrator 10). This is a precaution just in case your settings for Adobe Illustrator will lose the line definitions, which occurs from time to time in the original, unpatched version of Illustrator 10. This bug is corrected in version 10.03. You can also load a set of my predefined lines: first download [lines.aia](http://www.senckenberg.de/odes/03-14.htm) (from www.senckenberg.de/odes/03-14.htm) and save

the file into the illustrator directory; then load the file in the menu that opens after clicking on the small arrowhead (see above). Only when a document is opened you can switch the weight and style of the lines by using the functions keys Shift-Control-F2 and -F3 for the outline types and Shift-Control-F5, -F7 and -F10 for the different seta line definitions.

8. Insert the scanned pencil drawing file into the Adobe Illustrator document: (File-Place), then select the file name of the illustration you would like to ink from its directory. Use the white arrow, the "Direct Selection Tool" (A), to move the illustration within the art board (page frame). Right-click on illustration in order to transform it: i.e. scale or rotate.
9. Select "Layers" and add a new layer (Create New Layer). Block the layer with the pencil drawing (Layer 1) by clicking into the open square right of the eye symbol. A padlock should appear within the square. Double click on "Layer 1" and check the "Dim Images" selection, in order to show your lines on "Layer 2", your drawing layer, in better contrast.
10. Click on the white square with the red transverse line (None) to block the "Fill" mode. This ends the preparation and drawing can now begin.

Drawing

11. Select the Pencil tool (N). This is the main tool for making curved lines. If you double click on the Pencil in the "Tools" palette, the "Pencil Tool Preferences" dialog will pop up (Fig. 6), uncheck the "Keep selected" and "Edit selected paths" options. In the upper area you will find two slide bars. With the "Fidelity" setting you can influence the smoothness of curves by changing the tolerance of the drawing tablet data. With the low setting more anchor points (see below) will be set. With a higher setting you can draw with a shaky hand, but it makes fine structured, e.g. serrated lines, impossible. The smoothness slider controls the amount of smoothing. With a lower value the path appears coarser.
12. What is a path? A path is sequence of straight and curved segments of a line separated by anchor points. When you start drawing a line with your digitiser board, you will see a fine line and a series of dots that is replaced by a black line after lifting the pen. In order to make the path visible again, use the "Direct-Selection" tool (A) and click on the black line. Within the black

line the path and anchor points become visible and can be manipulated.

You can move the anchor points with the mouse or the digitiser pen, add or erase anchor points if needed (press the Pen icon longer, then select the Pen⁺ or Pen⁻ icon to add or delete anchor points and click on the anchor point). Curved elements can be transformed by pulling on the pair of direction lines attached to the anchor point (Fig. 7).

If you want to mark several lines you can encircle them with the lasso tool (Q), then you can, for example, erase these paths, group, move (A) or rotate (R) them.

Sometimes it is best to draw only short segments of long lines and join them later: encircle the ends of two lines with the lasso tool (Q) after highlighting the path, then join them (Ctrl-J) (Fig. 8). If the line is uneven use the smooth tool (press longer with the mouse on the pencil tool icon, then select the second tool, move it over the uneven part of the line). In order to draw long continuous lines it is also possible to check the two option boxes "Keep selected" and "Edit selected paths" in the pencil preferences dialog (double click the pencil icon) (Fig. 6). Then the highlighted path will be connected automatically with the newly drawn stroke. With these settings parts of a path can be corrected by simply redrawing with the pen over the segment that needs to be changed. However, this procedure does not work when drawing setae or other objects where lines are close to each other, because then this function will erase the previously drawn stroke.

13. Some more important tools: if you want to move entire objects use the black arrow (V) after making the path visible with the Direct-selection tool (A); if you prefer to erase only a part of a path, click on the Scissors icon (C) and mark two anchor points. The highlighted path segment between these anchor points can be erased by pressing the "Erase" button of your keyboard. Using Ctrl 1 the whole drawing can be shown on screen. With the Navigator (Shift-F6) the size of the section of the drawing can be changed easily.
14. Scalebars: use the Pen function (P) and click on both ends of the scale bar. A straight line will be drawn. In order to adjust this line horizontally or vertically, make the pencil drawing invisible by clicking on the eye symbol of level 1, then press Ctrl and period (.), a grid will appear; then use the Direct-selection tool (A), click on the line so that the path is highlighted, right click and select

"grouping", press the Rotate icon (R) and adjust the line at the grid (Fig. 9).

15. Long setae are rather difficult to draw freehand directly. It is helpful to move both sliders of the Pencil (N) options (you get there by double clicking on the Pencil icon) (Fig. 4) more to the right to make smooth curves. It is important to uncheck the two option boxes "Keep selected" and "Edit selected paths", otherwise the first line of the seta will be erased after drawing the second.

Long setae are easily drawn in the following way: draw one side of the seta, highlight the path (with the Direct-selection tool), right click, select "grouping", then hit Ctrl C (Windows keyboard shortcut for copy), then Ctrl V (Windows shortcut for pasting), a copy of the seta line will show up. With the Direct-selection tool (A) move the line parallel to the first seta line, the distance should equal the basal thickness of the seta. Click on the Rotate icon (R), click on the basal end of the second line and push the distal end towards the first line to make the tip of the seta.

Plates

16. In the opening dialog select portrait and DIN A3 as size. Open the first drawing (File-Open), mark the whole drawing by using Ctrl A (Windows shortcut for marking the whole file contents), then right click and select "grouping", then copy the marked drawing, click on the newly created document and paste. You can move the drawing with the Direct-selection tool (A), rotate it (R) or if required change the size (right click, select "transform" and "scaling"). In Adobe Illustrator the line weights remain unchanged after scaling the drawing.
17. When all plates are arranged, lettering for each detailed drawing can be inserted. Select a font type and font size first. A good size for DIN A3 lettering is 36 pt (or for DIN A4: 18 pt), "Arial" is a clear font type, but check also the author's instructions of the journal where you want to publish your drawings. Click first on the Type icon (T) and then on the place where the letter shall appear, type the letter; repeat the whole procedure for the next letters.
18. Arrows: draw a line, then select from the "Effect" menu "Stylise-Arrowhead", mark the path with the Direct-select tool (A) select a shape of the arrowhead, its size (e.g. 150%) and on which end of the line the arrowhead should appear (Fig. 10).

19. In order to export the plates, open the file then select File-Export, create a new file name in the dialogue, then select the appropriate file format. At this stage 'TIFF' with the lossless LZW compression is recommended (format in the extension selection below the file name).
20. To print the plate, load the file into Adobe Photoshop, call up "Print Options" (Ctrl-Alt-P) in the File menu: select "Scale to Fit Media" in order to scale down the DIN A3 size to DIN A4. Then File-Print.
4. Select the Airbrush (J). Select a sufficiently large brush (50-100), Mode: dissolve; Pressure: 1-3%. Set the "Foreground colour" to black.
5. Slowly move over the marked area of your drawing area and press the mouse or digitiser pen. A cloud of small dots will appear on the area.
6. If the area is too dark, change the "Foreground colour" to white and apply the shading again. An example of this shading method is given in Fig. 12.

Shading

1. Load a TIFF file into Adobe Photoshop for applying shading.
2. Create a new layer you want to work on (Shift-Ctrl-N). Block the original layer by marking the second check box.
3. Mark one of the segments with the "Magnetic lasso" tool (click on the lasso icon for some seconds, select the third lasso option. The magnetic lasso will stick to lines. When a segment or article of the animal is surrounded by the lasso line, hit "Enter". Now you can shade this part of the animal without the shading being sprayed over the line.

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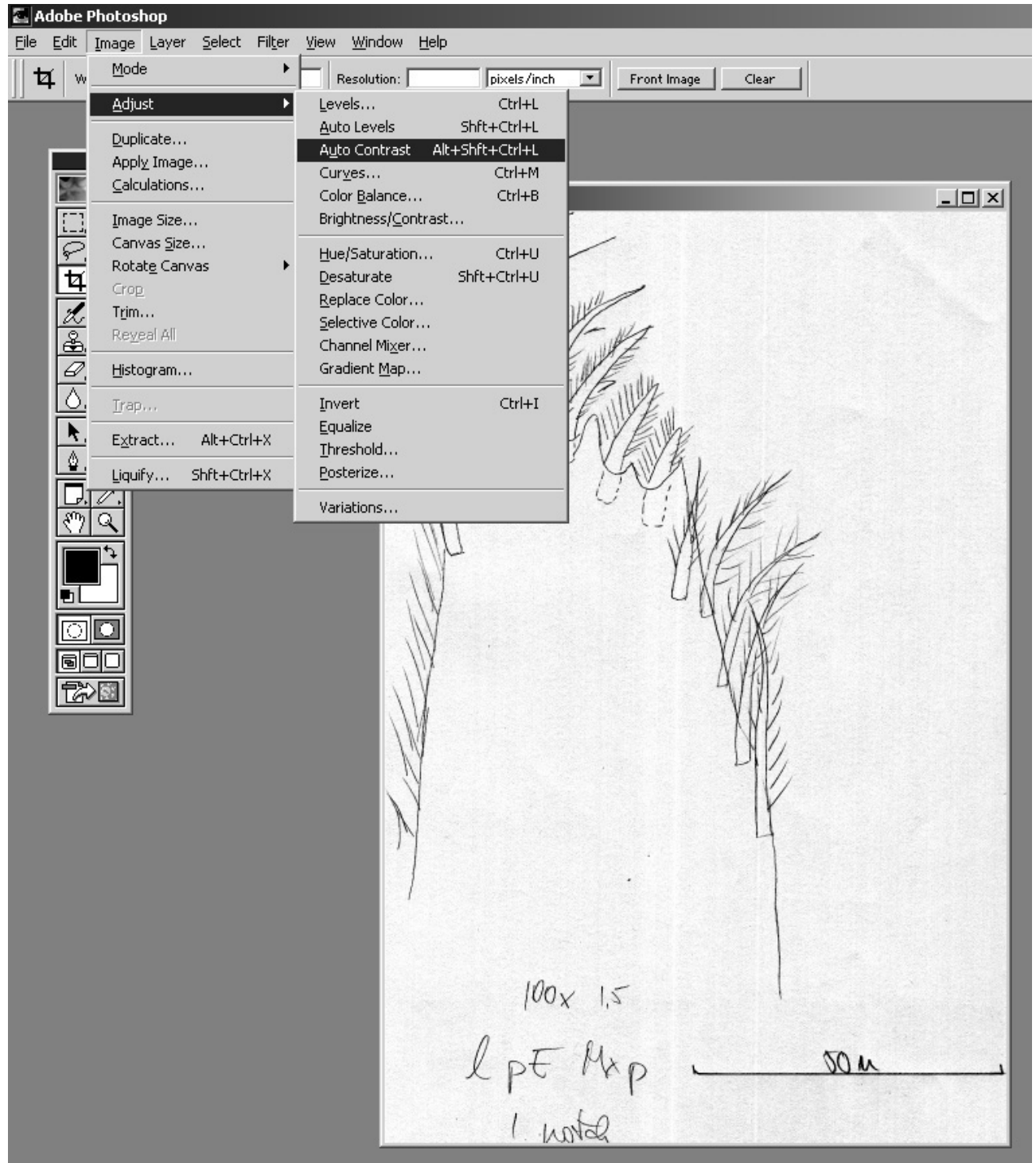


Fig. 2: The pencil drawing is scanned in using Adobe Photoshop 6.0 and the contrast is improved using the “Auto Contrast” function.

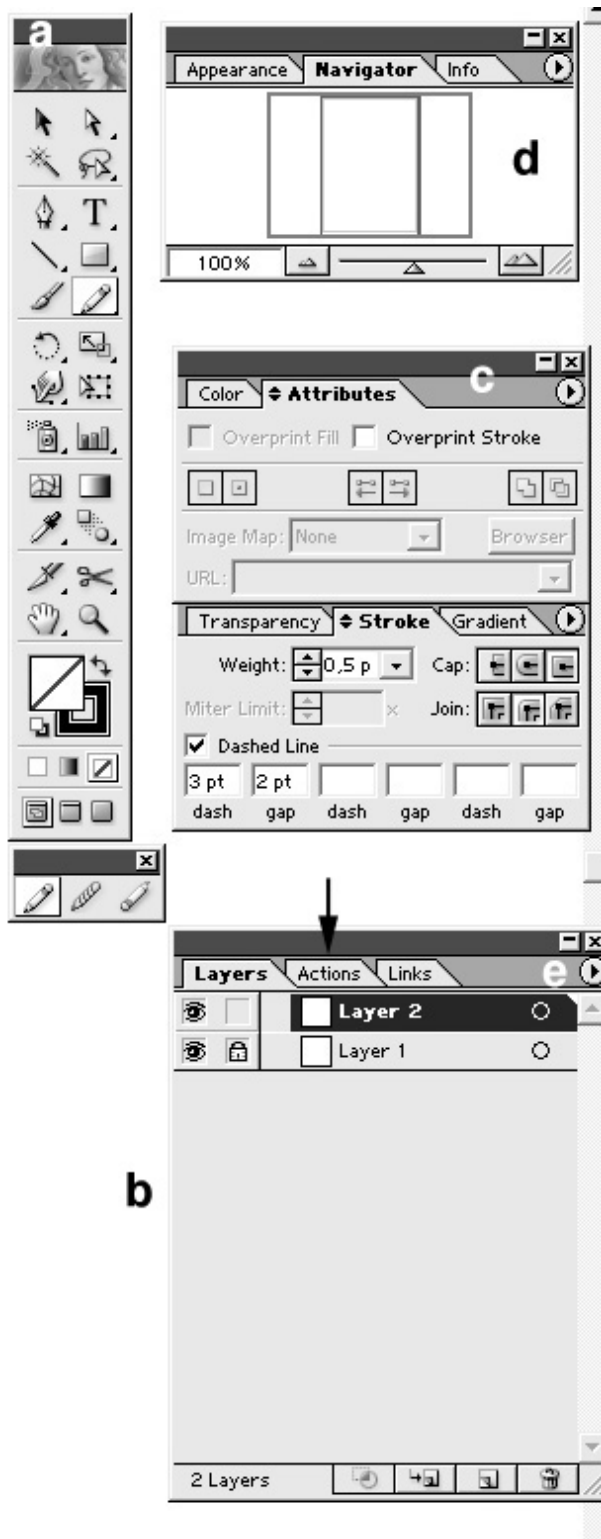


Fig. 3: Windows in Adobe Illustrator recommended for the preparation of line drawings. **a:** general tool bar. **b:** layers menu, arrow (**e**) indicates location of Actions menu. **c:** attributes and strokes window, which is important for the setup of lines. **d:** navigator window allows changes in the section of an enlarged drawing, moving the slider changes enlargement.

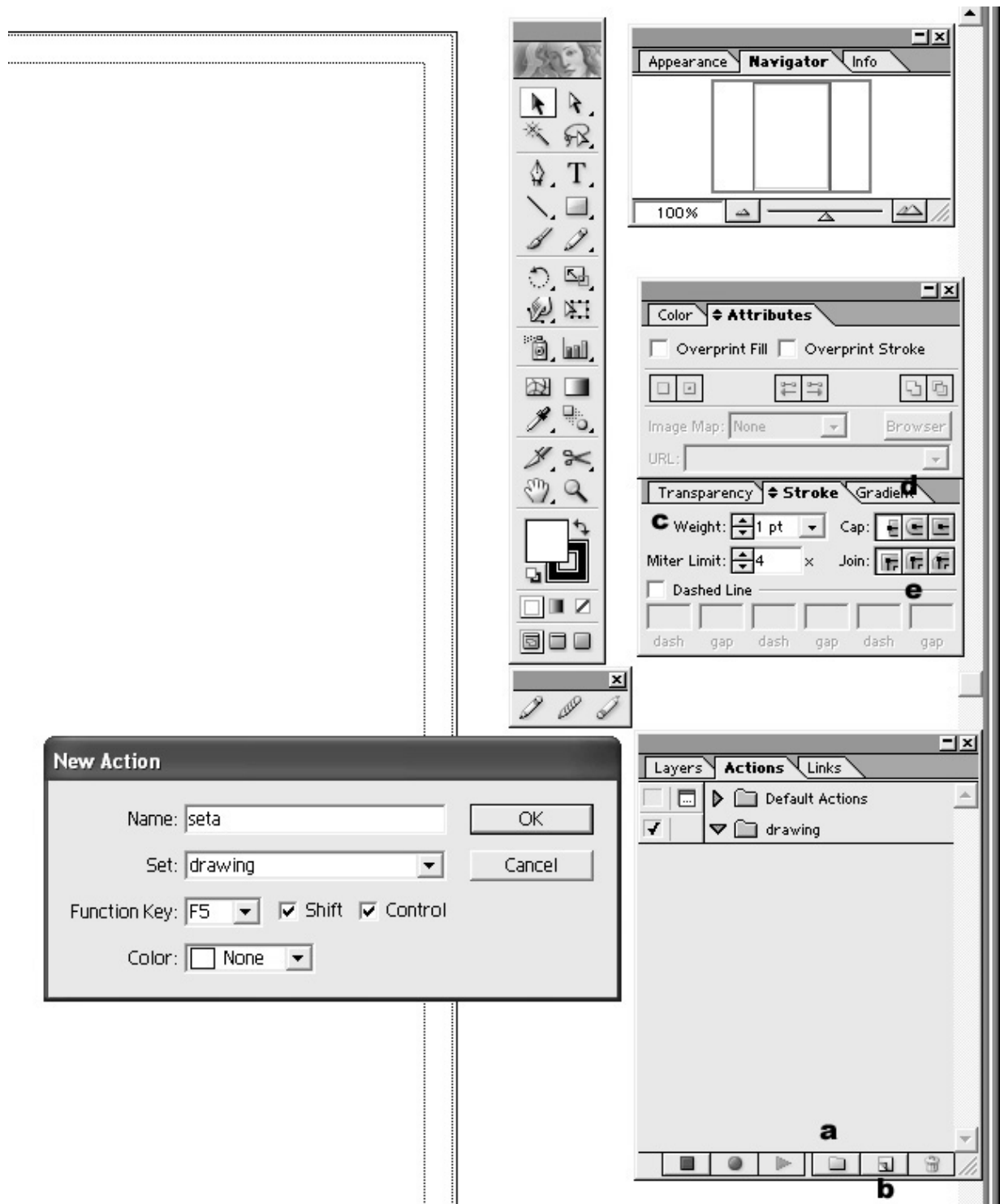


Fig. 4: Definition of new actions. Icon "a" is used for the definition of a new set of actions. Pressing icon "b" calls up the dialog "New Action", where line types and a keyboard shortcut are defined. Weight "c" is the width of the line; Cap "d" creates a rounded end, Join "e" a rounded angle.

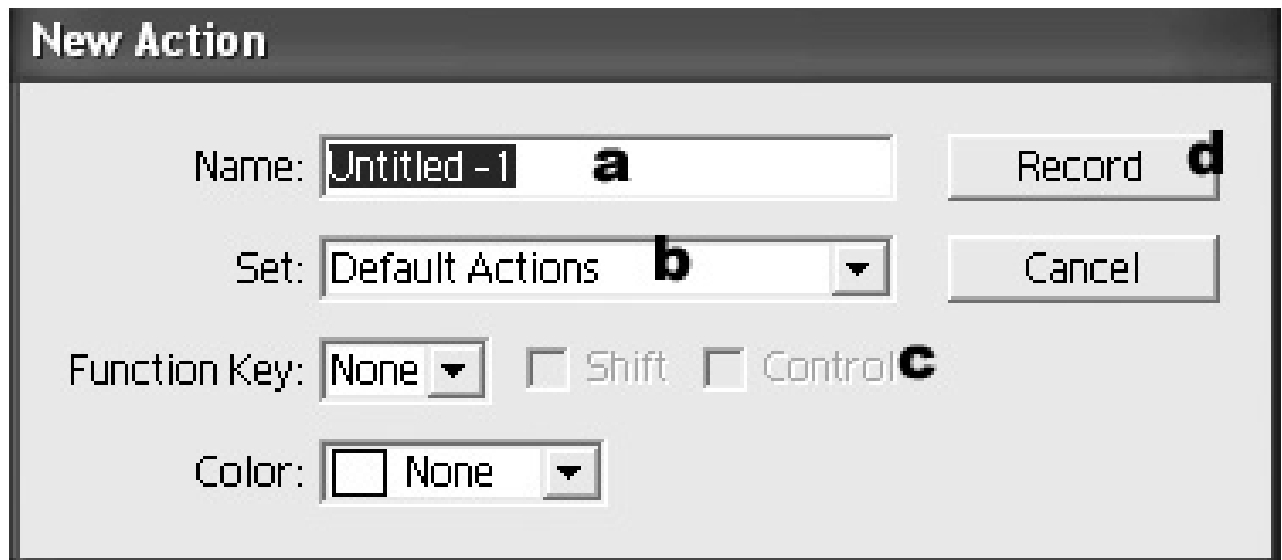


Fig. 5: Insert name of action in "a". Allocate a new action to actionset in "b". Define function key with "c" and record the line definition with "d".

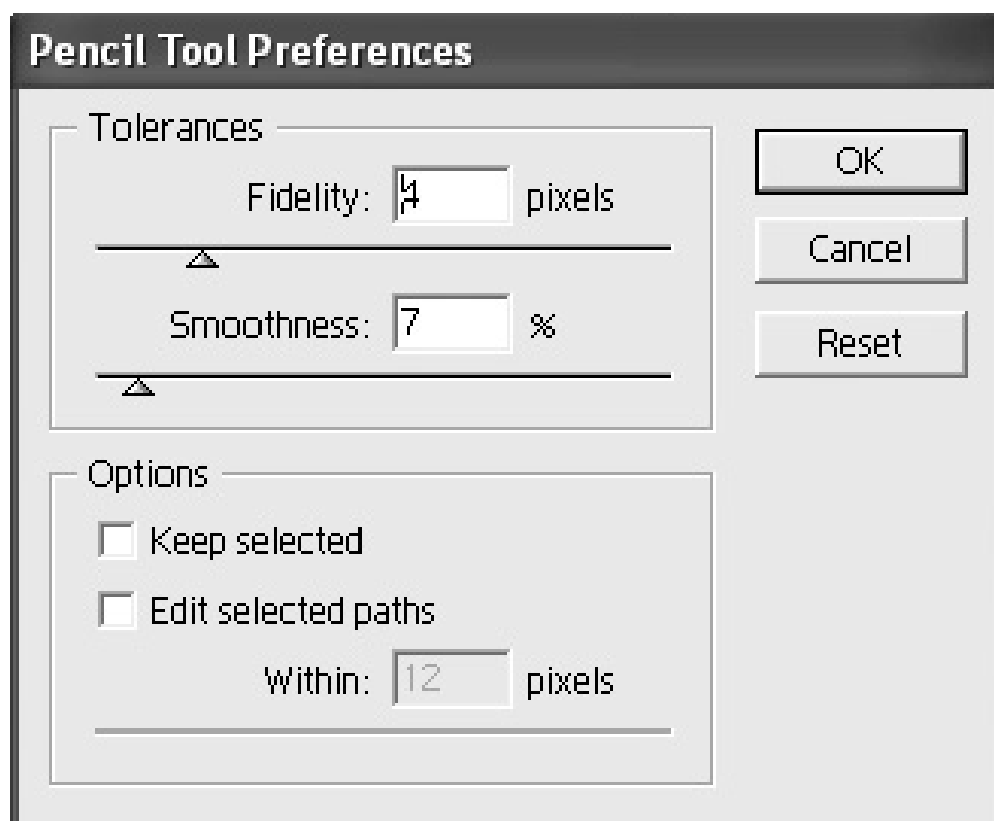


Fig. 6: The most important tool for drawing is the Pencil function of the software. In the Pencil Tool Preferences tolerance levels of the pencil movement can be preset. Checking both boxes in Options allows the continuation of lines after the path is highlighted.

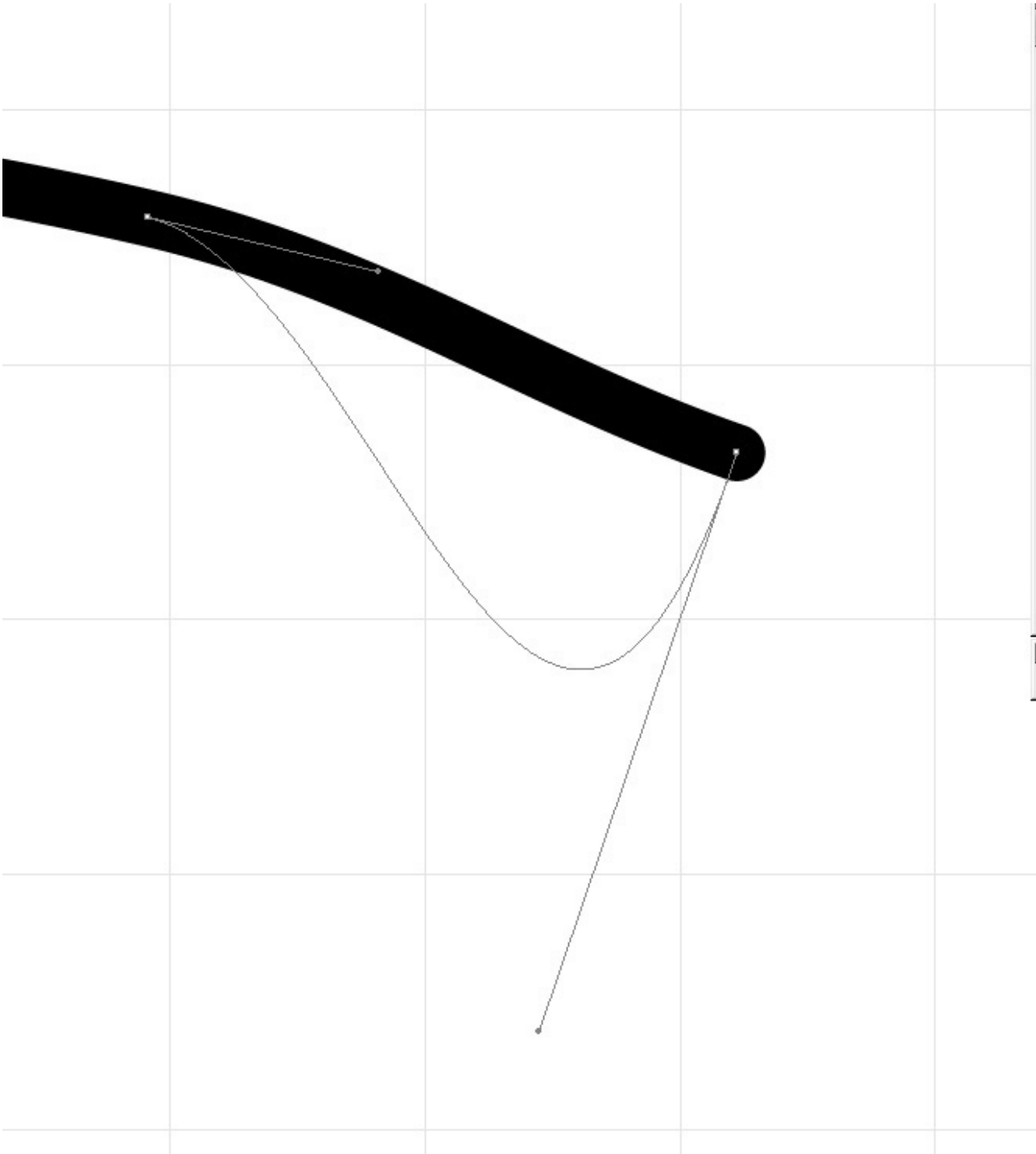


Fig. 7: The course of a line can be modified by moving anchor points (small squares) within the path or by pulling on the black round end of the direction line with the mouse. When the mouse is released the course of the line is being changed.

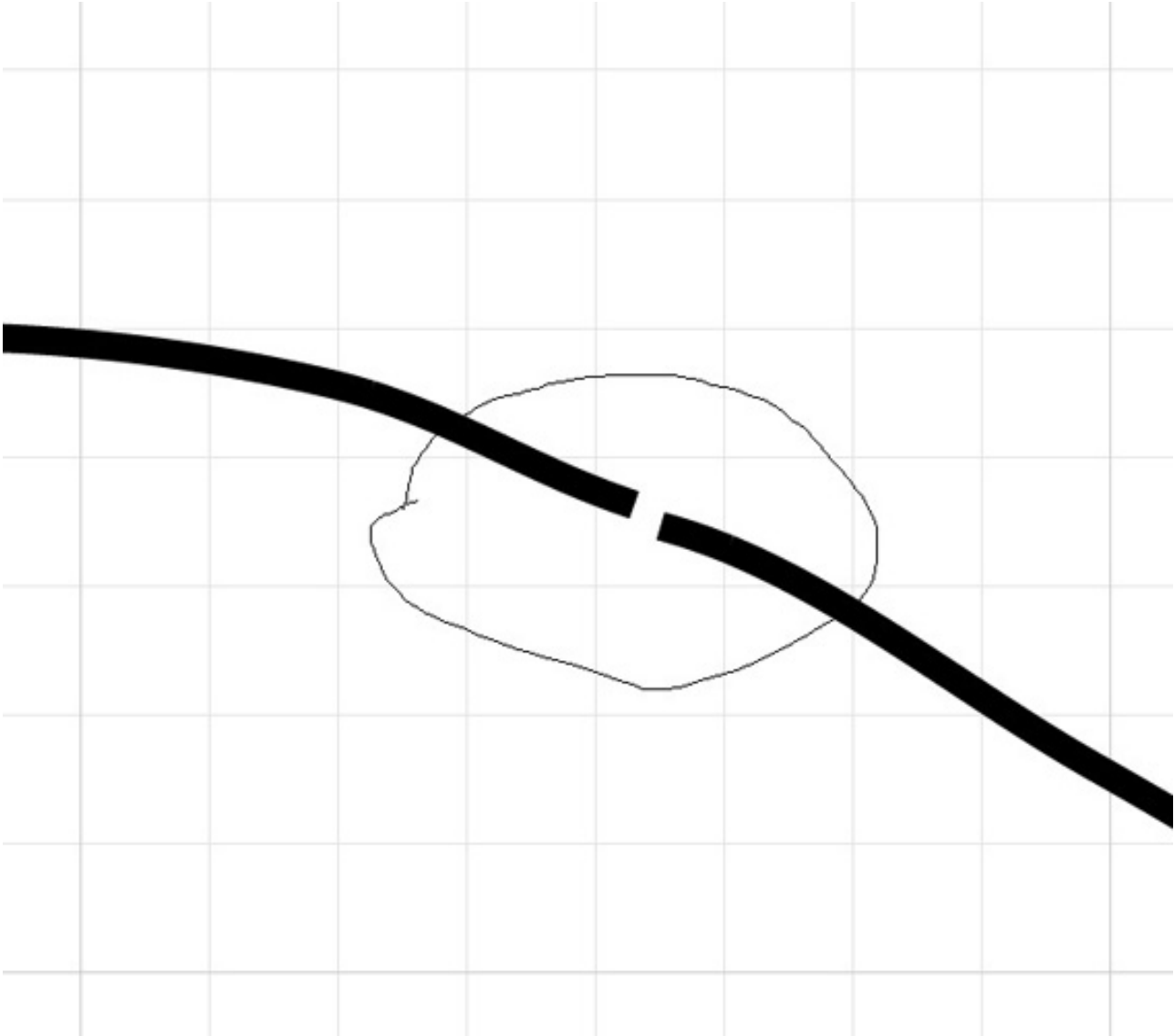


Fig. 8: In order to join two segments of a line, encircle the ends with the lasso tool after highlighting both paths. Ctrl-J will fuse the ends.



Fig. 9: Scalebars are drawn with the Pencil tool. Both ends of the scalebar are marked. After a rightclick with the mouse, select grouping and "R" for Rotate, then align the scalebar using the mouse.

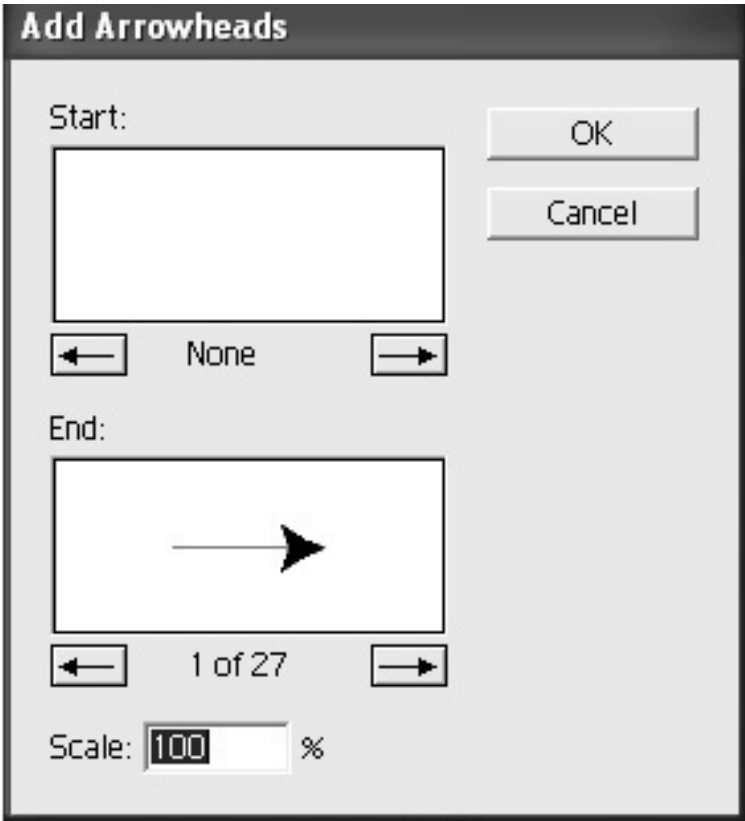


Fig. 10: Arrowhead dialog. The beginning or end of a line can be provided with an arrowhead. The shape and size (Scale) can be selected.

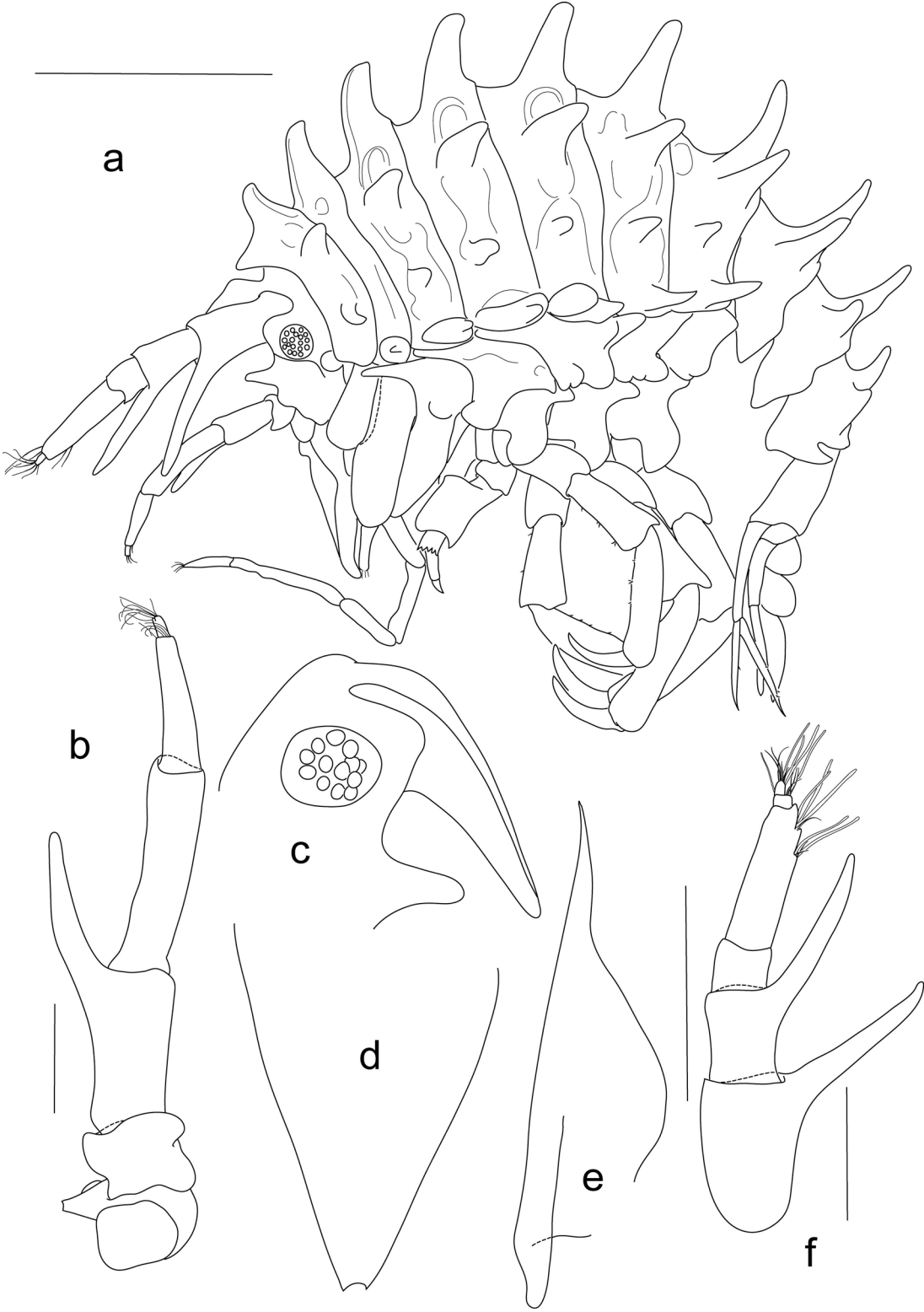


Fig. 11: Example of a figure plate and lettering.

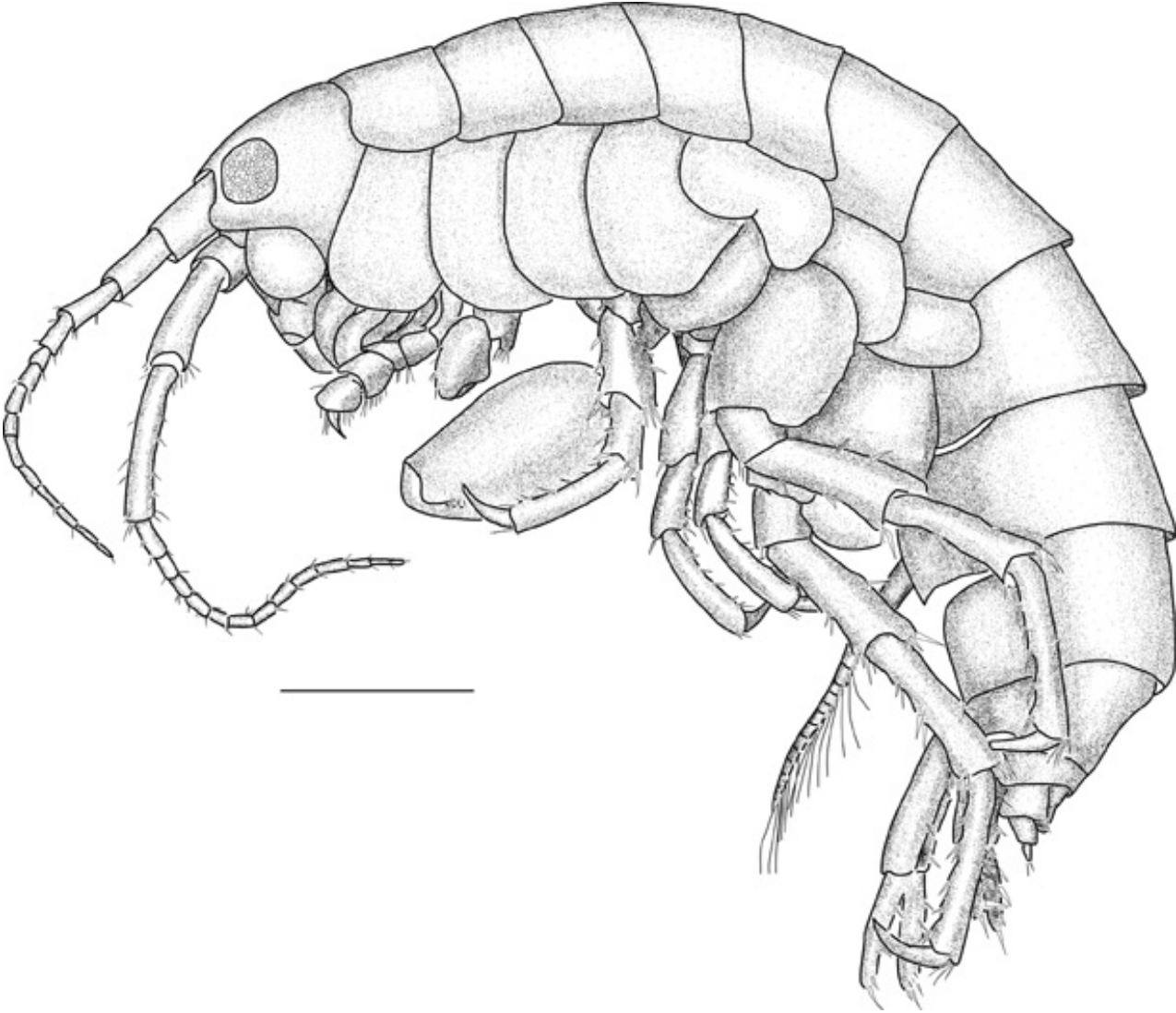


Fig. 12: Example of shading done using Adobe Photoshop.