Why draw seeds?
Illustrating archaeobotany

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Archaeobotany is the study of botanical remains from archaeological excavations (for its aims and methods, see Greig (1989) and Nesbitt (1995)). Most plant material decays soon after deposition unless charred, desiccated, mineralised or waterlogged. In past settlements plant material – such as wood, seeds and chaff – often came into contact with fire, whether through use as fuel or through waste disposal, and was preserved by charring. Although charring often affects the shape of seeds, overall wood and seed anatomy and morphology are remarkably well preserved. While colour differences are lost – charred seeds are, of course, black – boundaries between different plant tissues are often clearer in charred material than uncharred. Charred seeds therefore lend themselves well to drawing.

In contrast, waterlogging usually leads to the loss of the interior of seeds and of some external characters. Waterlogged material must be studied while it is still wet, and usually lends itself best to photography. In this article we restrict ourselves to charred plant remains, with illustrations drawn from Turkish and Syrian material.

It is probably fair to say that archaeobotanists in Britain make less use of illustrations – of any kind – than on the continent of Europe. We do not believe that this is because of any real aversion to the use of illustration, but rather reflects the history of archaeobotany in this country. Most archaeobotanists in Britain work on plant remains from development-linked contract archaeology. There are problems both with funding on-site recovery of plant remains in the first place, and with funding adequate post-excavation work. An endless succession of short-term contracts does not lend itself to the kind of major reports that are typical in Germany or the Netherlands.

However, even research-led archaeobotanical reports are often little illustrated. We suggest that it is not only financial factors that are at work. Archaeobotany is a relatively new field here and, unlike pottery studies for example, has no tradition of extensive illustration. Generally, archaeobotanists are not used to the concept of budgeting for illustration in post-excavation work, and illustrators are not familiar with this kind of work. In this article we hope to show how illustration can be useful in archaeobotanical reports, and to discuss some of the technical issues involved. The illustrations in the article are largely of Turkish seeds, drawn by an illustrator (Jane Goddard) for an archaeobotanist (Mark Nesbitt); the illustrations of Syrian material were carried out for Delwen Samuel. As the material has been drawn for a variety of publications over the last seven years, some variations in density of shading and orientation of views will be apparent.

The importance of illustrations

Illustrations of plant remains are useful for a number of reasons. Firstly, and most importantly, a picture is far more effective than words alone in conveying the appearance of a plant part, and thus enabling other archaeobotanists to confirm the identification. Although a sophisticated botanical vocabulary is available for seed descriptions, they are a poor tool for conveying the subtle differences that differentiate seeds (throughout this article "seed" is used in the widest sense to mean all the parts of plant fruits that occur on archaeological sites). Words are best used to draw attention to the key points in illustrations. Much work remains to be done on identification criteria and in some cases there is still controversy as to exactly how a given plant part should be identified, so a visual check on critical identifications is often much needed.

Secondly, illustrations are a valuable learning aid. Archaeobotanists identify ancient plant remains by comparing them to reference collections of named modern botanical material. However, illustrations are a valuable supplement, for example where a particular species is missing from a reference collection. They are also much handier for casual browsing then reference collections. Illustrations are no substitute for a good reference collection, but most archaeobotanists use both. Thirdly, illustrations are valuable at the more mundane level of making a report – especially a

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fairly technical archaeobotanical report – more readable. Pictures can do a lot for the impact of a text.

The role of photographs

Two kinds of illustration are used: photographs and drawings. Photographs lie outside the main scope of this article but are discussed for comparative purposes. At the microscopic level, photographs are the way in which images from Scanning Electron Microscopy (SEM) are preserved. SEM photographs are sharp and have reasonable depth of field, but poorly represent three-dimensional shapes, and cannot be used for items over about 3mm in length, unless several SEM photographs are joined together. SEM is particularly useful for very small items which are difficult to draw, and for showing subtle cell patterns or characters in plant anatomy (e.g. for tubers see Jon Hather (1993)). Because material must be glued to a stub for SEM photography, it can be difficult to orientate the seed for best viewing. Some of the good and bad points of SEM photographs are shown by those reproduced in a useful guide to European seeds (Schoch et al. 1988).

Photomicrography with a camera attached to a reflected-light microscope is sometimes used. Here the problem is depth of field: with all but the flattest seeds, it is virtually impossible to have the whole seed in focus. Even when skilfully used, it can be difficult to light surface features adequately, particularly on charred, black seeds. When unskilfully used – as is most often the case – photomicrographs are useless. They highlight unimportant features – small fissures, surface damage, pieces of dirt – but the important features often fade into the background. Examples of

Fig. 1. Cereal grains, showing dorsal, lateral, ventral views and transverse section (nomenclature of views follows Hillman et al 1996), x5. Botanical (Latin) names are given in italics and are followed by the name of the excavation from which the seed derives. a. einkorn wheat *(Triticum monococcum)*, Kuruçay; b, c. emmer wheat *(T. dicoccum)*, Kuruçay; d, e. free-threshing wheat *(T. durum/aestivum)* Sardis; f. rye *(Secale cereale)*, Kaman-Kalehöyük.

successful photomicrography include, for uncharred modern material, Berggren (1981), and for charred ancient seeds, Behre (1976). Examples of fuzzy, poorly lit photos are abundant in Körber-Grohne (1979).

Macro photographs, using a macro lens attached to a camera, have been widely used by archaeobotanists. This is useful for photographs of *groups* of reasonably large seeds: for example, cereal grains (well used by Helbaek (1970), van Zeist, (1968-1970) and Körber-Grohne (1987)) or grape pips (e.g. Gorny (1995): 163). The seeds are best photographed on a sheet of glass supported 15cm or more above a white background. With careful arrangement of lighting from above, preferably using cool light from a fibre-optic lighting unit, shadows diffuse invisibly into the background. However, a macro lens will not magnify individual seeds sufficiently for illustration. Dorrell (1994) offers useful advice on macro photography.

Drawings

Drawings of seeds have many advantages: no matter how large the seed, or how oddly shaped, an object can be drawn with no problems of depth of field; the ability to present - and stress - the three dimensions greatly increases the ability to convey shape; and irrelevant features can be excluded, simplified or toned down, while those that are diagnostic can be stressed. For example, on the emmer cereal grains (figure 1b-c), note the clear longitudinal grooving and rather triangular cross-section so typical of this species. In contrast, the free-threshing wheat grains (figure 1d-e) have smoother flanks and a more rounded cross-section. A similar contrast in cross section can be seen between hulled barley (2a) and naked barley (2b). The drawing also clearly shows the characteristic transverse wrinkling on the surface of naked barley.

Another class of plant remains for which drawing is ideal is chaff: the remains of the cereal ear after the grain has been threshed out (figures 3 and 4). Chaff is usually covered in the remains of torn structures and can be difficult to interpret on a photograph; a drawing can concentrate on the diagnostic elements. For some other seeds, such as the pulses (figure 5), the details are less important, and it is more the shape that must be communicated. We have adopted a similar approach for drawings of grass seeds for a new identification key (figure 8): to concentrate on the shape and on the arrangement of the major features, while excluding details of surface appearance that would not, in any case, often survive charring.

The main disadvantage is the labour intensive nature of good drawings: items with complex patterning, or the use of multiple drawings to show morphological variation within a seed type, may be too time-consuming and thus too expensive. However, relative to the total cost of an archaeobotanical project, illustration may form a small part of the overall budget. For example, the cost of drawing 150 modern grass seeds (in four views each) to illustrate an identification guide was less than 3% of the total budget of the project (two of the drawings are shown in figure 8). Careful selection of seeds and views should allow some professional illustration to be part of any major archaeobotanical publication: the most critical aspect is ensuring that it is included in the budget

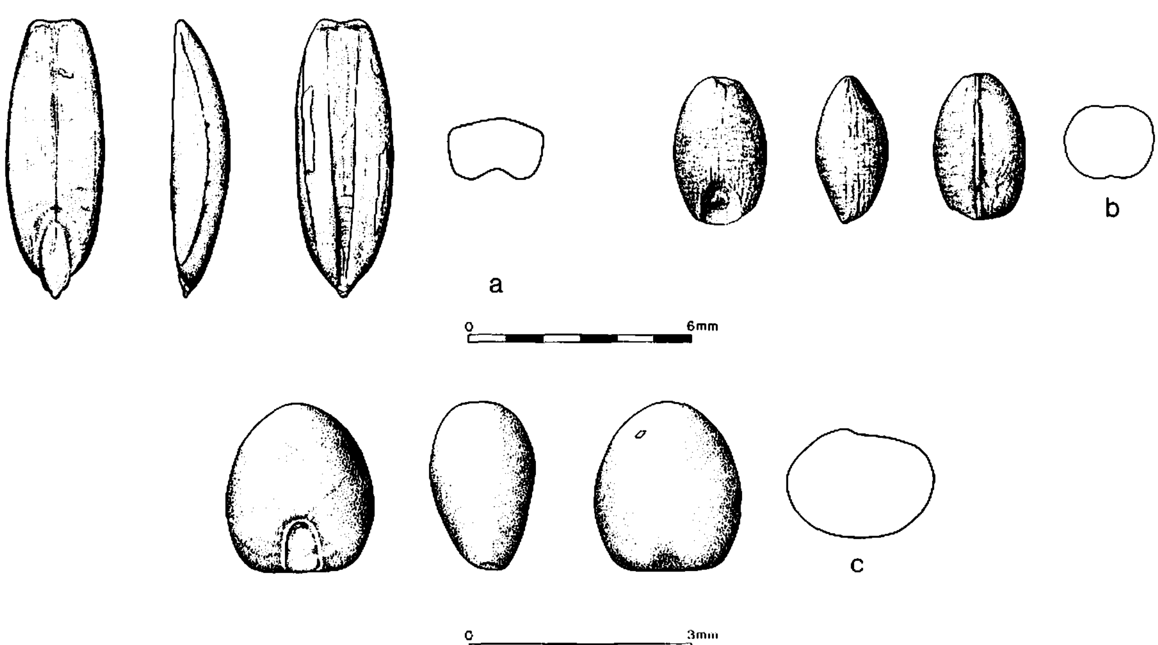

Fig. 2. Cereal grains, showing dorsal, lateral, ventral views and transverse section. a. two-row hulled barley *(Hordeum distichum)*, x5, Gordion; b. naked six-row barley *(H. vulgare* var. *nudum)*, x5, Can Hasan I; c. common millet *(Panicum miliaceum)*, x10, Gordion.

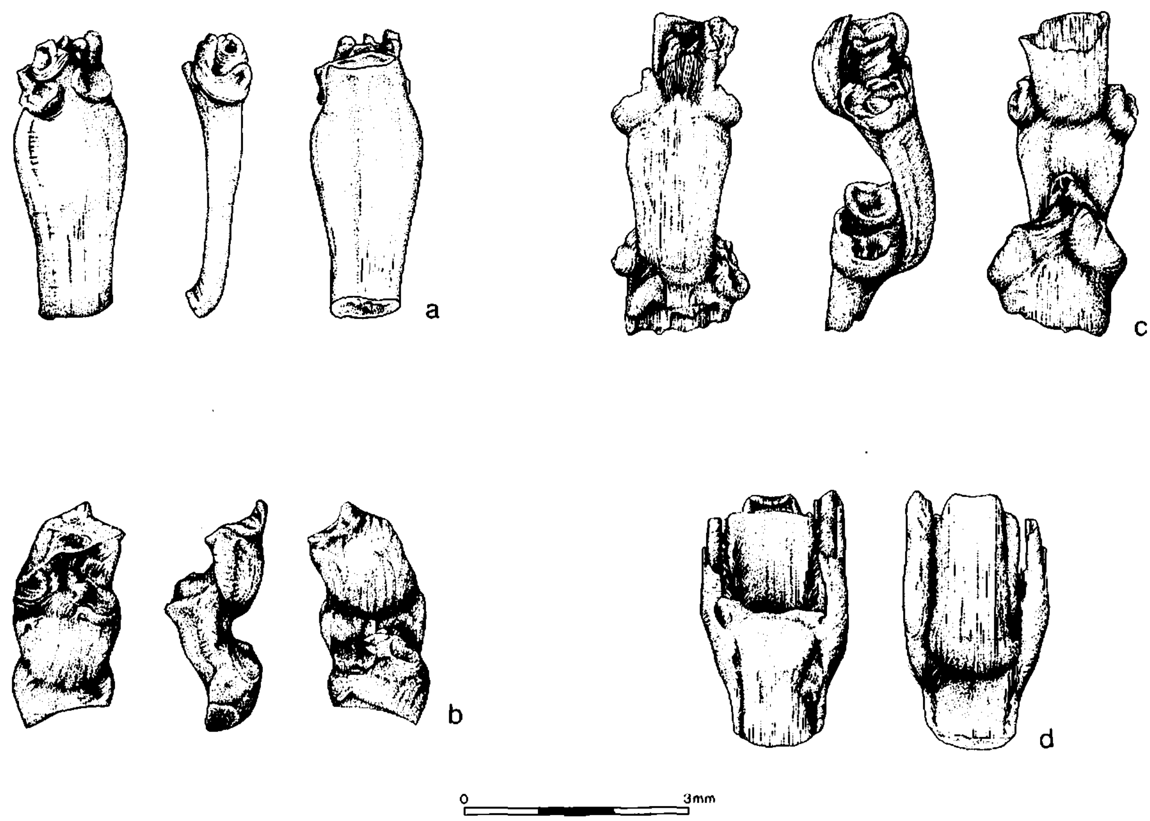

Fig. 3. Cereal chaff, showing abaxial ("front"), lateral ("side") and adaxial ("back") views, x10. a. bread wheat rachis segment *(Triticum aestivum)*, Dilkaya; b. bread wheat rachis segment (compact type), Qaryat Medad, Syria; c. macaroni wheat rachis segment *(Triticum durum)*, Qaryat Medad, Syria; d. barley rachis segment, abaxial and adaxial views only, Can Hasan I.

from the beginning.

A varied approach to illustration is best: for example, drawings to show the main seed types, macro photographs to show groups of the larger seeds (of which individual items may have been drawn), and SEM photographs to show small seeds, cell patterns and plant anatomy.

Although it is natural to choose seeds in good condition for illustration, it is worth including frequent types of damage: for example, the "popped", testa-less seeds of *Camelina*. The archaeobotanist should also guard against a tendency to choose the material one can identify, and to forget those seeds hidden under the "unidentified" classification.

Practical aspects

The first stage in drawing is to decide which views should be shown, and at what scale they should be drawn. There is some agreement amongst archaeobotanists as to what is ideal for different classes of plant remains. For example cereal grains are usually shown in four views, including a cross-section (figure 1); pulses in two views (figure 5), and chaff in two or three views (figures 3 and 4). As each extra fully-shaded view increases the amount of time required for that seed, there may need to be a balance between the number of views of each seed, and the number of seeds illustrated. If this is a factor, then the archaeobotanist must consider which views are least informative and need not be drawn.

A decision must also be made about consistent layout of asymmetrical objects: there is no universal agreement on this. For the lateral view of cereal grains, in some cases we followed the system of Kroll (1983) with the embryo placed on the left (e.g. figure 1d, 1e, 2a); in others the system of van Zeist, with the embryo on the right (figure 1a, 1b, 1c, 1f). We now invariably follow van Zeist, and always place the cereal embryo on the right; for other seeds with equivalent features we adopt the same orientation to the right. Thus, for the pulses the radicle should be to the right (as in figure 5a), not to the left (as in figure 5b).

The choice of final degree of magnification has often been arbitrary, although usually consistent within one publication. This means that it can be difficult to compare seed drawings between different publications. We try to use a standard set of final magnifications:

cereal grains	x5
cereal chaff	x10, sometimes x15
pulses	x10
larger items, e.g. fruit stones	x2 or x5
weed seeds	x10 or x20, depending on size

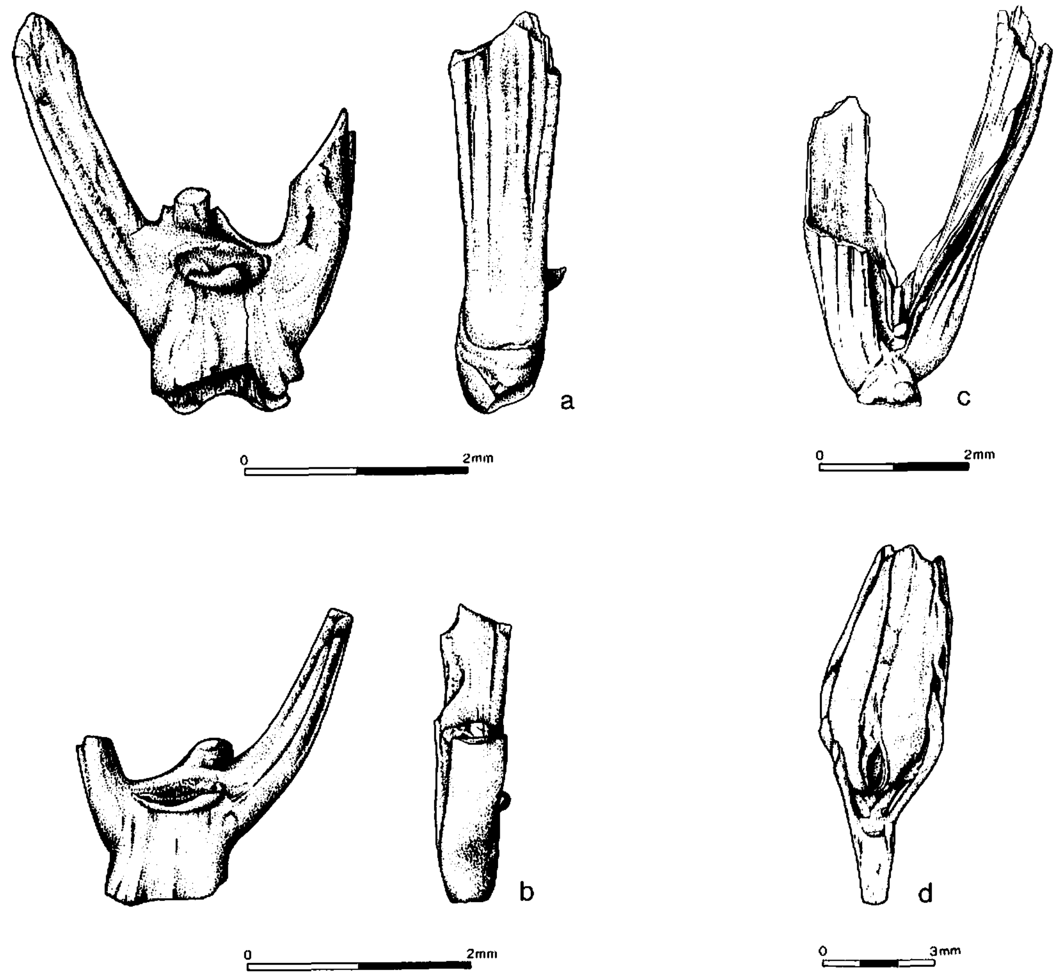

Fig. 4. Cereal chaff. a. emmer wheat, spikelet fork, Çayboyu; b. einkorn wheat, spikelet fork in adaxial and lateral views, x15, Çayboyu; c. emmer wheat, lateral view of terminal spikelet fork, x10, Gordion; d. intact two-row hulled barley spikelet, adaxial view, x5, Gordion.

Drawings are usually prepared at twice this magnification, for linear reduction to 50%. However, where the original would be too large (and thus time-consuming) to prepare at double final size, we are flexible. Thus, a piece of cereal chaff to be printed at x10 could be drawn at x15 rather than x20. However, care needs to be taken that the correct linear reduction is applied to items drawn at different magnifications. Once mounted for printing, we always provide a simple scale for each drawing. Even if information on magnification is provided in the caption, this is both difficult to visualise, and may change if the drawings are reduced in photocopying of the printed version.

The next stage is preparation of a pencil sketch of the outline and main features of the seed or other item (e.g. tuber) chosen for illustration. No shading is necessary as this will be applied in inking up of the final version. Preparation of the drawing will require a microscope for all but the very largest objects. Stereo microscopes, operated via reflected light with a magnification range between 5 to 50, are standard equipment in archaeobotanical laboratories.

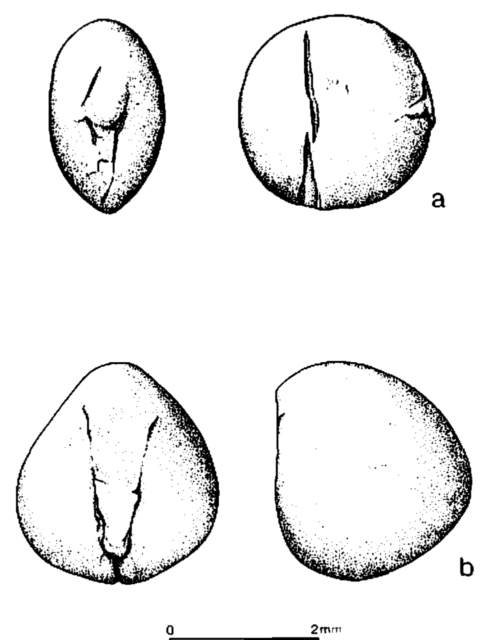

Fig. 5. Pulses, in proximal and lateral views, x10. a. lentil *(Lens culinaris)* Gordion.; b. bitter vetch *(Vicia ervilia)* Gordion.

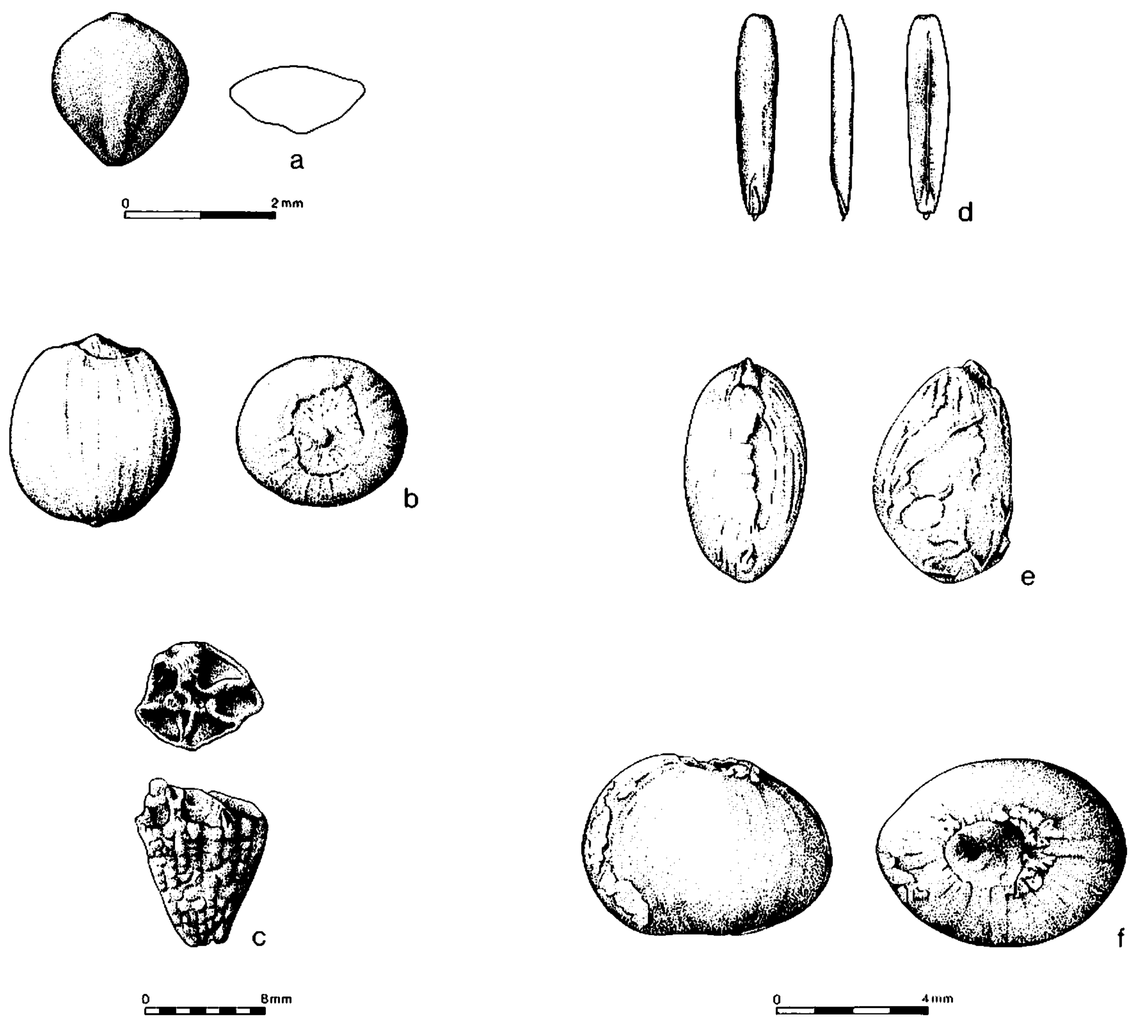

Fig. 6. Seeds of wild plants. a. sea club-rush *(Bolboschoenus maritimus)*, x10, Hallan Çemi; b. hazelnut *(Corylus* sp.*)*, x2, Gordion; c. *Gundelia tournefortii*, x2, Hallan Çemi; d. brome grass *(Bromus* sp.*)*, x5, Gordion; e. cotton *(Gossypium arboreum/ herbaceum)*, x5, Gordion; f. terebinth nut *(Pistacia* sp.*)*, x5, Can Hasan I.

There are three basic techniques for producing a measured sketch of a microscopic object. Firstly, a measured drawing can be produced using an eyepiece graticule (also known as a micrometer). A graticule contains 100 divisions; once conversion factors have been calculated for a range of magnifications on a microscope, the graticule can be used to measure objects under the lens (see Bradbury (1991) for details). The length and breadth of the seed can be measured for a given view, then the x and y co-ordinates of key points measured and plotted on. The outlines can then be drawn in freehand, using these points of reference. The advantage of this technique is that the only extra equipment required is a graticule.

Another technique uses a drawing tube (also known as a *camera lucida*), which attaches between the microscope body and the eyepieces. This allows the user to see both the magnified object, and a sheet of paper placed to one side of the microscope. One can then draw in the main features of the seed by tracing with a pencil around the outlines and key points of the seed. The drawing tube is a rapid and accurate tool for producing accurate drawings, but it can be difficult to ensure that the resulting drawing is at the right magnification.

We prefer to combine these techniques. We use the graticule to measure the length and breadth of the seed in each of the chosen views, and draw a box for each at the desired magnification. We then use the camera lucida to draw in the outlines and key features. Although drawing tubes are expensive, they can save a lot of time. The measured boxes ensure that all the views are drawn to an exact magnification. The pencil drawing can be prepared by the illustrator, but can be done instead by the archaeobotanist, who can then show which characters can be emphasised. This can also save the illustrator's time, allowing more seeds to be inked in.

For cross-sections of cereal grains, we place the distal end of the grain in a sandbath (thus looking down onto the embryo end) and draw the outline of

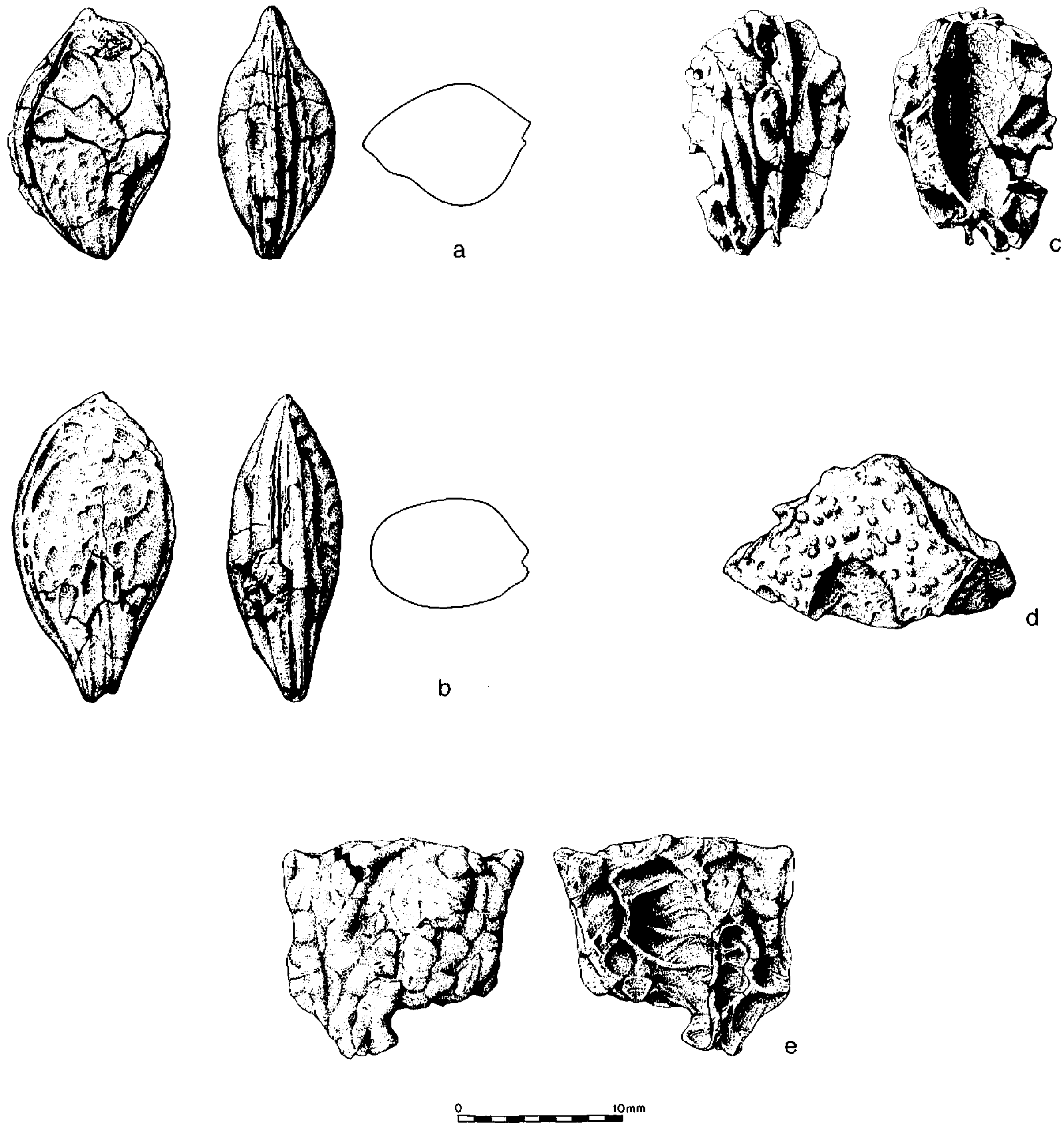

Fig. 7. Fruit remains, all from Qaryat Medad, Syria, x2.5. a. damson/greengage type plum *(Prunus domestica* ssp. *italica/ insititia)*; b. "European" type plum *(Prunus domestica* ssp. *domestica)*; c. fragment of peach stone *(Persica vulgaris)*; d. fragment of Citrus peel; e. fragment of walnut shell *(Juglans regia)*.

the widest point. A sandbath is a vital tool for placing seeds in a desired orientation; it consists of a small glass dish filled with sand or glass granules.

Once the pencil drawing has been prepared, and any queries have been checked, it can be inked in. With the seed under the microscope – frequent checks back and forth by the illustrator will be needed as shading progresses – ink drawings can be prepared on a piece of draughting film taped on top of the pencil drawing.

Care must be taken in handling: charred seeds are usually robust but very vulnerable to shaking or pressure. Seeds should be housed in rigid, appropriately-sized containers, such as gelatine capsules in small glass tubes. Charred objects should be handled with special soft forceps or a paintbrush. For orientation of items under the microscope, a sandbath is essential. If the seeds are taken away for drawing, then all this equipment – microscope, light, graticule, drawing tube, sandbath, forceps – must be lent to the illustrator.

Drawings that set standards

Two archaeobotanists have consistently used top-quality illustrations in their work: Willem van Zeist in the Netherlands, and Helmut Kroll in Germany. These drawings are widely admired by archaeobotanists, and would make a good starting

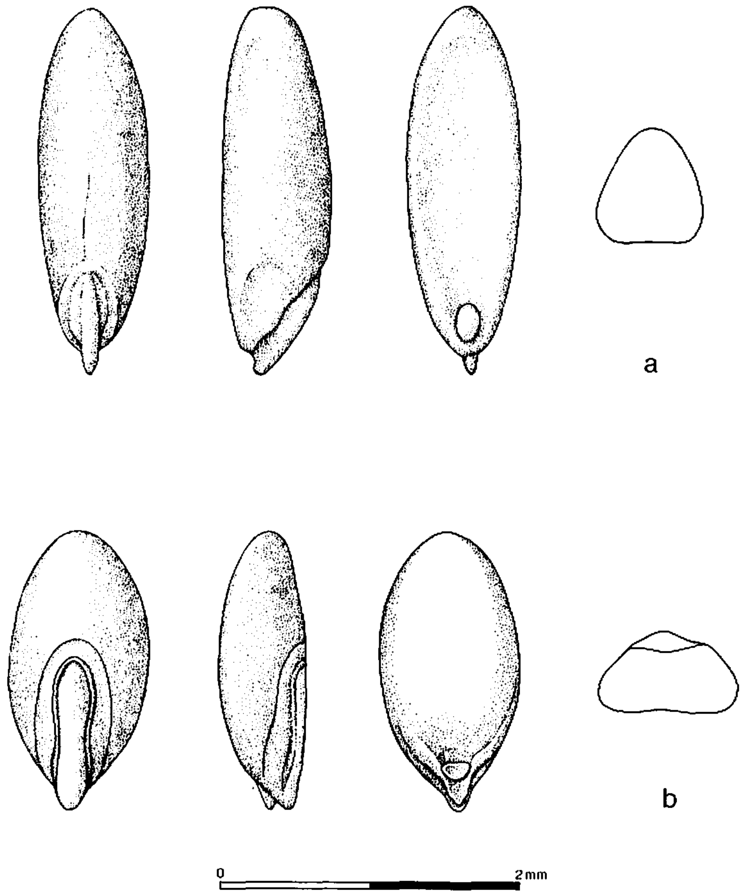

Fig. 8. Modern, uncharred, grass caryopses drawn for an identification key, dorsal, lateral, ventral views and transverse section, x20. a. *Beckmannia eruciformis*; b. *Tetrapogon villosus*.

point for any illustrator interested in this field. The most notable set of seed drawings, by H.R. Roelink, appear in van Zeist's major series of studies of Near Eastern plant remains, published in *Palaeohistoria* (van Zeist and Bakker-Heeres, 1982, 1984a, 1984b, 1985, van Zeist, et al., 1984). Drawings of equally high quality appear in Kroll's work on Greek archaeobotany (Kroll, 1979, 1983). Many of these illustrations are reproduced in Zohary and Hopf (1993). More of Jane Goddard's work can be seen in Nesbitt (1993), but note the printer's erroneous exchange of captions between figures 2 and 6. For those interested in seeing a wider range of illustrations, archaeobotanical papers frequently appear in the journal *Vegetation History and Archaeobotany*.

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References

Behre, K.-E. 1976. *Die Pflanzenreste aus der frühgeschichtlichen Wurt Elisenhof.* Studien zur Küstenarchäologie Schleswig-Holsteins. Serie A 2. Herbert Lang, Bern.

Berggren, G. 1981. *Atlas of seeds and small fruits of Northwest-European plant species. Part 3. Salicaceae-Cruciferae.* Swedish Museum of Natural History, Stockholm.

Bradbury, S. 1991. *Basic measurement techniques for light microscopy.* Microscopy Handbooks 23. Oxford University Press, Oxford.

Dorrell, P. G. 1994. *Photography in archaeology and conservation. Second edition.* Cambridge manuals in archaeology. Cambridge University Press, Cambridge.

Gorny, R. L. 1995. Viticulture and ancient Anatolia. In *The origins and ancient history of wine,* edited by P. E. McGovern, S. J. Fleming and S. H. Katz, pp. 133-174. Gordon and Breach, Luxembourg.

Greig, J. 1989. *Archaeobotany.* Handbooks for Archaeologists 4. European Science Foundation, Strasbourg.

Hather, J. G. 1993. *An archaeobotanical guide to the identification of roots and tubers. Volume 1. Europe and south west Asia.* Oxbow Monograph 28. Oxbow Books, Oxford.

Helbaek, H. 1970. The plant husbandry of Hacılar. In Excavations at Hacılar. Volume I., edited by J. Mellaart, pp. 189-244. British Institute of Archaeology at Ankara, Occasional Publication 9. Edinburgh University Press, Edinburgh.

Hillman, G. C., S. Mason, D. de Moulins and M. Nesbitt 1996 for 1995. Identification of archaeological remains of wheat: the 1992 London workshop. *Circaea* 12(2): 195-209.

Körber-Grohne, U. (editor) 1979. *Festschrift Maria Hopf.* Archaeo-Pysika 8. Rudolf Habelt, Köln.

Körber-Grohne, U. 1987. *Nutzpflanzen in Deutschland.* Konrad Theiss, Stuttgart.

Kroll, H. J. 1979. Kulturpflanzen aus Dimini. In *Festschrift Maria Hopf,* edited by U. Körber-Grohne, pp. 173-189. Archaeo-Physika. vol. 8. Rheinland-Verlag, Köln.

Kroll, H. J.1983. *Kastanas. Die Pflanzenfunde.* Prähistorische Archäologie in Südosteuropa 2. Volker Spiess, Berlin.

Nesbitt, M. 1993. Ancient crop husbandry at Kaman-Kalehöyük: 1991 archaeobotanical report. In *Essays on Anatolian Archaeology,* edited by T. Mikasa, pp. 75-97. Bulletin of the Middle Eastern Culture Center in Japan. vol. 7. Harrassowitz, Wiesbaden.

Nesbitt, M. 1995. Plants and people in ancient Anatolia. *Biblical Archaeologist* 58(2):68-81.

Schoch, W. H., B. Pawlik and F. H. Schweingruber 1988. *Botanische Makroreste. Ein Atlas zur Bestimmung häufig gefundener und ökologisch wichtiger Pflanzensamen.* Paul Haupt, Bern.

van Zeist, W. 1968-1970. Prehistoric and early historic food plants in the Netherlands. *Palaeohistoria* 14:41-173.

van Zeist, W. and J. A. H. Bakker-Heeres 1982. Archaeobotanical studies in the Levant. 1. Neolithic sites in the Damascus basin: Aswad, Ghoraifé, Ramad. *Palaeohistoria* 24:165-256.

van Zeist, W. and J. A. H. Bakker-Heeres 1984a. Archaeobotanical studies in the Levant. 2. Neolithic and Halaf levels at Ras Shamra. *Palaeohistoria* 26:151-170.

van Zeist, W. and J. A. H. Bakker-Heeres 1984b. Archaeobotanical studies in the Levant. 3. Late-Palaeolithic Mureybit. *Palaeohistoria* 26:171-199.

van Zeist, W. and J. A. H. Bakker-Heeres 1985. Archaeobotanical studies in the Levant. 4. Bronze Age sites on the north Syrian Euphrates. *Palaeohistoria* 27:247-316.

van Zeist, W., P. E. L. Smith, R. M. Palfenier-Vegter, M. Suwijn and W. A. Casparie 1984. An archaeobotanical study of Ganj Dareh Tepe, Iran. *Palaeohistoria* 26:201-224.

Zohary, D. and M. Hopf 1993. *Domestication of plants in the old world. The origin and spread of cultivated plants in West Asia, Europe, and the Nile Valley.* Second ed. Clarendon Press, Oxford.

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