Acta Palaeobot. 35 (1): 121–132, 1995

# THE METHOD OF MAKING POSITIVE CASTS OF PLANT IMPRESSIONS IN POTTERY: A FIELD AND LABORATORY MANUAL

ANWAR A. MAGID and KNUT KRZYWINSKI

University of Bergen, Botanical Institute, Allegt. 41, 5007 Bergen, Norway

ABSTRACT. Methods of making positive casts of plant impressions in pottery are described with the aim to provide archaeologists and palaeoethnobotanists with a simple manual for field and laboratory use. Procedures for coating specimens for SEM examination are described; results of experimental charring of grains are shown.

KEY WORDS: archaeobotany, methods, plant impressions in pottery, artificial charring

## INTRODUCTION

The expanding scope of and interdisciplinarity between archaeology[1] and palaeoethnobotany/archaeoethnobotany challenge these disciplines to develop and promote strategies for integral research, models of interpretation, and methods of data collection and analytical procedure. Accordingly, methods and techniques to collect different types of archaeobotanical data have been developed and are being refined (e.g. Ayyad et al. 1991, Carruthers 1991, Fægri & Iversen 1975, Green 1979, Helbæk 1960, Magid & Krzywinski 1988, Renfrew 1973, Stemler & Falk 1981, Robinson & Straker 1991, etc.).

The present writers (an archaeologist and a botanist) are aware of the significance of integrated archaeological and palaeoethnobotanical activities when addressing research issues such as the development of prehistoric man's utilization of plants for different purposes. Hence, they acknowledge the need to develop and disseminate methods of data collection and analysis which are usable by and practically accessible to both archaeologists and botanists. The present paper is a joint endeavor to compile a practical field and laboratory manual for the method of making positive casts of plant impressions in pottery which can be used by archaeologists and palaeoethnobotanists.

## HISTORY AND DEVELOPMENT OF THE METHOD: HIGHLIGHTS

The development and application of the method of making positive casts of plant impressions in pottery is at least one hundred years old. Some of the earliest publications we are aware of concerning impressions of plants are those of Mortimer (1905) and Cree (1908). The value of impressions of plants (e.g. seeds and grains) in pottery and baked clay as a source of evidence became fully recognized with the development of the study of plant remains in Scandinavia and Britain in the works of scholars such as G. F. L. Sarauw, K. Jessen, and H. Helbæk (Renfrew 1973). We are not, however, aware of any published or unpublished work before the early 1970s which explicitly deals with procedures for examining potsherds for plant impressions or for making positive casts of plant impressions in pottery and baked clay. Instances of some of the important contributions that dealt in varying degrees of detail with the laboratory procedures for making positive casts of plant impressions in pottery are those of Renfrew (1973) and Stemler and Falk (1981).

[1] Different and sometimes contradictory definitions and explanations of the terms palaeoetnbotany and archaeoethnobotany have been proposed (e.g. Popper & Hastorf 1988 Helbæk H. 1954, 1960, Renfrew 1973, etc.). Since the issue of definition of terminology is not the subject matter of this work, both terms are used equally here to mean the study of ancient plants regardless of the context, the nature of the plants, or the purpose of their study.

In this paper, we seek to make an explicit field and laboratory manual which is simple and practically usable both by archaeologists and palaeoethnobotanists working under different field conditions and/or with different laboratory facilities. Although we fully acknowledge all previous contributions proposed for making positive casts of plant impressions in pottery, we still realize that such primary manual as the present one is needed for the following reasons:

1. Although many discoveries have been made and significant information has been obtained on the basis of findings of evidence of plant impressions in pottery or baked clay, no attempt that we are aware of has been made to provide a sufficiently explicit field and laboratory manual for the collection of data and the making of positive casts of such impressions.

2. Quite a few archaeologists are unable to collect or examine data for plant-imprints because they lack a field manual and because of the difficulties that arise and/or the expense incurred when seeking the assistance of a specialist in the field. The provision of a simple field manual may help to solve such problems as these and hence encourage archaeologists to start laying more emphasis on data which bear evidence of plant impressions.

3. There is an obvious benefit to be gained from adding significant details and improving existing laboratory procedures and from proposing additional new field procedures. Of course, we do not claim that the present manual is perfect, only that it is an explicit initiative which invites other colleagues working on similar research-issues to apply, build on, improve, and add to it.

## PRINCIPLES OF THE METHOD OF MAKING POSITIVE CASTS

The method of making positive casts of plant impressions in pottery is based on and derived from the following facts and observations:

1. Pottery, mainly the hand-made type, often contains impressions of small plant materials, for instance of grains, seeds, leaves, husks, etc. These plant materials may originally have been in the clay or may have accidentally been incorporated when the clay was mixed or the vessels shaped (Magid 1989, Renfrew 1973). It is, however, more common that these plant materials have been added intentionally as an organic tempering medium (Haaland 1978, Magid 1989) or sometimes even as decoration (Schery 1954).

2. When in the clay, "..... the dry plant materials absorb a certain amount of water from their moist clay surroundings, and the passage of water from the clay deposits a layer of fine clay particles around them." (Magid 1989). "This fine cast often reproduces minute morphological details [of the surface, e.g.] of the [wet] grain [or any other small part of a plant material]" (Helbæk 1955).

3. During the process of firing the clay, the plant materials are burnt out leaving a depression or cavity on the surface or within the walls of the vessel. This depression or cavity corresponds to the size and shape of the original wet plant material. It also often retains more or less the same external morphological features as the original plant material that has been burnt away (Renfrew 1973).

In order to achieve a thorough examination of the impressions of plants in pottery and baked clay and to make proper positive casts of them we suggest the following procedures.

### Field-procedure

The field procedure consists of the following basic[2] steps:

1. Cleaning

(i) Potsherds retrieved by means of wet sieving

If the potsherds to be examined for impressions of plants are retrieved by wet sieving or are hand-picked from a wet/moist context (e.g. in temperate zones and humid tropics), they may be treated as follows:

First. Carefully and repeatedly wash them in a basin of water until the water becomes clear and, hence, the potsherds are clean and free from the mud and dry clay that was adhering to their surfaces. Hard and soft (e.g. cleaning-, tooth-, etc.) brushes can be used in the cleaning.

---

[2] In cases when extended field work and excavations are planned and qualified staff and equipment are available, the field procedure may be more extensive than the basic procedure stated above and may even include most of the laboratory procedure.

Second. Leave the collection of potsherds to dry in a place which is not exposed to direct heat or high temperatures (to prevent fragile sherds from cracking and becoming brittle).

Third. When the sherds are dry, check the collection again and brush clean the surfaces of potsherds which still bear traces, patches, or a thin layer of dry clay.

(ii) Potsherds retrieved by means of dry sieving

If the potsherds are retrieved by dry sieving or are hand picked from a dry context (e.g. in arid and semi-arid areas), their surfaces should be properly cleaned using hard and soft (cleaning-, tooth-, etc.) brushes; the dust created as a result of this cleaning can be blown away by an air-pump or a hand-operated air-blower. Water can be used for cleaning if the sediments adhering to the surface of the sherds cannot be removed by dry brushing.

(iii) Complete pottery vessels

Depending on the context in which they are found, the cleaning of complete, empty pottery vessels is basically the same as described in (i) or (ii). However, in order to avoid cracking or otherwise damaging vessels that are filled with sediments, the following rules should be followed:

a) After being recovered the vessels should be left at a normal room temperature for a few hours before their contents, e.g. sediments, are removed. This is done to prevent cracking due to sudden changes of temperature, sudden replacement of sediments by air, and other similar hazards.

b) The contents of the vessel should be gently removed in stages using pins of different lengths and thicknesses and small, sharp, pointed digging-spoons. The sediments extracted may be froth flotated so as to retrieve macrofossil plant remains.

The preparatory cleaning of pottery described in points (i) and (ii) should always be done regardless of the purpose of the study (e.g. decoration or typology) of pottery. Thus, it is done here in order to obtain clean surfaces[3] of potsherds/vessels and, hence, to facilitate examining them for impressions of plants.

[3] Chemicals and sonication (provided certain conditions obtain) are used to clean the pottery if the sediments cannot be washed with water (as will be discussed later).

2. Inspection of plant-impressions in pottery

Preliminary inspection of plant-impressions in pottery is mostly carried out in the field in order to achieve a thorough coverage of all the pottery excavated, to reduce the cost of its transportation, and to save the space it would take in the car and the laboratory, especially if the collection of pottery recovered is large and bulky and has to be transported over long distances. The preliminary field inspection consists mainly of the gross sorting of the pottery recovered with the objective of selecting all the potsherds/vessels which have cavities or depressions which are characterized by regular shapes, e.g. rounded, elongated, or oval (Magid 1989), or exhibit distinct impressions of plants, e.g. leaves of grass species (ibid.). It is reported that impressions of plants have been found in the sections of accidentally and freshly broken potsherds (Magid 1982). This indicates that impressions of plants may also be found embedded within the walls of the pottery. However, looking for such impressions as are embedded within the walls of the pottery can only be done "at the cost of breaking pots and potsherds to examine their sections" (ibid.). This kind of inspection is very rarely done because "archaeologists tend to allow only non-destructive examination of their finds" (Stemler & Falk 1981).

The gross sorting can be done with the naked eye and/or using a magnifying glass (x10). If a field-laboratory is available, conventional light microscopic examination can be performed to cross-check the potsherds which are thought to bear impressions of plants (ibid.). It is often the case that this cross-checking leads to dropping some of the visually selected sherds and, hence, to saving some of the storage-containers/space and to minimizing the time and expense of the laboratory procedure.

The labeling of the sherds with plant-impressions and the documentation of the contexts in which they are found are often indispensable for reconstructing and interpreting the socio-economic contexts of the plants and their utilization. Proper labeling of potsherds/vessels is also appreciated and requested by palaeoethnobotanists because they are often engaged in studies of plant-impressions in pottery excavated from different archaeological sites. So every potsherd or vessel which bears impressions of plants should be given a proper label[4] consisting of the name of the site, the trench, and the level/layer in which it was found and then be carefully packed and stored. It is also important to write a brief description (and perhaps take photographs) of the contexts in which the specimens are found. Obviously, this type of documentation requires that the person who is performing the inspection of plant impressions continuously follows and observes or directly participates in the excavation. Alternatively, there may be a close cooperation between that person and the excavator(s) so as to secure the information and documentation needed.

A daily record of the total weight of potsherds examined for plant-imprints, the types of pottery examined, and their approximate age should be kept. Counting the total number of potsherds is by and large an erroneous procedure because, regardless of the criteria used to define the size, potsherds have different sizes (e.g. small, medium, large); and some of the large sherds may break during the excavations or while being examined. One cannot, however, omit to record the number of complete vessels examined in addition to recording their weights and measuring their sizes.

It is essential, perhaps unavoidable, to carry out the field procedure if the following interrelated conditions obtain:

1. The archaeological site being excavated is rich in pottery, e.g. if a few tens or hundreds of kilograms of potsherds are recovered daily. In this case, doing the gross sorting of the pottery collection in the field would certainly eliminate a waste of resources (e.g. packing materials, transport, storage, etc.).

2. There is an archaeologist trained/experienced in the examination of plant-impressions in potsherds or a student or specialist in palaeoethnobotany present during the excavation process. In this case the potsherds excavated would be examined and fully documented on a daily basis and expense and waste of time and resources would be minimized.

[4] At this stage the labelling is done on plastic/cloth bags. Only after the sherd has been treated in the laboratory (as will be described later) is it labelled on the surface on the other side of the one which bears the impression.

The laboratory procedure

The laboratory procedure can be divided into two main interrelated procedures. These are the preparation of the impressions/cavities and the molding of the positive casts of the impressions.

First. The preparation of the impressions/cavities

The preparation of the impressions/cavities consists of the following steps:

1. Final examination of all the sherds for plant-impressions.

All the sherds which are thought to bear plant-impressions should be examined under a lighted magnifying glass and a reflected light stereo-microscope (max. x40). Some of the benefits gained by carrying out this step are:

a) This final inspection often leads to eliminating a few sherds selected during the stage of gross sorting, hence avoiding waste of chemicals (especially in parts of the world where it is not easy to obtain them).

b) The examination of impressions/cavities using powerful microscopes (e.g. x40) often reveals that some of them need further treatment (e.g. cleaning or widening) before proceeding to make positive casts of them.

2. Preparation of the original impressions/cavities before making the positive casts.

The primary reason for this step is to clean and prepare the impressions properly prior to making the casts. It consists of the following procedure:

a) Careful cleaning of potsherds with distilled water using soft cleaning brushes. If some of the sherds are fragile and there is a risk that they might disintegrate, it has been suggested that these sherds should be stabilized by coating their surfaces with lacquer (Stemler & Falk 1981). Then the sherds are left (preferably on a bed of tissue-papers) to dry out in the presence of any source of high temperature (i.e. more than 20–25°C).

b) Dilute acetic acid (ibid.; Stemler 1990) or 5–10% hydrochloric acid can be used to clean impressions filled with sediments which cannot be removed with water (e.g. calcium carbonates). Careful probing with the tip of a dissecting needle may be done to remove the sediment particles and fine sand/quartz grains that firmly adhere (a jet of water from a syringe often effects the same results).

c) The sherds are then rinsed in an ultra-sonic-bath[5] (with distilled water) for about 5 minutes and then removed from the bath and left (on a bed of tissue papers)[6] to dry out in the presence of any direct source of heat.

d) When all the sherds are thoroughly dry, each sherd should be labeled on the surface on the other side of the one which bears plant-impressions. The labels should be carefully copied from those made in the field during the search for sherds with plant-impressions (see page 123 and footnote 4). A small patch on the surface of the sherd may be smeared with a thin coat of finger-nail polish. When it dries, the label can be written on this patch with India ink. This will ensure that the writing remains fixed for a long time.

e) When all procedures described in the foregoing are completed, a jet of air generated from an air-pump is blown into all the impressions to ensure that they are clean before making the positive casts.

3. Additional preparation procedures

The present writers have frequently examined potsherds with impressions/cavities which needed additional preparation. The two most common cases we encountered and their treatments can be described as follows:

a) Incomplete cavities/impressions

Incomplete cavities/impressions appear on the surface of the potsherds in a form of cracks, small or narrow openings or incomplete edges/openings (Fig. 1, no. 1-A). In all these cases, the basic procedure followed is to determine whether the edges of the cavity are actually the borders of the original specimen before it was lost (e.g. as a result of burning or falling off). This may be revealed by cautiously and gently tapping and trimming the edges of the crack, cavity, or opening using dissecting needles and a sharp knife blade with a pointed end. If the original border of the cavity is large, the gentle tapping and trimming will result in the collapse of thin flakes and small particles of sediments which mask the original cavity-rim (i.e. the primary border between the original plant/specimen and the clay surrounding it). A steady hand, an ability to concentrate for long periods, and a touch of artistic talent contribute to the perfection of the end result, though success in performing this task is largely attributable to training and experience. Failure in performing this task will result in producing incomplete or damaged positive casts. When this "surgical" operation is completed, the procedure for preparing the impressions/cavities described above (cf. no. 1 and 2) is followed in this case as well.

b) Impressions/cavities at the edge of the potsherd

Impressions/cavities of plants are often found either close to or partly on the edge of the surface of the potsherd, and this makes it difficult to make complete positive casts or to recover them from these impressions. In order to overcome this problem and obtain complete positive casts, an artificial extension surface made of unfired modeling clay is glued to the potsherd along the edge where the plant-impression is found (Fig. 1, no. 1-B). Care should be taken to assure that the extension be broad enough and so nearly level with the surface of the sherd as to avoid tilting and spillage of the casting mix. Any brand of ceramic-adhesive can be used to glue the extension-clay to the potsherd. It should also be observed that all the preparation procedures mentioned in the foregoing (except labeling) should be followed for the potsherd before the extension-clay is glued to it. However, the labels (cf. step 2-d) can be made after the procedure with the extension-clay is completed.

Second. The molding of positive casts

Stemler and Falk (1981) have rightly stated that direct examination of the plant-impressions does not generally provide satisfactory results because the image obtained in this manner "is reversed from what one expects and is difficult to interpret". Thus, impressions of plants are prepared so as to help producing positive casts and hence to provide a correct image which eases the interpretation.

Specialists in the study of plant impressions in pottery use different types of molding compounds to make the positive casts; all are generally flexible, elastic and extractive: for instance, Renfrew (1973) prefers to use the Revultex VRB 949 solution, while Stemler and Falk (1981) stated that they use a molding

---

5 Treatments (2-b and 2-c) with dilute acetic and hydrochloric acids and ultrasonic water-bath should be applied to well-fired sherds only. There is a high risk of damage to the impressions or of disintegration of sherds if badly-fired pottery is subjected to these treatments.

6 Until the following step (2-e) is completed, sherds with different bag-labels should be separated from each other.

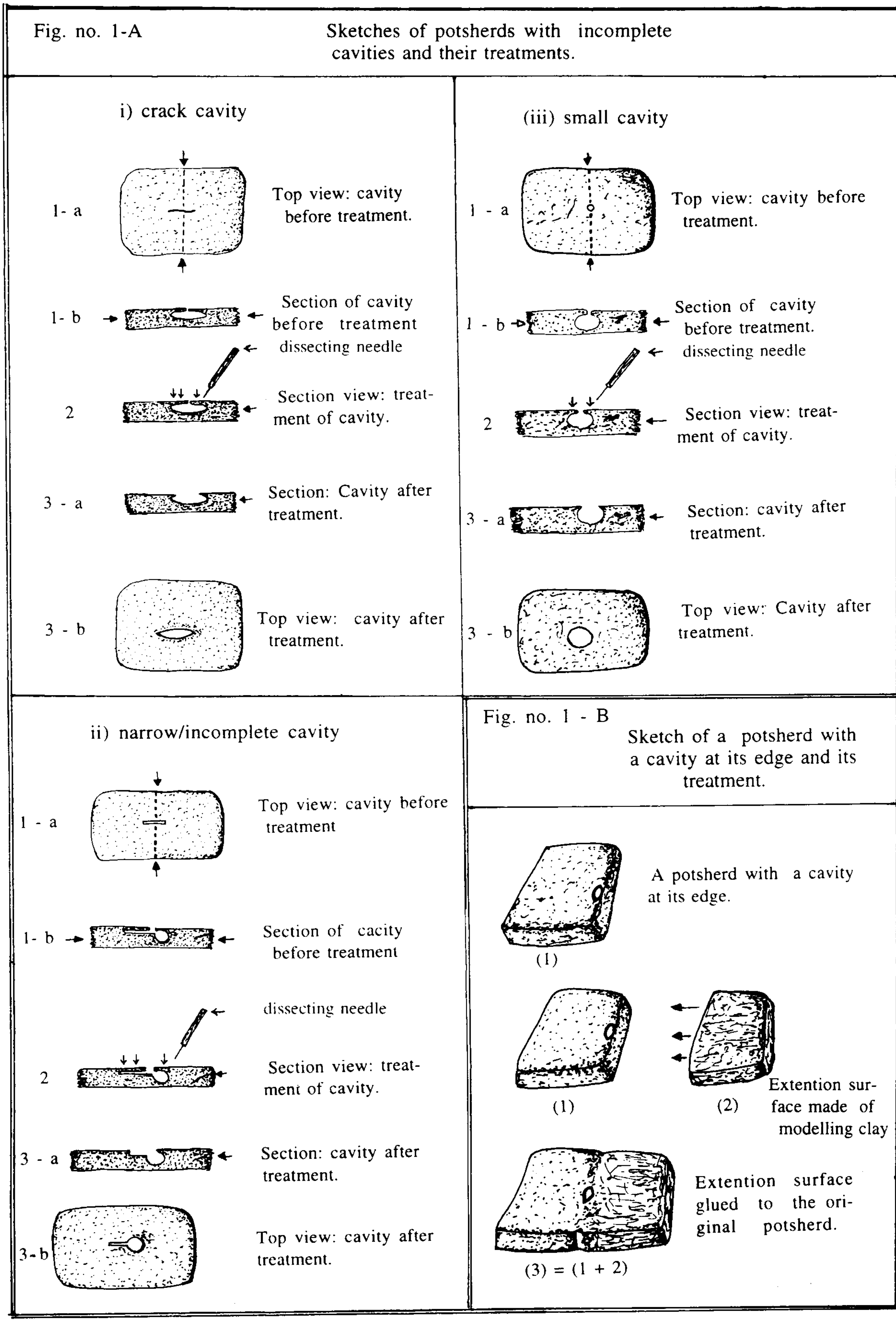



**Fig. 1.** Examples for additional preparation procedure

compound called Mold it. The present writers experimented with different molding compounds and found that the RTV-M400 silicone rubber with its elastic filling compounds is most appropriate to use for molding positive casts of impressions because it is characterized by the following properties. It is:

1. easy to process,
2. has excellent release properties,
3. offers the greatest accuracy of reproduction,
4. has good resistance to high temperatures,
5. has negligible shrinkage, and
6. vulcanizes at room temperature.

The hardener we use with the RTV-M400 is 3% T-37 or 3% T-40 which are mixtures of organic components, tin, and silica ester (Magid 1982). Iron oxide powder or India ink is also mixed with the molding compound (as we shall explain below).

The procedure we follow to make the positive casts consists of the following steps:

1. With a small paint-brush each impression and the area immediately around it on the surface of the potsherd is made slippery by applying a mixture of Vaseline (9 grams), paraffin (1 gram), and toluene (100 ml.) in order to facilitate the extraction of the positive casts without ruining them or the cavity (Magid 1982).

2. The casting material (in this case RTV-M400) is thoroughly mixed with an appropriate amount of iron oxide (FeO) or India ink.[7] Both provide a dark-grey, light-absorbent surface (similar to that of the carbonized remains) which facilitates photography and the identification of the positive casts. On the one hand, India ink gives better results as regards the thinning of the casting material and thorough penetration into particularly small cavities; on the other hand, iron oxide gives better conductivity if the cast is examined with a Scanning Electron Microscope (abbreviated SEM).

3. A hardener (3% T-37 or 3% T-40)[8] is then added quickly but thoroughly mixed with the casting material (in this case RTV-M400). The amount of the hardening catalyst added should be approximately one third of that of the casting material. Hardening catalysts are always used with silicon-casting materials such as RTV-M400, but are not needed if the casting material used is, e.g., "Mold it". In order to avoid producing broken casts, the casting mix should be properly mixed so that all air bubbles that might be trapped in it are expelled. A watch-glass, a small spatula, and a dissecting needle are the basic tools used in preparing the casting mix.

4. The casting mix is steadily and properly poured into the cavity until it is filled up and some of the casting mix spills onto the area immediately around the cavity on the surface of the potsherd. When it is dry, the casting mix which spilled onto the surface around the cavity serves as a tab (base) which facilitates extracting the positive cast. A small spatula is used to take the casting mix from the watch-glass and to hold it one to two inches above the cavity at an angle that allows a steady string-flow of the casting mix pour into the cavity. If the cavity is deep or has a narrow opening, the casting mix can be injected into it by means of a syringe. Steps 3 and 4 may be viewed as the climax of the method of making positive casts; so they should be properly prepared and followed.

5. The specimen (i.e. the sherd and the casting mix) is put into an air-evacuating apparatus for 1 to 2 minutes. As stated earlier, air bubbles may be trapped in the casting mix. When the casting mix dries, these air bubbles break and produce broken casts (Fig. 2A, B). Thus, the step of air evacuation is carried out in order to eliminate the possibilities of having air bubbles in the casting mix and hence to avoid producing broken positive casts.

6. The specimens are left to dry, and subsequently the positive casts are carefully extracted from their cavities in the potsherds using a pair of forceps (Magid 1989), a dissecting needle, and a razor blade.

7. The identification of the casts, the next step, is beyond the scope of this paper. However, in this connection it is relevant to men-

[7] If the casting material used is in a powdered state, e.g. as Mold it is, then it is recommended to use India ink because it serves to liquefy the casting-powder and colouring-catalyst. Iron oxide (FeO) serves as colouring-catalyst only.

[8] 3%T-37 is a slow-hardening catalyst which helps consolidate the casting material in 3-4 hours. 3% T-40 is a fast-hardening catalyst which helps consolidate the casting material in less than an hour but requires that the casting mix be prepared and poured quickly. Both, however, if left for longer periods of drying than required or excessively used would increase the risks of broken casts (Magid 1989).

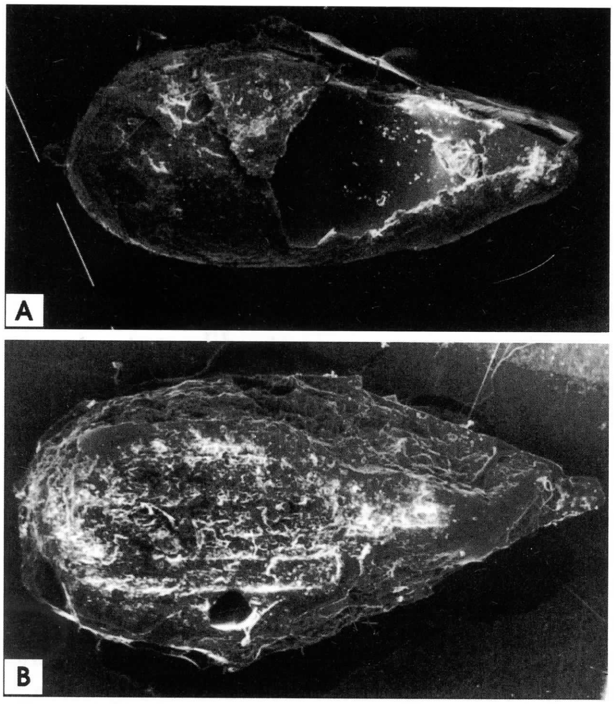


**Fig. 2.** Examples for damaged/broken positive casts. A – damaged positive cast due to improper filling of casting mix in the cavity, B – a positive cast with broken air bubble due to improper mixing of casting mix

tion the following technical procedure and general points:

a) Basically the identification is made by comparing the external morphological features (e.g. surface patterns, shape, size, etc.) of the latex casts with those of specimens in a reference collection of extant plants.

b) The cast-specimens may be examined directly under a reflected light stereo-microscope (e.g. x40); but it is highly recommended to use a Scanning Electron Microscope (SEM) because it has an immense depth of focus, high resolution, powerful magnification, and ease of handling and at the same time permits photographing the specimens (Magid 1982). However, examination by SEM requires mounting the specimens on stubs[9] and coating them (cf. appendix 1).

c) A large collection of extant plants (Magid 1989, Renfrew 1973, Stemler & Falk 1981) at different stages of growth and maturity should be available for comparison when identifying the latex casts. In order to account for possible distortions and changes in the size and shape of the casts examined, both carbonized specimens and casts of impressions of extant plants should be prepared (cf. appendix 2) and made available for comparative study.

d) It is also essential to cross-check the identification results obtained (through direct or indirect contacts) with colleagues and specialists who are doing similar research. So it is strongly recommended to provide/publish photographs both of the replicas of the ancient specimens and of their modern counterparts. Taking into consideration the current rapid development of information technology, the present writers advocate that researchers in the field of palaeoethnobotany/archaeoethnobotany should start to share images of their reference material by making it available on Internet in Worldwide Web (WWW) format.

[9] Mounting specimens on a stub is generally done with silver print paint (Stemler Falk 1981); but we found that an ordinary transparent glue of the type used for gluing paper, leather, ceramics, and the like is equally efficient for mounting the specimens on the stubs.

## REFERENCES


AYYAD S. K., KRZYWINSKI K. & PIERCE R. H. 1991. Mudbrick as a bearer of agricultural information: archaeopalynological study. Norw. Archaeol. Rev., 24 (2): 77–96.

CARRUTHERS W. J. 1991. Mineralized plant remains: some examples from sites in southern England. In: Hajnalova E. (ed.) Palaeoethnobotany and archaeology, IWGP $8^{th}$ Symposium, Nitra-Nové Vozokany 1989. Archaeol. Inst. Slov. Acad., Acta Interdisc. Archaeol. 7: 75-80.

CREE J. E. 1908. Notice of a kitchenmidden and superimposed mediaeval stone floor found at Tusculum, North Berwick. Proc. Soc. Anitquaries Scotl., 10.

FÆGRI K. & IVERSEN J. 1975. Textbook of pollen analysis. Munksgaard, Copenhagen.

GREEN F. J. 1979. Phosphate mineralization of seeds from archaeological sites. J. Archaeol. Sci., 6: 279–284.

HAALAND R. 1978. Ethnographical observation of pottery making in Darfur, West Sudan, with some reflections on archaeological interpretation. Stud. Scandin. Prehist., 1: 47-61.

HELBÆK H. 1954. Prehistoric food plants and weeds in Denmark. A survey of archaeological research 1923–54. Danm. Geol. Unders., 2 R., 80: 250–261.

— 1955. The botany of the Vallhagar Iron Age field. In: Stenberger M. (ed.) Vallhagar, a Migration Period site on Gotland, Sweden. Part 2. Munksgaard, Copenhagen: 653–700.

— 1960. Cereals and weed grasses in Phase A. In: Braidwood R. J. & Braidwood L. J. (eds) Excavations in the Plain of Antioch I. Univ. Chicago Press, Chicago.

MAGID A. 1982. The Khartoum Neolithic in the light of archaeoethnobotany. A case study from the sites of the Nofalab and the Islang sites. Unpublished M. A., University of Khartoum.

— 1989. Plant domestication in the Middle Nile Basin. BAR Intern. Series 523. Oxford.

— & KRZYWINSKI K. 1988. Extraction of pollen from pottery: technique and objectives. Arkeolog. Skrift., 4: 195–204.

MORTIMER J. R. 1905. Forty years researches in British and Saxon burial mounds of East Yorkshire. Brown & Sons, Ltd., London.

POPPER V. S. & HASTORF C. A. 1988. Introduction. In: Hastorf C. A. & Popper V. S. (eds) Current Palaeoethnobotany. Univ. Chicago Press, Chicago: 1–16.

RENFREW J. M. 1973. Palaeoethnobotany. The Prehistoric food plants of the Near East and Europe. Methuen & Co. Ltd., London.

ROBINSON M. & STRAKER V. 1991. Silica skeleton and macroscopic plant remains from ash. In: Renfrew J. M. (ed.) New light on early farming. Recent developments in palaeoethnobotany. Edinburgh Univ. Press, Edinburgh: 3–14.

SCHERY R. W. 1954. Plants for man. Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

STEMLER A. B. L. 1990. A scanning electron microscopic analysis of plant impressions in pottery from the sites of Kadero, El Zakiab, Um Direiwa and El Kadada. Archéologie du Nil Moyen, 4: 87–105.

— & FALK R. H. 1981. SEM of archaeological plant specimens. Scanning Electron Microscopy, 3: 191–196.

## APPENDIX 1

### COATING SPECIMENS FOR SEM EXAMINATION

### How to coat samples that do not resist a surface temperature higher than 40–45°C

1. Connect the black power lead for the thermocouple module to the rear of the panel. The stage temperature will stay at about 5° C during coating. The surface temperature of the samples may reach 40–45° C.

2. Place your sample in the coating chamber (max. 6 stubs). Close the chamber properly.

3. Open the outlet valve of the Argon-bottle. Do not touch the regulation-vavle or the main valve.

4. Turn "Operation" switch on front panel to "Pump" position and wait until the vacuum gauge indicates about 0.1 torr.

5a. Open leak valve for about 30 sec. and flush system with Argon. Close leak valve and allow system to pump down to 0.02 torr if possible.

5b. If it is hard to reach 0.02 torr you can adjust the leak valve so that the pressure rises to between 0.1–0.2 torr. Leave it like this for some minutes, then close the valve and try to reach 0.02 torr or better.

6. You should flush the system as described in no. 5a at least two times and end up with a vacuum better than 0.02 torr.

7. Set the timer to an adequate value. 2.5–3 min. for Gold/Palladium target or 3–4 min. for Gold target is normally sufficient and the same time is used for our specimens which were mounted on the stubs with transparent glue and no further treatment before coating.

8. Turn "Operation" switch to "Set HT" position and turn voltage control knob to 2.5 kV. The mA-meter will now indicate 5–10 mA or less.

9. NB! This operation is very critical – be careful! Gradually open the leak valve until the mA-meter reads 19–21 mA. When the needle starts moving, turn the knob very little and wait and see. Do not exceed 25 mA.

10. When the needle of the mA has reached about 20 mA (do fine adjustment on the leak valve afterwards) press timer button and switch to "Timer" position.

11. When the specimens are coated, turn down the voltage control knob then close the Argon leak valve properly, but do not overtighten, and finally switch off the "Operation" switch.

12. Ventilate the system by pulling the knob on top of the chamber. Take out your samples. When all is finished, close the Argon outlet valve of the Argon-bottle.

### How to coat samples that can resist a surface temperature of 70–75°C

1. Disconnect the black power lead for the thermocouple module from the rear of the panel. The stage temperature will stay at about 25° C during coating, but the surface temperature may reach 70–75° C.

2. Place your sample in the coating chamber (max. 6 stubs). Close the chamber properly.

3. Open the outlet valve of the Argon-bottle. Do not touch the regulation-vavle or the main valve.

4. Turn "Operation" switch on front panel to "Pump" position and wait until the vacuum gauge indicates about 0.1 torr.

5a. Open leak valve for about 30 sec. and flush system with Argon. Close leak valve and allow system to pump down to 0.02 torr if possible.

5b. If it is hard to reach 0.02 torr you can adjust the leak valve so that the pressure rises to between 0.1–0.2 torr. Leave it like this for some minutes, then close the valve and try to reach 0.02 torr or better.

6. You should flush the system as described in no. 5a at least two times and end up with a vacuum better than 0.02 torr.

7. Set the timer to an adequate value. 2.5–3 min. for Gold/Palladium target or 3–4 min. for Gold target is normally sufficient and the same time is used for our specimens which were mounted on the stubs with transparent glue and no further treatment before coating.

8. Turn "Operation" switch to "Set HT" position and turn voltage control knob to 2.5 kV. The mA-meter will now indicate 5–10 mA or less.

9. NB! This operation is very critical – be careful! Gradually open the leak valve until the mA-meter reads 19–21 mA. When the needle starts moving, turn the knob very little and wait and see. Do not exceed 25 mA.

10. When the needle of the mA has reached about 20 mA (do fine adjustment on the leak valve afterwards) press timer button and switch to "Timer" position.

11. When the specimens are coated, turn down the voltage control knob then close the Argon leak valve properly, but do not overtighten, and finally switch off the "Operation" switch.

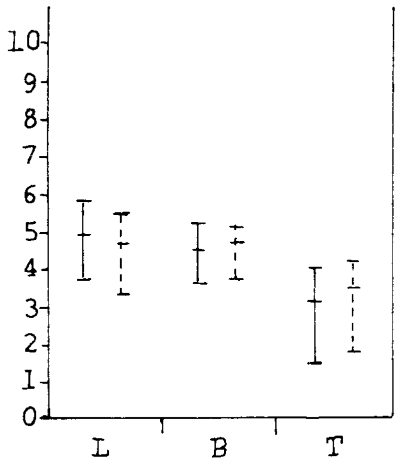
12. Ventilate the system by pulling the knob on top of the chamber. Take out your samples. When all is finished, close the Argon outlet valve of the Argon-bottle.

# APPENDIX 2

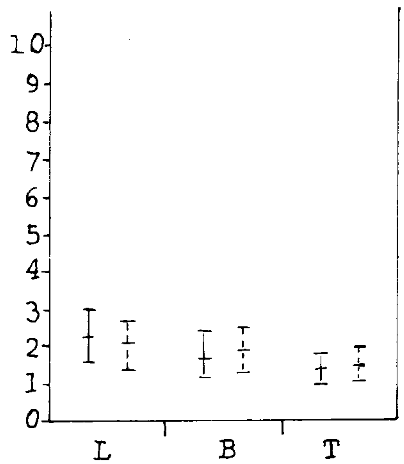
## RESULTS OF EXPERIMENTS ON CARBONIZATION AND CASTS OF IMPRESSIONS OF EXTANT PLANTS (MAINLY SEEDS/GRAINS)

Plots showing changes in dimensions of grains (of seven species) due carbonization.

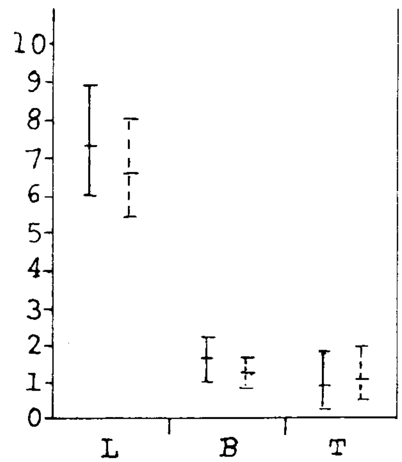
1. Sorghum vulgare L.



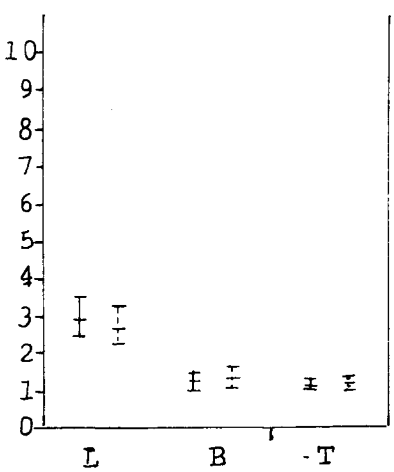

2. Pennisetum americanum (L.) K. Schum.



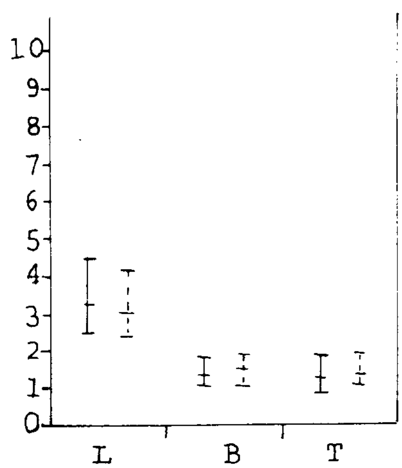

3. Sorghum arundinaceum (Desv.) Stapf.



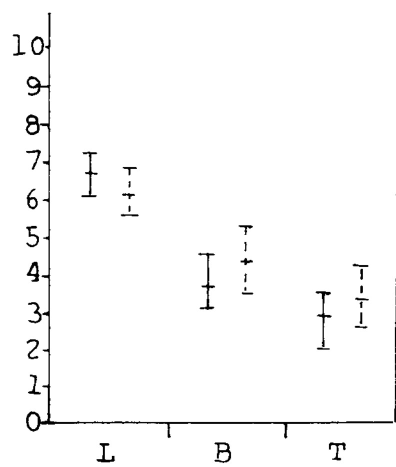

4. Setaria verticillata (L.) Beauv.



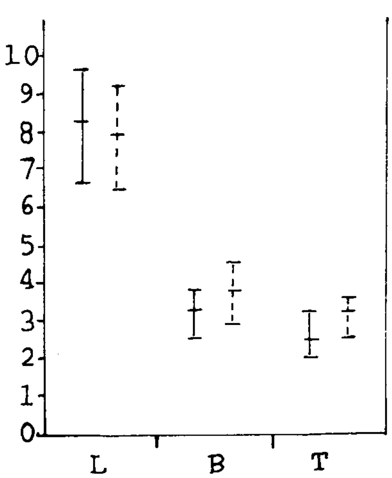

5. Echinochloa pyramidalis (L.) Hitchc. et Chase



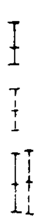

6. Triticum aestivum L.




7. Hordeum vulgare L.




Key:
L – length, B – breadth, T – thickness



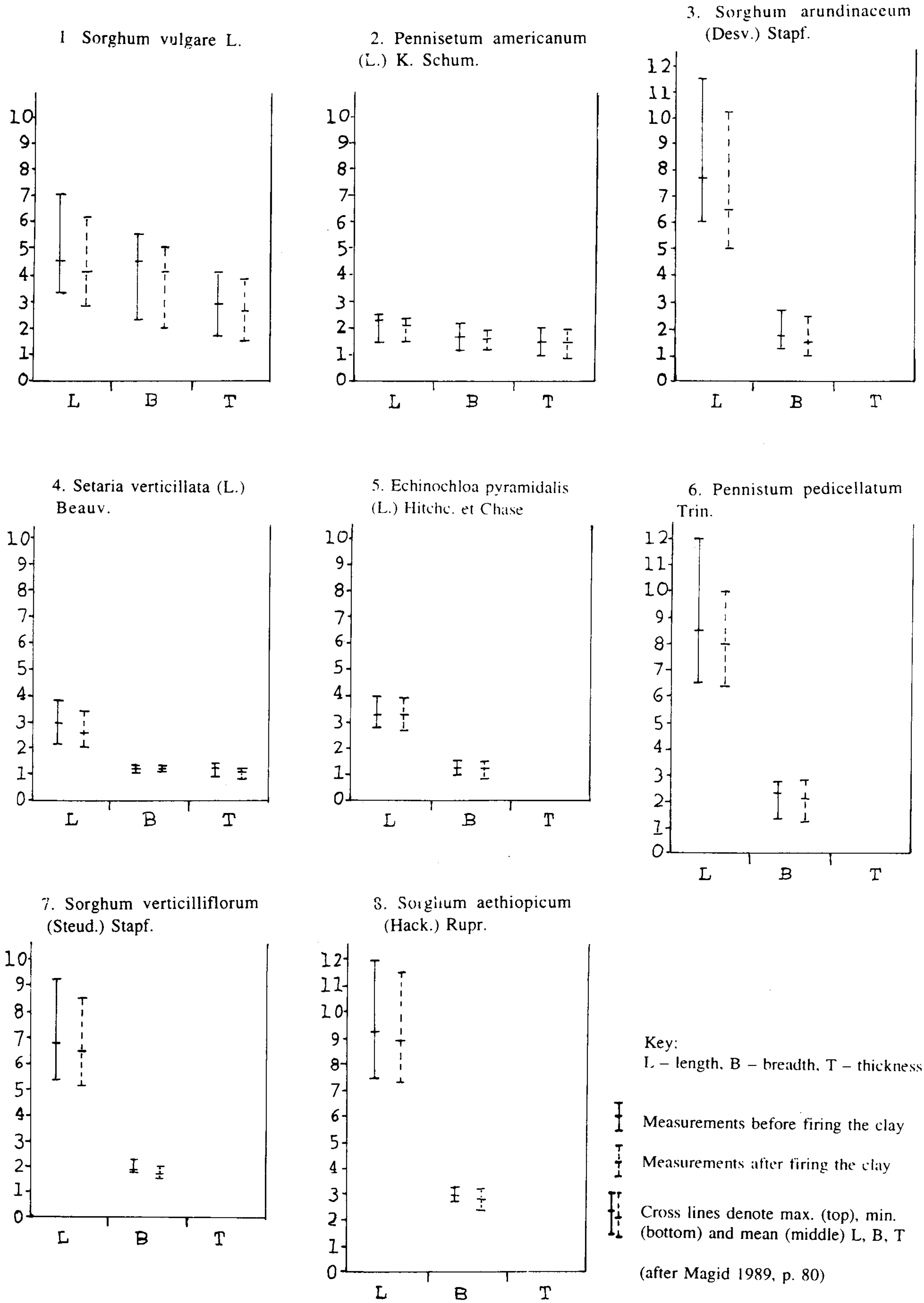
Measurements before carbonization

Measurements after carbonization

Cross lines denote max. (top), min. (bottom) and mean (middle) L, B, T

(after Magid 1989, p. 77)

Plots showing changes in dimensions of grain- impressions of eight species as seen from their positive casts.




(after Magid 1989, p. 80)