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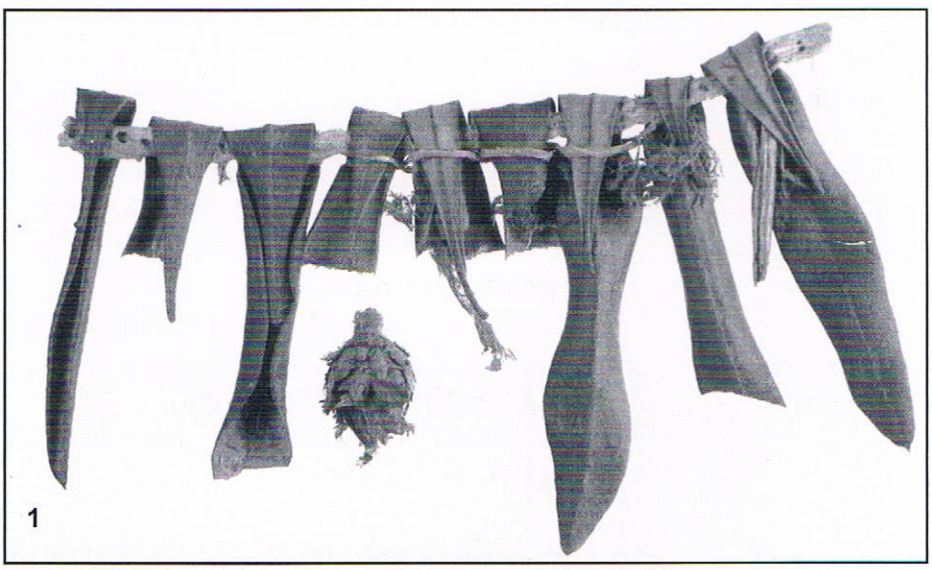
An Introduction to Plants in Archaeology

While archaeologists discover and study stones and pots, coins and swords - in fact anything that has survived the depredation of time and weather - the identification of plant material is a different matter, quite literally since it decays more easily. Although human and animal bones preserve well and have always been examined by physicians and zoologists, only comparatively recently have archaeologists come to appreciate the intense value of frail botanical specimens. This is probably due to more sophisticated techniques being available, such as scanning electron microscopes, and the floatation and sifting of excavated material. But perhaps it is also to do with ecological awareness of the sites in general - site evaluations are now normal before archaeological study begins. Probably the first systematic work on the subject was that by Professor Dimbleby (Dimbleby 1967) of the Institute of Archaeology of London. For many years now this Institute has been at the forefront of these studies, notably with Gordon Hillman and Prof. David Harris training a succession of archaeo-biological scholars. For many decades identification of excavated material has been carried out at the Jodrell Laboratory of the Royal Botanic Gardens at Kew by staff such as L.A. Boodle, Dr C.R. Metcalfe (who collaborated with Dr L. Chalk at Oxford) and F. Richardson, and more recently Dr D.F. Cutler, Rowena Gale and Dr P. Gasson. Practical handbooks on the subject are very welcome (Cutler 1978; Gale & Cutler 2002). Kew now has a part-time archaeobotanist, Dr Mark Nesbitt, as is the plant anatomist Dr Caroline Cartwright, at the British Museum's Laboratory.

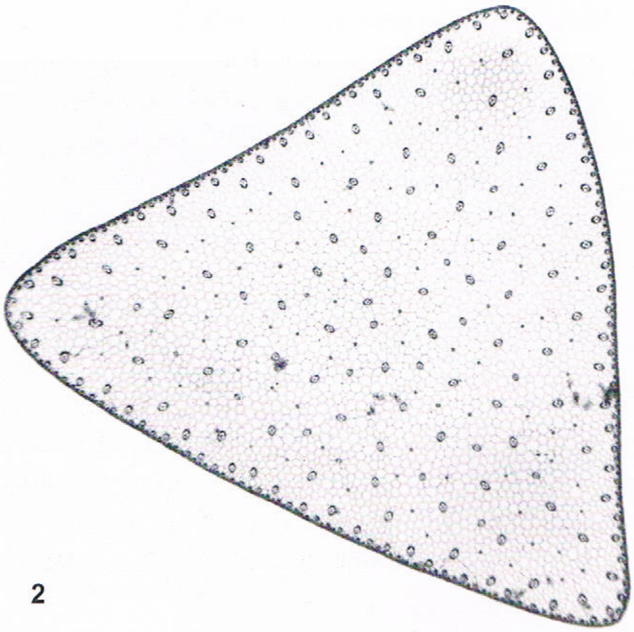
In former days when an archaeologist found an old pot he was more interested in the container itself than the seeds or resin it held, yet it was for the sake of its contents that the pot was placed in the tomb by its contemporaries. In Egypt Georg Schweinfurth (1836-1925) assembled material in the fascinating Agricultural Museum, with duplicates in Berlin-Dahlem; a study continued by the Swede Dr Vivi Tackholm and her Egyptian students (Tackholm & Drar 1941-54; Tackholm 1976). One of the pioneering botanical reports alongside the archaeological discoveries was that of P.E. Newberry and L.A Boodle on Tutankhamun's tomb (Carter & Mace 1927; see also Hepper 1990).

Let us now look at some of the principles behind the study of plants in archaeology. When plant material is well preserved it is often possible to recognise it visually or with the help of a hand lens (Fig.1).



1 Garland of olive *(Olea europaea)* leaves folded over a papyrus (Cyperus papyrus) pith core and a cornflower *(Centaurea depressa)* head, from Tutankhamun's tomb. Courtesy of Royal Botanic Gardens, Kew.

More frequently semi-decayed specimens have to be examined microscopically in order to distinguish any characteristic cellular structure (Fig. 2).



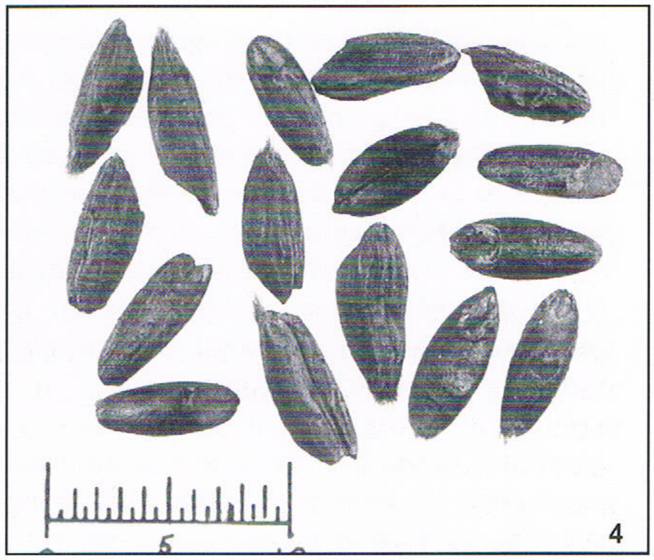
2 Transverse section of papyrus *(Cyperus papyrus)* showing triangular form and vascular bundles amid a lattice of thin-walled cells and air cavities. Courtesy Royal Botanic Gardens, Kew.

Pollen grains & phytoliths

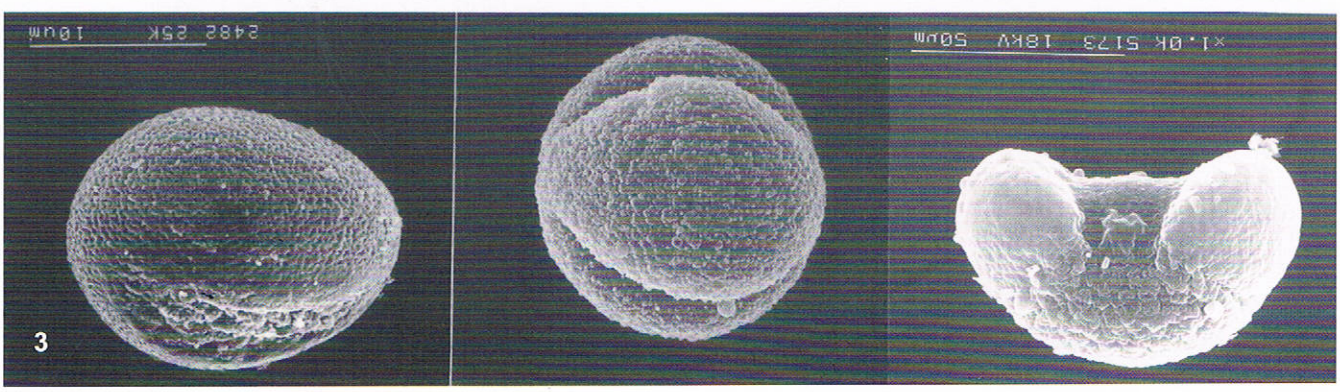
However, many archaeological sites are wet or at least damp, so delicate plant tissues rapidly decompose. Exceptions to this are pollen grains and phytoliths - the latter being silica particles especially characteristic of grasses and remaining in soil long after the plants have disappeared. Pollen coats are extremely resistant in waterlogged conditions, hence the importance of studying cores from peat-bogs and lake sediments. They are usually patterned, lobed or sculptured in some way which makes them distinctive for certain plant families, genera of even species (Fig. 3). This enables experienced botanists (palynologists) to identify them and to conclude whether the sample showed a woodland or grassland site; or whether the pollen was derived from wild or cultivated plants.

Seeds

Also quite resistant to decay are seeds, but that is not to say they will germinate. This is contrary to popular belief that 'mummy wheat' from the Egyptian tombs will grow (Fig. 4).



4 Well-preserved grains of emmer wheat (*Triticum dicoccon*) from a tomb at Saqqara; so-called 'mummy wheat'. Courtesy David Dixon.



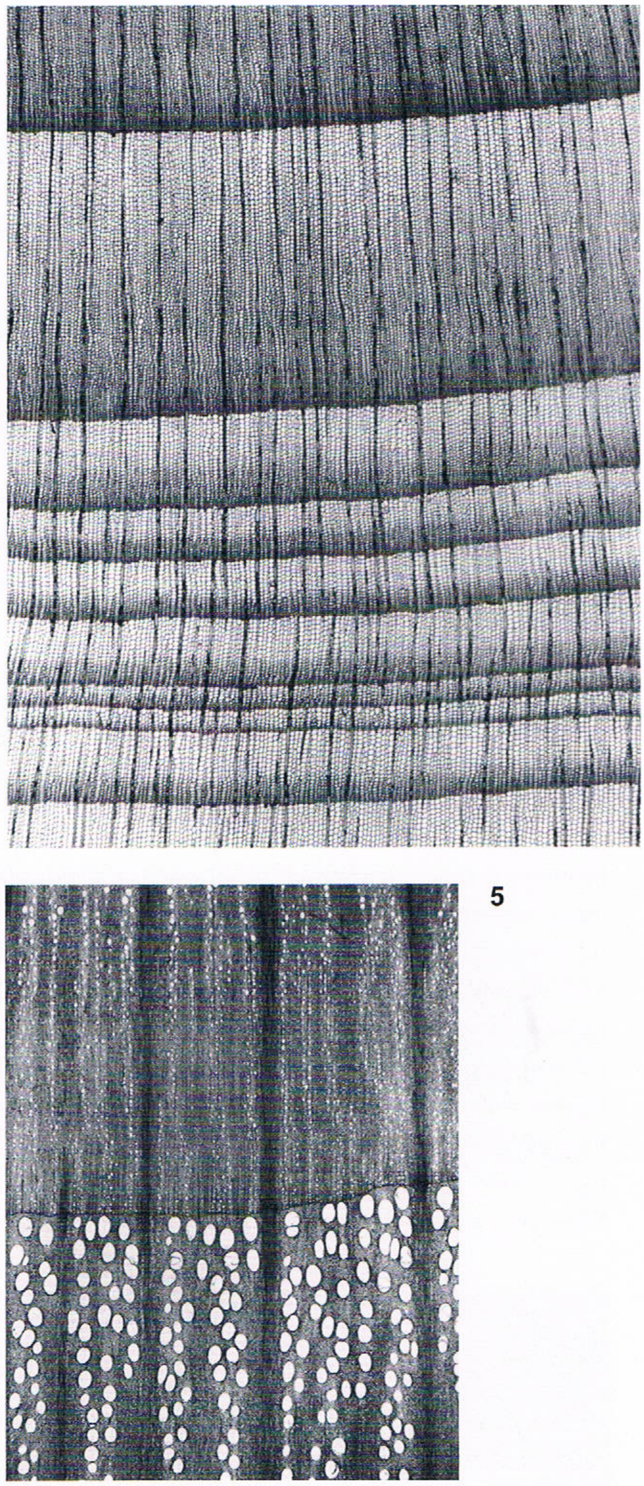
3 Pollen grains photographed highly magnified under scanning electron microscope; left-right: cedar *(Cedrus)*;oak *(Quercus)*; date palm *(Phoenix)*. Courtesy Palynology Unit, Kew.

In fact most of such seeds are carbonized while retaining features of their original appearance, thus allowing for identification. Although the dry atmosphere of many Egyptian tombs has preserved seeds in a remarkably complete state, the seeds' interior which originally contained the living 'germ' is dead. This embryo in the fresh seed is dormant but its life-processes continue at a very reduced rate. In the course of time, however, the living protoplasm ages in a way we still cannot fully explain and the time comes when life ceases altogether and it is incapable of reproducing itself. Examples of so-called 'mummy wheat' that have been reported to have germinated are, I fear, the result of modern grains being cunningly introduced into the tombs or simply switched with ancient ones after excavation (Barton 1961, p.1-6). Excavated seeds may also be carbonized yet retain their shape and characteristics. Carbonization takes place when the store is over-heated or slightly burnt.

Identified seeds, like the pollen grains already mentioned, can yield a great deal of information about the ecology of the site and its use by past inhabitants. The identification of cereal grains is a specialist occupation. Pioneering work was carried out by the famous Danish botanical archaeologist Professor Hans Helbaek at Nimrud. Working in Copenhagen he systematically identified wild and cultivated Near Eastern seeds setting a new standard for archaeological reports (Helbaek 1953,1958,1966). Botanists and archaeologists have worked closely together in order to unravel the intricacies of the origin of cultivated cereals and other crops and their cultivation (Zohary & Hopf 1994).

TIMBER AND FIBRES

Wooden objects and baulks of timber are best preserved in either very dry or very wet anaerobic conditions. Ancient Egyptian tombs are an example of the former and sunken wooden ships of the latter state (Gale, Gasson, Hepper & Killen 2000). In both cases identification of the tree species is usually only possible by anatomical examination. This will show up the cellular structure which is diagnostic for each species (Fig. 5).



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5 Photomicrograph of transverse sections of timber showing characteristic cellular structure and annual rings: cedar of Lebanon *(Cedrus libani)*; oak *(Quercus macrolepis)*. Courtesy Royal Botanic Gardens, Kew.

Charred wood, such as those from recent excavations in Sidon where beams of strawberry tree (*Arbutus andrachne*) were identified (Asouti & Griffiths 2003), also show up the cells especially if fractured rather than cut. Kew and the Institute of Archaeology have vast collections of microscope slides accumulated over many years. These are stained preparations usually from living specimens, which may be used for comparison with archaeological pieces. However, allowance needs to be made for shrinkage and distortion of ancient material. Restoration of the original appearance is sometimes possible after treatment with Parozone or chlor-zinc-iodine reagent.

When brittle ancient fibres and leaves (Fig. 6) from dry sites have to be identified, David Cutler advises immersing them in boiling water for 10 minutes to become pliable. In order to examine the characteristic cellular structure of the lower epidermis the softened material can be either peeled or scraped. Peeling the epidermis is easy in monoctyledons because the cells and venation are in lines; dicots are much more difficult owing to their reticulate venation. If scraping is necessary the epidermis should be placed lowermost on the glass slide and the upper cells scaped away. Hard material needs to be soaked in Jeffrey's solution (10% nitric acid, 10% chromic acid) to soften it for sectioning with a razor and examination under low magnification to determine the whole structure. In this way it is possible to distinguish at a glance a palm from a grass, and a grass from a sedge. Thereafter, it may be necessary to use high-power to resolve differences between cells in order to identify genera and species. The cells become clearer when immersed in parazone, then washed and treated with 70% glycerine. Staining techniques show up the various tissues in different colours. Thus cellulose is coloured green (or blue or yellow) by alcian stain; safranin stains lignin red, while phenol distinguishes unstainable silica. However, a stain, haematoxylin, commonly used on fresh material is of little use to show up cellulose on archaeological specimens.

The age of timber specimens can often be determined quite accurately by carbon dating or by dendrochronology. Carbon dating is achieved by assessing the time taken to break-down the isotopes in plant cell carbon in the cellulose. Dendrochronology is the study of the variable annual rings occurring in timber for centuries and comparing their thickness with already dated samples. Dr Peter Kuniholm has set up an Aegean and Near Eastern dendrochronology project at Cornell University.

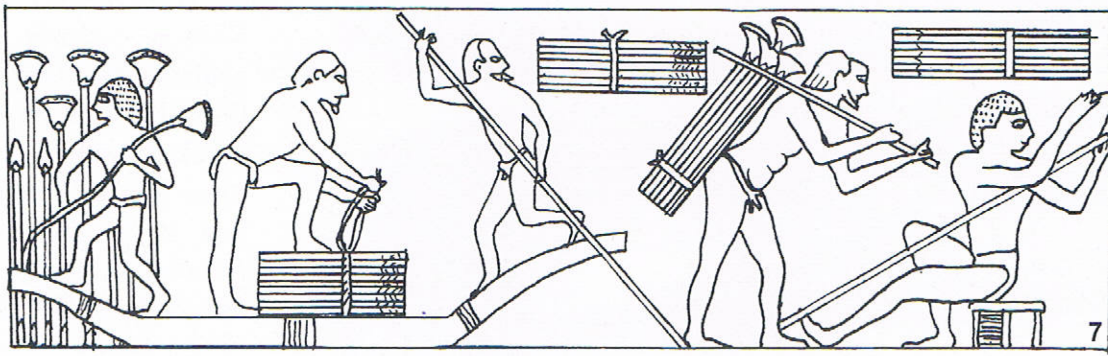
6 Ancient Egyptian sandals from a temple at Saqqara made of papyrus (*Cyperus papyrus*), doum (*Hyphaene thebaica*) and date palm (*Phoenix dactylifera*). Courtesy of Royal Botanic Gardens, Kew.

Papyrus

Lebanon is said to have had a special relationship with papyrus in as much that the Greek name for the papyrus pith *bublos* is reputed to be derived from the town of Byblos on the coast (see p. 54-58). If so, it must have been for importing papyrus from Egypt (and on to Greece), since the nearest papyrus swamps are at Huleh far to the south east. Natalie Lewis (1974), however, goes deeply into various authors' suggestions and she questions whether this was the correct derivation. There is no doubt that papyrus was manufactured in Egypt and for centuries exported writing sheets to the Mediterranean civilizations. It turns up in dry sites, such as the celebrated caves by the Dead Sea, but soon deteriorates when moist (Leach & Tait, 2000).

8 Papyrus writing material being made in the classical manner by the author in 1969.

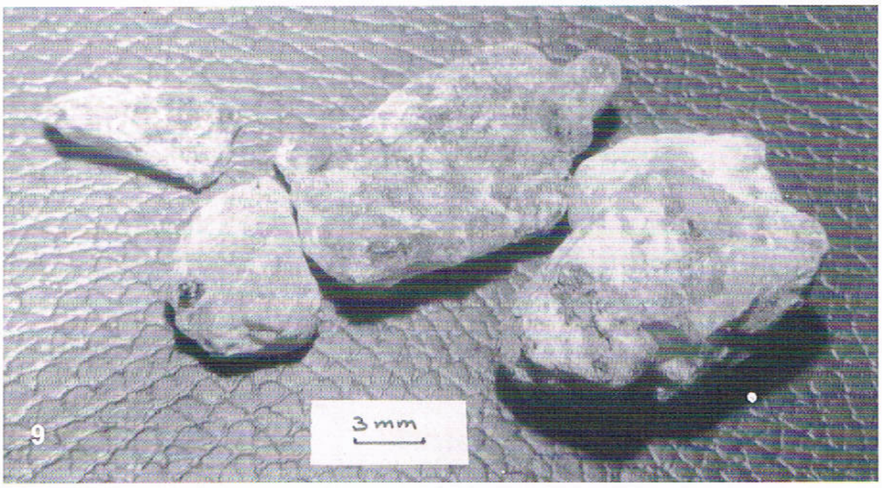
The papyrus sedge (*Cyperus papyrus*) grew in extensive swamps in the Nile Delta but has long since been exterminated there. Egyptian murals (Fig. 7) depict the gathering and preparation of the tall, green triangular stalks (Fig. 2). The hard rind was peeled off to be used for ropes and sandals, while the inner pith was cut longitudinally for writing material. The strips were laid side by side, with another layer glued at right angles (Fig. 8) (Hepper & Reynolds,1967; Hepper 1992). When dry the paper was written on with a rush pen using soot (carbon) ink.



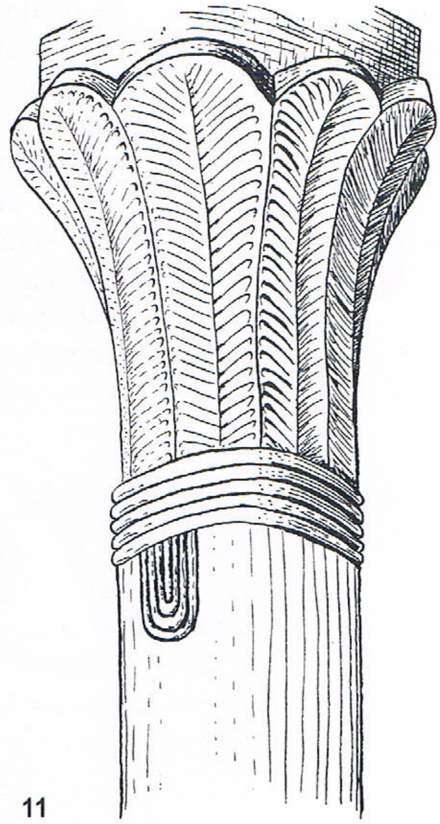
7 A mural in a tomb showing the gathering of papyrus in the Nile Delta; c.1400 BC. After pl.18 in N. de G. Davies, *The Tomb of Puyemré at Thebes*. New York, 1932.

Resins

In ancient times resins and natural oils were important and valuable plant products. They were usually obtained from incisions in the branches of certain trees and shrubs (for example frankincense, *Boswellia sacra*, Fig. 9) or by distilling the oils from the leaves or flowers of fragrant plants (such as safflower, *Carthamus tinctorius*). They were used for medicine, personal hygiene, mummification and religious purposes, fresh or burnt. Identification of the orign of resins and oils found in excavations involves sophisticated chemical analysis (Serpico & Wight 2000; Serpico 2000).



9 Lumps of white resin from trees of frankincense (*Boswellia sacra*) from southern Arabia. Photo. F. Nigel Hepper



11 A granite column with capital carved in the form of date palm (*Phoenix dactylifera*) leaves; funerary temple of Sahure at Abusir, c.2500 BC. After Lange & Hirmer, *Egypt*, pl. 48, Phaidon Press (1961).

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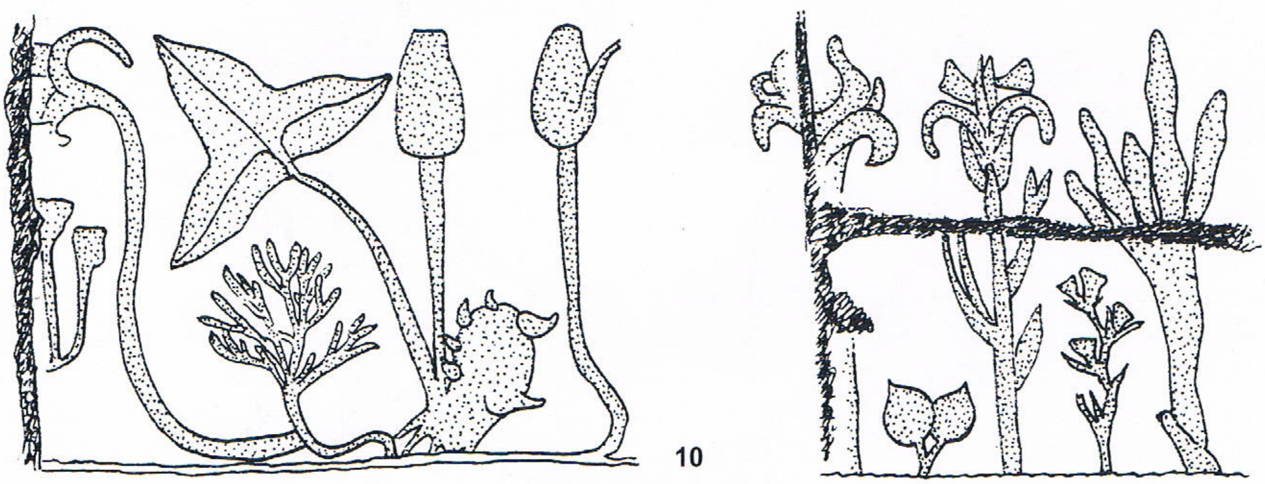
Plants in art and architecture

Although we are not dealing here with actual plant material, it is worth mentioning that a great deal of information about a civilization may be obtained from the study of botanical (and zoological) motifs used to ornament buildings, their contents and tombs. While some artists and sculptors used artistic licence to make unidentifiable symbolic botanical patterns, many others were observant and remarkably accurate. For example, the stonework on the Temple of Bel at Palmira shows splendidly carved bunches of grapes and leaves, and temple column capitals in Abusir are carved date palm leaves (Fig.10).

Especially interesting are the botanical reliefs on temple walls at Karnak built by Tuthmosis III to commemorate his military campaigns in Lebanon/Syria about 1529 BC (Beau 1990). In the so-called 'botanical garden' these reliefs display some of the foreign flora and fauna seen there, such as *Arum* and *Iris* (Fig.11). On a much



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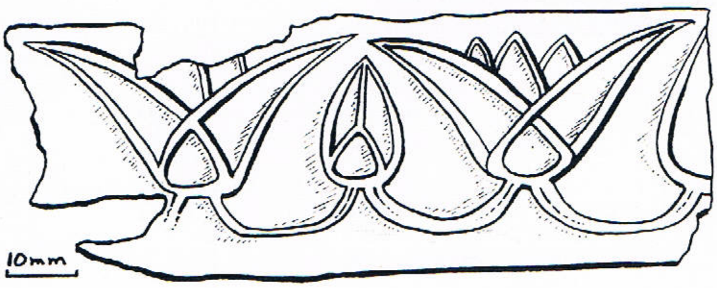
10 Reliefs on walls at Karnak of flora, *Arum* (left), *Iris* and other plants, encountered during Tuthmosis III's military campaigns in Lebanon/Syria.

smaller scale, ivory carvings from Samaria depict lotus water-lilies *(Nymphaea lotus)* (Fig. 12). Beautiful personal ornaments in faience, precious stones and gold and silver were moulded or carved and coloured in the shape of leaves and flowers, such as those from Ur of the Chaldees (Fig. 13).

This overview cannot do justice to the wealth of study now taking place on botanical aspects of archaeology using the latest technology available, but I hope it provides the reader with an insight into past and present research methods on the subject. Every year sees the publication of numerous reports and specialist papers in journals, as well as comprehensive works such as J.R. Lucas's classic *Ancient Egyptian Materials and Industries* (1926-46), which has been superseded by *Ancient Egyptian Materials and Technology* (Nicholson & Shaw 2000). Interested readers are referred to the latter fascinating and informative publication.



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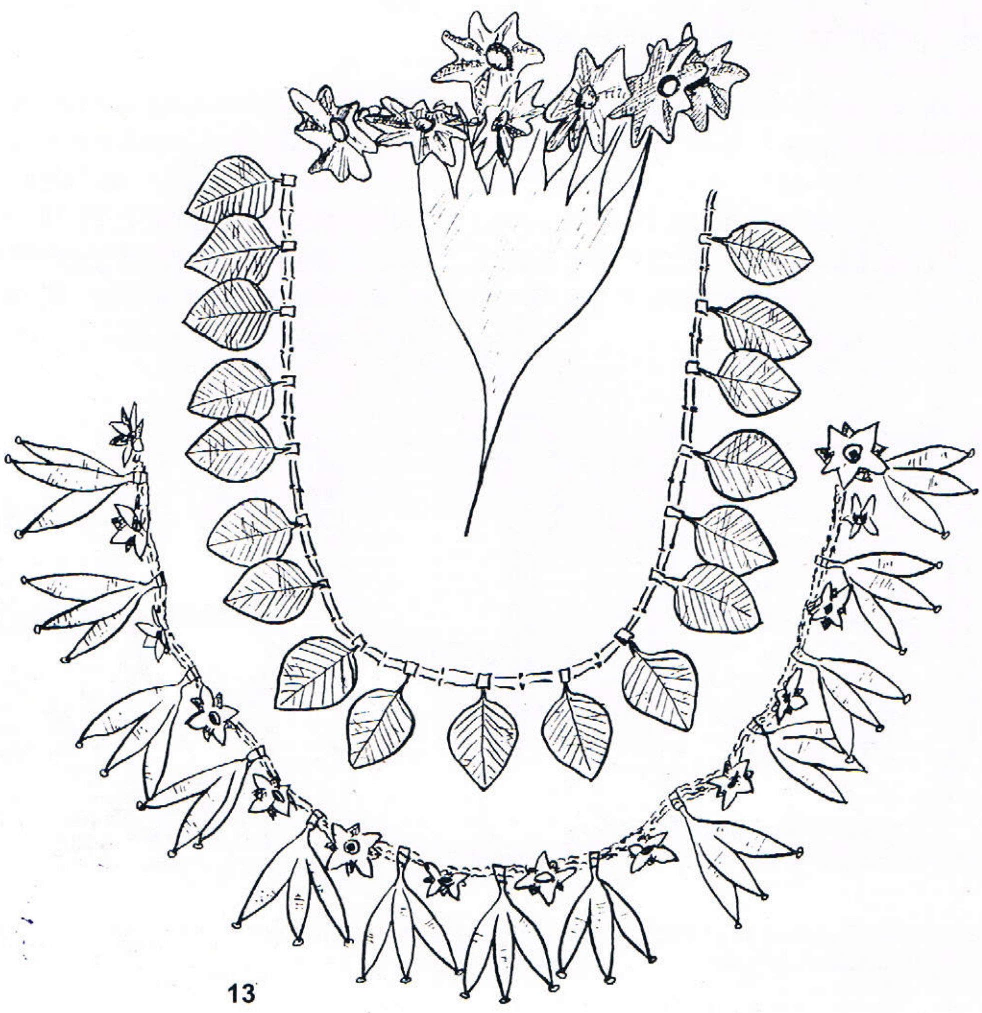
12 Ivory carving from ancient Samaria in the form of a lotus water-lily (*Nymphaea lotus*); it was probably glued on to palace furniture. After *Palestine Exploration Quarterly* 1932, pl.II (3).

13 Jewellery from Ur of the Chaldees showing beech (*Fagus orientalis*) leaves in gold and floral motifs. After H. Frankfort, *Architecture of Ancient Orient*, pl. 30 (1958).



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