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Botany meets archaeology: people and plants in the past

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Abstract

This paper explores the close links between botany and archaeology, using case studies from the ancient Mediterranean. It explains the kinds of palaeobotanical remains that archaeologists can recover and the methods used to analyse them. The importance of iconographic and textual evidence is also underlined. Examples of key research areas that focus on ancient plants are discussed: diet and palaeoeconomy; medicines, poisons, and psychotropics; perfumes, cosmetics, and dyes; and prestige.

Key words: Archaeology, flowers, food, gardens, palaeobotany, perfume.

Introduction

Archaeology is more often associated with the discovery of tombs, temples, and palaces than with plants. Yet small and fragile plant remains can be every bit as valuable, if not more so, than these large, permanent structures in providing information about human life in the past. During the eighteenth and early nineteenth centuries, archaeology fell under the broad umbrella of natural sciences, and by the start of the twentieth century, botanists, geologists, and zoologists were working with archaeologists to research a shared interest in the past (Wilkinson and Stevens, 2008). It is only in the last 50 years, however, that archaeologists have truly realized the wealth of knowledge that can be gained from a careful collection and study of ancient botanical remains and have developed analytical techniques and research questions accordingly. This has led to the rise of specialists within archaeology who focus on palaeobotany (palaeobotanists or archaeobotanists), although the corresponding increase in the resulting specialist analyses has contributed to a distinction between 'science' and 'interpretation' in perceptions and publications. This article explores the techniques used by archaeologists to recover ancient botanical material, explains what can and cannot be recovered, and then discusses some of the key areas of research that have been approached using floral remains specifically. The emphasis is on the Classical world of ancient Greece and Rome and their Bronze Age forerunners, as well as Egypt and the Near East, although palaeobotanical remains and the social practices they represent occur across the world.

Recovery of palaeobotanical remains

The analysis of botanical remains from archaeological excavations is a three-step process: recovery, identification, interpretation (Pearsall, 2000). Recovery rates of archaeobotanical evidence depend on both the strategy of the excavation and the environmental conditions of the site (Box 1). It is crucial that a sampling strategy be devised prior to excavation and in consultation with an archaeobotanist, although it can always be modified as the project progresses. This ensures sufficient samples for producing statistically significant results as well as for applying a range of relevant analytical techniques to answer the research questions of the project. It is important to be aware of the taphonomic processes that can introduce plant material to any archaeological site. Although archaeologists focus on the potential anthropogenic activities indicated by the plants, animal activity, erosion, deposition, and aeolian action can also all contribute to a site's palaeobotanical record and must be considered prior to interpretation of the archaeological record.

It is important to mention archaeological survey as well as excavation. Developed to provide diachronic information about a region rather than one specific site, contemporary landscape and vegetation has become an integral part of these studies (e.g. Watrous *et al*., 2004). It is not expected that landscapes will have remained the same since human activity began, but understanding the diversity of species and ecological niches contributes towards a more holistic study of the region. It is also possible to carry out

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Geographical Information Systems analyses incorporating vegetation and landscape features into modelling past routes, for example.

Types of palaeobotanical remains

Palaeobotanical material can be divided into macrofossils, visible to the naked eye, and microfossils that require magnification to examine. The identification of any botanical remains is dependent on analogies with modern flora and with archaeological reference collections (Dincauze, 2000). Flowers and vegetative remains are rarely preserved in the archaeological record, except in special environmental conditions (Box 1).

Macrofossils

This category includes charcoal, carbonised or charred seeds, shells, and grains, root casts, impressions on clay, mineralized and petrified remains, and coprolites (mineralized or dessicated faeces). In the Mediterranean, carbonization is the most common way that ancient botanical material has been preserved and ranges from large pieces of charcoal indicating structural destruction or firewood to charred seeds. These charred seeds tend to come from plants that require processing prior to consumption (e.g. cereals), often performed near a hearth, as well as any weeds that were accidentally harvested (Wilkinson and Steven, 2008). It is important to consider that plants eaten away from the settlement are unlikely to occur in archaeological assemblages, hence any picture of ancient diet based on macrofossils alone may be incomplete.

The practice of taking casts where plant roots once pierced the soil has reached its fullest potential at the site of Pompeii, buried by the eruption of Vesuvius in AD 79. Pioneered by Wilhelmina Jashemski, it is possible to identify not only the plant species that once grew here but to piece together the planting pattern and even irrigation systems of ancient gardens (Jashemski, 1974, 1979). Casts can also be made of plant impressions, usually found on ceramics or other baked clay artefacts (Magid and Krzywinski, 1995). For example, vine leaves are recognizable on the base of a ceramic basin from Myrtos Fournou Korifi in southern Crete (Warren, 1972), hinting at the exploitation of the grape by humans early in the Bronze Age (c.3000 BC). Impressions like these on the bases of vessels are usually the result of the ceramics standing on mats to dry before firing, but others result from plant material that may have been deliberately incorporated as a temper for the clay or used in cords that were wound around the vessel.

Mineralized plant remains are rare, requiring a special set of conditions for their creation, whereby dissolved minerals replace the plant cellular structure or encase the remains, such as caves or rock shelters (Hansen, 2001) and cesspits (Wilkinson and Stevens, 2008). Roman latrines are an excellent source of mineralized plant remains; at Sagalassos in Turkey, complex depositional processes have led to a combination of charred plant material with mineralized seeds in fifth–seventh-century AD latrine deposits, including fig (*Ficus carica*), plum (*Prunus* sp.), grape (*Vitis vinifera*), coriander (*Coriandrum sativum*), and dill (*Anethum graveolens*), showing the inhabitants ate a typical Roman–Early Byzantine diet, apart from a notable lack of olives (Baeten *et al*., 2012).

In contrast to other types of botanical remains, plant matter from coprolites is a reasonably secure indicator of plants that were consumed and defecated by humans, especially if the remains come from latrines, mummy intestines, or burials (Reinhard and Bryant, 1992). Specific biomarkers also allow a distinction between human and animal faecal matter to be made, crucial when it comes to drawing conclusions about ancient human diet (Shillito *et al*., 2011). Coprolites are better preserved in arid regions and thus are more common finds in New World archaeology; indeed coprolite analysis has shown that edible flowers (e.g. *Yucca*, *Agave, Opuntia, Cucurbita* spp.) played an important role in the diet of the prehistoric peoples of the American southwest (Reinhard and Bryant, 1992).

Box 1. Preservation of botanical remains.

Environmental conditions and the soil pH will affect the preservation and recovery of botanical remains. Desiccation common to arid regions can preserve remains not usually found in the archaeological record such as fruits, flowers, leaves, and membranes (Wilkinson and Stevens, 2008). This is the process that allows spectacular survival of plant material in Egypt (e.g. Murray, 2000), including the dried flower garlands found in tombs such as that of Tutankhamun which included cornflowers (*Centurea cyanis*) and mayweed (*Anthemis pseudocotula*) (Hepper, 2009). Waterlogging also leads to greater preservation of organic remains, perhaps at its most exceptional in the case of shipwrecks (Gorham and Bryant, 2001). For example, underwater excavation of the Late Bronze Age wreck discovered at Ulu Burun, off the coast of Turkey, yielded enormous quantities of organic materials (Haldane, 1993; Pulak, 1998). These were a combination of plant products that were traded across the eastern Mediterranean as well as those used for food on board the ship and included almond (*Amygdalus communis*), olive (*Olea europaea*), pomegranate (*Punica granatum*), fig (*Ficus carica*), grape (*Vitis vinifera*), coriander (*Coriandrum sativum*), and thorny burnet (*Sarcopoterium spinosum*) used as dunnage (padding to keep the cargo in position in the ship's hold) (Haldane, 1993).

Microfossils and biomolecular analysis

Microfossils such as phytoliths and pollen need magnification to be visible and such studies are complemented by an increasing number of biomolecular studies. Phytoliths, or the silica skeletons from plant tissue, survive after a plant has died and their analysis can provide valuable information about use of space within a structure or site. For example, a study of the phytoliths from surfaces in the Neolithic village of Makri in northern Greece indicates the settlement was inhabited all year long and engaged in cereal farming and pastoralism, as well as helping identify areas for crop processing (Tsartsidou *et al*., 2009). Phytoliths can also be recovered from artefacts, showing, for example, whether a quern was used primarily for cereals or tubers (Wilkinson and Stevens, 2008).

As pollen grains are produced in varying amounts, shapes, and sizes by the male reproductive organs of all spermatophyte plants, palynology can be a useful tool in reconstructing the vegetation cover of landscapes in the past. Only those which are anemophilous are recoverable through archaeological methods (taking sediment cores from marshes or lacustrine areas where pollen is preserved in the waterlogged, anaerobic environment), leading to a preponderance of forest and grassy plants in any sample. These requirements naturally limit the number of samples available in drier eastern Mediterranean countries such as Greece and Egypt. It is also possible to recover pollen from coprolites, complementing the information on general vegetation cover with details about animal grazing or fodder practices, as well as human diet – even including whether plant matter was cooked (Hunt *et al*., 2001). A deposit of pollen will usually be a combination of local pollen from contemporary vegetation, regional pollen brought via wind, water, or soil erosion, and residual pollen accumulated over time (Evans and O'Connor, 1999). This highlights one of the main advantages of phytolith studies compared to palynology for archaeologists, as the phytoliths tend to be deposited in the soil where the plant decays, thus giving a more immediate location for its growth or use. Moreover, pollen is often only identifiable to genus level (e.g. *Quercus*), so may not provide adequate specificity for any meaningful interpretation. For this reason, palynology is generally used by archaeologists to look at vegetation on a regional level rather than providing site-specific information. Palynological investigation of the cores from Lake Kournas on Crete has revealed changes in the Holocene environment such as the arrival of the carob (*Ceratonia siliqua*) that can be linked to human activity, as well as to the Late Bronze Age eruption of the volcano on Santorini (Bottema and Sarpaki, 2003). Vegetation burning and grazing can also be identified in the pollen record, furthering the understanding of prehistoric land management practices (Atherden, 2000).

Biomolecular studies are increasing in prominence and accuracy. Residue analysis uses the separation and identification (via gas chromatography and mass spectrometry) of biomarkers associated with plants. Tartaric acid and calcium tartrate in vessels from 6th-millennium BC Iran suggests that grapes were their content, most likely wine as evidenced by the terebinth resin used as a preservative for the alcohol in ancient times (McGovern, 1996). It now seems possible to isolate plant DNA from inside ceramic vessels producing a more accurate picture of their contents and hence of ancient trade: Classical amphoras from Chios yielded DNA of olive (*Olea europaea*), oregano (*Origanum vulgare*), and an unspecified *Pistacia* species (Hansson and Foley, 2008). Stable isotope analysis of human hair and bone can reveal important information about diet, such as whether plant foods were derived from C3 or C4 carbon sugars; in the case of Nubian mummies, a seasonal fluctuation was recognized between summer consumption of millet and sorghum and the year-round staples of wheat and barley (Aufderheide *et al*., 2003). Indirect evidence of plants in ancient diet can also be gained from osteological studies. Dental microwear may indicate a carbohydrate-rich diet or the accidental chewing of stone from grinding tools used in cereal preparation (Eshed *et al*., 2006) while skeletal stress markers can indicate agricultural activities like harvesting (Peterson, 2000).

Literary and iconographic sources

Literary sources

Although flowers are poorly represented in typical archaeobotanical assemblages, literary sources can fill out the picture of their uses in antiquity to a much greater degree. Studies of Classical Antiquity differ from many other archaeological subfields because of the wealth of texts that survive and complement the information gained from excavations and landscape studies. In the case of agriculture, Roman authors wrote books focusing specifically on agricultural practices, most famously Varro (*Res Rustica*), Columella (*De Re Rustica*), and Cato the Elder (*De Agri Cultura*). Yet such texts served literary and moral functions, and while they do provide important descriptions of ancient farming, there is little place in these for ornamental flowers rather than useful crops. The classification of the natural world rather than its cultivation was of interest to earlier Greek authors, and Aristotle wrote books on plant systematics over a millennium before Linnaeus developed the system still in use today. Unfortunately, Aristotle's main works on botany do not survive but two books by his student Theophrastus discuss plant anatomy, classification, and propagation (*De Historia Plantarum* and *De Causis Plantarum*). Medicinal texts are another key source, and the works attributed to Hippocrates, Galen, and Dioscorides include many flowers within their pharmacognosies. Incidental references to flowers can be gleaned from many other types of Greek and Roman texts, including drama, poetry, and history.

Ancient Egypt and the Near East also left behind copious textual evidence. In the Near East, these take the form of clay tablets written in cuneiform. The medical tablets from the library at Nineveh are filled with lists of plants used in healing, as well as the incantations needed to cure the sick. In contrast, the epic of Gilgamesh records the hero's trip to the bottom of the sea to collect a magical thorny plant that will make him young again – just one example of the occurrence in ancient mythologies of plants with special powers. Without textual evidence it would be impossible to know about such imagined plants. Egyptian medical texts also survive, most famously the Ebers Papyrus, which records how plants were combined with other substances into healing remedies. For example, a urinary problem could be treated by taking a concoction of water, duat-plant, uam seeds, linseed, gruel, berry of the uan-tree, abu-plant from Lower Egypt, abu-plant from

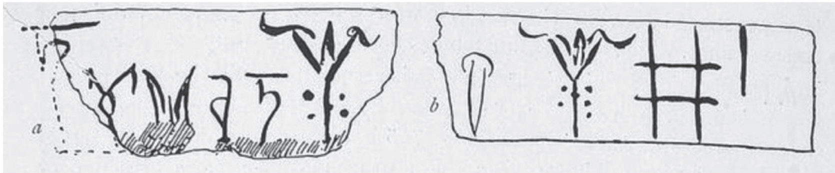

Fig. 1. Drawings of Linear B tablets from Knossos showing saffron. Evans A. 1935. *The Palace of Minos at Knossos*, vol IV.2. London: Macmillan, fig 704.

Upper Egypt, crocus from the Delta, and crocus from the hills (Bryan, 1930). Reading such a list highlights one of the main problems when working with ancient texts – translating the names of plants can be extremely problematic.

Linear B, the script in use in the palaces of Late Bronze Age Greece, was used to write an early form of Greek, so plant names there are usually more easily translated. One of the most important agricultural commodities listed in these clay tablets was saffron, a valuable spice derived from crocuses (*Crocus sativus* or *Crocus cartwrightianus*) (Day, 2011a) (Fig. 1). Interestingly, pulses are never recorded in Linear B, although palaeobotany has proven that they were an integral part of diet in the Late Bronze Age (Sarpaki, 1992). This omission reflects rather that lentils and beans were not deemed worth recording by the palaces, which focused their attention on overseeing higher-value crops like wheat, barley, and saffron. This is a good example of how a combination of textual and archaeobotanical sources can provide a more complete picture of ancient diet than either used in isolation.

Iconography

Images of plants and flowers survive in abundance from the ancient Mediterranean, and can be found on ceramics, frescoes, and jewellery, to name some more common media. It is easy to assume that iconography avoids the authorial bias inherent in many texts, but images too arise from a combination of cultural conditions, artists' knowledge, and patrons' desires. More intriguing are the depictions of imaginary plants (Box 2). Nevertheless, floral iconography has been used by archaeologists to learn about multiple roles of plants in the past, including trade, ritual, diet, daily life, and the environment.

Classical Greek and Roman pottery tends to feature floral imagery in borders of scenes, such as ivy or rosettes, but earlier material is rich. The plentiful floral imagery on the pottery of the Minoans, the Bronze Age inhabitants of Crete, has always exerted a fascination, and, along with the floral frescoes, is responsible for this society becoming known as a peaceful 'flower-loving' civilization. The stylized plant-like motifs of Middle Bronze Age Kamares ware pottery (Fig. 2) gave way to more realistic flowers in Late Minoan times before a return to stylized flowers once more in later Mycenaean art. Crocuses and lilies are two of the most prevalent species represented by Minoans, and rather than seeing them as simply nice decoration for vessels or walls, it is likely that the choice of motif was closely tied to the cultural and religious associations of these plants (Day, 2011b).

What do the remains of plants teach us about life in the past?

This section moves on from considering the types of remains that archaeologists use to elucidate information about the roles of plants in the ancient world to the broader research questions about both daily life and special events that can be approached through this information. Several themes have been selected as especially pertinent to flowers: diet and palaeoeconomy; medicine, poison, and psychotropics; perfumes, cosmetics, and dyes; prestige. These represent only a sample of the ancient uses of the botanical world. Plant material was also essential for building materials like timbers, roofs, mudbrick, and rope. The existence of containers made in perishable materials such as baskets woven from reeds are accessed predominantly via iconography or texts, while the gourds thought to be used for holding liquids in Neolithic and Early Bronze Age times survive in the round-bottomed, long-necked ceramic jugs that mimic their shape. Within archaeology, it was a popular belief that questions relating to economy and technology could better be approached through material remains than those that deal with ideology or ritual. Known as 'Hawkes'

Fig. 2. Kamares Ware ceramic vessel from Knossos. Evans A. 1928. *The Palace of Minos at Knossos*, vol. II.1. London: Macmillan, pl IX.d.

Box 2. Imaginary plants.

Depictions of imaginary plants combine features of several species: for example, the lilies painted in the Spring Fresco on the walls of Delta 2 in the Late Bronze Age town of Akrotiri on Santorini blend the characteristics of white madonna lilies (*Lilium candidum*) with those of red *Lilium chalcedonicum*. Should this be interpreted as artistic licence, or a meaningful manipulation of nature; as a mistake, or a lack of distinction between separate species? Similarly, does the mingling of species that bloom at separate times of the year, as in the Birds and Monkeys frieze from the House of the Frescoes at Knossos (Fig. 3), represent a lack of knowledge, wilful ignorance in the name of spectacular composition, or represent a mythical landscape?

Artifice and deceit is also part and parcel of Roman fresco painting, most famously preserved on the walls at Pompeii, although examples come from elsewhere in the Roman world too. Garden paintings form a distinct genre within the wider corpus, and these frescoes cover entire walls in trees, shrubs, and flowers, complementing the real gardens often visible beyond the painted walls and creating an illusion of space. Some 24 species are represented in the underground room at Livia's villa at Prima Porta (Caneva and Bohuny, 2003), and have been interpreted as particularly symbolic of the Augustan era of first-century AD Rome (Kellum, 1994). Garden frescoes were also painted on the rear walls of real gardens, for example in the House of Menander at Pompeii, thus serving to extend the view beyond the confines of reality, as well as remaining in bloom all year round.

ladder of inference' after the originator of the concept, it relegated palaeobotanical studies (amongst other scientific analyses) to exploring mainly economic prehistory (Trigger, 1989). The development of 'post-processual' approaches in archaeology, however, led to the realization that consumption practices are embedded within a culturally specific ideological framework and therefore the plants used for food, medicine, fuel, building, etc. can be used to access interpretations of society.

Fig. 3. Section of the Birds and Monkeys fresco from House of the Frescoes, Knossos. Evans A. 1928. *The Palace of Minos at Knossos*, vol. II.2. London: Macmillan, pl. XI.

Diet and palaeoeconomy

Piecing together ancient diet is, of course, closely connected to the study of botanical remains. Animal and fish bones attest to the consumption of meat, and associated dairy practices can be gleaned from residue analysis, zooarchaeological remains, or texts. The majority of people in the ancient world, however, only ate meat on special occasions such as after sacrifices; vegetables, fruits, pulses, grains, and olive oil provided the bulk of calories (Megaloudi, 2006). Grapes, grain, and olive oil became known to scholars as the 'Mediterranean Triad' for their key role in diet in the region (Sarpaki, 1992). This is substantiated archaeologically through agricultural tools and processing installations (Box 3).

Apart from the usual charred cereals and pulses and the material traces of oil and wine processing, archaeobotanical remains of other plant foods can also be found. Carrot and purslane seeds (*Daucus carota* and *Portulaca oleracea*) were recovered at Iron Age Kastanas, for example (Megaloudi, 2006). Much like today, flowers per se do not seem to have been especially important as foodstuffs in the Mediterranean, and indeed the fruits of many plants are tastier and more beneficial to humans from a calorific perspective. Capers, the edible flower bud of *Capparis spinosa*, were probably consumed although archaeobotanical remains are of the seeds rather than the buds (Megaloudi, 2006). Caper flowers were depicted in Minoan frescoes from Knossos and Ayia Triada, perhaps hinting at Bronze Age consumption too (Cameron, 1975; Chapin, 2004).

Beyond the specifics of human diet, the remains of food plants can be used to learn about wider social practices associated with food production and consumption. Domestication of many crops can be followed through comparing changing seed or stone morphology with modern wild and cultivated samples (e.g. the olive, Margaritis and Jones, 2008). Weeds that accompany the harvested grains into settlement contexts tell of cultivation practices such as manuring and can indicate the sowing and harvesting times (Wilkinson and Stevens, 2008). The locations of the fields from which the Philistine city of Ashkelon imported wheat has been suggested based on a comparison of the ancient weed seeds with vegetation zones; moreover, the presence of young capsules of white-flowered toadflax (*Linaria chalapensis*) is interpreted as indicating the farmers' early harvest of crops before the arrival of the approaching Babylonian army (Weiss and Kislev, 2004).

Textual sources are key in providing a more nuanced understanding of the social hierarchies displayed through eating and drinking. For elite Romans, elaborate recipes containing expensive and rare ingredients showed off the wealth of the host as well as his good taste, in both the physical and moral sense. The best source of Roman recipes is Apicius, compiled most probably in the fourth or fifth century AD. Dishes tend

Box 3. Agricultural tools and processing installations.

Wine production is indicated by the remains of presses; one of the oldest comes from the Late Bronze Age site of Vathypetro in central Crete (Fig. 4). There, a spouted basin is set into a plastered platform; as the grapes were pressed within the basin, the juice ran into the collecting vessels placed on the floor below. A Black Figure vase from the sixth century BC confirms the wine-related use of such an assemblage, as it shows wine pressing in identical vessels, here carried out by satyrs (the mythological followers of Dionysus), and provides the additional detail of a basket placed inside the pressing basin to filter juice.

Olives also required pressing to yield the oil that was essential not just for eating, but in hygiene and for lamps. As olives are harder to press than grapes, the remains of olive presses tend to be more robust. Stone press weights and press beds are the main remains identified through archaeological fieldwork, again complemented by a range of images on ceramics (Foxhall, 2007). Ancient cereal processing also leaves its mark on the landscape in the form of threshing floors (although dating these installations is problematic as they remained in use up until the twentieth century), quernstones, and mortars (Fig. 5).

Fig. 4. Late Bronze Age wine pressing assemblage at Vathypetro, Crete. Photo: J. Day.

Fig. 5. Late Bronze Age stone mortar for pounding cereals at Gournia, Crete. Photo: J. Day.

to be covered in sauces made from numerous spices, such as this example which is for a roast flamingo: ‘In a mortar, mix pepper, lovage, celery seed, fried sesame seed, parsley, mint, dried onion, and dates. Add honey, wine, stock, vinegar, olive oil, and boiled wine. Blend and heat. Pout over the flamingo and serve’ (Apicius VI.6). Such complex recipes are in contrast to the simpler dishes that were perceived as luxurious in earlier Classical Greek times.

Although the Greeks did not use spices to the same extreme as occurred in later Roman recipes, exotic flavours were still much sought after, and myths frequently surrounded their origins. The fifth-century BC historian Herodotus described how cinnamon was collected in Arabia: the sticks were used by giant birds to make their nests and, rather than climb up to get the spice, human gatherers left animal carcasses on the ground, which the birds dragged up to their nests to eat; being too heavy, the nest then broke and the cinnamon sticks could be safely collected from the ground (Herodotus III, 110–111). This story was later dismissed by the encyclopaedist Pliny the Elder, who more accurately described cinnamon as coming from southeastern Asia via the ocean (Dalby, 2000). This trade route that brought eastern spices into the Roman Empire was hugely important. While black pepper (*Piper nigrum*) is mentioned frequently in recipes and descriptions of banquets, archaeological fieldwork at the Red Sea port of Berenike in eastern Egypt has revealed the importance of this trade to the Roman economy. Thousands of peppercorns were recovered on site, including 7.5 kg in a storage jar, highlighting the scale of the spice trade between India and the Roman Empire (Cappers, 2006).

Medicines, poisons, and psychotropics

As opposed to their limited roles as foodstuffs, many plants are a source of medicinal, poisonous (Box 4), and psychotropic substances, and this did not go unnoticed in the ancient Mediterranean. Texts are hugely important in filling in the details about *materia medica* in the Classical world, but archaeology and iconography again provide complementary evidence. Crucially, the distinction between a plant’s therapeutic use and its use as a poison was often merely one of dosage (Cilliers and Retief, 2000).

One of the most popular medicines in the ancient Mediterranean was the sap of the opium poppy (*Papaver somniferum*). A variety of evidence demonstrates that this

Box 4. Toxic plants in ancient Mediterranean.

While opium was generally used for analgesic and sedative purposes, other plant extracts were put to more nefarious uses. Three of the most common were hemlock (*Conium maculatum*), henbane (*Hyosycamus niger*), and aconite (*Aconitum napellus*) (Kaufman, 1932; Cilliers and Retief, 2000). Hemlock was, of course, the drug that Socrates chose to end his life, as described by Plato (Bloch, 2001). Imperial Rome was rife with incidents of poisoning, especially amongst the imperial family itself (e.g. Claudius was poisoned by his wife Agrippina, and Nero was a renowned poisoner). King Mithridates VI of Pontus was so afraid of being poisoned that he developed a universal antidote that became known as 'mithridatium'. Variations of this recipe could contain over 50 ingredients, many of them rare plant products such as storax (*Styrax officinalis*), bdelion (*Commiphora* sp.), and spikenard (*Nardostachys jatamansi*) (Totelin, 2004). The unusual plant and animal assemblage from a storage jar at Villa Vesuvio near Pompeii suggests that the farmhouse was a venue for the preparation of pharmacological compounds, maybe even a version of 'mithridatium' (Ciaraldi, 2000). Archaeological evidence of Greek and Roman poisons has not been found to date, as the same jars used for medicines or perfume could have held poison, and archaeobotanical finds of seeds do not necessarily indicate that plant's use in a malign manner. Poisons can be identified in human hair, although the misidentification of cocaine and nicotine in Egyptian mummy hair somewhat discredited this technique (Wilson, 2005). Future tests of residues inside vessels or on utensils may reveal poison traces in much the same way that a hunting poison derived from castor beans (*Ricinus communis*) has been identified on a Palaeolithic tool from south Africa (D'Errico *et al*., 2012), but the intention remains impossible to ascertain.

plant and its by products were used and traded across the eastern Mediterranean from the Bronze Age. Of course, the poppy provides food for humans – its seeds can be eaten and made into oil – and it has been found in domestic archaeobotanical assemblages (Megaloudi, 2006). Over 50 years ago, Late Bronze Age Cypriot ceramic juglets known as Base Ring Ware were proposed to be containers for opium suspended in liquid because, when inverted, the vessel shape bears a striking similarity to an opium poppy capsule, compounded by the painted or incised lines that mimic the cuts in the capsule through which the sap is exuded (Merrillees, 1962) (Fig. 6). These small vessels have been found all around the eastern Mediterranean, in Syria, Palestine, and Egypt as well as Cyprus, and their shape would have been an advertisement for their contents.

Various chemical tests later seemed to confirm opium as the contents, although this remains debated (for details, see Collard, 2011). Other indicators of the poppy's early use can be found on Crete, including the terracotta 'Gazi goddess', who has incised poppy capsules in her headdress, and the ceramic globular vessels (rhyta) from Mochlos with incisions and painted scars (Nicgorski, 1999; Merlin, 2003). Poppies also occur on the gold Acropolis ring and dress pins with crystal heads found at Mycenae (Merlin, 2003). In later Classical times, many written sources refer to the poppy (*mékon*) and opium (also called *mekónion*). Hippocrates recognized its use as a narcotic, and Dioscorides discussed the preparation of a poppy-derived sleeping aid (Kritikos and Papadaki, 1967). In Egypt, too, the opium poppy was known, and apart from featuring in medical texts like the Ebers Papyrus, where it was called 'Spn' (Rosso, 2010), poppy iconography was also popular.

Psychotropic use of plants in the Classical World is little studied, perhaps partly because of a scholarly reluctance to ascribe 'drug taking' to the cultures that are seen as the origins of Western civilization. Although the Mediterranean does not contain the same diversity of psychotropic plants that can be found in Amazonia, for example, there are still a number of species that can alter consciousness, especially members of the Solanaceae family (Schultes and Hofman, 1992; Merlin, 2003). As with many traditional societies, the consumption of mind-altering plants would have been carried out within carefully controlled ritual circumstances, often by ritual specialists, rather than simply for individual pleasure. It is in the context of ritual activity, therefore, that use of psychotropics in Classical Antiquity should be explored.

Regular interaction with the Olympian deities did not require the consumption of any kind of mind-altering substance, relying instead on prayers, festivals, and sacrifices. Exceptional cases may, however, have made use of pyschotropics. The oracle of Apollo at Delphi made pronouncements via a priestess who sat upon a tripod in a trance, the cause of which has been much debated. One theory suggested that

Fig. 6. Base Ring Ware juglet from Enkomi, Cyprus. UCD Classical Museum (UCD 0006). Photo: J. Day.

the Pythia, the priestess, chewed laurel leaves (*Lauris nobilis*) or inhaled fumes from burning them (Devereux, 1997). This plant was a symbol of Apollo, and wreaths of it were awarded to victors in athletic competitions. The lack of psychotropic alkaloids in laurel makes its use for entering trance unlikely, and other suggested plants include henbane (*Hyoscyamus niger*) and *Datura* sp. (Devereux, 1997), while recent research has turned towards noxious gases as the source of oracular inspiration (Spiller *et al*., 2002).

Another ancient ritual that may have employed psychotropic plants was the Eleusinian Mysteries. Celebrating Demeter, goddess of fertility, and her daughter Persephone, initiates drank a beverage known as the *kykeion* at one stage during the ceremonies. The secrecy which all members of the cult swore to uphold means that much remains mysterious even today about the Mysteries, including the ingredients of *kykeion*. Some scholars believe that ergot (*Claviceps purpurea*), a parasite that grows on cereals, was added to wine to give believers a more intense experience of religious awe (Wasson *et al*., 1978). This would also have been an appropriate substance for use in worshipping Demeter, often depicted with ears of grain in her hand, underlining her role as goddess of cereals. It is worth mentioning that ancient Greeks were aware of cannabis (*Cannabis sativa*), at least for its medicinal properties, even if it did not feature in their rituals (Butrica, 2002).

Perfumes, cosmetics, and dyes

One of the most important uses for flowers in the ancient world was in the manufacture of perfume, a process about which a surprising amount of information is known. Theophrastus describes in some detail the methods and ingredients for producing perfumed oils in his time (fourth or third century BC) in his book *On odours*. He states that olive oil must be less than a year old to be used and explains how it needs to be treated with an astringent substance to prepare it for the addition of scents (Theophrastus, IV). Fragrance can be added either through indirectly heating the oil with aromatics in a water bath or through cold steeping of the aromatics (Theophrastus, V). Perfumes made use of all parts of plants such as flowers, leaves, roots, gums, fruits, and twigs, often in combination (Theophrastus, VI). He mentions various flowers, such as crocus, iris, lily, and rose, as well as quince, myrtle, laurel, myrrh, and cinnamon, as popular aromatics (Theophrastus, VI). These cannot be pinned down to a precise species as Theophrastus himself only uses common names. Storage of perfume is also discussed, and Theophrastus notes that they are ruined by being left in the hot sun; perfumes derived from flowers lose their fragrance most quickly but those from myrrh and iris root can be kept for years (Theophrastus, IX).

Supporting this hugely important literary resource are the remains of perfumeries that have been excavated. The island of Delos was renowned in antiquity for producing perfume and Hellenistic-period perfumeries have been identified there based on a combination of equipment for pressing oil, storage jars, furnaces for heating, and basins for steeping as the fragrances were added (Brun, 2000). The area around Corinth was associated with perfume production also, and the small ceramic aryballoi that contained the oil were shipped around the Mediterranean from Archaic times. In Italy, it was the Campanian region that was famed for aromatics, especially rose-scented perfume. The manufacturing process is shown in a fresco from the House of Vettii, Pompeii, where cupids are involved in extracting oil from a wedge press and adding rose petals to a steeping basin, while nearby a lady tries some sample fragrances (Mattingly, 1990). Jashemski's work at Pompeii has identified commercial gardens within the city, most likely where flowers for the perfume industry were grown, and inscriptions from the town even provide the names of two perfume makers or *unguentarii*, M. Decidius Fastus and Phoebus (Jashemski, 1979). Flowers in Campania were also used to make garlands, essential to deck out animals for sacrifice, as well as for wearing at festivals and *convivia*, the dining parties of Roman elite. Evidence for garlands is primarily textual and iconographic, again Pompeian wall paintings but also sculpture.

Interestingly, the same method of perfume manufacture was used over a millennium before the Pompeian perfume industry developed, during the Bronze Age. Clay tablets inscribed with Linear B script from the Mycenaean-era palace at Pylos refer to supplies for the manufacture of scented oils, as well as even naming Thyestes the 'unguent boiler', i.e. someone whose profession was to mix perfume. Deliveries of olive oil and other scented ingredients such as coriander and sage (*Salvia* sp.) were recorded, and it seems likely that the perfume was made in courtyards on the north east of the palace (Shelmerdine, 1985). Linear B also refers to henna (*Lawsonia inermis*) being used in perfume making, probably to colour it – a practice that Theophrastus also knew about (Theophrastus VI, 31). In the Late Bronze Age, scented oils were traded all around the Mediterranean in ceramic stirrup jars. Other ceramic evidence for aromatic production can be seen in the traces of oil of iris that were identified through residue analysis of vessels from c.2000 BC from Chamalevri on Crete (Tzedakis and Martlew, 2002).

Resins and gums were as popular as scented oil in antiquity. The Canaanite jars containing terebinth resin (*Pistacia* sp.) found in the late Bronze Age Ulu Burun shipwreck, off the coast of Turkey, were most likely for use in aromatics (Haldane, 1993). Ancient Egypt was a big consumer of fragrant resins, in particular frankincense (*Boswellia* sp.) and myrrh (*Commiphora* sp.). As well as their use in incense, they were necessary in the mummification process, as bodies were packed with fragrant substances once the viscera had been removed (Abdel-Maksoud and El-Amin, 2011). Neither frankincense nor myrrh grew in Egypt, and they had to be imported from the Land of Punt, a region somewhere to the south along the Red Sea. Famously, queen Hatshepsut sent an expedition to Punt c.1500 BC to bring back live incense trees ('*ntwy*), aiming to bring this valuable commodity under Egyptian control (Dixon, 1969). The expedition is painted on the walls on Hatshepsut's funerary temple and shows small, whole trees, complete with root balls, being transported by bearers. Unfortunately for Egyptians, the trees did not flourish away from their homeland and Egypt once more had to rely on trade routes for such valued aromatics. This same trade route was the source of later

Roman imports of incense, considered the best aromatic for offering to the gods (Peacock and Williams, 2007).

Various floral products were also used in cosmetic recipes, most popularly rose, saffron, and iris, although mineral-based make-up using ochre, chalk, or kohl was more common (Manniche, 1999; Olson, 2009). Skin was moisturized with oils – from the olive in Greece, while sesame (*Sesamum indicum*) was popular in Egypt (Manniche, 1999). Nails, lips, and even ears may have been coloured from as far back as the Bronze Age; frescoes from Akrotiri show red and orange tinted body parts on many of the women depicted there, perhaps achieved with saffron or henna (Day, 2011b). Distinguishing archaeological remains that relate to cosmetics from medicinal ones is tricky as the same small phials and utensils were used for both (Olson, 2009).

While there was undoubtedly an element of hygiene involved in the use of oils and cosmetics, they were also important in funerary ceremonies (to anoint bodies) and other rituals. Fragrant smoke is a common way of nourishing deities and the practice of burning incense was prevalent all round the ancient eastern Mediterranean. Moreover, access to the exotic plant ingredients used to make some of the scents was an indicator of elite status in society; at Pylos, perfume manufacture was under the control of the *wanax*, the leader (Murphy, 2013), and Egyptian pharaohs wanted to control the incense trade. Being scented with exotic perfumes would have been an almost unconscious message to all who inhaled the aroma of the wearer's social status (Murphy, 2013).

Plants were also essential for making dyes. The most famous of ancient dyes, the vivid Tyrian purple beloved of Roman emperors, derived from the *Murex* species of mollusc rather than any plant. Unlike the mounds of empty shells that can signify a murex dye works, information about the use of plants in dyeing depends heavily on ancient texts and modern experiments. Although a dye works has been identified at Rachi, near Isthmia in Greece (Kardara, 1961), and plentiful loom weights and spindle whorls attest to textile production at numerous sites across the ancient world, the dyes themselves remain elusive. Saffron will dye cloth a bright and colourfast yellow, making it superior to the numerous other yellow dyes available such as safflower (*Carthamus tinctorius*) and chamomile (*Anthemis tinctoria*). The prominence of this plant in Aegean Bronze Age writing and iconography, coupled with the yellow clothes that are shown in contemporary frescoes, suggests that at least one of its uses was for dying fabric (Day, 2011b). Reds came from madder (*Rubia tinctorum*) and kermes. Indigo (*Indigofera tinctoria*) has been identified as a pigment in frescoes at the Mycenaean site of Thebes (Brysbaert and Vandenabeele, 2004).

Plants and prestige

As already mentioned, the cross-Mediterranean movement of plants for foodstuffs, medicines, and industrial uses in antiquity can be traced through archaeological and textual sources. It is worth mentioning a few further specific examples to illustrate the significant roles plants played in ancient economy and society and the extent to which desirable species travelled around the Mediterranean. Waterlogged plant remains from Roman London include a number of species with Mediterranean origins, such as peach (*Prunus persica*), dill (*Anethum graveolens*), and mulberry (*Morus nigra*) (Willcox, 1977). Their appearance in Britain reflects both the occupying Romans' wishes for tastes of home as well as the changing tastes of the native Britons. It is also possible to see a correlation between importing exotic or luxury plants for food and the elites in Roman society. Studies of central Europe during Roman times have shown that some plant foods, like pomegranate (*Punica granatum*) and pistachio (*Pistacia vera*), are only found in military sites in probable officers' dwellings (Bakels and Jacomet, 2003). Over time, imported plant foods that could survive in these new territories were successfully grown [e.g. walnuts (*Juglans regia*) and coriander (*Coriandrum sativum*)] and this wider availability is mirrored by their appearance in a wider range of civilian archaeological contexts as luxuries became daily foodstuffs (Bakels and Jacomet, 2003).

Plants did not have to be eaten or made into perfume to bring prestige to those who owned them; often their display was enough. The Roman triumph, an elaborate parade of spoils through the capital city that was granted to military victors, occasionally included plants. Emperors Titus and Vespasian exhibited balsalm trees (*Commiphora* sp.) from Judaea in Rome, leading Pliny to comment that 'The balsam-tree is now a subject of Rome, and pays tribute together with the race to which it belongs' (NH XII, 111). Egyptian pharaohs also bought into this idea of capturing plants, and Tuthmosis III had the plants he brought back from his Syrian campaigns depicted on the walls at Karnak for all to see (Schwaller de Lubicz, 1999).

Royal gardens in the ancient world were undoubtedly for the display of plants as statements of power and knowledge. Assyrian rulers seem to have had a penchant for bringing back plants from their military campaigns and establishing them in gardens in their capital cities. An inscription of king Tiglath-Pileser I (1114–1076 BC) records: 'I took cedar, box tree, Kanish oak from the lands over which I had gained dominion – such trees which none among previous kings, my forefathers, had ever planted – and I planted [them] in the orchards of my land' (Kuhrt, 1995). This is the tradition into which the semi-mythical Hanging Gardens of Babylon fit, now probably identified at Nineveh (Dalley, 1993). Successfully growing captured foreign species can be seen as a reflection of the rulers' authority over the natural world and a justification of their right to rule (Day, 2010). Gardens also could have sacred aspects however, and the plants that grew within them were often for use in ritual. Egyptian temple gardens provided offerings for the deity of the temple, such as lettuces (*Lactuca sativa*) for Min, the god of fertility, the milky sap reminiscent of semen (Day, 2010). Temples in Classical Greece also had gardens surrounding them. Excavations at the temple to Hephaistos in the agora in Athens revealed planting pits cut into the bedrock around the building, many containing broken ceramic flowerpots (Thompson, 1937).

Association with certain plants could bring fame and fortune to places, most famously in the case of silphium. Now extinct but thought to have belonged to the *Ferula* genus, silphium is depicted on coins and mentioned in literary sources. The origin of the plant was Cyrene, a Greek colony in north Africa, and trade in it led to great prosperity for the city. It was highly desirable because of its use as a contraceptive and maybe also an aphrodisiac (Koerper and Kolls, 1999). Unfortunately, the demand seems to have led to overharvesting, and silphium became extinct during the Roman period, the last stem apparently sent to Emperor Nero.

The future of plants and archaeology

Although the integration of archaeology and botany has progressed enormously throughout the last century, there are many paths open for future cooperation. Interest in contemporary climate change and its effect on vegetation is reflected by an increasing recognition of the impact that environmental change would have had on ancient societies. As scientific data unravelling ancient weather patterns becomes both more accurate and more plentiful, studies linking archaeology, landscapes, and palaeoclimatology will perhaps become more common (e.g. Moody, 2005). Advances in analytical techniques will undoubtedly lead to further developments in identifying plant remains on a microscopic or chemical level, and the continued presence of palaeobotanists on fieldwork projects will ensure that plant remains are not overlooked in favour of ceramics or other more obvious remains. Moreover, continuing archaeological fieldwork and research based upon texts and iconography will augment current knowledge with new discoveries. Fresh ways of thinking about the roles of plants in ancient society has highlighted the relevance of palaeobotany not just for studies of subsistence but also for issues such as status, identity, and ritual. To some extent, ethnobotanical studies must be as responsible for this as the changes within archaeological discourse, as they demonstrate to archaeologists the enormously rich and intertwined lives of people and plants. The rise too in archaeological interest in feasting and sensory experiences means that plant-derived substances are no longer viewed as merely calorie providers but facilitators of social dynamics and even of communication with divinities.

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