Summary 'Mediterranean polyculture' (the systematic exploitation of olives and vines in addition to cereals from the beginning of the Bronze Age) has been considered as one of the main factors which led to the development of palatial institutions in Bronze Age Crete and mainland Greece. This paper reviews all the available, direct archaeological evidence for olive and vine exploitation and oil and wine production and use from Bronze Age Crete (microbotanical, macrobotanical, artefactual, epigraphic), discussing at the same time their taphonomic, analytical and interpretative problems. It is suggested that, at present, there is no reliable direct archaeological evidence to substantiate the 'Mediterranean polyculture' model. More significantly, research on wine and oil, if disconnected from the discourse of subsistence and the cultural-evolutionary models such as that of subsistence-redistribution and viewed within the framework of the anthropology of consumption, can more fruitfully illuminate important issues related to the dialects of power such as establishment and legitimation of authority, exploitation of labour and factional competition.

INTRODUCTION

In 1972 Colin Renfrew in his highly influential book The Emergence of Civilisation, launched the so-called 'Mediterranean polyculture' hypothesis, as part of his attempt to explain the development of palatial institutions in Bronze Age Crete and southern Greece by using a non-diffusionist, endogenous model (C. Renfrew 1972). In general terms, the hypothesis suggests that the systematic exploitation of vines and olives (in addition to the cereal-dominated agricultural basis) in the extremely diverse Cretan landscape from the beginning of the Bronze Age, led to local and regional specialization in agriculture, as some crops were better suited in some areas than others. This specialization led to the need for a redistributive authority to ensure the circulation of the different products, initially at a local level. This authority eventually became the authority of the palatial institutions.

The model was admittedly based on a more or less literal transfer of the cultural evolutionary idea developed by Service (1962), who himself built on data from Polynesia which, as recent research has shown (Earle 1977), was rather different from the picture that Service presented.
Renfrew's model received extensive criticisms mainly on theoretical grounds (Cherry 1984, 1986; Gamble 1979, 1981, 1982; Gilman 1981, 1991; Halstead 1988, 1992a, 1994; Halstead and O'Shea 1982; Lewthwaite 1983; van Andel and Runnels 1988). Most of his critics paid little attention, however, to the issue of tree-crops which occupied a prominent position in Renfrew's argument. They either accepted his hypothesis or they chose to ignore it altogether and to concentrate on other issues.

The archaeological study of the issue of tree-crops is, therefore, of obvious importance, not only because agricultural developments in Bronze Age Crete carry significance on their own right, but also because the initial development of institutionalized hierarchy in Europe has been attributed to this factor. Furthermore, the investigation of this problem can shed light on wider issues concerning the relations between agricultural products and the processes and dynamics of production and reproduction of authority and power.

The empirical foundation of Renfrew's hypothesis regarding tree-crops and their products has been questioned by some researchers (Halstead 1994; Hansen 1988; Runnels and Hansen 1986) but a systematic, detailed and combined critical evaluation of all the archaeological evidence was yet to appear. This article aims to do just that. It presents the direct archaeological evidence for the occurrence of olives and grapes and their products in Bronze Age Crete and discusses its reliability and significance. The final aim is twofold: to illustrate and discuss briefly the picture these data provide and to point to the problems of using direct data in the investigation of viticulture and olive cultivation (and oil and wine consumption) in prehistory in general, and in our case in particular.

**Botanical, Artefactual and Documentary Evidence for Olives/Oil and Vines/Wine and their Taphonomic Problems**

The direct evidence of grape and olive from Minoan Crete can be grouped into the following categories: 1) plant macrofossils; 2) plant microfossils; 3) artefacts associated with the processing of grapes and olives for wine and oil production; 4) documentary evidence. Different categories of data may shed light on different problems. In other words, there are many questions of a different nature, related to the problem of olives and grapes in Minoan Crete which can be (and indeed are) very easily conflated in the archaeological literature. These are: a) the availability of wild progenitors of the species in the island and their geographical extent; b) the possible husbandry of these wild species by humans for different purposes; c) the date and the biological and social conditions of the domesticating process of these plants; d) the systematic exploitation of these plants by humans.

**Plant Macrofossils**

The plant macrofossil category includes seeds which have been preserved by carbonisation, waterlogging (rarely) or fossilisation (very rarely). The preservation of olive and grape botanical remains is less likely in storage conditions than, for example, the preservation of cereals or legumes, for two main reasons: a) most of the known processing stages of the olive and grape do not involve fire, though an exception is the process of boiling olives before crushing, a practice recorded ethnographically from Crete (e.g. Vickery 1936, 52); b) large caches of stored grain are easily preserved archaeologically after destruction caused by fire;
preservation of this kind is not possible with stored wine and oil or olives; only dried grapes are an exception. On the other hand, olive and grape pips as rubbish, being durable, have good (better than cereals) chances of preservation. Also, the (ethnographically recorded) practice of using olive pips as fuel can result in their archaeological preservation, as seems to have been the case with the recent find of an olive pip concentration in a pottery kiln at LM I Mochlos (Table 1).

Another issue which complicates the taphonomy of the olive and has implications for the archaeological investigation of the problem, is that of the crushing of olive pits when the fruits are pressed. Oil production requires pressing of olives on hard surfaces which in most cases results in the crushing of pits. Thus the finds of crushed pits, especially when they exhibit fractures with rounded edges suggesting fracturing when fresh (cf. Neef 1990, 298), is a more or less positive indication of olive-pressing for oil. There are installations and practices, however, which do not produce crushed pits: they just bruise the olives to separate the skin from the stone, but this practice produces less oil and needs greater effort (Foxhall 1990, 115–16). Most olive presses known, including the Roman trupetum, would crush the olive stones. According to Drachman, Roman authors thought that the crushed stone would spoil the flavour of oil (1932, 9), a belief which, according to Foxhall (1990, 115–16) is not true.

Thus in most cases where olive stones are crushed, the possibilities of their archaeological recovery are reduced. On the other hand, complete olive stones found in excavations can equally be the remains of fruits eaten fresh, and are not necessarily remains of oil production. The recovery procedures followed by Minoan archaeologists introduce another bias. As in the majority of cases seeds have been collected by hand, fragmented olive pips would have less chance of being noticed by the eye of the excavator and, therefore, of being collected. The potential remains of olive-pressing activity are thus missing.

Although it is usually thought that the remains of wine production survive less well than those of grapes eaten as fruits or as raisins (mainly because the former have passed through many processes and may have been dispersed after pressing), this is not necessarily true: wine production involves large quantities of grapes, thus creating concentrations of grape seeds which can be archaeologically more visible than the isolated remains of grapes eaten as fruits. Furthermore, unlike olives, grape pips are not usually crushed during pressing. It is also worth mentioning that finds of grape pips with skins are usually interpreted as an indication of wine making (e.g. Kyllo 1982, 433 for Vrysi-Ag. Epiktitos, Cyprus; Valamoti and Mangafa 1993 for Toumba Thessalonikis).

Leaf impressions in clay and charred wood do not directly indicate cultivation of the plant. Both might have been collected from the wild, for purposes other than making wine and oil or eating grapes and olives. For example, as J. Renfrew notes (1972), vine leaves are often used as a base for drying pots during pottery manufacture, as was the case at EM Myrtos (see also below). Leaves can also be used as fodder, and wood can serve several purposes: firewood, construction material, etc. In addition, charcoal poses many analytical problems as archaeological evidence. The taphonomic problems of charcoal are not very well understood (Boyd 1988) and, furthermore, for some taxa, including Olea and Vitis, distinction between wild and domesticated plants is impossible.
The distinction between wild and domesticated plants is a problem not only in wood but also in seeds. Firstly, there are conceptual difficulties in this attempt. As the Cambridge Palaeoeconomy School has shown, there is a variety of human strategies for plant management which lie between the above two extremes, making the dichotomy between 'wild' and 'domesticated' a false one and the attempt at their separation in many cases rather meaningless (see for example Higgs and Jarman 1969). Secondly, the practical archaeobotanical problems in distinguishing between wild and domesticated forms of grape and olive seeds are no less severe: i) the charred remains have changed in shape because of heating, so metrical indices based on fresh seeds may be quite misleading (for grapes see Logothetis 1970, 28; Smith and Jones 1990; cf. Sarpaki in press 1; for olives Liphschitz et al. 1991, 444); ii) the morphological change which occurs in the olive after domestication involves mainly an increase in the size of the mesocarp — the fresh, oil-containing part — and not so much the stone (Liphschitz et al. 1991, 441-2); iii) the biology of the olive and especially its propagation method complicates the issue further: the stones from domesticated trees produce a phenotypically wild (feral) tree and not a domesticated one; iv) there exist many different varieties of olives and vines producing seeds which are morphologically variable both in shape and size (cf. Núñez and Walker 1989, 206).

The distinction between wild and cultivated olives and vines can be attempted in cases where a large sample exists, provided that the above limitations are taken into account and corrective formulae and indices (e.g. Smith and Jones 1990) are used. Given the reduced chances of the preservation of olive (especially oil) and grape (especially wine) remains in storage conditions, however, the acquisition of such a large sample (especially of olive seeds) is very difficult.

On the whole, leaves and wood indicate the availability of the taxa in the surrounding environment and its use by humans for a variety of purposes. They are not proof of olive and vine domestication, systematic exploitation or their use for oil and wine. The mere presence of seeds certainly reflects the use of plants for a specific purpose on an occasional or regular basis but they do not necessarily reflect systematic use and exploitation of fruits for oil, wine or other uses. In order to deal with these last issues other parameters must be taken into account, such as the quantity of material, its preservation status, its contextual associations and its association with certain implements suggesting specific processing activities.

**Plant microfossils**

The most common microfossil trace of olive and grape in the archaeological record is pollen. *Olea*, being primarily an anemophilous species, produces relatively large quantities of pollen. With *Vitis* the situation is rather more complicated: wild *Vitis* produces fairly large amounts of pollen, whereas the domesticated one being self pollinated produces very little (Zohary and Hopf 1993, 143-8). We should not expect to find much *Vitis* pollen, therefore, even in situations where extensive grape cultivation is practised. The climatic and geological conditions prevailing in Crete are in any case not very favourable for pollen preservation and reduce further the chances of using this type of evidence in the context of this problem. Furthermore, even with the more readily available olive pollen, the identification problem is acute: not only is the distinction between wild and domesticated plants impossible, but its confusion with
other species of the same family is likely, especially when SEM microscope is not used. Pollen, therefore, indicates at best only the availability of specific taxa in the surrounding environment. Very high percentages of pollen, especially in olive, may reflect cultivation but this has to be proved after considering all the alternative possibilities and taking into account pollen taphonomy.

Artefacts associated with the processing of olives and grapes

Oil production from olives involves three basic steps (for discussion on olive-processing technology see Drachman 1932; Frankel 1984; R. J. Forbes 1993; Hadjisavvas 1992; Sarpaki 1989, 28; Sordinas 1971; cf. also several articles in Amouretti and Brun 1993): the crushing of fruits, the pressing of the crushed pulp, and finally the separation of oil from water in the juicy product of the pressed pulp (it contains 60–75% water and 6–25% oil — Forbes and Foxhall 1978, 39). For the first stage a hard surface (a crushing bed), over which a stone can be rolled, is employed or even a simpler device involving a mortar and pestle can be used. Implements made of other materials like wood can also be employed, resulting in the de-fleshing of the olives without crushing the olive stones (but see above). The second stage involves more perishable materials like wood and sacks, with low archaeological visibility. The third involves open containers or tanks, preferably with a spout near the base which allows the water to be poured off, leaving the oil in the tank. The above process can be simplified by compressing the first two steps in one. It can also include other complementary steps like the boiling of olives before crushing (see above). The final step of separation can be carried out in simple, multi-purpose containers by merely skimming the oil from the surface. The wine-producing process is less elaborate and involves only the pressing of grapes and the collection of the juice. Here, only pressing equipment (permanent or portable) and storage vessels are necessary.

This category of material is not without its problems: apart from the low survival of some parts, the generalized form of the equipment allows them to function for several purposes. For example, the vessels usually described as oil separators can also be used for wine pressing. Indeed, archaeologists ascribe either or both functions to very similar objects. Furthermore, a simple container with a spout does not necessarily imply either wine making or oil production: it may have been used for more common, everyday activities such as washing (cf. Warren 1972, 139). Despite these problems, this type of material has better chances of survival than botanical remains and, given a reliable identification, can be a quite useful piece of evidence. Attribution to the processing of liquids is more reliable when such vessels are found in situ accompanied by collecting vessels and other relevant equipment, e.g. pithoi, amphorae. Most importantly, this category of evidence gives the most unequivocal material evidence for olive and grape processing and oil and wine consumption in relation to the other categories discussed above. As Dennell has suggested (1974, 283; 1976), it is the identification of the crop-processing activities rather than any other procedure in archaeobotanical analysis which allows us to put the discussion of plant exploitation on a sound basis.

Textual evidence

The documentary evidence provided by the archives of tablets written in Linear A and
more especially Linear B, despite its wealth of information, carries with it a great many interpretative problems which have been discussed repeatedly in the relevant literature (e.g. Finley 1957; Halstead 1992a, 1992b; Killen 1985; Olivier 1994). Documents provide information on a certain sector of the overall economic system, that of the palaces, or rather on specific transactions within this palatial sector. Despite all their biases and ambiguity, they are invaluable as one category of evidence among the whole range discussed here.

Finally, before presenting the data, a warning should be made that the picture which they illustrate always runs the risk of being biased, both in terms of chronology (as the later Minoan periods are better known than the earlier ones) and in terms of settlement hierarchy (higher rank sites being better investigated than lower rank ones). But as we will see later, this is not always the case. In some areas the combined efforts of intensive surveys, extensive expeditions and chance finds, coupled with the rescue archaeology boom, have to some extent improved the situation.

RESULTS

The macro-botanical data: conventions

Plant macrofossil remains of olive and grape from Minoan Crete are summarized in Tables 1 and 2. It can be seen from these tables that the quality and quantity of evidence varies but overall there is a clear lack of substantial specialist reports on botanical remains from Minoan Crete. Collection of plant remains by flotation has been carried out only on seven sites, Kommos (Shay et al. 1995), Kasteli (Sarpaki in press 2), Mochlos, Palaikastro (Sarpaki, pers. comm.), Pseira (Jones and Smith in press; Jones and Snowdon in press), Monastiraki (Mylona, pers. comm.) and Knossos Stratigraphic Museum (Jones, pers. comm.), and sampling and recovery were not systematic in all these cases. The remaining evidence comes from isolated finds, usually identified by the excavators in the trench. In order to provide a rough assessment of the reliability of this evidence, a reliability index was used, with scores from 1 (least reliable) to 6 (most reliable). This index provides a measure of the validity of evidence with regard to the systematic exploitation of olive and vine for their fruits (eaten raw or dry, pressed for wine and oil etc.). It does not measure the validity of the finds as regards the presence of species on the site or their husbandry (occasional or not) by humans. The criteria for attributing scores to different finds were: a) the quantity of specimens. This is a relative criterion but the relatively low archaeological visibility of grape and olive remains, especially in storage conditions, has been taken into account. So, for example, 1–10 specimens of seeds are considered too few to be reliable. The frequency of olive and grape remains (their presence in a given number of samples) where applicable, has also been taken into account. b) The preservation status of the material. Thus, charred material was considered relatively reliable evidence but the so-called fossilized material was not, since the possibility of recent intrusion is very high. In cases where the form of preservation is not stated, the material is considered equally unreliable. c) The examination of the material by a specialist, either archaeobotanist or botanist was also considered proof of reliability. d) Finally, the contextual association of the material has been considered important. For example, grape seeds or skins found in jars or pithoi are considered to be more reliable evidence than an isolated seed found without...
any artefactual association. Wood and leaf impressions will gain a low score since, as has been explained above, they do not necessarily reflect systematic use of the fruit.

So, for example, a sample of 30 carbonized grape seeds found at the bottom of a pithos and identified as such by a specialist will score 6, whereas a sample of 1–2 seeds reported as seen by the excavator in the trench and of which the preservation status is not stated will score 1.

Macro-botanical data for olives and oil

1) As can be seen from Table 1, all the relatively reliable olive stone finds come from later contexts and mainly from the period of the second palaces but also from the later ‘Mycenaean’ periods. The only reliable evidence for the presence of olives in the first palace period comes from MM II Kommos. The isolated olive stones from the EM period (one each from Vasiliki, Myrtos, Knossos) are very unreliable as evidence: apart from their low number there are other problems related to their preservation status and their contextual associations. The Myrtos stone is described as ‘fossilized’ (an indication that it could be recent) and for Knossos and Vasiliki the preservation status is not stated. Besides, neither the Vasiliki nor the Knossos stone have been examined by a specialist. Similar problems apply to the find from the tholos tomb at Lebena. In addition, this tholos tomb was used from EM I to MM Ia and so the exact dating of the find is uncertain.

The charcoal evidence from EM Myrtos has been attributed to cultivated olive trees by Rackham (1972). The distinction between wild and cultivated olives is not possible from charcoal as we have seen, and Rackham based this conclusion on the observation that the olive wood resembles the degenerated material which comes from trees that have been previously managed by pruning or pollarding (1972, 299–300). This is based on the unjustified assumption that cultivated trees are managed repeatedly and wild trees not so. To strengthen his argument, he also notes that some pieces of charcoal come from thin olive poles (5–8 cm in diameter). Indeed the branches of a shrubby wild olive plant are thin and one wonders how it would be possible to separate charcoal from the pruning of cultivated trees, from that coming from wild maquis olives which had been previously harvested for wood or fodder. The charcoal from Myrtos, therefore, is not conclusive evidence for olive cultivation during the EM period.

2) The contextual associations of some olive finds imply uses other than subsistence. The olive stones from the tholos tombs at Lebena and Kamilari were found together with other food remains, indicating some sort of funerary feast (cf. Branigan 1993). (The stones from Poros were not accompanied by any other food remains and it has been thus suggested that they were introduced by rodents — Muhly 1992, 167.) The finds from LM I Zakros and from LM II Knossos Unexplored Mansion, the latter found in a conical cup together with unidentifiable herbs, also point to some ritual use. Olives in a cup were also noted from LM III Knossos.

3) All the relatively reliable evidence comes from either palatial contexts, elite buildings (Knossos Unexplored Mansion) or large towns with a presumably high rank in the settlement hierarchy (Kommos, Khania, Palaikastro, etc.) (Fig. 1).

Macro-botanical data for grapes and wine

Table 2 summarizes the botanical evidence for grape and wine from Minoan Crete. Most of the evidence comes from LM contexts (especially the period of the second palaces),
<table>
<thead>
<tr>
<th>Site</th>
<th>Date</th>
<th>Context</th>
<th>Type of remains</th>
<th>Quantity</th>
<th>Preservation status</th>
<th>Studied by specialist</th>
<th>Reliability</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Myrtos</td>
<td>EM</td>
<td>village, unspecified</td>
<td>seed</td>
<td>1</td>
<td>complete, 'fossilized'</td>
<td>Yes</td>
<td>1.5</td>
<td>Renfrew, J. 1972.</td>
</tr>
<tr>
<td>Myrtos</td>
<td>EM</td>
<td>village, various loc.</td>
<td>wood, many pieces</td>
<td></td>
<td>carbonized</td>
<td>Yes</td>
<td>3</td>
<td>Rackham 1972.</td>
</tr>
<tr>
<td>Knossos</td>
<td>EM I</td>
<td>well</td>
<td>seeds</td>
<td>?</td>
<td>?</td>
<td>No</td>
<td>1</td>
<td>Hood 1971, 86.</td>
</tr>
<tr>
<td>Kamilari</td>
<td>MM I– MM II</td>
<td>tomb, associated with other carbonized seeds</td>
<td>seeds</td>
<td>'some'</td>
<td>carbonized</td>
<td>No</td>
<td>2</td>
<td>Levi 1976, 715.</td>
</tr>
<tr>
<td>Kommos</td>
<td>MM I</td>
<td>town, unspec.</td>
<td>seeds</td>
<td>many fragments in one sample</td>
<td>fragmented carbonized</td>
<td>Yes</td>
<td>6</td>
<td>Shay et al. 1995.</td>
</tr>
<tr>
<td>Phaistos</td>
<td>First palace period</td>
<td>palace</td>
<td>wood</td>
<td>few pieces</td>
<td>carbonized</td>
<td>Yes</td>
<td>3</td>
<td>Folieri and Coccolini 1986.</td>
</tr>
<tr>
<td>Kommos</td>
<td>MM II</td>
<td>town, unspec.</td>
<td>seeds</td>
<td>many fragments in four samples</td>
<td>fragmented carbonized</td>
<td>Yes</td>
<td>6</td>
<td>Shay et al. 1995.</td>
</tr>
<tr>
<td>Kommos</td>
<td>MM II– III</td>
<td>town, unspec.</td>
<td>seeds</td>
<td>many fragments in two samples</td>
<td>fragmented carbonized</td>
<td>Yes</td>
<td>6</td>
<td>Shay et al. 1995.</td>
</tr>
<tr>
<td>Komnos</td>
<td>MM</td>
<td>town, hearths or building material</td>
<td>wood</td>
<td>abundant</td>
<td>carbonized</td>
<td>Yes</td>
<td>3</td>
<td>Shay et al. 1995.</td>
</tr>
<tr>
<td>Knossos Royal Road</td>
<td>LM I</td>
<td>palatial settlement, unspec.</td>
<td>seed</td>
<td>1</td>
<td>clay impression</td>
<td>Yes</td>
<td>3</td>
<td>Åström and Hjelmqvist 1971.</td>
</tr>
<tr>
<td>Site</td>
<td>Level</td>
<td>Material</td>
<td>Preservation</td>
<td>Fragments</td>
<td>Host</td>
<td>Reference</td>
<td></td>
<td></td>
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<td>--------------</td>
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<td>-----------</td>
<td>------</td>
<td>-----------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zakros</td>
<td>LM I</td>
<td>palace, well; ritual?</td>
<td>olive fruits</td>
<td>'many'</td>
<td>complete, waterlogged</td>
<td>No</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Mochlos</td>
<td>LM I</td>
<td>settlement, building 4, room 2, by a stone mortar</td>
<td>olive stones</td>
<td>'many'</td>
<td>some complete, some fragments?</td>
<td>No</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Mochlos</td>
<td>LM I</td>
<td>town, building 4, room 4, rubbish pit</td>
<td>olive stones</td>
<td>'many'</td>
<td>?</td>
<td>No</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Mochlos</td>
<td>LM I</td>
<td>town, contents of a pottery kiln</td>
<td>olive stones</td>
<td>'many'</td>
<td>?</td>
<td>No</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Pseira</td>
<td>LM I</td>
<td>town</td>
<td>olive stones</td>
<td>2</td>
<td>fragmented carbonized</td>
<td>Yes</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Archanes: Phourni</td>
<td>LM I</td>
<td>building in the cemetery; contents of a pot</td>
<td>seeds</td>
<td>?</td>
<td>?</td>
<td>No</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Kommos</td>
<td>LM II</td>
<td>town, unspec.</td>
<td>seeds</td>
<td>7 in 8 samples</td>
<td>carbonized</td>
<td>Yes</td>
<td>5,5</td>
<td></td>
</tr>
<tr>
<td>Knossos</td>
<td>LM II</td>
<td>elite building; 2 in a conical cup; ritual?</td>
<td>seeds</td>
<td>3</td>
<td>complete carbonized</td>
<td>Yes</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Kommos</td>
<td>LM III</td>
<td>town, unspec.</td>
<td>seeds</td>
<td>22 in 23 samples</td>
<td>carbonized</td>
<td>Yes</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Knossos</td>
<td>LM III (IIIc)</td>
<td>'sanctuary'; contents of cup.</td>
<td>seeds</td>
<td>?</td>
<td>complete, carbonized</td>
<td>No</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Phaistos</td>
<td>LM</td>
<td>bottom of larnax</td>
<td>seeds</td>
<td>?</td>
<td>'many'</td>
<td>No</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Kommos</td>
<td>LM</td>
<td>town, unspec.</td>
<td>wood</td>
<td>abundant</td>
<td>carbonized</td>
<td>Yes</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Palaikastro</td>
<td>LM</td>
<td>town, unspec.</td>
<td>seeds</td>
<td>'few' 'some'</td>
<td>?</td>
<td>No</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Kastelli Khania</td>
<td>LM</td>
<td>town</td>
<td>seeds</td>
<td>14 frag.</td>
<td>fragmented; carbonized</td>
<td>Yes</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Knossos Strat. Museum</td>
<td>LM</td>
<td>palatial settlement</td>
<td>seeds</td>
<td>?</td>
<td>carbonized</td>
<td>Yes</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Phaistos</td>
<td>M?</td>
<td>unspec.</td>
<td>seeds</td>
<td>?</td>
<td>complete, ?</td>
<td>Yes</td>
<td>1.5</td>
<td></td>
</tr>
</tbody>
</table>

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<td>Myrtos</td>
<td>EM II</td>
<td>village; room floor (sample 1); content of pithos (sample 2)</td>
<td>seeds, stalks, skins, vine leaf impression</td>
<td>68</td>
<td>measurable seeds</td>
<td>Yes</td>
<td>6</td>
<td>Renfrew, J. 1972.</td>
</tr>
<tr>
<td>Pseira</td>
<td>MM I?</td>
<td>town, unspec.</td>
<td>seed</td>
<td>1</td>
<td>carbonized</td>
<td>Yes</td>
<td>3</td>
<td>Jones and Smith in press</td>
</tr>
<tr>
<td>Phaistos</td>
<td>First palace period</td>
<td>palace, content of pithos</td>
<td>seeds and skin</td>
<td>more than 50</td>
<td>carbonized</td>
<td>Yes</td>
<td>6</td>
<td>Logothetis 1970, 42.</td>
</tr>
<tr>
<td>Monastiraki</td>
<td>MM II</td>
<td>(palatial?) settlement, bottom of pithos</td>
<td>seeds</td>
<td>?</td>
<td>?</td>
<td>No</td>
<td>1</td>
<td>Matz 1951, 38.</td>
</tr>
<tr>
<td>Monastiraki</td>
<td>First palace period</td>
<td>(palatial?) settlement, content of a pithos</td>
<td>seeds and skins</td>
<td>'possibly thousands'</td>
<td>carbonized</td>
<td>No</td>
<td>5</td>
<td>Mylona, pers. comm.</td>
</tr>
<tr>
<td>Knossos</td>
<td>MM II or III</td>
<td>settlement, unspec.</td>
<td>seed</td>
<td>1</td>
<td>clay impression</td>
<td>Yes</td>
<td>3</td>
<td>Åström and Hjelmqvist 1971</td>
</tr>
<tr>
<td>Zakros</td>
<td>LM I</td>
<td>palace, well</td>
<td>seeds</td>
<td>2-3</td>
<td>waterlogged</td>
<td>Yes</td>
<td>3</td>
<td>Logothetis 1970, 104; Platon 1971, 196.</td>
</tr>
<tr>
<td>Pseira</td>
<td>LM I</td>
<td>town</td>
<td>seed</td>
<td>1</td>
<td>carbonized</td>
<td>Yes</td>
<td>3</td>
<td>Jones and Snowdon in press</td>
</tr>
<tr>
<td>Vathypetro</td>
<td>LM I</td>
<td>'villa'</td>
<td>wood</td>
<td>few pieces</td>
<td>carbonized</td>
<td>No</td>
<td>2</td>
<td>Marinatos 1951, 104.</td>
</tr>
<tr>
<td>Kommos</td>
<td>LM I</td>
<td>town, unspec.</td>
<td>seed</td>
<td>1</td>
<td>carbonized</td>
<td>Yes</td>
<td>3</td>
<td>Shay et al. 1995.</td>
</tr>
<tr>
<td>Knossos Strat. Museum</td>
<td>LM I</td>
<td>palatial settlement, unspec.</td>
<td>seeds</td>
<td>'many'</td>
<td>carbonized</td>
<td>Yes</td>
<td>5</td>
<td>Jones, pers. comm.</td>
</tr>
<tr>
<td>Knossos unexplored mansion</td>
<td>LM II</td>
<td>high rank residence, unspec.</td>
<td>seeds</td>
<td>4</td>
<td>carbonized</td>
<td>Yes</td>
<td>3</td>
<td>Jones 1984.</td>
</tr>
<tr>
<td>Kommos</td>
<td>LM II</td>
<td>town, unspec.</td>
<td>seeds</td>
<td>4 in 3 samples</td>
<td>carbonized</td>
<td>Yes</td>
<td>3</td>
<td>Shay et al. 1995.</td>
</tr>
<tr>
<td>Kommos</td>
<td>LM III</td>
<td>town, unspec.</td>
<td>seeds</td>
<td>5 in 3 samples</td>
<td>carbonized</td>
<td>Yes</td>
<td>3</td>
<td>Shay et al. 1995.</td>
</tr>
<tr>
<td>Kasteli Khania</td>
<td>LM</td>
<td>town, unspec.</td>
<td>seeds</td>
<td>3-4</td>
<td>mineralized</td>
<td>Yes</td>
<td>3</td>
<td>Sarpaki 1992a; in press 2</td>
</tr>
</tbody>
</table>

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with some exceptions: the large assemblage from Monastiraki, the finds from Phaistos and the single clay impression from Knossos, all from the first palace period, and the EM finds from Myrtos. The Myrtos seeds are the only finds from a pre-palatial context in Minoan Crete. Again, all finds from the later periods come from palaces and palatial centres (Phaistos, Knossos, Zakros, Kasteli, Monastiraki), large towns (Kommos) and high rank ‘villas’ (Vathypetro; see below) (Fig. 2).

The micro-botanical data

Plant microfossil evidence for olive and vine in Crete come from the pollen diagrams at Tersana and Limnes on Akrotiri (the second being poorly dated) in north-west Crete (Gennett 1982; Moody 1987; Moody et al. 1990) and Ag. Galini in the south central part of the island (Bottema 1980). The only well dated data directly related to the period under investigation is the olive pollen from Tersana (Fig. 2). This evidence shows high olive pollen values during the EM period and a dramatic decrease of these values during the MM period. This has been interpreted by the researchers mentioned above as evidence for extensive olive cultivation.

These anthropogenic changes of the EM and MM landscape, as proposed by Moody (1987), Moody et al. (1990) and Gennett (1982) and mentioned above, require some discussion here. The above researchers have interpreted the Akrotiri cores, in particular the Tersana diagram, as evidence for extensive cultivation of olive during the EM period which declined (together with cereal cultivation) during the MM period (Fig. 2). Firstly, as has been shown by Liphschitz et al. (1991), it is almost impossible to distinguish between wild and domesticated Olea pollen as they are morphologically identical (the same applies to wood as well). Moreover, as the same authors state, the identification of pollen using a light microscope may confuse Olea with Phillyrea media, and only with the use of SEM is their distinction secure. So, there are serious doubts as to whether we are really dealing here with domesticated olive pollen and not with that of a wild one or even
of another species. In addition, as Moody states, the Gramineae pollen could be anything from reeds to cereals (1987, 74). Secondly, the hypothesis of intensive cultivation of olive in the EM period and rapid decline in the MM period, during which the area was continuously occupied, fails to meet a number of objections: the same study has shown an increase in the number of settlements in the area from 31 during EM to 94 during MM (Moody 1987, 302). What was the main subsistence crop, especially if, as Moody claims (1987, 94), the decline of grass pollen indicates a decline of cereal cultivation as well? And why should people abandon such an expensive investment in capital, labour and time as olive cultivation? Why does the Limnes diagram from the same geographical area not show a similar picture? Given the paucity of archaeoenvironmental data from Bronze Age Crete, it is extremely dangerous to argue conclusively for extensive olive cultivation during the EM period or for a decline during the MM period (cf. Runnels and Hansen 1986).

The proposed human impact inferred from the Tersana diagram cannot be seriously supported for the moment. It seems that an alternative hypothesis emphasizing climatic factors is more plausible, although a convincing interpretation should perhaps await further studies. The fluctuations in Olea pollen indicate wild plants rather than cultivated, especially in north-west Crete where the high precipitation (in relation to other parts of Crete) would favour the wide natural presence of this species. The rise of Olea pollen together with the rise of grass pollen may simply mean a decline of woodland (especially deciduous) species like Quercus, Fraxinus and Pinus which in a very humid climate can outcompete the shrubby form of wild olive. This species, being quite drought resistant, can survive in cases in which the above woodland species and especially the deciduous forms cannot; free of their competition it can thrive. Moreover, being a wind-pollinated species, it is likely to be over-represented in relation to other plants which, it must be stressed, are still represented, especially the Mediterranean trees and shrubs. At the same time, the decline of woodland species leaves a more open environment and therefore more chances for grasses to develop. Consequently, the decline of Olea and grass pollen may indicate that the conditions again became humid enough to allow the regeneration of woodland species. This suggestion is supported by the observation made by Gennett (1982, 282) that the increase of Olea pollen follows an increase of Cistaceae pollen (grouped under 'Herbs' in Fig. 2), a very common component of the garrigue. The maquis/garrigue clearance which Moody suggests (1987, 93) as an indication of Olea cultivation, therefore, is not substantiated. The presence of Cistaceae, a xerophytic plant family, points to dry and hot conditions (and possible fires — Bottema 1990, 124) and so supports the above re-interpretation. The argument for the regeneration of trees as a result of changing climatic conditions is supported by the presence of Ericaceae which has been interpreted elsewhere as an indicator of 'an increase of precipitation or moister conditions' (Bottema 1990, 125). This family shows its lowest values at the same time as oaks and deciduous trees and peaks during the MM period, after the decline of Olea, when other tree species return. It is also worth noting that during the EM period there are indications of the occurrence of fires in the high values of the well known pyrophilous family of Cistaceae (le Houerou 1981; Bottema 1990, 124) and the presence of many pieces of charcoal in the sediment from that period (Moody 1987, 85). This
Figure 2
The Tersana pollen diagram (after Moody et al. 1990).
phenomenon is to be expected during hot and dry conditions, although anthropogenic factors should not be excluded. Furthermore, charcoal is absent from the MM sediment (Moody 1987, 86), a fact which coincides with the decline of Cistaceae and the presence of several water-demanding species, all indicating humid conditions.

A second alternative hypothesis is that the above picture reflects changes in grazing pressure: the Olea-Cistaceae zone may reflect increased grazing pressure leading to the decline of more palatable taxa and the survival of less palatable ones like Cistaceae (which due to the oils they contain are unattractive to animals; cf. Ellenberg 1988, 21) and Olea (in its wild form is spiny with very narrow leaves and therefore not very attractive). This hypothesis, however, does not explain the co-presence of grass pollen with Olea and Cistaceae and so the first alternative hypothesis seems more plausible at present.

It is worth mentioning that Vitis pollen is present in all three diagrams before the Minoan period indicating the presence and the availability of the genus in the island. In Ag. Galini, Vitis is present from c. 7500 BC to c. 5300 BC while in Tersana and Limnes it is present before the end of the sixth millennium.

Artefacts

Objects of different form have been associated with wine and oil production in Minoan Crete (Table 3). One very common artefact is the clay lekane, usually with handles and a spout at the base. Objects of similar shape made of stone have also been found (two examples, one from Petras and one from Knossos). Such finds have been interpreted by some Minoan archaeologists (e.g. N. Platon, S. Marinatos) as wine presses and by others as oil separators (e.g. Bosanquet, Boyd-Hawes). Others like Warren (1972, 138–9) believe that they could have been used for both activities, since these do not clash in terms of time-scheduling (cf. Kopaka and Platon 1993 for a typology and a thorough discussion).

Other installations include elevated built structures with spouts at their bases, sometimes with collecting vessels, which are usually interpreted as wine presses (Palaikastro, Zakros), stone basins with spouts sometimes with collecting vessels (Mochlos, Zou, Knossos, Phaistos, Kommos, Palaikastro: Kouremenos, Vathypetro), or amorphous stone tables (Knossos Stratigraphic Museum), the last two types usually interpreted as olive-crushing installations. The same interpretation has been attributed to the peculiar circular stone object of 52 cm diameter found at Palaikastro ‘with a circular runner at the upper face and rim raised above the central part’ (Dawkins 1904–5, 276–77). It is doubtful, however, whether this last object has been used as an oil press because it is too narrow for a cylindrical stone or similar object to be rolled over it. Finally, the clay lekane with the long spout from LM III Kommos, initially thought to be a possible oil separator by Shaw, the excavator, is very dubious as such, not only because of its small diameter (0.34 m) but also because of its unnecessarily long spout. Blitzer’s interpretation as a metallurgical installation is probably closer to reality. Vats with base holes such as those found at Mallia (Palmer 1994a, 25) have been excluded from this analysis because there is no proof that they were used as wine presses.

As for the reliability of the interpretation of the rest of the objects, little can be said. It is obvious, however, that the occurrence of clay and stone lekanai in situ, especially when accompanied by collecting vessels is a
**TABLE 3**

OBJECTS IDENTIFIED AS WINE PRESSES OR/AND OLIVE PRESSES AND OIL SEPARATORS FROM MINOAN CRETE.

THE SUGGESTED USE IS THAT OF THE EXCAVATOR.

<table>
<thead>
<tr>
<th>Site</th>
<th>Date</th>
<th>Context</th>
<th>Type/Suggested use</th>
<th>Number</th>
<th>Comments</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Myrtos</td>
<td>EM II</td>
<td>village</td>
<td>clay lekanai with spout; various uses</td>
<td>4 (2 more fragmented)</td>
<td>no collecting vessel is mentioned</td>
<td>Warren 1972, 138–9.</td>
</tr>
<tr>
<td>Knossos</td>
<td>EM II</td>
<td>house; 'Royal road'</td>
<td>fragmented clay lekane; oil separator or wine press</td>
<td>1</td>
<td>no evidence for spout or collecting vessel</td>
<td>Warren 1981, 230, pl. 202a-b; Kopaka and Platon 1993, 44.</td>
</tr>
<tr>
<td>Mallia, quartier G</td>
<td>MM I</td>
<td>town</td>
<td>spouted clay lekane; oil separator</td>
<td>1</td>
<td>accompanied by a pithos</td>
<td>van Effenterre 1980, fig. 238; Kopaka and Platon 1993, 44.</td>
</tr>
<tr>
<td>Mallia</td>
<td>MM III–LM I?</td>
<td>palace</td>
<td>spouted clay lekane; oil separator</td>
<td>1</td>
<td>accompanied by collecting vessel</td>
<td>Chapoutier and Demarge 1942, 20, fig. 24; van Effenterre 1980, 370.</td>
</tr>
<tr>
<td>Sphakia, Sitia</td>
<td>MM IIIB</td>
<td>clay spouted lekane; wine press</td>
<td>1</td>
<td>no information</td>
<td>unpubl.; Kopaka and Platon 1993, 53.</td>
<td></td>
</tr>
<tr>
<td>Choiromandres, Zakros</td>
<td>MM III–LM I</td>
<td>'guard post'</td>
<td>'Bassine et grand seau de pressoir avec ecoulement pour le moult'</td>
<td>1</td>
<td>no information</td>
<td>Tzedakis et al. 1990, 51.</td>
</tr>
<tr>
<td>Profitis Ilias, TourtoULoi Sitia</td>
<td>MM III–LM I</td>
<td>'villa'</td>
<td>spouted clay lekanai; wine press</td>
<td>3</td>
<td>in one case with collecting vessel in situ (similar to the one at Vathypetro)</td>
<td>Platon 1960, 259; Platon 1961b, 209; 1966b, 297, 300.</td>
</tr>
<tr>
<td>Kato Zakros</td>
<td>MM III–LM I</td>
<td>town by the palace</td>
<td>spouted clay lekane; wine press</td>
<td>1</td>
<td>accompanied by collecting vessel and another lekane</td>
<td>Hogarth 1900–1, 130–1; Kopaka and Platon 1993, 58.</td>
</tr>
<tr>
<td>Zou</td>
<td>MM III–LM I</td>
<td>'villa'</td>
<td>spouted stone basins; olive-crushing beds</td>
<td>2</td>
<td>no information</td>
<td>Platon 1960</td>
</tr>
<tr>
<td>Archanes</td>
<td>LM I</td>
<td>isolated building within the Phourmi cemetery</td>
<td>spouted clay lekane; wine press</td>
<td>1</td>
<td>it flushes into a depression carved in the rock; evidence for dried must?</td>
<td>Sakellarakis and Sakellarakis 1978, 172; Sakellarakis and Sapouna-Sakellarakis 1991, 86–7.</td>
</tr>
<tr>
<td>Kato Zakros</td>
<td>LM I</td>
<td>town by the palace</td>
<td>spouted clay lekane; wine press</td>
<td>1</td>
<td>collecting vessel and another vessel</td>
<td>Hogarth 1900–1, 130–1; Kopaka and Platon 1993, 58.</td>
</tr>
<tr>
<td>Kato Zakros</td>
<td>LM I</td>
<td>town by the palace</td>
<td>spouted clay lekane; wine press</td>
<td>1</td>
<td>collecting vessel and built supportive walls</td>
<td>Hogarth 1900–1, 141.</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Place</th>
<th>Period</th>
<th>Feature</th>
<th>Type</th>
<th>Notes</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kato Zakros</td>
<td>LM I</td>
<td>town by the palace</td>
<td>spouted clay lekane; wine press</td>
<td>built depression for collecting vessel</td>
<td>Platon 1964, 221; 1966c, 149.</td>
</tr>
<tr>
<td>Kato Zakros</td>
<td>LM I</td>
<td>town by the palace</td>
<td>spouted clay lekane; wine press</td>
<td>accompanied by collecting pithos</td>
<td>Platon 1966d, 164.</td>
</tr>
<tr>
<td>Kato Zakros</td>
<td>LM I</td>
<td>town by the palace</td>
<td>built platform; wine press</td>
<td>accompanied by collecting pithos</td>
<td>Platon 1966c, 144, pl. 143b</td>
</tr>
<tr>
<td>Kato Zakros</td>
<td>LM I</td>
<td>town by the palace</td>
<td>spouted clay lekane</td>
<td>no collecting vessel is mentioned</td>
<td>Platon 1980, 425.</td>
</tr>
<tr>
<td>Kato Zakros</td>
<td>LM I</td>
<td>town by the palace</td>
<td>spouted clay lekane; wine press</td>
<td>collecting vessel</td>
<td></td>
</tr>
<tr>
<td>Epano Zakros</td>
<td>LM I</td>
<td>'villa' with second floor and frescoes</td>
<td>two spouted clay lekanai; double wine press</td>
<td>they flush to a pithos; two collecting vessels underneath</td>
<td>Platon 1966a, 136; 1966e, 165–6; 1967, 218–19.</td>
</tr>
<tr>
<td>Knossos</td>
<td>LM I</td>
<td>palace, central court</td>
<td>stone spouted lekane; ?</td>
<td>no collecting vessel</td>
<td>Raison 1969, pl. 88 above; Kopaka and Platon 1993, 44, fig. 8.</td>
</tr>
<tr>
<td>Vathypetro</td>
<td>LM I</td>
<td>'villa'</td>
<td>spouted clay lekane; wine press</td>
<td>accompanied by collecting vessel</td>
<td>Marinatos 1952, 266, 272; Marinatos and Hirmer 1960, 140, fig. 62 above.</td>
</tr>
<tr>
<td>Mochlos</td>
<td>LM I</td>
<td>settlement</td>
<td>stone mortar 'for crushing olives'</td>
<td>0.35 m height, 0.50 m diam. with spout; olive stones nearby</td>
<td>Soles and Davaras 1993, 59.</td>
</tr>
<tr>
<td>Vathypetro</td>
<td>LM I</td>
<td>'villa'</td>
<td>stony flat surface; olive-crushing bed or wine press</td>
<td>stone made collecting vessel</td>
<td>Marinatos 1951, 103, fig. 3; 1952, 272; Marinatos and Hirmer 1960, 140, fig. 62 (below).</td>
</tr>
<tr>
<td>Palaikastro</td>
<td>LM Ib?</td>
<td>town</td>
<td>spouted clay lekane; oil separator</td>
<td>accompanied by pithos</td>
<td>Bosanquet 1902–3, 279.</td>
</tr>
<tr>
<td>Palaikastro</td>
<td>LM I</td>
<td>town</td>
<td>wine press</td>
<td>'bed' supported by two house walls and by another wall built for this purpose; collecting vessel</td>
<td>Dawkins 1902–3, 295.</td>
</tr>
<tr>
<td>Palaikastro</td>
<td>LM I</td>
<td>town</td>
<td>spouted clay lekane; oil separator</td>
<td>associated with pithos</td>
<td>Bosanquet 1902–3, 288.</td>
</tr>
</tbody>
</table>

**TABLE 3 (continued)**
<table>
<thead>
<tr>
<th>Location</th>
<th>Period</th>
<th>Type</th>
<th>Purpose</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palaikastro</td>
<td>LM IA</td>
<td>town</td>
<td>spouted clay lekane; oil separator</td>
<td>1 on the floor; no collecting vessel</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>MacGillivray et al. 1987, 151, pl. 24f.</td>
</tr>
<tr>
<td>Gournia</td>
<td>LM I</td>
<td>town</td>
<td>spouted clay lekane; oil separator</td>
<td>1 no collecting vessel</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Boyd-Hawes et al. 1908, 28.</td>
</tr>
<tr>
<td>Gournia</td>
<td>LM I</td>
<td>town</td>
<td>spouted clay lekane; oil separator</td>
<td>1 originally placed on a bench</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Boyd-Hawes et al. 1908, 27–8, fig. 11; Silverman 1978, 158, fig. 25f.</td>
</tr>
<tr>
<td>Kommos</td>
<td>LM II/III</td>
<td>town</td>
<td>slab with spout and circular cavity; wine press (Shaw); oil press (Blitzer)</td>
<td>1 standing on a built platform; remains of pithos underneath</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Shaw 1978, 119, pl. 35; Blitzer 1995.</td>
</tr>
<tr>
<td>Kommos</td>
<td>LM I–II</td>
<td>town, building T</td>
<td>stone spouted shallow basin</td>
<td>1 from the fill</td>
</tr>
<tr>
<td>Kommos</td>
<td>LM III</td>
<td>town</td>
<td>spouted stone basin; oil and/or wine processing equipment (Shaw); oil press (Blitzer)</td>
<td>1 on a built platform; evidence for collecting vessel</td>
</tr>
<tr>
<td>Knossos Strat. Museum</td>
<td>LM III</td>
<td>'palace'</td>
<td>stone table; olive-crushing bed</td>
<td>1 no information</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Warren 1983, 73.</td>
</tr>
<tr>
<td>Knossos</td>
<td>LM II–III</td>
<td>unexplored mansion</td>
<td>spouted trough; installation for 'washing processes or producing olive oil'</td>
<td>1 large, ovoid in shape</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Popham et al. 1984, 6, 233; pl. 242c.</td>
</tr>
<tr>
<td>Phaistos</td>
<td>LM III?</td>
<td>'palace'</td>
<td>?</td>
<td>1 ovoid stone basin bending in a U-shape reservoir</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Kopaka and Platon 1993, 63, fig. 27.</td>
</tr>
<tr>
<td>Palaikastro</td>
<td>LM III?</td>
<td>town</td>
<td>'primitive form of olive press'</td>
<td>1 circular stone in a raised platform; trough immediately west of it</td>
</tr>
<tr>
<td>Palaikastro</td>
<td>LM</td>
<td>town</td>
<td>olive-crushing bed</td>
<td>1 circular shape stone, 0.52 m in diameter 'with a circular runnel on the upper face and rim raised above the central part'</td>
</tr>
<tr>
<td>Kommos</td>
<td>LM III</td>
<td>town</td>
<td>clay lekane with long spout; oil separator?; for perfume production? (Shaw); metallurgical installation (Blitzer)</td>
<td>1 circular shape, 0.34 m diameter</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Shaw 1977, 208, pl. 49b; Blitzer 1995.</td>
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positive indication of their use as wine presses in particular, since oil separators would not require collecting vessels underneath for the water: a channel carved in the floor would have been sufficient, unless drainage is very difficult. Also, the stone basins with spouts are perhaps rightly attributed to olive crushing, for two main reasons: first, being made of stone they are suitable for this task which requires hard surfaces and, secondly, being shallow they are not suitable for other tasks such as grape pressing, washing etc. which involve relatively large quantities of liquid. Serious doubts must be expressed, however, about the ‘olive-crushing bed’ of the Stratigraphic Museum at Knossos. Neither its morphology (shapeless stone table) nor its context or comparative evidence (none) justify its interpretation.

The great majority of these installations comes from the second palace period, with three exceptions. Myrtos is one, but the clay lekanai from Myrtos are found without any accompanying vessel and it is therefore very doubtful whether they were used as wine presses or oil separators. As the excavator notes (Warren 1972, 138-9), they could have been used for washing vegetables or wool. Indeed, the chromatography analysis of one of them has shown that the lipids found in it were of animal origin rather than plant, pointing to its possible use for wool washing (Bowyer 1972). The second exception is the fragment of a clay lekane from EM II Knossos but since there is no evidence for a spout or collecting vessel connected to this artefact it is again doubtful whether it had been a grape- or/and olive-processing facility. The third exception is the clay lekane with pithos from MM I Mallia.

It is also interesting that the artefacts associated with oil production come from the new palace period and the later phases and that during the ‘Mycenaean’ period they become larger in shape and possibly more specialized in function with separate crushing and pressing equipment (cf. Kommos-Blitzer 1993, fig. 2 probably for crushing and fig. 3 probably for pressing).

The spatial context of these artefacts is also of interest: with the exception of the finds from EM Myrtos discussed above, they all (with one possible exception, that of Zou) come either from palaces or from settlements of relatively high rank (Fig.1). These are the important large towns of Gournia, Kommos, Palaikastro and Petras and country buildings or ‘villas’. It is worth noting that at Palaikastro the wine press comes from a room with frescoes (MacGillivray et al. 1992, 126–8) and the ‘oil separator’ from Building 2 which has been described by the excavators as ‘amongst the richer’ of the town (MacGillivray et al. 1987, 151). The Petras find comes from a house with a second floor and wall paintings (Catling 1987, 59). The Zakros presses come from the ‘town’ and not directly from the palace but this does not mean that wine processing is an activity unrelated to the palace. First, at Zakros there are no clear boundaries between the palace and the town and, secondly, all the food-processing activities seemed to have taken place in buildings outside the main palatial complex (Chrysoulaki and Platon 1987, 83). As for the ‘villas’, leaving aside the interesting but unsolved problems of their precise social function (see Bonias 1986; Cadogan 1971; Cherry 1978; Hagg and Marinatos, in press; Halstead 1981; Hood 1983; Watrous 1984), it is commonly recognized that many of the neopalatial ‘villas’ are not ordinary country houses since their architecture and finds imply concentration of wealth and high status occupants, as well as some sort of relation with the palaces. In our case, the ‘villas’ of Vathypetro, Epano Zakros, Profitis
Ilias, Azokeramos all seem to be high-rank settlements (note the existence of frescoes at Profitis Ilias, of a second floor at Azokeramos, of both at Epano Zakros, etc.; also Vathypetro is probably the ‘villa’ which architecturally is closest to the palaces — Marinatos and Hirmer 1960, 66). The same can be said for the isolated house (Building 4) from Archanes: Fourni cemetery. Not only its clear connection with the palatial centre of Archanes: Tourkogeitonia (Sakellarakis and Sapouna-Sakellarakis 1991) but also its architectural arrangement and finds (which included seal stones, for example) point to a high-rank building.

Most of the above artefacts are accompanied by in situ collecting vessels, suggesting a more probable use as wine presses than oil separators. Artefacts which have been classified as olive-crushing beds are relatively rare. The Kommos installations require some further discussion here, given the controversy surrounding their functional attribution. Blitzer’s interpretation of artefacts as oil installations is accepted here (contra Shaw, and Palmer 1994a who regard them as wine presses), for the following reasons: a) although the two artefacts found in situ are accompanied by collecting vessels, their raw material (stone) makes them more suitable for olive crushing or pressing which require a hard surface; b) the two basins are shallow and thus unsuitable for grape pressing which produces abundant liquid and so requires deep basins. The circular table with the spout (Blitzer 1993, fig. 3) is totally flat and could form the basis for a wooden basket, functioning thus as a wine press (similar to examples illustrated in classical vases) but close observation reveals that the spout is very narrow and so meant to facilitate the pouring of a liquid running in small quantities such as oil produced after pressing, and not the abundant liquid and solid substances of the must, produced by grape pressing; c) close to the installations, stone weights were found which might have been used with wooden beams (Blitzer 1993, 167), an apparatus typical of oil presses in later periods.

**Documentary evidence**

i) *Olives/oil*

The ideograms for olives and oil exist not only in Linear B but also in Linear A and Cretan ‘hieroglyphic’ (Ventris and Chadwick 1956, 31) indicating their use by humans from the period of the first palaces. Linear B offers information on the subject which, despite the large volume of studies, remains ambiguous. We certainly know that the palaces kept (or controlled?) olive orchards (e.g. the Gv series from Knossos-Ventris and Chadwick 1956, 272–4) but archival evidence for the use of olive oil as a basic foodstuff is very doubtful or non-existent. In contrast, the archives offer very clear evidence for the use of oil in the perfume and unguent manufacturing industry (possibly for anointing garments, as well — Palmer 1963; Shelmerdine 1985, 125) controlled by the palaces (Chadwick 1976; Foster 1974; Georgiou 1973; Killen 1995; Melena 1983; Palmer 1963; Shelmerdine 1985) and point to the ritual character of, at least some, oil consumption. E.L. Bennett long ago noticed that in the olive oil tablets from Pylos the names of the persons mentioned are chiefly divine, the places are partly sanctuaries and the occasions are mostly festivals (1958, 37–8). It is also important to note that sometimes the oil is earmarked for a particular festival (as in the Pylian tablets Fr 343, 1217, 1222 – Shelmerdine 1985, 124). The ritual character of some olive oil in the tablets is confirmed by the Knossian finds as in the series Fp
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(e.g. Chadwick 1966, 27–30). Thus olive oil moved towards the palaces as a sort of tribute and within the palace it was used either for festivals and other ritual activities or for allocations to palace personnel and officials for perfume and unguent manufacture and probably for personal use. Killen (1995, 220) has recently suggested that quantities of oil were also allocated to palace officials and élites (see below) who may have used it in external transactions.

The quantity recorded in the tablets referring to religious offerings is relatively small: it is usually c.91 and sometimes reaches c.291. (Baumbach 1979, 203) but for other transactions quantities are large: in Fh 372, for example, c.5400 l. are mentioned, possibly allocated to the palace official ku-pi-ri-jo for his own benefit (Killen 1995, 218).

Of considerable importance is also the suggestion that the majority (a ratio of 7 to 2) of oil used in perfume manufacture came from wild rather than domesticated olives. This suggestion, first expressed by Chadwick (1976, 122) although with reservations, was recently repeated by Melena (1983) who points out that oil from domesticated olives has a high fat content which makes it unsuitable for perfume use, in contrast to the oil from wild olives.

Was (1973, 15) has suggested that the Linear A tablet from Agia Triada HT 101 bears evidence that olive oil was also used as ‘payment’ for labour but given the speculative character of the discussion based on Linear A, the above information should be viewed with caution.

ii) Grapes—Wine

Wine and vines do not occur in the Linear B tablets with the same frequency as olives and oil (although, the ideogram for wine occurs in Linear A — Ventris and Chadwick 1956, 35 — and even in hieroglyphic at the Phaistos early palace — Palmer 1994, 27), a fact which not only explains the lack of many systematic studies on the subject but, more importantly, reveals something of their status within the Mycenaean economy. Palmer’s recent Ph.D. thesis (1989; 1994) has usefully summarised and discussed the evidence. According to her (1988; 1994, 60) vines were trained to climb up trees (possibly figs as they occur together in the tablets) as anadendrades, a cultivation method which reproduces the growth habit of the plant in its natural habitat. Wine (which was not produced by the palace directly) was not a staple of the Mycenaean diet but enjoyed a high status listed with foods such as meat, cheese and honey and it was never part of rations for lower palace personnel. Although the majority of references to wine are associated with ritual offerings there are indications of other uses such as in perfume manufacture and as ‘part of the price for imported alum’ (Palmer 1989, 183). Also of considerable importance is her observation that wine was not distributed by the palace on a regular basis as was done with other commodities, such as barley for example. Moreover, there is no indication of the existence of an administrative section or even a simple scribe specialising in the distribution of wine (1989, 80). Significantly, however, there are indications that wine may have been distributed by the palace in order to be consumed at certain ceremonies and feasts (Palmer 1989, 67–70; see also below).

The recorded quantities of wine vary considerably (Palmer 1989, 191). In the case of religious offerings it is usually small (1–31 l) especially at Knossos, but there are occasional tablets with large quantities, such as PY Un 2 listing 585 l., although this
ambiguous record probably lists menu for a large ceremonial banquet and it does not, therefore, represent strictly religious offerings (Killen pers. comm; cf. Killen 1994; Palmer 1994, 107). The distribution tablets usually list larger quantities as do the collection tablets (e.g. distribution tablet PY Vn 20: 110001.; possible collection tablet KN Gm 840: 140001.).

**Miscellaneous evidence**

We will not discuss in detail other finds which are sometimes used to support arguments for olive and grape cultivation or use. One such class of evidence is lamps. The EM lamps found in the Mesara tholos tomb (see for example Xanthoudides 1924, 14, 52, 63, 71, 97) have been used by Renfrew (1972, 286) as evidence for olive cultivation in the EM period. Lamps may, however, have used wax, animal fat or other sorts of vegetable oil such as poppyseed, sesame, flax, etc. (cf. Runnels and Hansen 1986), substances from plants documented archaeobotanically from Bronze Age sites outside Crete (e.g. flax: Argissa, Kastanas, Lerna, Pefkakia, Tiryns—Kroll 1991, 174–5; Assiros—Wardle 1989; opium poppy: Assiros, Kastanas, Tiryns—Kroll 1991, 174–5) and the use of which is recorded in the Mycenaean documents (Melena 1983).

Sometimes excavators encounter soil with a greasy texture which they interpret as evidence for oil (e.g. Cadogan 1978, 83; Evans 1921, 459), but this could have come from other sorts of lipids and not necessarily from olive oil. Any further speculations on this subject would require chemical examination of the soil.

Finally, the pictorial representation of olive and grape (e.g. Möbius 1935) is highly unreliable evidence, given the subjectivity of artistic expressions. Moreover, the artistic representation of a plant does not necessarily imply its use and *vice versa*.

**DISCUSSION**

The evidence presented above, taken as a whole, hardly illuminates the issue of olive cultivation and viticulture in Bronze Age Crete. The problems of the relatively low archaeological visibility of olive and grape remains especially in storage contexts, coupled with the drawbacks of Minoan archaeology, do not allow us to draw a conclusive picture of the issue. The first conclusion to be drawn from the above discussion is that a thorough investigation of the issue of olive cultivation and viticulture in Minoan Crete cannot rely only on the primary, direct archaeological evidence. Alternative approaches should be considered. Undoubtedly, however, the quantity and, to some extent, the quality of data have improved since the publication of *The Emergence*. Moreover, the attempt undertaken above to clarify the chronological and spatial correlates of the material allows for a more valid discussion.

The direct botanical and artefactual evidence does not support the idea that the systematic exploitation of olive and vine initiated in the EM period. Most of the evidence points to a later, more or less systematic, use of olives and vines which falls certainly within the palatial period. This is more so for olive exploitation since the isolated finds of one or two seeds from the EM period are very unreliable, the artefactual evidence doubtful and the pollen rain ambiguous in interpretation. The same applies to viticulture (note that none of the early clay spouted lekanai, for example, even when found *in situ*, resembles the later elevated installations with the collecting vessel at a lower level) with the exception
of the relatively large assemblage from Myrtos. Within the palatial period, the great majority of the evidence of all kinds points to a later palace and 'Mycenaean' date. Of great interest is also the fact that for the 'postpalatial' period there are no unambiguous installations related to wine production.

The occasional early finds of olive stones, grape pips and olive wood, and the Myrtos grape-pip assemblage in particular, may indicate opportunistic use of both crops from the beginning of the EM period in 'wild', 'domesticated', 'feral', or 'semi-wild' form. It is well known that the Mediterranean and the Aegean in particular falls within the geographical range of wild grapes and olives (Zohary and Hopf 1993). The author has encountered in Crete an uncultivated vine in a habitat resembling that of the true wild vine (stream bank), climbing other trees. Turland et al. (1993, 157) have also recorded its presence in the Fasas valley in west Crete. There exists the possibility that wild vines have survived until today, therefore, and anyway the presence of wild vines and olives from the Neolithic onwards is confirmed by the palynological record (cf. above the Tersana pollen diagram for olives — assuming that the identification of olive without SEM is correct — and Ag. Galini diagram for vines where their presence is documented from Neolithic times; cf also Turland et al. 1993, 120; Hamilakis unpubl. field notes, for the widespread occurrence of wild or feral olives in pre-modern times). The above finds, therefore, may well illustrate the occasional use of both plants during the EM period for many different purposes: as firewood, as fodder, as a source of oil and perfume or for the production of an alcoholic drink. It must be stressed here that wild grape fruits are edible and according to some authors (Núñez and Walker 1989, 220; Olmo 1976; Zohary and Hopf 1993, 144), the production of a kind of wine does not necessarily need the sweet, cultivated grapes, though others (e.g. Sherratt 1995 n. 90) disagree, pointing that in the later case an additional source of sugar is needed, which may alter the nature of the drink. Also, as Núñez and Walker remind us,

grape berries may be eaten by both human and animals, grape seeds may be pressed to give grape seed oil and the fermentation products of grape berries not only may be consumed as wine but also as vinegar ... (vinegar) plays important roles not only in preserving foodstuffs but also in pottery, where it prevents the sloughing and enhances the joining elements before vessels are dried and fired (1989, 228).

During the EM period, a sort of low-level management, control and protection strategy (from grazing, for example) might have been practiced, along with occasional use, which gave way to a more systematic exploitation during the later Minoan periods. (cf. Olmo 1976; Zohary and Spiegel-Roy 1975, for management of wild vines). Undoubtedly, considerably fewer EM settlements have been excavated than later (especially neopalatial) ones, but if systematic wine and oil production was practised in the EM period we should expect to find at least some artefactual evidence (of the sort we find in the later periods) in EM settlements such as Myrtos, Vasiliki, Trypiti, Ag. Photia, in EM buildings below later structures at sites such as Knossos, Phaistos, Mallia, Palaikastro, Ag. Triada, or in smaller settlements such as that of Debla and cave settlements in west Crete (Zoniana, Melidoni; see Branigan 1988 for EM settlements up to 1987, and Archaeological Reports for more recent excavations).

Systematic production of oil seems to have started during the second palace period and

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increased in importance, at least in some areas such as Kommos, during the ‘post-palatial’ period. It is worth noting here that the stirrup jar, a shape which has been connected to a specific precious liquid (it is very likely that this completely new shape was introduced for a new commodity and was established as a marker of that commodity, most probably oil: the narrow spout indicates a liquid which should be poured in small quantities and with care — cf. Haskell 1985, 223–5), is introduced during the neopalatial period but becomes more common and more widespread during the later periods (Haskell 1985). West Crete seems to have played a significant role in the circulation of stirrup jars in the Aegean (Catling et al. 1980; Haskell 1981, 245). By contrast, artefactual evidence for wine production during the ‘post-palatial’ period is lacking, assuming that the stone implements such as that from Kommos, Phaistos, etc. (Table 3) are for oil. Nevertheless, we know from the tablets that the production of wine continued, although the scale seemed to be lower than that of oil. This lack, however, may be related to a change in the scale of wine production and possibly to a change in the sphere of its circulation and consumption. The suggestion that wine in Linear B is an élite item may be significant in this respect.

Looking at the spatial distribution of these finds (Fig. 1) it is evident that most of them come from high-rank sites, palaces, large towns, or ‘villas’ of palatial character. This is more striking in the case of wine presses (or oil separators, according to some): all those of which the context can be defined (with the exception of the problematic material from Myrtos — see above) are concentrated in and around palaces (Mallia, Zakros), at élite houses in large towns (Palaikastro, Kommos, Gournia, Petras) or ‘villas’ or other isolated buildings with an architectural arrangement and finds indicating high rank (Archanes, Vathypetro, Epano Zakros, Profitis Ilias Sitias, Azokeramos Sitias; see above). One could claim that this picture is an artefact of archaeological research which is biased towards the large and important sites. This may be true to some extent, but in this specific case our point carries at least some validity: there is some evidence that lower-rank sites lack finds indicating viticulture and olive growing and processing. For example, in the case of Petras, at least four sites of the same date have been excavated completely or partially in the same area: the settlement at Agia Photia: Analoukas (Tsipopoulou 1991) and the farmhouses at Achladia: Riza (Platon 1955b, 1965; possibly part of a settlement), Piskokephalo: Klimataria (Platon 1955a, 1956) and Zou (Platon 1957, 1960, 1961a), in all of which the architecture and finds indicate lower rank in relation to Petras (cf. Tsipopoulou 1991; Driessen and MacGillivray 1989). None of these sites has yielded any evidence for wine production and only Zou yielded two artefacts which may have been used for crushing olives.

Also the documentary evidence offers some illuminating points: i) wine and oil were treated differently from the other agricultural products by the palatial authorities. Culinary use (in contrast to industrial and ritual use) is not documented and their distribution was not as regular as with cereals; ii) wine seems to have been a high rank item and its consumption may have been connected to feasting and drinking ceremonies, at least in some cases.

Looking very briefly at the archaeological evidence for vines and olives in the Eastern Mediterranean, the following picture emerges: according to Zohary and Hopf (1993, 148) botanical evidence (seeds and charred wood) point to signs of Vitis
cultivation as early as the Chalcolithic and Early Bronze Age in the Levant. This is based on the ambiguous assumption that since wild *Vitis* is absent today from Jordan and Judea and it is unlikely that it was grown wild in the area at the time, it therefore must be domesticated (1993, 149). From further east, from Godin Tepe, western Iran, evidence for wine production comes from a mid-third millennium BC jar which was found to contain tartaric acid suggestive of wine (Badler et al.1990). From the same site and period, artefactual evidence (pressing equipment) indicating wine production is also found (Badler in press). Charred pips are also found in Egypt from the beginning of the third millennium (Zohary and Hopf 1993,149). Finds of olive stones and charred wood from Chalcolithic Palestine have been described by Zohary and Hopf (1993, 141) as 'definite signs of olive cultivation' on the basis of the same assumption as with vine cultivation. Probable evidence for oil production comes from Chalcolithic sites in the Jordan valley where large amounts of crushed stones have been found (Neef 1990). In short, despite the ambiguity of much of the evidence (see above on the taphonomic and analytical problems), both vine and olive use and wine and oil production in the Eastern Mediterranean seem to pre-date similar developments in Crete.

CONCLUSIONS

In the work of most researchers of the Mediterranean Bronze Age until very recently, the stereotype of 'Mediterranean Triad' was dominant. They contemplated a more or less stable agricultural pattern in which cereals, vines and olives were systematically exploited from the beginning of the Bronze Age until a few years ago. The uncritical use of ethnographic analogy is, to a large extent, responsible for that. Recent archaeological, ethnographic and historical work suggests, however, that the picture is far more complicated, both chronologically and geographically (e.g. H. Forbes 1992, 1993; Triantafyllidou-Baladié 1987). The 'Mediterranean polyculture' hypothesis employed this stereotype in order to fulfil the requirements of the cultural-evolutionary model of 'subsistence-redistribution'.

Admittedly, given the nature of the evidence and the recovery and analytical biases of the archaeological research (Hamilakis in press 1), problems such as that discussed here, cannot be adequately addressed by using only direct archaeological data. Furthermore, in some respects, indirect data (such as drinking vessels, for example) can be more illuminating, provided that they are used within a certain theoretical framework, an attempt which is being carried out elsewhere (Hamilakis 1995). Nevertheless, the data presented and evaluated above (and mostly the processing installations which are more clearly connected to wine and oil production) show some strong indications which have to be taken seriously into account in any subsequent investigation. Agricultural patterns in Bronze Age Crete do not seem to conform to the dominant picture according to which vines and olives were exploited systematically from the beginning of the Bronze Age, constituting basic elements of the Minoan agricultural economy. Systematic wine production seems to have started in the first-palace period, reaching a peak in the second-palace period. Systematic production of oil seems to have started in the second-palace period and intensified during the 'post-palatial' period. Both products show a strong association with the élites. This has implications not only for the study of the Minoan agriculture (e.g. status of the products under consideration,
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scale of production and consumption), but also for the investigation of the development of authority in general and the palatial institutions in particular. The ‘Mediterranean polyculture’ hypothesis does not seem to find support from the direct archaeological data. Alternative models for the development of institutionalised hierarchy in Crete should, therefore, be investigated and tested. More importantly, wine and oil production and consumption disconnected from the ‘Mediterranean polyculture’ hypothesis, can acquire a more active role shedding light on crucial aspects of Minoan society involving the relation between crops, consumption patterns and the reproduction and legitimisation of authority.

The association of vine- and olive-related finds with palatial and second-order centres indicates that these crops and their products may have played a role other than that of the widely and systematically exploited subsistence crops. This role has to be understood within a different theoretical framework from the one employed so far, framework which should emphasise the aspect of demand and the dialectics of consumption: the potential of wine and oil as items participating in complex social interactions such as feasting and drinking ceremonies and intra-elite gift exchange. These social processes, the importance of which has been repeatedly emphasised in the anthropological literature (for recent discussions on feasting and drinking with some examples cf. Brumfiel 1987, 1989; Hamilakis 1995, in press 2; Sherratt 1987, 1991, 1995; the literature on the social significance of gift-exchange is plentiful and well known), in their turn, may be connected to the development of power in Bronze Age Crete. The systematic production and use of wine from the first-palace period onwards may have served the need for large-scale feasting and drinking. These events may illustrate a social strategy of the established élites aimed at the consolidation and legitimisation of power, exploitation of labour (capitalising on what might have been perceived as conspicuous generosity) and attraction of a retinue, out-competing rival élites at the same time. This argument is supported by the fact that wine-related finds reach their peak at the second-palace period when more first and second order centres appear, some in close proximity, indicating possible intensification of factional competition (cf. Brumfiel and Fox 1994), although some circulation of wine outside Crete at the time is also likely. By the same token, the evidence of the decrease of wine consumption in the ‘post-palatial’ period may indicate a decrease of such competition, in a period when it is well known that centralization of power was brought about with very few centres still thriving. The evidence for the beginning of the systematic exploitation of oil during the second-palace period coincides with the evidence for intensification of external contacts from this period onwards, supporting the argument for its use as an élite item, most probably as a base for perfumes and unguents. The above arguments are discussed in greater detail and tested elsewhere (Hamilakis 1995).

The results discussed above have also wider implications (which require a more extensive consideration) both for the theories on the emergence of social stratification in Europe, and for ecological archaeology in general. For the first, they cast serious doubts on the argument emphasising the managerial role of élites, and suggest that consumption rather than production might prove a more illuminating approach to the problem. For ecological archaeology, they suggest that ecofacts alone can prove an inadequate source of information, not only for addressing complicated issues of social
relations but even for reconstructing agricultural practices. Moreover, they point to the need to consider the potential of crops in acquiring an active role in the dialectics of power, rather than viewing them as simply nutritional sources and ascribing to them a passive role in the discourse of subsistence.

Acknowledgements

This paper is based on a Ph.D. dissertation submitted at the Department of Archaeology and Prehistory, University of Sheffield (January 1995). I would like to thank Paul Halstead, my thesis supervisor, for reading many versions of the chapter on which this paper is based (saving me from many mistakes as well as correcting the English) and for being such an invaluable source of help, ideas and humour; Keith Branigan, my thesis advisor for comments and support; and the following people for comments, discussions and for kindly giving me access to unpublished data and sending me off-prints of their work: Harriet Blitzer, S. Bottema, Chr. Boulotis, Glynnis Jones, Athanasia Kanta, J. Killen, Dimitra Mylona, Anaya Sarpaki, Tom and Jennifer Shay, J. Soles and especially Andrew Sherratt for inspiration, encouragement and many useful comments. I am responsible for the remaining errors and mis-understandings. The figures were drawn by Vangelio Kiriatzi (Fig. 1) and David Schofield (Fig. 2). The Onassis Foundation funded the last year of the project on which this paper is based.

Department of Archaeology
University of Wales
Lampeter
Dyfed
SA48 7ED
Wales

ABBREVIATIONS

AJA  American Journal of Archaeology
AR  Archaeological Reports
ArchDelt  Arkhaiologikon Deltion
BCH  Bulletin de Correspondance Hellénique
BICS  Bulletin of the Institute of Classical Studies (London)
BSA  Annual of the British School at Athens
Cretological Proceedings of the International Cretological Conferences (1–7)
Ergon  Ergon tis Arkhaiologikis Etairias.
JAS  Journal of Archaeological Science
PCPS  Proceedings of the Cambridge Philological Society
Prakt  Praktika tis Arkhaiologikis Etairias.

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