Coats of Many Colours: Dyeing and Dyeworks in Classical and Hellenistic Greece

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Abstract

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In the past, craft production in Classical and Hellenistic Greece has been studied mainly from a technological or social perspective. On the other hand, the study of ancient economies has largely neglected the role of craft production in favour of issues such as the nature of ancient economies, mechanisms for the exchange of goods, and the roles of agricultural production and slavery in economic activity. In this study I hope to have redressed this by looking at dyeing activity from an economic and social perspective. I have used a range of archaeological and historical evidence to build up a picture of the way dyeing (and by extension craft production) fitted into the subsistence strategies of the Classical and Hellenistic Greek household. The range of ingredients used, including dyes, fibres and chemical substances, and the nature of the processes carried out by ancient Greek dyers, are discussed. A methodology for the identification of dyeing activity in the archaeological record is proposed. Following a discussion of previous approaches to the study of ancient economic activity, a framework for the study of craft production in its economic and social context is also proposed. The evidence for dyeing activity in Classical and Hellenistic Greece is then analysed with reference to this framework, in order to assess the organisation and level of specialisation of dyeing and the way it fitted in with other subsistence activities on a seasonal basis.

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Chapter 1

'You Set the Scene': Introduction

The aim of this study is to provide an account of the economic and social role of dyeing in Classical and Hellenistic Greece. To this end, it will include discussions of the ingredients (chapters 2 and 3), equipment and processes (chapter 4) used by Classical and Hellenistic Greek dyers, and how these can be identified in the archaeological record (chapter 5). In order to set dyeing in its economic context, approaches to the study of ancient economic activity, and craft production in particular, will be evaluated (chapter 6). The organisation of dyeing activity, as identified in the archaeological and historical record, will then be investigated, as will the level of specialisation of dyeing activity. The seasonal aspects of dyeing will also be considered, in order to assess how it links to other craft production activities (chapter 7). Finally, the role of dyeing in the economic activity of the household will be discussed (chapter 8).

This chapter will aim to set the scene for this study by setting out the nature of the evidence available for studying Classical and Hellenistic Greek dyeing. The uses of textiles in Classical and Hellenistic Greek dyeing will also be reviewed, in order to show the importance of undertaking a study such as this. The chronological focus of this work is the period from roughly the start of the fifth century BC to roughly the middle of the second century BC. It is worth stressing that these are not fixed boundaries, and it is important to consider the periods before and after these somewhat arbitrary cut-off points, particularly since the Classical and Hellenistic Greeks themselves would not have noticed huge social and economic changes the moment a particular historical period ended.

1.1 Sources of evidence for studying dyeing

There is a wide range of evidence, both archaeological and historical, for many aspects of dyeing in Classical and Hellenistic Greece. Literary sources provide a great deal of important information on dyeing activities in Classical and Hellenistic Greece. There are no sources from Classical and Hellenistic Greece which are specifically about dyeing. A wide range of ancient texts do contain references to dyeing activity, however, and they will be discussed below. These references are generally incidental, used to add colour to a play or story, or are used to illustrate theories presented by philosophers, and it is important to be aware of the reasons for their inclusion in texts when one is seeking to interpret them. Despite the fragmentary nature of the literary evidence for dyeing, however, it is possible to produce a

partial picture of Classical and Hellenistic Greek dyeing activity. All translations given in the text are taken from the works cited in the Bibliography unless otherwise stated.

A variety of different types of literary sources contain evidence of dyeing activity, including 'scientific' or philosophical works, 'histories', plays and poems. For example, 'scientific' works, such as those of Aristotle and Theophrastus, contain a number of references to dyes and dyeing processes. Aristotle's 'scientific' treatises include the *Historia Animalium*, which was an investigation into the natures of animals. This was made up of '*historiae*', 'things worthy of note' (French 1994:1), which would explain how the natures of animals fulfilled themselves (French 1994:43-44), their '*telos*'. Aristotle believed that every animal had a final purpose for existing, and its life led to the fulfilment of this purpose (French 1994:89). This approach affects how Aristotle writes about the purple shellfish (*HA* 528b 18-529a 25 and 546b 15-547b 11): a large part of this discussion is taken up with the reproductive habits of the shellfish, which reflects the fact that for Aristotle this was its true purpose; though another important feature of the nature of this particular animal is the purple dye produced from it. The accounts of the production and use of this dye, as well as the other general facts given by Aristotle, can therefore be seen to be *historiae* which serve to explain how this aspect of the nature of this creature was fulfilled. Other Aristotelian treatises contain accounts of parts of the dyeing process. The *Meteorologica* contains an allusion to the dyeing process in a discussion of the reasons why some things are boiled: once again this is in the context of providing interesting facts which illustrate the natures of various natural phenomena (French 1994:28). The dyeing references in the Aristotelian treatise *On Colours* deal with the reasons and mechanisms for things being coloured.

Theophrastus was Aristotle's pupil and successor as head of the Lyceum, and he also produced a number of treatises about natural phenomena which contain references to dyeing. This may be in part because his father was supposedly a fuller (Theophrastus *De Causis Plantarum* 'Introduction' p.vii), which may have meant that he had a certain amount of practical knowledge of, and interest in, textile production. His approach differs from that of Aristotle, however, and this has implications for the usefulness of his work for this study. In the *Enquiry Into Plants*, for instance, Theophrastus discusses the 'natures' of plants, describing their parts and reproductive systems; however, he defines the 'nature of a thing' differently from Aristotle, and does not share Aristotle's theory that everything had a final purpose for existing. This work is therefore also a collection of *historiae* which illustrate the natures of plants, as well as simply things worthy of report. Moreover, Theophrastus thought that one of the most valuable purposes of plants was to produce fruit for people, and also that

plants were at their most perfect when in bloom and producing fruit. As a result, he does not always discuss the uses of plants in dyeing, since this is not their ultimate purpose. Saffron, for example, is described in some detail (*Enquiry Into Plants* 6. 6. 10), although its use as a source of dye is not mentioned. Where plant dyes are mentioned, they are produced from fruits (or are thought to be so, for instance *Enquiry Into Plants* 3. 8. 6), or are seaweeds and lichens which may have been thought remarkable and exotic (for instance *Enquiry Into Plants* 4. 6. 5). The uses of plants in fulling and tanning are mentioned (for instance *Enquiry Into Plants* 9. 12. 5), perhaps as a result of his personal experience.

A writer of a collection of *historiae* such as Herodotus occasionally mentions specific things relating to dyeing and textile production when they are interesting or exotic. Most references to aspects of dyeing in Herodotus' *Histories* however are incidental, and do not give details about the precise nature of dyeing activity. References to dyeing in plays and poetry are similar; they provide tantalising glimpses of aspects of dyeing processes and ingredients, but do not give details. For example, a playwright may make one of his characters say that she will dye with saffron (Aristophanes *Lysistrata* 51), but does not make clear exactly how this will be done. It is probably to be assumed that the intended audience (in this case Athenian citizens in the fifth century BC) would have been familiar with the dyeing processes, and that further elaboration is not necessary and also would not suit the purposes of the play. These sources do however provide a large amount of valuable evidence, from references to coloured textiles, allusions to parts of the dyeing processes, and other references, which can be combined to provide insights not only about the processes and ingredients used in dyeing but also the place of dyeing in society as a whole. These literary sources are supplemented by epigraphic evidence, which also contains references to coloured and decorated textiles, as well as to aspects of the organisation of dyeing activity.

The nature of the available Classical and Hellenistic Greek sources, therefore, is such that it is necessary to look elsewhere in the historical record for further information. To this end, a number of sources that were written outside the period covered by this study can be used, although this is not without problems. Two such sources are Pliny's *Natural History* (hereafter *NH*) and Dioscorides' *Greek Herbal*, both written in the first century AD. Both authors rely heavily on earlier Greek sources, which they list in their respective works, and add further information about dyeing activity.

Pliny, while also citing a number of earlier Latin authors, uses mostly Greek sources, principally Aristotle and Theophrastus. He also uses a number of works which are no longer extant, by authors such as Democritus (French 1994:218-223), in order to achieve his purpose of making a complete survey of the facts about the natural resources available for the use of

the Romans (French 1994:207). Pliny's philosophical interests were different from those of Aristotle and Theophrastus, and often he appears simply to take 'facts' from their works in order to express his idea that 'nature' created all things for the good of man. In the case of the murex, for example, he more or less copies word for word parts of Aristotle's description of the creature and then adds practical information about the methods of dyeing and delivers a sermon about the luxury and moral decline of Roman society (*NH* 9. 124-141). In his medical work the *Greek Herbal* Dioscorides, a Greek doctor, uses similar sources to Pliny, such as Theophrastus and the Greek medical text of Sextus Niger, which also draws on a number of earlier sources, in his description of plants useful in medicine. Since his main aim is to provide medical information, Dioscorides mentions only in passing that certain plants can also be used as sources of dyes or textiles.

As these sources were written outside the area and period of this study, however, they cannot be used without some qualification. Although they provide a great deal of information on potential sources of dyes, for example, I will not always rely solely on their evidence where there is no corroboration from sources written within my study period. However, it is likely that dyestuffs known to these writers (especially to Dioscorides, who wrote in Greek) were also known to people earlier than them, particularly given the fact that many of the sources for Pliny's work at least were Classical and Hellenistic Greek writers.

Another later work which contains useful information for this study is the *Papyrus Holmiensis*, which was written in Egypt in the third century AD (Balfour-Paul 1998:124) but may have derived from Hellenistic works (Forbes 1956:128). This papyrus, one of the only ancient sources which are actually about the dyeing process, is a work of 'chemistry' or alchemy, and contains instructions for dyeing a wide range of materials, including stones and also textiles. As a result, a large part of the papyrus is devoted to a number of dyeing recipes, which give details of the ingredients, equipment and processes used, and the colours produced. However, while this may contain some material from the Hellenistic period, the recipes within it are also likely to have been updated to include the latest methods available to dyers up until the time when they were written, and may not all have been used by earlier dyers. Another papyrus, the *Papyrus Leidensis*, dates from a similar period and has a similar content to the *Papyrus Holmiensis*. Moreover, these papyri derive from Egypt, and the methods and ingredients of dyers there may not all have been the same as those of their counterparts in Greece. They are not entirely irrelevant however, as a number of the basic principles and processes may have been common to dyers from the Classical and Hellenistic periods (and earlier) as well as the late Roman period and across a wide geographical area.

The chemical processes taking place in the dye vat did not change over time, and the ways that dyers coped with them may also have remained the same.

There is also a great deal of modern comparative information relating to dyeing which can be used in the study of Classical and Hellenistic Greek dyeing. This includes accounts of natural dyeing carried out in 'primitive' societies as well as in Western societies today, since where chemical dyeing techniques are not used the principles of natural dyeing are the same today as they were in Classical and Hellenistic Greece. These accounts then can be used in conjunction with Classical and Hellenistic Greek accounts and the *Papyrus Holmiensis* to build up a detailed picture of the dyeing process. Another area where modern information is useful relates to the availability of dyestuffs. A number of the plants used as sources of dyestuffs by Classical and Hellenistic Greek dyers still grow in Greece today, and information relating to them is valuable. It is possible to use these modern botanical accounts to suggest a number of potential dyestuffs, consisting of those plants and animals which are found in Greece and can be used in dyeing, whether they are mentioned only by later authors such as Pliny and Dioscorides or whether there is also modern evidence for their use.

The picture of dyeing activity produced from the historical evidence is complemented by evidence from the archaeological record. Through the excavation and/or survey of sites of dyeing activity (where they can be identified) evidence of the equipment and ingredients used by dyers can be produced. This can prove useful in shedding light on dyeing processes and the organisation of dyeing activity. It is often very difficult to find evidence of dyes and textiles in the archaeological record, since the fact that they are organic materials means that in many cases they are not preserved due to conditions in Greece. Moreover, there has not been any significant tradition of recovering plant remains in Greek archaeology. There are instances where dyed textiles have been preserved, however, and in these cases chemical tests can be used to identify the dyes used. The equipment used for dyeing is often more visible in the archaeological record, and also more likely to have been preserved, especially if it was specially constructed. There are also more general features of archaeology in Greece which have meant that identifying evidence of dyeing, especially in published reports, is difficult. To a large extent areas of housing and workshops have been neglected in Greek archaeology until recently, and the emphasis has largely been on monumental structures. There are some significant exceptions to this, including the well-excavated urban sites of Olynthus in Northern Greece and Halieis in the Argolid, as well as areas of settlement at Isthmia and Mycenae. This is partly as a result of the continued occupation of many ancient settlements: it is extremely difficult to excavate large areas of ancient Athens, for example (although some

areas of housing in Athens have been excavated). The sites referred to above which have seen large-scale excavations of housing areas are all abandoned now.

Much of the secondary sources related to dyeing in Classical and Hellenistic Greece are influenced by the work of Forbes (1956), who covered dyeing in the ancient world from the early Mesopotamian civilisations to the Roman Empire. This work draws on a wide range of material, including Classical and Hellenistic Greek literary sources as well as the papyri mentioned above and a wide range of other historical material, and seems to concentrate on ancient Egypt, the Near East and the Roman Empire. Forbes (1956) relies to a large extent on the work of the Elder Pliny when constructing his account of dyeing in the Classical world (i.e. 'ancient Greece' and Rome), as well as on scholarship from the early twentieth century (such as the work of Pfister (1935)). Much of the scholarship relating to ancient dyeing in the second half of the twentieth century seems, to a large extent, to be based on Forbes' account, with the result that there has been very little new work dealing with this area. In terms of archaeological scholarship, many of the sites identified as dyeworks in Classical and Hellenistic Greece seem to be evaluated in comparison with the site on the Rachi hill at Isthmia (see Appendix, 10) which was published initially by Broneer between 1955 and 1962, and formally published as a dyeworks by Kardara in 1961, after comparison with sites from the near east (although its identification as a dyeing site has recently been reassessed by Anderson-Stojanovic (see for instance 1996, 1997)). This site has often been used by others as an example of a dyeing site (see for example White 1984), against which to evaluate other potential sites of dyeing activity. As a result, many potential dyeing sites have not been analysed in a way which can attempt to identify their purpose without automatic comparison to one particular site.

As with the historical evidence, it can be seen that the archaeological evidence for dyeing is not complete. However, there is still a great deal of archaeological material which can shed light on ancient dyeing activity. When this is used in conjunction with historical evidence, it is possible to produce a detailed account of the ingredients, equipment and processes used by Classical and Hellenistic Greek dyers, and the way in which dyeing activity was organised in the context of the economic and social life of Classical and Hellenistic Greece.

1.2 Textiles in Classical and Hellenistic Greece

Before discussing dyeing in detail, it is necessary first to give a brief account of the kinds of products which were dyed, and the colours which were produced. This section will begin with the kinds of textiles produced in Classical and Hellenistic Greece and their uses. A

brief discussion of the range of colours produced by dyers will follow. These topics will be fully covered in chapters 2, 3 and 4. It is also important to consider the role played by textiles in society, as this would have influenced their form and the way they were used.

Textiles played an important role of Classical and Hellenistic Greek life. They had a wide variety of uses including clothing, bedding, carpets and curtains. There are references to a variety of different garments worn by Classical and Hellenistic Greeks, although these all seem to have been very similar, and there was very little difference in the construction of men's and women's clothing. There was however a great deal of difference in the way men and women wore clothing. Generally ancient Greek clothing was very simple in form, and most garments were made from a single large piece of cloth. Different garments were formed by the method of folding the cloth, and the actual material it was made from. Garments included the *chiton*, a unisex 'tunic', and the *peplos* (a female dress) which were often made from fine cloth such as linen. The *chiton* consisted of a large rectangular cloth wrapped around the wearer and folded at shoulder height to create a flap. It was fastened at each shoulder with pins (Houston 1947:39-42). A belt could be worn with the *chiton*; the exact positioning of the belt in relation to the flap varied, and different effects could be created by wearing the belt to produce variations in the shape of the garment. The open side of the *chiton* could be sewn up, as could the shoulders. The *chiton* could be worn at a number of lengths, by varying the folds of the cloth (Houston 1947:42-62). If one required more mobility, perhaps for working, only one shoulder was pinned (Houston 1947:46).

Outer garments worn by both sexes included the *himation* and *chlamys*, both forms of cloak made from heavier materials such as wool (Brunello 1973:93-94). Another type of cloak worn by men was the *tribon* (Davidson 2000:147), while women sometimes wore a *pharos* (Brunello 1973:94). These cloaks were again rectangular cloths which were folded and fastened in a range of ways to achieve different shapes and styles. The simplest was to throw the cloak over one shoulder and hold it in front; a more elaborate way of wearing the *himation* involved wearing it over one shoulder and under an armpit, folding it to produce a number of pleats (Houston 1947:62-70). Women also wore veils (Brunello 1973:94).

These textiles came in a variety of colours and patterns. Different weaving techniques were used to produce different patterns, including ornamental borders (*IG* II² 1514 ii 54-55), stripes (*IG* II² 1514 ii 45-47) and spots (*IG* II² 1514 ii 6-7). Textiles could be woven with writing (*IG* II² 1514 ii 7-9) or figures all over, perhaps telling a story, or in panels in one part of the cloth (Barber 1992:109-116). A wide range of colours and shades were used in these patterns, and also to colour whole textiles: they include purple (see for instance Euripides

Orestes 1457-1458); red (see for instance Aristophanes *The Peace* 173-174); yellow (see for instance Aristophanes *Thesmophoriazusae* 253); green (see for instance *IG* II² 1514 ii 16-17); white (*IG* II² 1514 ii 15-16); and black (Euripides *Helen* 1186-1187). The sources of these colours will be discussed in detail in chapter 2.

Textiles played a very important part in Classical and Hellenistic Greek society. They were not only used to provide warmth and ornament, but also to convey different messages and meanings. For instance, textiles were an important and valuable form of property, particularly for women. Foxhall and Stears (2000) suggest that clothing fell under female control, and that all women owned at least some. The production of textiles was an important economic activity and was generally carried out by women, and it is argued (Foxhall and Stears 2000) that all textiles produced by women within a household belonged at one level to women, since they made them. In legal terms, in Athens women owned textiles as a form of wealth, which they took with them into marriage and retained in the event of divorce (Foxhall and Stears 2000).

As well as being an important form of wealth, textiles could also be used to indicate wealth and status. For instance, in Classical Athens the cloak a man wore gave out information about his character and level of wealth. A man who wore a *tribon*, for example, was thought of as modest and poor, or may even have had Spartan or oligarchic sympathies; someone wearing a *chlamys* on the other hand was thought of as wealthy (Davidson 2000:147). Women's clothes also carried a number of meanings. Clothing made from diaphanous fabric was considered seductive: in Aristophanes *Lysistrata* (40-48, 148-156), women are told to wear diaphanous robes in order to distract their menfolk from thoughts of war. Prostitutes also wore diaphanous clothes (Davidson 2000:146-147). On the other hand, the ideal woman, at least in Athens, wore clothes which were not revealing and covered most of her body (Davidson 2000:144-145). Clothes could also be used to express the stages of a person's life, since a number of 'rites of passage' (at least of women) involve the use of textiles; these include the dressing of both the bride and the corpse for instance (Foxhall 1998).

Colours could also indicate wealth and status. Purple for example was very expensive and prestigious (see Aeschylus *Agamemnon* 958-963), and therefore purple textiles were a sign of wealth. In many cases textiles were not wholly purple, which would have been extremely costly and available only to a few, but contained some purple as an indication of a certain degree of wealth and status. This may have been in the form of embroidery (such as the *peplos* dedicated to Athena by the Athenians at the Panathenaic festival (Barber

1992:116)), perhaps as an ornamental border (*IG* II² 1514 ii 54-55) or a stripe (*IG* II² ii 1514 45-47). In this way, people who were not able to afford a purple *chiton* could still demonstrate that they were fairly wealthy and able to afford certain high status items; in the same way, few people today can afford an Armani suit but Armani belts, for example, are within the budget of large numbers of people. As well as indicating wealth, different coloured textiles were associated with different groups in society. Yellow was essentially a female colour, and it is associated with women through myth and ritual: the *peplos* dedicated to Athena at the Panathenaia was yellow, for example (Barber 1992:116). Yellow clothes are also used to imply femininity by Aristophanes; in the *Thesmophoriazusae* (253, 939-942) men dress up in yellow clothes to pass as women and infiltrate a women-only festival. Other colours were associated with particular contexts; for instance white was a colour of mourning, and so the clothes worn by mourners were white or grey (Foxhall and Stears 2000).

1.3 Conclusion

It can be seen from this brief survey that textiles had an extremely important role in Classical and Hellenistic Greek society. Their colours seem to have been an important feature, serving to indicate for instance wealth and status as well as gender. It can be seen from the range and importance of colours indicated by ancient sources that dyeing was a widespread activity which affected everyone. It was also an activity that could have been carried out by large numbers of people. Dyeing was not only socially important however: the widespread use of coloured textiles indicates that it was also important in economic terms. However, this has not been reflected in previous scholarship, which has to a great extent neglected certain aspects of textile production. Dyeing in particular has not been studied in any great detail; it would seem, given the importance of coloured textiles in ancient Greece that a detailed study is desirable. The fact that no ancient literary sources deal explicitly with the processes, ingredients and organisation of dyeing may be partly to blame for this. As indicated above however there are numerous references to dyeing in the historical record, which can be used alongside archaeological evidence to gain new insights into the ingredients, processes and economic aspects of dyeing in Classical and Hellenistic Greece.

Chapter 2

Dyeing Materials i: Dyes

The aim of this chapter is to provide a detailed account of the potential range of dyes used in Classical and Hellenistic Greek textile dyeing activity with reference to historical and archaeological evidence. In order to obtain the range of colours outlined in chapter 1, ancient dyers would have used a large number of different dyes. They were produced from a wide range of substances including both animal and plant matter. This chapter will consider individual dyestuffs in turn, looking first at dyes produced from animals and second at dyes produced from plants. The discussion of the dyestuffs will include a summary of the evidence for its use in Classical and Hellenistic Greece, and a description of the nature of the dyestuff and its production from the raw material. The use of dyes in the dyeing process will be covered in chapter 4.

It is unlikely that the dyestuffs discussed below cover the whole range of those used by Greek dyers during the Classical and Hellenistic periods, since a great deal of knowledge concerning dyestuffs was doubtless unrecorded. Plant lore, in particular, may have been transmitted orally, with the result that it has not survived into the twenty-first century. However, it is possible to identify a number of dyestuffs which would have been known or available in the area and during the period covered by this study. In the discussion which follows, different dyes are discussed in differing degrees of detail. This is not an ideal situation, since it would be most desirable to consider each dyestuff equally. However, it is unavoidable given the nature of the evidence, which is plentiful for some dyestuffs but scarce for others. This is partly a result of the value of different dyes in ancient society. Some dyestuffs, and the colours they produced, were considered to be extremely prestigious and symbols of high status, and it is understandable that these substances would be accorded a great deal of attention by ancient writers. Other dyestuffs which were not so prestigious were perhaps not considered as worthy of discussion, at least in their role as raw material for dyes, although they may have been the subject of discussion for other reasons. Moreover, not all dyestuffs survive in the archaeological record in Greece in the same way. Organic material, including some plant and animal material, is not often well preserved in the archaeological record, whereas other materials (such as shell) are more likely to survive in an identifiable form. As a result, it is possible to say a great deal about some dyestuffs, but next to nothing about others. However, the amount of detail in which dyes are discussed is not intended to imply anything other than the amounts of evidence available for each. There are references in

some secondary accounts to dyes derived from minerals and metals (see Forbes 1956; Schrot 1975:506-7), although it would seem likely that these were used mainly for pigments used in painting rather than textiles.

2.1 Animal dyes

Only a small number of dyes were produced from animals in the ancient Greek world. They included however the most famous and prestigious dyestuff in the ancient world.

2.1.1 Shellfish purple

The most famous dye used in the ancient world was the so-called 'Tyrian purple' or purple (πορφύρα), which was derived from certain species of shellfish found in the Mediterranean, the *Muricidae* and *Thaididae* (Balfour-Paul 1998:14). This purple dye, a vat dye which was colour-fast (Reese 1987:203), was probably one of the most expensive in the ancient world, and its use denoted high status, as indicated in the epithets accorded to it such as 'royal purple' and 'imperial purple'. This is borne out by evidence from the literary sources, since there are numerous references to purple clothing, especially worn by high status people. For example, in Aeschylus' *Agamemnon* (958-963) Clytaemnestra illustrates the wealth of her household thus:

> There is the sea (and who shall drain it dry?) producing stain of plenteous purple, costly as silver and ever fresh, wherewith to dye our vestments; and of these our house, thanks be to Heaven, hath ample store; it knows no penury
>
> ἔστιν θάλασσα, τίς δέ νιν κατασβέσει;
> τρέφουσα πολλῆς πορφύρας ἰσάργυρον
> κηκίδα παγκαίνιστον εἱμάτων βαφάς.
> οἶκος δ' ὑπάρχει τῶνδε σὺν θεοῖς ἄλις
> ἔχειν. πένεσθαι δ' οὐκ ἐπίσταται δόμος.

This being such a prestigious substance, ancient authors, have described its derivation and production in great detail, although their accuracy is questionable. Aristotle is the main source of information for shellfish purple in the period covered by this study, since he deals with a number of different aspects of shellfish purple use and production in a number of treatises (e.g. *HA* 528b 18-529a 25 and 546b 15-547b 11; *On Colours* 794a 16-794b 11 and 795b 7-22). According to Aristotle (*HA* 547a 15-18) 'the bloom [ἄνθος] [that is the source of the dye] is situated between the *mecon* and the neck'. This 'bloom' was in fact the hypobranchial gland to be found in the mantle cavity of the living shellfish (Reese 1987:203). When squeezed the gland secretes a white fluid, which first turns yellow and then purple or red through exposure to light

and air (Forbes 1956:117). The dye substance is the chemical compound 4-4'-dibromoindigo or 6-6'-dibromoindigo (Boyle 1981:14). Each shellfish yields a very small amount of pure dye, 0.1 mg, and previous research has shown that from twelve thousand *Murex brandaris* one can produce 1.5 g of pure purple dye (Reese 1987:203-204). Although it has been claimed that the above amount would only be enough to dye the trim of one garment (Reese 1987:204), it appears from recent investigation that this is not the case and that in fact the dye is extremely powerful, a single gland being enough to dye 1 g of wool a deep purple (Jameson, Runnels and van Andel 1994:317).

A number of types of purple shellfish (πορφῦραι) are described by Aristotle (*HA* 547a 4-13) which are found in different areas.

> Some are large, like those found near Sigeion and Lekton; others are small, like those found in the Euripus and on the Carian coast. Those found in the bays are large and rough ... Those found on beaches and along rocky coasts are small in size
>
> ἔνιαι μὲν μεγάλαι, οἷον αἱ περὶ τὸ Σίγειον καὶ Λεκτόν, αἱ δὲ μικραί, οἷον ἐν τῷ Εὐρίπῳ καὶ περὶ τὴν Καρίαν. καὶ αἱ μὲν ἐν τοῖς κόλποις μεγάλαι καὶ τραχεῖαι . . . αἱ δ' ἐν τοῖς αἰγιαλοῖς καὶ περὶ τὰς ἀκτὰς τὸ μὲν μέγεθος γίγνονται μικραί.

Three main species of purple shellfish were used to produce purple dye in the Mediterranean. They were *Murex* (or *Bolinus*) *brandaris*, *Murex trunculus*, and *Thais* (or *Purpura*) *haemastoma* (see Figures 1, 2, 3 and 4). As indicated from the passage from Aristotle cited above, these different shellfish had different habitats. Reese (1980:81) states that *Murex trunculus* prefers rocky ground at depths of up to around 100 metres, whereas *Murex brandaris* can be found on sandy and muddy bottoms, at depths of up to 135 metres.

The colours obtained from the dye substance differ among the different species of shellfish. Aristotle (*HA* 547a 4-13) states that the larger shellfish, those found 'in the bays' and in northern areas, mostly contain a darker 'bloom', although it can also be red. The shellfish found 'on beaches and along rocky coasts', and those found in southern areas, produce a red colour. Thompson (1947:216-217) states that it is *Murex brandaris* which is found in more northerly areas, and produces a darker violet colour than the other shellfish. *Murex trunculus* produces a red colour, as does *Thais haemastoma* (Brunello 1973:58), thus corresponding with Aristotle's southern species. The colour produced could also be varied by using different combinations of different species, and different amounts of water, light and air (Reese 1987:203).

According to Aristotle (*HA* 547a 28-34) the purple shellfish were caught using apparatus resembling lobster pots containing bait. They were trapped during the spring, when they were 'honeycombing' (perhaps breeding or reproducing), but not during the 'dog days' (Aristotle *HA* 547a 13-14) of high summer. The optimum times of the year for catching purple shellfish seem to have been autumn, winter and parts of spring (Brunello 1973:58-59). The shellfish could survive for up to fifty days after being captured (Thompson 1947:214) during which time one would assume that they would have to be kept in vessels or tanks containing seawater. In order for the dye to be obtained the gland containing it had to be extracted from the animal while it was still alive. This could be done by carefully opening or crushing the molluscs (Aristotle *HA* 547a 22-28), the shells then being discarded. Crushed and discarded murex shells provide an important source of archaeological evidence for purple-dyeing activity. Large quantities of shells have been found at such dyeworks sites as the Peribolos of Apollo in Corinth (*AR* 1967-1968:7-8), the east coast of Delos (Bruneau 1969:767-769; 1978:110-114), the Lower Town in Lesbos (*AR* 1987-1988:60) and Skala Oropou in Attica (Dragona-Latsoudi 1985:61). Once removed from the shell, the animals were cut open (Aristotle *HA* 547a 23-26) and then left in containers exposed to the sun to ferment in the open air. Salt was added to the fermenting flesh of the shellfish, and after a number of days the fermented mass was placed in vessels and water was added. After boiling, this solution was used for dyeing (Reese 1980:83).

2.1.2 Kermes

Kermes is a red dye which was thought in ancient times to have been produced from a 'scarlet berry' (φοινικοῦς κόκκος). This 'berry' was considered to be an extra product of the kermes-oak (πρῖνος), besides leaves, flowers and fruit (Theophrastus *Enquiry Into Plants* 3. 16. 1). There was considerable confusion about the precise nature of the source of this dyestuff throughout antiquity: this 'berry' was also referred to by Dioscorides (*Greek Herbal* 4. 48) as a 'grain' and by Pliny as a 'red kernel' (*NH* 9. 141), a 'grain' called 'scolecium' or 'little worm' (*NH* 16. 32 and 24. 8) and a 'scarlet berry' (*NH* 24. 8). It was in fact none of these. The source of the scarlet dye was a scale insect, *Kermococcus vermilio Planchon*, one of a number of scale insects with dyeing properties (Wallert 1986:146), which lives on the kermes-oak (*Quercus coccifera L.*), a tree ubiquitous throughout Greece (Forbes 1956:102) (see Figure 6). The kermes-oak grows in dry places, particularly stony hillsides (Huxley and Taylor 1977:71; Polunin and Huxley 1987:56). Dioscorides (*Greek Herbal* 4. 48) does not distinguish between the tree and the insects living on it, stating that

> Coccum tinctile is a little shrub, full of sprigs to which cling the grains . . . which being taken out are laid up in store . . . that in Cilicia grows upon oaks, in fashion to a little snail, which ye women there, gathering with ye mouth, doe call Coccum (*sic*).

The confusion of the above authors relating to whether or not the kermes was a vegetable product or an insect is understandable given the appearance of the adult female, the insect which contains the actual dye substance. Since the female is immobile, it resembles a small scale-like object attached to the kermes-oak (Beavis 1988:108). The eggs of the female, which were contained inside her body, constituted the colouring matter. The insects reach their maximum size in April and May, after which the development of the eggs begins, and are harvested in May and June (Forbes 1956:102-103). The colouring matter of the kermes-insect is kermesic acid, which is related to carminic acid (Forbes 1956:102). The process by which the actual dye was produced was less elaborate than that of the shellfish purple dye. Once the insects had been gathered they were killed by either immersion in, or exposure to the vapours of, vinegar. They were then dried and either sold as 'grains' or pressed into cakes (Forbes 1956:103).

In order to produce a bright red colour alum and urine could be used along with kermes in the dyeing process (see sections 3.2 and 4.1.2 below). Once again, however, the colour produced was not always uniform, as can be seen from the following quotation from the *Plictho* of Giovanventura Rosetti (Wallert 1986:147), a sixteenth century AD dyeing manual which is nevertheless relevant.

> And be advised that when you want to dye by grain, inasmuch as the grain is very variable in itself and similarly for colours, somewhat more and somewhat less colour, and less substance according to the grain.

The quality of the colour could differ according to the region in which the insect was gathered, with climate perhaps having some influence (Wallert 1986:147). As well as being a prominent product of Cilicia (Dioscorides *Greek Herbal* 4. 48) the kermes insect was, according to Pliny (*NH* 16. 32), well-known and well-regarded from Galatia, Africa and Pisidia, with the worst kind coming from Sardinia. In the sixteenth century the kermes of Corinth was famous (Wallert 1986:147), although whether this was so in the Classical and Hellenistic periods is not known.

2.1.3 Lac-dye

A related dye is the 'lac-dye' produced from the insect *Coccus lacca* Kerr which is indigenous to India and Pakistan (Wallert 1986:147). This dye, or textiles dyed with it, may have been imported to the Mediterranean from the Hellenistic period (Forbes 1956:105). The

insect which produces 'lac-dye' lives on various trees, including the bo-tree (*Ficus religiosa*), the jujube (*Zizyphus jujba*) and the dak tree (*Butea frondosa*). The later fifth-century Greek author Ctesias, a doctor resident at the Persian court, included an account of this dye-producing insect in his *Indika* (21), preserved in the *Bibliotheca* of Photius, the ninth century AD Patriarch of Constantinople (Henry 1947:75-6):

> *L'historien rapporte qu'il naît dans le pays des animaux gros comme un scarabée et rouges comme le cinabre; l'insecte a des très longues pattes et il est mou comme un ver de terre. Ils naissent sur les arbres qui portent l'ambre et ils en font périr les fruits comme les charançons s'attaquent aux vignes en Grèce. Ces insectes, les Indiens les écrasent pour en teindre leurs étoffes de pourpre, leurs tuniques et tout ce qu'ils veulent et leurs teintures sont supérieures à celles de Perse.*

The dyeing matter produced by this insect was laccaic acid, a substance related to carminic and kermesic acids. Its colour could vary from orange-yellow to red depending on the region in which it was produced (Wallert 1986:147). The dye is produced from the substance secreted by the insects when they attached themselves to the tree, a viscous fluid which formed a cellule around the animal. The dye is extracted from this 'stick lac' with a hot soda solution, which is then evaporated. The residue is moulded into cakes and sold (Forbes 1956:105).

2.2 Plant dyes

The majority of dyestuffs used in Classical and Hellenistic Greece were produced from plants. Dyes were produced from flowers, roots and leaves, depending on the plant. Some of these dyes were expensive and prestigious, while others were not, and served as substitutes for more expensive dyes.

2.2.1 Saffron

Classical and Hellenistic Greek dyers were 'just mad about saffron' (Donovan *Mellow Yellow* line 1) as a source of yellow-orange dye, which was used particularly as a female symbol. There are numerous references to textiles dyed with saffron, particularly when used by women (or by men wishing to disguise themselves as women), in Classical and Hellenistic Greek texts. Examples include line 51 of *Lysistrata* by Aristophanes: 'O by the Twain I'll use the saffron dye' (κροκωτὸν ἄρα νὴ τὼ θεὼ 'γὼ βάψομαι); and the following passage from Euripides *Hecuba* (466-469):

> Or in Pallas' town to the car all-glorious
> Shall I yoke the steeds on the saffron-glowing

Veil of Athena

ἢ Παλλάδος ἐν πόλει
τᾶς καλλιδίφρου τ' Ἀθα-
ναίας ἐν κροκέῳ πέπλῳ
ζεύξομαι ἅρματι πώλους.

Other references to the use of saffron for dyeing clothes are too numerous to mention in full (see for example Aristophanes *Lysistrata* 42-48, 645; *Thesmophoriazusae* 253; Aeschylus *Agamemnon* 239).

Saffron, which was called κρόκος in ancient Greek, is produced from a crocus, *Crocus sativus* L.. This variety of crocus is only known in cultivation; the wild saffron crocus found in Greece today is *Crocus cartwrightianus*, which is closely related to *Crocus sativus* (Huxley and Taylor 1977:154; Polunin and Huxley 1987:223) (see Figure 7). Whether the saffron used by ancient dyers was from wild or cultivated plants is not altogether certain. It appears that in the classical and Hellenistic periods saffron was cultivated in Greece, since Theophrastus (*Enquiry Into Plants* 6. 8. 3) refers to two types of crocus, 'the scentless mountain form and the cultivated one' (ὅ τε ὀρεινὸς ἄοσμος καὶ ὁ ἥμερος). Hort, the translator of Theophrastus' *Enquiry Into Plants*, suggests that the latter was the saffron crocus. It may be then that only cultivated saffron crocuses were used to produce the dyestuff, although it is equally possible that, given the similarities between the two types, both wild and cultivated plants were used according to availability. The long orange-red stigmas of the plant are used for dyeing, since they contain the colouring matter crocetin (Hill 1952;131; Kharbade and Agrawal 1988:4; Polunin and Huxley 1987:223). This crocus, which has purple flowers, blooms in the autumn (Theophrastus *Enquiry Into Plants* 6. 8. 3), and as soon as the flowers open the stigmas are removed and dried. At least four thousand flowers are needed to produce one ounce (28 g) of the dye (Hill 1952:132).

2.2.2 Lichen

Another purplish-red dye was produced from certain species of lichen. According to Theophrastus (*Enquiry Into Plants* 4. 6. 5)

> in Crete there is an abundant and luxurious growth on the rocks close to land, with which they dye not only their ribbons, but also wool and clothes. And, as long as the dye is fresh, the colour is far more beautiful than the purple dye; it occurs on the north coast in greater abundance and fairer, as do the sponges and other such things.
>
> καὶ ἐν Κρήτῃ δὲ φύεται πρὸς τῇ γῇ ἐπὶ τῶν πετρῶν πλεῖστον καὶ κάλλιστον ᾧ βάπτουσιν οὐ μόνον τὰς ταινίας ἀλλὰ καὶ ἔρια καὶ

ἱμάτια. καὶ ἕως ἂν ᾖ πρόσφατος ἡ βαφή, πολὺ καλλίων ἡ χρόα τῆς πορφύρας. γίνεται δ' ἐν τῇ προσβόρρῳ καὶ πλεῖον καὶ κάλλιον, ὥσπερ αἱ σπογγιαὶ καὶ ἄλλα τοιαῦτα.

It is thought that although Theophrastus calls this seaweed (φῦκος), he is referring here to the *Roccellae* lichens which grow on coasts in warm areas (Smith 1921:412). The principal species of lichen used for dyeing was *Roccella tinctoria* (Hill 1952:134) (see Figure 8), although others such as *R. fuciformis* and *R. montagnei* were also used (Wallert 1986:148). The dye produced from these lichens is known as archil or orchil, which is formed from a number of acids present in the lichen (Smith 1921:413). The two main colouring substances in the *Roccellae* are erythrin and lecanoric acid which through treatment with ammonia are split into orcin, β-orcin and carbonic acid. As a result of a reaction with oxygen, orcin can be converted to orcein, the actual colouring principle of archil (Wallert 1986:145).

The preparation of the dye, then, would require a number of stages, as indicated by the method recommended by Lauder Lindsay cited by Smith (1921:415). Firstly, any impurities should be removed, and then the plants should be crushed and water added. After this is done ammonia is added and the solution is left to ferment, preferably in warm conditions (Bolton 1960:44). It is stirred frequently, in order that all of the solution is exposed to oxygen. The colour produced can be altered to some extent with the addition of different mordants. According to Bolton (1960:44) the fermentation period varies from three weeks to twenty-eight days. This is likely to have been longer in the ancient world since it is probable that use of ordinary ammonia as recommended by Bolton (1960:44) will hasten the yield of archil compared to those sources of ammonia available in the ancient world. Although the accounts of the preparation of archil given by Lauder Lindsay (Smith 1921:415) and Bolton (1960:44) are modern, they are still relevant to this study, since the basic chemistry, and therefore the processes involved in the preparation of archil such as exposure to ammonia and oxygen and fermentation, are the same today as in the Classical and Hellenistic periods.

2.2.3 'Sea oak'

Another sea-side plant which produces a dye is the 'sea oak'. Theophrastus (*Enquiry Into Plants* 4. 6. 7-8) states that 'the "oak" is useful to women for dyeing wool' (χρήσιμον δὲ ἡ δρῦς εἰς βαφὴν ἐρίων ταῖς γυναιξίν). It would seem that this plant is a seaweed, since Theophrastus states that it has no roots, and grows on stones and shells. The leaves of the plant are slender and fleshy with a purple colour. It is not clear what colour dye this plant produces.

2.2.4 'Lykeion'

A yellow dye known as 'lykeion' was produced from the berries of certain species of the buckthorn, *Rhamnus infectoria*. The unripe berries of the plant, known as 'Persian berries' (Hill 1952:132), contain the colouring matter rhamnetine, which can be extracted using boiling water. The berries were dried and used to form a lake with a mordant and soda. Different mordants produced different colours, with for example alum yielding a yellow colour and tin yielding an orange. Boiling the vat would produce a deeper colour, since the xanthorammine would be converted into rhamnetine (Forbes 1956:124-125). At a dyeworks site at Kolonna in central Crete a clay bottle was found with the stamped inscription 'NIKIAC ΛΥΚΙΟC'. It is possible that this bottle originally contained lykeion, which had been bought from one Nikias (Watrous 1980:281).

Other species of *Rhamnus* also produce yellow-green dyes. They include *Rhamnus catharticus*, *Rhamnus frangula* and *Rhamnus saxatilis*. All are native to southern Europe, and the berries of all of them can be used to produce a dye. In addition, the bark of *Rhamnus catharticus* could be used for dyeing brown (Brunello 1973:380-381).

2.2.5 Oak gall

A black dye was produced from gall on the valonia oak, *Quercus aegilops*. Theophrastus (*Enquiry Into Plants* 3. 8. 6) states that this tree produces a black gall (κηκίς) 'with which they dye wool', as well as being used in tanning:

> κηκίδας δὲ πάντα φέρει τὰ γένη, μόνη δὲ εἰς τὰ δέρματα χρησίμην ἡ ἡμερίς. . . . φέρει καὶ τὴν ἑτέραν τὴν μέλαιναν ᾗ τὰ ἔρια βάπτουσιν.

They would have been available to dyers from late June, when they appeared on the trees. The acorns of this tree, which is native to Greece, are very large, and their cups are also a source of dyestuff (Huxley and Taylor 1977:71) (see Figure 9).

Many other species of oak were used for dyeing, with the bark from the *Quercus robur*, *Quercus pendulata*, *Quercus ilex* and *Quercus cerris* all being suitable for producing colours including blacks, browns, reds and yellows (Brunello 1973:378-379).

2.2.6 Sumach

The sumach (ῥοῦς), *Rhus coriaria*, was also used by both tanners and dyers (see Figure 10). Theophrastus (*Enquiry Into Plants* 3. 18. 5) states that it is used for dyeing white leather (βάπτουσι δὲ τούτῳ καὶ οἱ σκυτοδέψαι τὰ δέρματα τὰ λευκά). The bark and

leaves of the tree, which prefers dry stony places, are a source of tannin, and they also produce a dye whose colours range from orange and yellow to brown (Brunello 1973:382; Huxley and Taylor 1977:100).

2.3 Potential sources of dye

The section above dealt with those dyes whose use by Classical and Hellenistic Greek dyers is indicated by some sort of evidence, either historical or archaeological. It is highly unlikely however that this limited range of dyes were all that were used by dyers. The following section will cover those dyestuffs which can be considered potentially available for dyers during the period covered by this study. That is, they are plants which are found in Greece, and which can be used to produce dyes. In a number of cases there is evidence that they were growing in Greece during the Classical and Hellenistic periods, since there is evidence of an awareness of the plants, but no mention in literary sources of their dyeing properties. Other plants which are known to grow in Greece and are mentioned by later sources are also mentioned, since it is possible that they were available in Classical and Hellenistic Greece, and their dyeing properties were known.

2.3.1 Indigo and woad

The main blue dye available to dyers in the ancient world was indigo. This colourfast dye can be obtained from a large number of plants (perhaps fifty, according to Brunello (1973:30-31)). These include those of the genus *Indigofera*, as well as those of *Isatis*, and others such as *Polygonum tinctorium*, *Lonchocarpus cyanescens*, *Strobilanthes flaccidifolius*, *Marsdenia tinctoria* and *Wrightia tinctoria* (Balfour-Paul 1998:90). All of the indigo-bearing plants contain the colourless glucoside indican in their leaves (Balfour-Paul 1998:89). After fermentation, indican divides into two substances, glucose and indoxyl. Upon oxidisation indoxyl is transformed into indigo (Brunello 1973:361).

The source of indigo most likely to have been available to the people of Classical and Hellenstic Greece was the woad plant (ἰσάτις), *Isatis tinctoria*, 'which ye Dyers vse' (Dioscorides *Greek Herbal* 2. 215). Woad, a biennial herb (see Figure 11), is a native of the Mediterranean and western Asia (Balfour-Paul 1998:93), the area from which many sub-species of the plant dispersed (Hurry 1930:8). The dyestuff is contained in the leaves of the plant in its first year; plants which are two years old produce spikes of yellow flowers and large dark seed pods. Less dye can be produced from woad than from other tropical indigo-bearing plants, and the indigo produced from woad works best with woollen fibres, unlike

some of the tropical varieties of indigo (Balfour-Paul 1998:93-4). The best indigo comes from leaves obtained in the first harvest, and from woad growing on soils rich in nitrogen. Variations in the leaves, particularly in their size and hairiness, also affects the quality of the dye obtained (Balfour-Paul 1998:98-99).

The preparation of the dye can be a fairly long, complex and unpleasant process. The plants are picked when their leaves are fully grown and still retain their green colour by the stem being cut above the ground. There were a number of ways to produce indigo from the leaves. It was possible to put freshly cut leaves straight into the dye vat with the necessary ingredients for fermentation (notably water and alkaline substances) without any further processing. However this method has limitations, since it can only take place soon after the leaves have been harvested, and in a place close to the area where the woad was grown. The dye produced using this method was also very weak. This method would not have been suitable for anything other than small-scale dyeing (Balfour-Paul 1998:102).

A more suitable process for use in dyeing on a larger scale was to turn the leaves into compost, thus starting the fermentation process before adding the woad to the dye vat. The leaves were crushed to a pulp, perhaps by using a mill such as was used in the early modern and medieval periods. Once crushed, the pulp was placed in heaps in order to drain, and then formed into balls which were then dried. After drying the balls were crushed to a powder, sprinkled with water and left to ferment until the woad had become a dark substance resembling clay, after which it was suitable for dyeing. This process was extremely unpleasant and time-consuming, since the woad was fermented twice due to its low dye content (Balfour-Paul 1998:104-105; Hurry 1930:13-27). Woad could be traded in its dried state, although it could not be traded over very long distances or for long periods of time since it could turn mouldy (Balfour-Paul 1998:103).

A more exotic source of indigo is the plant *Indigofera tinctoria*, a native of India which may have been known to Greek dyers in the Hellenistic period. Indigo could be produced from this plant by extracting the indigo fully from the leaves (Balfour-Paul 1998:102-103). This is done by steeping fresh plants in water, stirring them in order to completely oxidise the water. The insoluble indigo which is produced will settle on the bottom of the vat as a sediment, and is sold as a solid pigment (Hill 1952:129; Forbes 1956:111-112). It is possible that during the Hellenistic period this solid indigo substance may have been known to some Greek dyers through trade contacts with Asia.

2.3.2 Madder

A rather cheaper red dye than the insect dyes described above was that produced from the plant madder (*Rubia tinctorum*), which was called ἐρυθρόδανον in ancient Greek. Madder is a herbaceous perennial plant, with angular stems around which are attached dark, shiny evergreen leaves (see Figure 12). The flowers of the plant are small and yellow, the fruits black. The root is thick and fleshy, with the reddish inside covered by a dark skin (Lewington 1990:205) (see Figure 13).

It is the root which produces the dye substance (Dioscorides *Greek Herbal* 3. 160), which consists of a number of different colouring principles such as alizarin and purpurin. The relative amounts of these substances can vary according to the age and quality of the plant, and also the methods of extraction (Wallert 1986:146). The colouring matter, occurring in the root in the form of glycosides (Wallert 1986:146), is found in a red layer between the core and the outer skin. In order to obtain the dye substance, therefore, it has to be separated from the woody parts of the plant (Forbes 1956:106).

In the ancient world madder was both a wild and a cultivated plant (Dioscorides *Greek Herbal* 3. 160). It is picked when it is between eighteen months and three years old, in late summer and autumn (Dean 1994:58-59; Forbes 1956:106). As with many other plant dyes, the root can be used for dyeing fresh or can be dried (Dean 1994:59; Forbes 1956:106). According to Theophrastus (*Enquiry Into Plants* 9. 8. 2):

> 'the digging of roots is done in some cases at the time of the wheat-harvest or a little earlier, but the greatest part of it in autumn after the rising of Arcturus when the plants have shed their leaves.'

One would imagine that this would apply to the collection of madder. Once picked, the roots are washed, dried and beaten to remove any dirt. They are then chopped up or crushed (Dean 1998:58-59; Forbes 1956:106). In order to extract the dye from the root a process of fermentation is employed. Using the substance erythrosin, which is present in the roots of madder, the colouring material ruberythrinic acid is split up into glucose and the actual dye substance alizarin. It appears from handbooks used by medieval dyers that bran could be added to aid the fermentation, although it is not known whether this was done by dyers in the period covered by this study (Wallert 1986:146).

2.3.3 Alkanet

A red dye known as alkanet was produced from the plant ἄγχουσα, *Anchusa tinctoria* (Forbes 1956:108) (see Figure 14). It is a perennial plant which grows in sandy soils, often on

uncultivated ground near to the sea (Brunello 1973:329; Huxley and Taylor 1977:120; Polunin and Huxley 1987:151). This plant has a red root (Theophrastus *Enquiry Into Plants* 7. 9. 3; Dioscorides *Greek Herbal* 4. 23) (see Figure 15), which contains the colouring substance dioxymethyl-anthrachinone (Forbes 1956:108). As with madder, it would seem that the alkanet root was picked in the autumn (Theophrastus *Enquiry Into Plants* 9. 8. 2).

2.3.4 Pomegranate

The pomegranate, *Punica granatum* (see Figures 16 and 17), is the source of a number of different coloured dyes. The large red flowers, which appear in June and July, are the source of a red dye (Polunin and Huxley 1987:133). A yellow dye, which can be used on both textiles and hides, is produced from the rind of the unripe fruit (Brunello 1973:378).

2.3.5 Safflower

Safflower (ἄκανος), the annual plant *Carthamus tinctorius* L., was also the source of more than one dye. Theophrastus (*Enquiry Into Plants* 6. 4. 5) states that 'there are different kinds of safflower, ... the wild and the cultivated':

> Διαφοραὶ δὲ τῶν μὲν ἀκάνων οὔκ εἰσι, τῆς κνήκου δ' εἰσίν· ἡ μὲν γὰρ ἀγρία ἡ δ' ἥμερος.

As with saffron, it is unclear whether the cultivated kind is cultivated for its dye, since Theophrastus does not mention the dyes produced from safflower. Both types of safflower appear from Theophrastus' description to be very similar. There are no apparent differences in the thistle-like flower heads of the plant, which are the source of the dyes (see Figure 18).

One of the dyes produced from safflower was a yellow dye which was 'highly fugitive' and prone to fading in light (Barber 1991:227). The other dye was a more colourfast red (Barber 1991:232). The flowers of the plant contain both red and yellow colouring substances, 'safflower yellow' and red carthamic acid, the former being weak and soluble, the latter insoluble (Forbes 1956:121). As with saffron, the preparation of safflower dye is also fairly simple. Safflower blooms in the autumn, usually after a long hot summer (Dean 1994:62). The flower heads are picked and pressed into cakes, and then dried. They are then sold in bales (Forbes 1956:121). In order to separate the two colouring substances, the flower heads are violently shaken and put in water, which serves to extract the yellow colour. The flowers are then placed in an alkaline solution, which dissolves the red colouring substance (Brunello 1973:340). Using this a range of colours from red to yellow can be produced (Forbes 1956:121).

2.3.6 Greek bean tree

The Greek bean tree or 'lotus' (λωτός), *Lotos medicago* arborea, was also a source of yellow dye (Forbes 1956:122). According to Pliny (*NH* 16. 123-124) 'their bark serves for staining hides and their root for dyeing wool'. The root was perhaps picked in autumn (Theophrastus *Enquiry Into Plants* 9. 8. 2).

2.3.7 Weld

Another possible yellow dye was weld, produced from the plant *Reseda luteolum*, (Forbes 1956:122). This is an annual plant native to south-eastern Europe, with upright stalks and small yellow flowers which grow in spikes at the top of the stalks (Brunello 1973:380) (see Figure 19). It is generally found in stony and fallow soils, in limestone areas, and it flowers between April and July (Polunin and Huxley 1987:83). All parts of the plant, but especially the flowers, contain the dye substance luteolin (Forbes 1956:124). In order to obtain the dye, the whole plant can be pulled up (Forbes 1956:124), or just the flower heads, which are then dried for use. Weld is usually harvested during the summer months (Dean 1998:59-60).

2.3.8 Walnut

A brown or black dye can be easily produced from the rind of the walnut, *Juglans regia* (Brunello 1973:363-364). The green rinds of the walnut, which appear in the late summer, contain the dye juglon (Forbes 1956:125).

2.3.9 Onion skins

The dry outer skins of the onion, *Allium cepa*, yield a yellow-brown dye (Brunello 1973:327) (see Figure 20) which is very easy to produce, since it involves putting the skins in a dyeing solution. Onions are produced in late spring and early summer, although the skins need to be dried and can be kept for dyeing later.

2.3.10 Spanish broom

The flowers of the Spanish broom, *Spartium junceum*, can be used to produce a yellow dye. The plant is found growing on stony open hillsides and sea cliffs, and the large yellow flowers grow on spikes in a similar way to those of weld (Huxley and Taylor 1977:93) (see Figure 21).

2.3.11 'Young fustic'

Another plant related to the *Rhus coriaria* is the *Rhus cotinus*, or 'young fustic'. This is a shrub which grows in dry stony places, as well as open woodland. The wood and the leaves (which are bluish-grey, turning red in autumn) are the source of the dye (Huxley and Taylor 1977:100; Polunin and Huxley 1987:120). The colours produced from the leaves include browns, blacks and greys, while the wood is the source of a yellow dyestuff which can also produce greens, oranges and browns (Brunello 1973:382).

2.4 Conclusion

It is unlikely, even given the inclusion of potential sources of dyestuffs, that the list above is a definitive account of all the dyes used by Classical and Hellenistic Greek dyers. Nevertheless, it outlines a number of the sources of dyes available to ancient Greek dyers, and also serves to highlight the problems faced when one wishes to find out about them. It can be seen that some of these dyes would have been easier for ancient dyers to obtain and use than others. Shellfish purple, for instance, could only be obtained in its 'raw' state by those who lived close to the sea and who had boats and fishing baskets. Its production was a long and unpleasant process, as was that of woad. Many plant dyes, on the other hand, were more easily available. Those which grew wild could have been available for people to pick them, while others could have been cultivated. The production of dyes from these plants was not always as unpleasant or complicated as shellfish purple and woad, and could have been easily carried out by large parts of the population. Onion skins or walnut rinds, for instance, were probably widely available and extremely easy to use, since they were from food products and to dye with them simply involved adding them to water and other ingredients if required (see Dean 1994:16-19). This has implications for the organisation of dyeing activity, and the levels of specialisation required to carry it out; these issues will be addressed in chapter 7. The following two chapters deal with the other ingredients used by ancient dyers, and the processes by which dyeing was done.

Chapter 3

Dyeing Materials ii: Other Materials

This chapter examines the materials other than dyes used in the dyeing process. These include the fibres to be dyed and the mordants used as fixing agents in the dyeing process.

3.1: Fibres

A wide range of fibres were available to Classical and Hellenistic Greeks, derived from both animals and plants. Wool and linen were particularly widespread, but others such as silk, hemp, and cotton were also known. The following sections will look in detail at each of these fibres, covering their derivation, production and preparation for dyeing. First animal fibres will be discussed, and this will be followed by a discussion of plant fibres.

3.1.1 Animal Fibres

3.1.1.1 Wool

Wool (ἔριον) was an important and commonly used fibre in antiquity. There are numerous mentions of woollen textiles of different kinds in the ancient historical sources, and they have also been found in the archaeological record. Ryder (1983:154-155) gives a description of two pieces of woollen cloth dating from the fifth century BC which were found in a Scythian tomb near the Greek city of Nymphaeum in the Crimea. A number of dyed woollen textiles from the late fifth and early fourth centuries BC were found in tombs in the cemetery of the ancient city of Pherai in northern Greece (Adrymi-Sismani 1983:23-42). These included blankets covering the bodies in the tombs and items of clothing including chitons worn by the dead, with colours including purple, pale beige, and an unspecified 'pale colour' (ἀνοιχτόχρωμο, Adrymi-Sismani 1983:32). The inscriptions detailing dedications of textiles to the temple of Artemis at Brauron in Attica contain numerous references to woollen garments (see e.g. *IG* II² 1518.B.ii.54, 71-2).

Wool is produced from the hairy covering of sheep and occasionally goats (e.g. Aristotle *H.A.* 606a.17). The wool fibres are more scaly and kinky than fibres from plants such as linen (see section 3.1.2.1 below), with the result that they can be felted, can be spun in a number of different ways to produce different types of yarn, and have better insulating qualities (Barber 1991:20). Wool fibres also have more natural elasticity than plant fibres (Barber 1991:20-21). The coat of the sheep is made up of two types of fibres, the thick, hairy

kemp, which forms an outer coat and is brittle and does not dye well, and the shorter, woolly undercoat. The domestication of sheep over many thousands of years has led to the gradual development of the woolly undercoat at the expense of the hairy outer coat (Ryder 1983:45).

There is evidence that a wide range of wool types were produced, from fine to coarse fibres, from sheep which were bred to produce different grades of wool. Aristotle, for instance, refers to sheep with both short and shaggy fleeces (*H.A.* 596b.5-10), and there were also sheep with 'crisp (or curled) wool' (Ryder 1983:148). A number of areas of the ancient Greek world were known for their production of high quality woollen articles, such as Asia Minor including such areas as Miletos (Aristophanes *Lysistrata* 729-730). Other areas noted for their wool production were Samos and Athens (Ryder 1983:150-153): soft or fine-woolled sheep are mentioned a speech by Demosthenes (47.52-53) as being illegally taken from a farm near the Hippodrome in Athens. Colonies in Libya such as Cyrene (Ryder 1983:153) and in Italy such as Syracuse (Ryder 1983:153) and Tarentum (Ryder 1983:153-154; see also e.g. *I.G.* II² 1517.B.II.141; 1518.B.II.49) were also renowned for their woollen products. The area around Colchis on the Black Sea may also have been associated with fine wool production (Ryder 1983:146-147). Areas outside the Greek world also produced fine woollens which were well-known in Greece, such as Phrygia (Aristophanes *Birds* 493) and Lydia (Ryder 1983:147-150).

Before wool could be dyed it was usual to remove it from the rest of the animal. This could be done in a number of ways. The most basic and primitive way was to collect wool from for example twigs and other sharp objects against which a moulting animal may have rubbed and deposited portions of its outer covering. Wool could also be plucked by hand from moulting animal (Barber 1991:21). Both of these methods would have produced chunks of wool.

A more sophisticated technique of separating animals from their wool was the use of shears, which developed during the Iron Age, perhaps as a result of new metalworking technology (Forbes 1956:8). Early shears were often made from a single strip of iron bent in the middle to provide a spring and with the blades formed by twisting the ends of the strip at ninety degrees to the rest of it. These shears were usually held in one hand, with the other free to clasp the sheep. Two-handed hinged/'pivoted' shears were also known in the Classical and Hellenistic world (Ryder 1983:696-697). Evidence for the use of shears in Classical and Hellenistic Greece is provided by, for example, Hesiod, who mentions shearing in *Works and*

Days (775), and Aristotle (*H.A.* 606a.10-15), who mentions the shearing of both sheep and goats.

Once it was removed from the animal, wool could be dyed before spinning, after spinning (as yarn), and after weaving as a piece of cloth. The following section will describe the processes which were carried out in order to prepare the wool for dyeing in each of these stages. In order to produce the best results from the dyeing process the wool was cleaned before dyeing (Forbes 1956:81). Any large impurities such as pieces of dirt or twigs could be removed from the wool by hand, and then it was washed. Certain substances could be used to aid in the cleaning process (Forbes 1956:81-85). These perhaps included alkanet (see section 2.3.3) and soapwort, which according to Pliny were used to prepare wool for dyeing (*NH* 22. 48; 24. 96). Other available detergent substances included urine and various alkaline minerals also used as mordants (see section 3.2 below) (Forbes 1956:82-85). After the wool had been cleaned it was then ready to be dyed, either before or after being made into yarn.

If the clean wool was to be dyed as yarn it had to be spun. In order to prepare it for spinning the wool could be combed or carded, with the different operations producing different types of thread. Combing resulted in the fibres all pointing the same way, and produced the thread known as worsted (Ryder 1983:740). Carding, on the other hand, was developed with the introduction of finer wool, which became matted easily and was difficult to comb. By this process the tangled wool fibres were loosened, and were crossed in different directions (Forbes 1956:21), producing woollen yarn (Barber 1991:22). Carding could be done with teasel or thistle heads, the Latin name for which, *carduus*, provided the name for this process (Ryder 1983:742). Spinning with a drop spindle (the type used in Classical and Hellenistic Greece) did not always require wool to be combed or carded. Wool fibres could be pulled apart with the fingers to produce satisfactory fibres for spinning. It seems likely that fine woollen yarns produced in Classical and Hellenistic Greece were combed rather than carded (Barber 1992:106-108).

The individual wool fibres were unsuitable for weaving, since they lacked the necessary strength and cohesion. This was remedied by twisting the fibres together to produce thread, which was perhaps prompted by the strands of wool produced by moulting sheep rubbing their fleeces against things (Ryder 1983:745). The actual spinning process involved the drawing out and twisting of the fibres from the mass of combed or carded wool. The simplest way of doing this was by hand, twisting the thread between the fingers, although this

was a slow process and problems could be caused by the twisted thread tangling (Barber 1991:41-42).

A less problematic way of spinning wool into thread involved the use of a spindle. This was a stick which served to collect the newly spun thread and prevent it from tangling or unravelling. A weight added to the stick, usually at the base, which helped to provide spin and kept the spindle upright (Ryder 1983:746). The type of spindle often illustrated on ancient Greek pots was a drop spindle, where the spindle was not supported but hung free from the fibres wound onto it Barber 1991:43). The wool to be spun could either be stored in a container or attached to another stick known as a distaff, which could be held in a hand, under the arm or tucked into a belt (Ryder 1983:747). Their are numerous references to spinning in ancient literary sources, and many painted ceramic products show scenes of women spinning (see Figures 24 and 25). Furthermore, spindle whorls often turn up in large quantities on archaeological sites of many different types all over Greece. For example, stone and terracotta spindle whorls have been found in many parts of the Citadel House Area of Mycenae (Bowkett 1995:38-40) and in the 'south industrial area' of the site at Korsiai in Boiotia (Fossey 1981:120).

In some cases woven textiles were dyed, and it is likely also that textile products such as clothing would have been re-dyed as their original colours faded. I will now look briefly at the weaving technology available to Classical and Hellenistic Greeks. The type of loom used in the Classical and Hellenistic periods was known as the 'warp weighted loom', which stood upright or at a slight angle (see Figure 27). The warp threads hung from a single beam at the top, known as the cloth beam (Barber 1991:92). In some cases the warp threads were hung from a woven band which was fastened to the cloth beam. This band was usually woven on a 'fixed or rigid heddle loom', which was used for making braids and trims as well as for the bands which were used to start the warp of larger textiles. This loom has a distinctive shape. It has a frame with attached heddles, which can be made of string, or of wood, reed, wire bone or horn, and have a hole for the thread (Barber 1991:117). The weft threads of bands woven in this way are left long, and thus form the warp threads for the larger textile woven on a warp weighted loom (Foxhall pers. comm.). Weights were used at the bottom of the loom to pull the warp threads taut. These weights were usually made from stone or clay, and were attached to groups of warp threads with cords.

Weaving started at the top of the loom, and as it progressed the rows of weft had to be packed upwards, or perhaps rolled up on a beam (Barber 1991:92). As with spinning, weaving

was a well-known and widespread practice in Classical and Hellenistic Greece, and there are many references it in the historical sources of the period. Moreover, there are numerous depictions of looms on painted pottery, which provide examples of these particular looms (see Figures 24 and 26). Since most of the warp-weighted loom was made of wood and other perishable substances, there are no surviving ancient looms, but huge numbers of the loomweights used to hold the warp threads in place have been found on a wide range of sites all over the Greek world. Sites examined in this study where loomweights have been found include the Citadel House Area of Mycenae (Bowkett 1995:36-41)(see Figure 28); the Rachi settlement at Isthmia (Anderson-Stojanovic 1996:90; Broneer 1955:140) (see Figure 29); Halieis (Ault 1994a:242-244); and Olynthus (Robinson 1930 and 1946; Robinson and Graham 1938).

Woollen fabrics were not produced solely by weaving: another method of producing fabric was by turning it into felt. This was probably the earliest fabric to have been made, and was perhaps developed from the discovery of matted fleece on sheep (Ryder 1983:738). Felt was produced by the compression of wool or hair while warm and moist. The warmth and moisture combined with compression causes the scales on the fibres to catch on to each other and form a solid fabric (Barber 1991:215). Patterns could be produced by the placing of coloured wool in the mass of fibres to be felted (Ryder 1983:738), and it is assumed that coloured felt was produced by using dyed wool or different natural colours of sheep's wool. That felting was known to Classical and Hellenistic Greeks is confirmed by literary references, such as Homer's description of Odysseus' helmet in the *Iliad* (10.260-271), and references to felt armour (Forbes 1956:91).

3.1.1.2 Silk

The use of silk for textiles was known to the Classical and Hellenistic Greeks, but it is not clear whether this extended to the production of silk from the raw material and the dyeing of the fabric. The type of silk which we are most acquainted with today is the variety produced by the silkworm *Bombyx mori* which feeds on the mulberry tree, described by Forbes (1956:49) as 'silk *par excellence*'. This is an Oriental species, native to China, and was not imported into the Graeco-Roman world until the sixth century AD (Sherwin-White 1978:378). There is evidence that 'true silk' was produced on the island of Thera in the Bronze Age; whether this practice continued into the Classical era is not clear (Panagiotakopulu et al 1995). The thread was produced by unwinding the cocoon, the larva

inside being killed with heat beforehand. As much as a thousand metres of thread could be produced from one cocoon in this way (Barber 1991:30).

Textiles made from this variety of silk have been found in a number of places around Europe, notably in the mid-sixth century BC late Hallstatt tomb at the Hohmichele in Germany. Of more relevance to this study, however, is the fact that the remains of six separate articles of 'true silk' were found in a fifth century BC tomb in the Kerameikos cemetery in Athens (Barber 1991:32). It is not clear whether this silk was imported as thread or as woven textiles, and it could have been dyed in either form. It is impossible from this limited evidence to assess the amount of true silk available, but it seems to me to be extremely unlikely that these small numbers of surviving silk textiles would have been the only ones to reach the Greek world and that this fabric would have been more widespread than the evidence would seem to suggest.

It is possible however that a variety of silk was cultivated in the Classical and Hellenistic Greek world, although this was not the 'true silk' produced in the Orient. Aristotle (*H.A.* 551b.10-15) refers to a similar creature from which thread was produced:

> Out of a certain larva, which has as it might be horns, and is different from the rest, there arises first of all a caterpillar (produced when the larva metamorphoses), then a *bombylis* (cocoon), then out of this a *nekydalos*: it goes through all these transformations in six months. Some of the women actually unwind the cocoons from these creatures, by reeling the thread off, and then weave a fabric from it; the first to do this weaving is said to have been a woman of Cos named Pamphile, daughter of Plates.
>
> Ἐκ δέ τινος σκώληκος μεγάλου, ὃς ἔχει οἷον κέρατα καὶ διαφέρει τῶν ἄλλων, γίγνεται πρῶτον μὲν μεταβάλλοντος τοῦ σκώληκος κάμπη, ἔπειτα βομβυλίς, ἐκ δὲ τούτου νεκύδαλος· ἐν ἓξ δὲ μησὶ μεταβάλλει ταύτας τὰς μορφὰς πάσας. ἐκ δὲ τούτου τοῦ ζῷου καὶ τὰ βομβύκια ἀναλύουσι τῶν γυναικῶν τινες ἀναπηνιζόμεναι κἄπειτα ὑφαίνουσιν· πρώτη δὲ λέγεται ὑφῆναι ἐν Κῷ Παμφίλη Πλάτεω θυγάτηρ.

This silk, known as 'tussah' or 'tusseh' (Forbes 1956:50; Horsfall and Lawrie 1949:291), was not produced from the same insect as the Oriental silk, but from one of the species of wild silk moth found around the eastern Mediterranean. Wild silk is stiffer than the cultivated variety, and does not dye as well, being resistant to alkaline substances (Horsfall and Lawrie 1949:291).

Aristotle's account has prompted Forbes (1956:51) to suggest two species of wild silk moth were used by ancient Greek craftsmen: 'bombyx', is identified with the *Pachypasa otus* moth, and 'necydalus' with the *Saturnia pyri* moth. The former in its larval stage is large,

with warts and bright red protuberances, and feeds on plants including cypress, oak (of unspecified species) and juniper. The silk produced from its cocoon is 'of reasonable quality' (Beavis 1988:140). The latter species is large and spiny in its larval stage, and feeds on a range of plants including fruit trees (again unspecified), ash and blackthorn. Its silk is glossy and brown, and of lower quality than that from *Panchypasa otus* (Beavis 1988:141). Beavis (1988:141) suggests that, contrary to Forbes' argument, only *Panchypasa otus* is likely to have been used to produce wild silk on Cos, given the fact that it better fits the description given by Aristotle, and also a list of food plants provided by Pliny (*NH* 11. 77). Aristotle's account, according to Beavis (1988:141-143), refers therefore to the different life stages of the *Panchypasa otus* moth, rather than to different species.

Silk was produced from the moth when it was in its cocoon stage. Aristotle (*HA* 551b 10-15) states that in order to obtain the silk for weaving, women unwound the cocoons by reeling off the thread from around the insect. According to Beavis (1988:146) this is perhaps a suggestion of the use of the 'traditional method' of obtaining the thread. In this method, the cocoons are dropped into boiling water, which kills the insect inside and perhaps dissolves the gum holding the cocoon together. The thread can then be reeled off from the cocoon. It is not clear how the production of silk was organised, and whether the moths were domesticated. Sherwin-White (1978:382) states that the moths were not fully domesticated, and that they would need to be reared wild in trees near the silk producer's house. As a result, 'a peaceful grove of trees and a house for the silk to be carded and spun in' were the main requirements for the production of wild silk (Sherwin-White 1978:382). Beavis (1988:146) disagrees, arguing that although the *Pachypasa otus* could not be domesticated to the same degree as the Chinese silk moth, it would be possible to rear it in captivity, if the conditions were right. A problem would occur since the larvae of *Pachypasa otus* hibernate, 'but this would not be insuperable'; it is possible that the insects could be captured between awaking from hibernation and pupation. It would seem likely that if these insects could be domesticated, to whatever degree, in some cases they would have been. Silk production could then have been carried out in a fairly organised fashion by certain producers producing goods for consumption outside their own personal needs. It is equally likely at the same time that in many cases silk producers would use the wild insects as and when they needed them, particularly if they were fairly common and accessible to all.

It is unlikely that the manufacture of wild silk really was invented by Pamphile, the daughter of Plates, from Cos as Aristotle (*HA* 551b 10-15) claims. Both Forbes (1956:52) and

Sherwin-White (1978:242, 378-83) argue that Aristotle's account of wild silk production is the earliest evidence of silk production centred around Cos 'and some other places' (Forbes 1956:52). Coan silk production appears to have been carried out extensively during the early Roman Empire, although it seems to have ceased during the second century AD, possibly as a result of increased imports of silk from China (Sherwin-White 1978:381-3). Silk production in the Roman period was linked to local dyeing activity, and there are references from Roman literary sources to purple silk garments from Cos (Sherwin-White 1978:242). There is however no direct evidence for this 'industry' either earlier than Aristotle's account or between that and the earliest Roman evidence (Sherwin-White 1978:381), although this does not mean that there was no silk production during this time. Indeed, it would seem remarkable if silk was produced only during Aristotle's lifetime, and then production ceased for the duration of the Hellenistic period until it was resurrected by the Romans.

The earliest evidence for 'diaphanous garments' comes from the fifth century BC, from sources such as sculpture and dramatic works, as for example in Aristophanes' *Lysistrata* from 411 BC (Sherwin-White 1978:380-1) (although it is possible that in the case of sculpture at least this may reflect growing expertise). In the play, Lysistrata describes the things which women can use to get their way (Aristophanes *Lysistrata* 46-48):

> Why, they're the very things I hope will save us,
> Your saffron dresses, and your finical shoes,
> Your paints, and perfumes, and your robes of gauze.
>
> ταῦτ' αὐτὰ γάρ τοι κἄσθ' ἃ σώσειν προσδοκῶ,
> τὰ κροκωτίδια καὶ τὰ μύρα χαὶ περιβαρίδες
> χἡ 'γχουσα καὶ τὰ διαφανῆ χιτώνια.

This may reflect the fact that garments made from 'true silk' such as those from the grave in the Kerameikos cemetery in Athens referred to above were finding their way to Greece, and it is possible that the production of wild silk on Cos and other places was influenced by this, as suggested by Barber (1991:32). It would seem that Aristophanes mentions diaphanous robes expecting the audience to recognise them as a weapon in the armoury of women to ensnare men. It is therefore unlikely that only small amounts of 'true silk' were appearing in Athens. What seems to be implied is that a considerable number of women had access to these enchanting garments. However, since there is no definite date for the start of 'wild silk' production in the Aegean (Sherwin-White 1978:381) it is not possible to say this with any certainty and it is equally likely that the production of 'wild silk' took place over a long

period of time, perhaps starting in the fifth century BC and continuing through the Hellenistic period.

Also in Aristophanes' *Lysistrata* are the first references to the diaphanous fabric called *amorginon* (see for example 150, 734-739) which was perhaps named after or originating from the Cycladic island of Amorgos. In a scene similar to that referred to above where Lysistrata is detailing the ways women can use their feminine wiles to achieve peace, she mentions the fact that they could sit at home in *chitons* made from *amorginon* which were apparently very revealing:

> εἰ γὰρ καθοίμεθ' ἔνδον ἐντετριμμέναι
> κἀν τοῖς χιτωνίοισι τοῖς ἀμοργίνοις
> γυμναὶ παρίοιμεν (Aristophanes *Lysistrata* 149-151)

There are numerous mentions of this material in the lists of dedications to Artemis at her temple at Brauron in Attica. For example, in 349/8 BC a woman called Philoumene dedicated to Artemis a *chiton* made from *amorginon* (ΦΙ[Λ]ΟΥΜΕΝΗ ΧΙΤΩΝΑ [Α]ΜΟΡΓΙΝΟΝ) (Foxhall and Stears 2000:Table 01; *IG* II² 1514 10), as did a woman called Pheidulla in 345/4 BC (ΑΝΤΙΒΙΟΥ ΓΥΝΗ ΦΕΙΔΥΛΛΑ ΧΙΤΩΝΙΟΝ ΑΜΟΡΓΙΝΟΝ ΑΠΛΟΥΝ) (*IG* II² 1514 50-51).

The precise nature of this fabric is unclear. A clue to its nature is provided by Aristophanes in *Lysistrata* (735-739), when Lysistrata argues with some women who are trying to desert her to carry out their domestic tasks:

> Second woman: τάλαιν' ἐγώ, τάλαινα τῆς ἀμόργιδος,
> ἣν ἄλοπον οἴκοι καταλέλοιφ'.
> Lysistrata: αὕτη 'τέρα
> ἐπὶ τὴν ἄμοργιν τὴν ἄλοπον ἐξέρχεται.
> χώρει πάλιν δεῦρ'.
> Second woman: ἀλλὰ νὴ τὴν Φώσφορον
> ἔγωγ' ἀποδείρασ' αὐτίκα μάλ' ἀπέρχομαι.

In the translation provided by Rogers (1951) this passage becomes:

> Second woman: O goodness gracious! O that lovely flax
> I left at home unhackled!
> Lysistrata: Here's another!
> *She's* stealing off to hackle flax forsooth.
> Come, come, get back.
> Second woman: O yes, and so I will,
> I'll comb it out and come again directly.

It is implied here that *amorginon* was a type of fine linen, of which part of the production process was known as hackling (see section 3.1.2.1 below). Beavis (1988:146) seems to agree with this view, stating that it was 'produced from the plant of the same name'. According to Forbes (1956:52) this is the plant *Malva silvestris*, or it may be another growing on the island of Amorgos. In the passage from *Lysistrata*, however, the wording is open to interpretation. The word Rogers translates as 'unhackled' is ἄλοπον, which seems to be derived from the word λοπός. This word is defined by Liddell and Scott (1997) as meaning 'shell, husk or peel'. Also, the verb in the Second Woman's reply to Lysistrata, which Rogers tranlsates as 'to comb out' is ἀποδέρω, which is defined in Liddell and Scott (1997) as meaning 'to strip off the skin'. It is possible then that this refers to the production of 'wild silk', which was done by unwinding the shell of the cocoon. The process of 'hackling' flax involved the removal of unwanted material from the stems of the plant from the fibres, which may also fit Aristophanes' wording.

It is possible then that *amorginon* is to be identified as a type of wild silk, perhaps produced largely, or originally, on Amorgos, along with other islands such as Cos. This would still raise questions over the fact that Athenian women had access to cocoons of wild silk moths, however, and also the fact that this material has often been referred to as being like linen (Forbes 1956:52). The actions described by Aristophanes could also be applied to the production of linen (see section 3.1.2.1 below), which may have been a fibre to which access would have been more widespread.

3.1.2 Plant fibres

3.1.2.1 Linen

Perhaps the most widespread plant fibre was linen, produced from the flax plant. The use of linen for textiles is mentioned in literary sources, such as in *Orestes* by Euripides (1431-3):

> And the flax from her distaff twining
> Her fingers wrought evermore,
> And ever her threads fell down to the floor.
>
> ἃ δὲ λίνον ἠλακάτᾳ
> δακτύλοις ἔλισσε,
> νῆμα θ' ἵετο πέδῳ.

There is also archaeological evidence for linen, for example from Eleusis in Attica, where a woven linen textile measuring 220 centimetres by 50 centimetres and dating from the fifth

century BC was found in the excavations of 1935 (Zisis 1954:587-589). The inscriptions listing the dedications deposited at the temple of Artemis at Brauron in Attica also refer to linen garments (see *IG* II² 1524 A column ii 69, column iii 105).

Linen is a bast fibre, that is it is made from woody plant fibres, produced from the annual flax plant (*Linum usitassium*) (Barber 1991:11; Hill 1952:27). The fibres from which linen is produced are contained inside the stem, where they occur in bundles forming a ring around the core of the plant. They are surrounded by a sort of skin. All of these substances must be removed so that the fibres can be obtained (Barber 1991:13). There are a number of stages in 'the age-old way of doing this' (Barber 1991:13). Flax harvested before the seeds ripen produces fine linen (Horsfall and Lawrie 1949:141), although this can be left until the seeds have ripened (Barber 1991:13). After harvesting the plants are left to dry, and then the seeds, leaves and other extraneous matter are removed by a process known as 'rippling' (Kirby 1963:21).

After drying, the next stage in the production of linen is known as 'retting', and is the most important stage in this process (Kirby 1963:21).

> Retting is a fermentation process which effects the decomposition of the glutinous pectinous substances surrounding the fibre, and so renders them soluble and capable of being removed (Horsfall and Lawrie 1949:141).

The word 'retting' derives from the verb 'to rot' (Barber 1991:13), and this is caused by the exposure of the stalks to water, fungi and bacteria (Kirby 1963:23). There are a number of ways in which this can be carried out. 'Dew retting', as the name suggests, involves spreading the stalks out on the ground to be exposed to the dew (Hill 1952:27), and is a slow process which produces fibres which are brittle and silvery grey (Barber 1991:13). Another method is by submerging the stalks in water, perhaps in a river or pond. This is quicker than dew retting and produces supple golden fibres (Barber 1991:13).

After retting, the fibres are dried once more and the pieces of stem material still attached to the fibres are removed, by processes known as 'breaking', 'scutching' and 'hackling'. The stem material is broken up and beaten to remove it from the fibres, usually with wooden tools, and then the fibres are combed to remove any last fragments of stem (Barber 1991:13). Shorter fibres, known as 'tow', are separated from the longer fibres and made into thread or rope separately (Hill 1952:27).

Linen could be dyed either in the form of spun thread or as a woven textile product. The spinning and weaving processes would have been carried out in the same manner as

described above for wool (see section 3.1.1.1). One important difference relates to the spinning process. Linen was often spun wet, since this makes the fibres easier to manipulate; when dry they are 'brittle, ornery and full of slivers' (Barber 1991:72). Moisture can be applied using saliva, or the threads can be passed through bowls containing water as part of the spinning process (Barber 1991:72-77).

3.1.2.2 Hemp

Hemp is a bast fibre like linen, produced from the plant *Cannabis sativa*. The date at which the growing of hemp for fibre was introduced into Greece is uncertain. Herodotus (4.74), writing in the fifth century BC refers to the use of hemp for textiles by the Scythians and Thracians, saying:

> They have hemp growing in their country, very like flax, save that hemp is by much the thicker and taller. This grows both of itself and also by their sowing, and of it the Thracians even make garments which are very like linen.
>
> Ἔστι δέ σφι κάνναβις φυομένη ἐν τῇ χώρῃ πλὴν παχύτητος καὶ μεγάθεος τῷ λίνῳ ἐμφερεστάτη· ταύτῃ δὲ πολλῷ ὑπερφέρει ἡ κάνναβις. αὕτη καὶ αὐτομάτη καὶ σπειρομένη φύεται, καὶ ἐξ αὐτῆς Θρήικες μὲν καὶ εἵματα ποιεῦνται τοῖσι λινέοισι ὁμοιότατα.

Herodotus' language seems to imply that hemp was not widely known at the time he was writing (Barber 1991:16), although the use of hemp textiles in Greece in the fifth century BC is known from the archaeological record. A textile found at Trachones in Attica was found to be made from hemp (Zisis 1954:590), although no traces of dye were found on it. There is no mention of hemp in Theophrastus' *Enquiry into Plants*, although in the Hellenistic period 'it was grown almost everywhere' and was so important a material in naval supplies that 'there was a brisk trade in hemp in the Euxine' (Forbes 1956:59).

As mentioned by Herodotus, hemp fibres are very like those produced from the flax plant. The fibres, which are long, strong and durable but lack the flexibility and elasticity of flax, are found inside the stem of the plant (Hill 1952:28). They are obtained in the same way as those of flax (Barber 1991:15), by drying, dew retting to remove the extraneous stem material, and then breaking, scutching and hackling to free the last bits of stem from the fibres. As with linen, hemp could be dyed as spun thread or as a woven textile, but was mostly used for coarse cloth.

3.1.2.3 Cotton

Although cotton was not grown in Greece in the Classical and Hellenistic periods, its use as a textile was certainly known to the Greeks in that time period, and imported cotton could have been dyed by Greek dyers. Herodotus (3.47) describes two corslets donated to Greeks by the Egyptian king Amasis, made from linen with embroidery in cotton and gold thread donated to the Messenians and to the temple of Athena at Lindos. He also comments on 'trees growing wild which produce a kind of wool better than sheep's wool in beauty and quality' (3.106) and mentions that the Indians in Xerxes' army 'were dressed in cotton' (7.65). Theophrastus (*Enquiry Into Plants* 4. 4. 5) also refers to a tree in India 'from which they make their clothes', and goes on to give a more detailed description of cotton growing on the island of Tylos as well as in India and Arabia (*Enquiry Into Plants* 4. 7. 7-8).

At Trachones in Attica a cotton textile was found along with the hemp mentioned above dating from the fifth century BC (Zisis 1954:590-1). Zisis (1954:591-2) refers to a type of wild cotton growing in Samos and other Aegean islands in connection with this textile, but concludes that it is unsuitable for making into textiles as it is too fine and that the cloth from Trachones must have been imported. As with silk, the fact that cotton textiles have been found in Greece would seem to me to suggest that larger numbers of this product than have actually been found in the archaeological record are likely to have found their way to the Greek world in the Classical and Hellenistic periods.

Cotton is produced from trees of the genus *Gossypium*, the fibre being produced from the fine hairs found on the seeds (Hill 1952:22). Thread is produced by spinning these hairs, although as they are short and delicate they require a method of spinning different to that used for wool and flax. The spindle used needs to be small and light, and supported in such a way that the thread is not broken by putting too much weight on it (Barber 1991:33).

3.2 Minerals and chemicals

A number of chemicals were needed during the dyeing process, particularly when certain dyes were used. These included 'levelling agents', substances used to aid in breaking down the dyes, and mordants, which were used with certain dyes to make them colourfast and which determined the exact hue resulting from the dye. They will be discussed below.

3.2.1 'Levelling agents'

Many of the dyes described in chapter 2 required the use of a chemical to break them down and help them attach to the fibres. Different types of dyes required different types of

levelling agent. So-called 'acid dyes', which include most of the plant dyes discussed in chapter 2, attach themselves to 'basic sites on a protein fibre' and require an acid solution to facilitate this. This may have been achieved through the use of acetic acid, perhaps derived from vinegar, or by partially fermenting the dyestuff (Barber 1991:235-236). Tannic acid, from for example tree barks, roots and fruits (especially from the oak), could also have been used. 'Basic dyes', on the other hand, include those produced from lichens, require an alkaline solution as a levelling agent. Suitable substances include ammonia, perhaps produced from urine, as well as some salts (Barber 1991:236). A wide range of other alkaline substances were available, and may have been used as levelling agents; they were also commonly used as mordants, and will be discussed in depth in section 3.2.2 below.

3.2.2 Mordants

A mordant is a chemical that combines with the dye and creates a lasting chemical bond between the colouring matter and the fibre. This results in the dye being colourfast, so that it will not fade or run through the effects of light and washing (Barber 1991:235). It was necessary to use a mordant with almost all of the dyes available to the ancient dyer in order to obtain fast colours, as only shellfish purple and indigo gave fast colours without the use of a mordant. Mordants can be used in addition to the levelling agent in the dyeing process, or they can be used instead of it, as the substances required were sometimes similar.

Different types of dyes require different types of mordants to cause the chemical reaction which binds the dye to the fibres to take place. As with levelling agents, the chemical make-up of 'basic dyes' and 'acid dyes' means that they require different types of substance to fix them to fibres. In order to dye with 'basic dyes', one needed an 'acid mordant', which could be derived from similar sources as acid levelling agents, that is tannic acid from tree barks, roots and fruits (such as oak galls, as discussed in section 2.2.5 above), as well as acetic acid from for instance vinegar. Vegetable oils may also have been used (Barber 1991:236).

'Basic mordants' were alkaline substances, usually derived from soluble metal salts. There were many sources of alkaline materials available to Classical and Hellenistic Greek dyers. One widely used mordant was 'alum', which in the ancient world was used to refer to a number of hydrated aluminium salts, where aluminium combined with either potassium, sodium or ammonium as well as the sulphate radical. Alum minerals can be formed naturally through the evaporation of seawater in certain places, and include the minerals kaolinite or

'common alum', 'soda alum', also called mendozite, 'ammonium alum' or tschermigite, alunite or 'alum rock' and alunogen (Barber 1991:238).

It is likely that alum was available only in certain parts of the ancient Mediterranean world. A number of the Cycladic islands were well-known sources of alum in the Classical and Hellenistic periods. Melos, for instance, is mentioned by Theophrastus (*De Lapidibus* 9. 62-63) as a source of a particular 'earth' which has been identified as a source of alum, which is perhaps reflected in the name of the Stypsis area in the south-east of the island: the Ancient Greek words στύψις and στυπτηρία refer to alum (Pittinger 1975:192-194). It is likely that the Melian earth was produced from deposits of bentonite, which was made up of kaolin and alum, perhaps with a high silica content. This is a granular mineral resembling coarse sugar in texture (Pittinger 1975:193). Theophrastus (*De Lapidibus* 9. 62-63) states that another useful 'earth' was found on Samos, although this differed from that of Melos. According to Pittinger (1970:193), this was likely to have been kaolinite, another source of alum. Another 'earth' was produced on the island of Kimolos (Theophrastus *De Lapidibus* 9. 62); this was a 'fuller's earth' which may have been useful as a mordant.

Other sources of alum were further afield. Large quantities came from Egypt, where it was produced in the Dakla and Kharga oases west of the Nile valley (Forbes 1955:182). According to Herodotus, the Egyptian pharaoh Amasis contributed one thousand talents of alum towards the reconstruction of Delphi after it had been destroyed by fire, and at the same time gave Greek settlers in Egypt twenty *minae* (Herodotus 2. 180). Alum was also produced in Cyprus, from where it was exported to the Near East before the Classical period. Pliny (*NH* 35. 52. 183-184) mentions Cypriot alum in the first century AD, so it is likely that this island was known as a source of alum by Classical and Hellenistic Greeks. Alum was also produced in the Near East, in Palestine and areas around the Persian gulf (Forbes 1991:182-183).

Other metal salts which can be used as mordants include those of chromium, iron, copper, zinc and tin (Barber 1991:236). When using these metals as mordants, it can suffice to simply use pieces of the metal, rather than having to turn them into the required compound through chemical means. It may also be the case that using vessels made from these materials can have the effect of a mordant, since the dye solution dissolves the metal from the walls of the vessel (Barber 1991:238-239).

A number of other alkaline materials were available to Classical and Hellenistic Greek dyers. A naturally occurring alkali was natron, a natural compound of sodium carbonate and

sodium bicarbonate, which was called νίτρον or λίτρον in ancient Greek (Forbes 1955:174). This substance was apparently only produced in Egypt, in three areas: the Wadi Natrum, an oasis in the western desert; an area near the ancient port of Naucratis; and the area of El Kab in Upper Egypt (Forbes 1955:174-175). Natron was apparently produced as a result of the creation and then drying up of small salt lakes. Layers of natron were left when the waters of these lakes seeped away, or dried up (Forbes 1955:174-175). According to Pliny (*NH* 31. 106-115), natron could be found in bodies of water in numerous places, including parts of Greece, such as in the waters of a lake in Clitae in Macedonia. He also states that natron is found in Media, in valleys which turn white in the dry season. Forbes (1955:179) suggests that Pliny here refers to a number of mineral waters with a high alkaline content; whether this would be high enough for them to be useful as mordants is unclear.

Another source of alkaline material was potash, or potassium carbonate. This was produced from burnt plants, usually by leaching the ashes (Barber 1991:238). Large quantities of ash were found at the Rachi settlement, particularly in cisterns, and Kardara (1961:266) suggests that they may have been potash used in the dyeing process; it is equally possible that they are destruction debris however.

Apart from acting as fixatives, mordants had another important effect on the dyeing process. Different combinations of mordants and dyes produced a wide range of colours and shades. Koren (1996:Tables I(b) and II(b)) lists some of the colours which can be produced. For example, when used without a mordant, saffron produces a yellow colour. When used with an aluminium mordant, however, it gives a yellow or dull orange shade; with copper, a green colour; and with an iron mordant a yellow-brown colour. Similarly, different mordants can give a number of green and yellow shades when used with safflower yellow, and iron gives a pink colour when used with safflower red. Madder can yield colours ranging from reds and purples to oranges and browns. In this way, then, the number of colours available to the ancient dyer could be increased. Examples of the range of colours and shades produced by combinations of madder and weld with different mordants can be seen at Figure 30: using iron, copper and alum mordants one can achieve colours including brown, purple and orange-red respectively with madder; dark green, light green and yellow respectively can be produced with weld.

Chapter 4

'Vat's Magic': Dyeing Processes

In the two preceding chapters the range of ingredients available to Classical and Hellenistic Greek dyers was discussed. This chapter will look at the ways these ingredients were used by dyers to colour fibres and textiles. There is a wide range of evidence to illustrate these processes, from ancient literary and archaeological evidence, to more recent dyeing using natural ingredients. Since the basic processes and principles of dyeing using natural ingredients (in some cases using the same ingredients as those used by ancient dyers) are the same today as they were in the Classical and Hellenistic periods, these accounts can provide valuable insights into the dyeing process where ancient evidence is incomplete or lacking altogether.

This chapter will deal solely with the dyeing process, since chapters 2 and 3 dealt with the production and preparation of the ingredients (dyestuffs, mordants and fibres) up to the point when they would be used for dyeing. The main discussion will include analysis of the preparation of the dye vat, the immersion of the fibres, and any further processes such as second dyeings of fibres and mixing colours. It will be divided into two subsections, discussing dyeing with 'vat dyes' and 'mordant dyes' separately. As the dyeing process is similar to other processes involving large quantities of liquids, there will be a short comparative discussion of processes such as fulling and tanning, as well as oil and wine production. This will prove useful when seeking to identify dyeing in the archaeological record and distinguish the equipment and material remains associated with it from that belonging to other processes, which will be discussed in depth in chapter 5.

4.1 Dyeing processes

The dyeing process as carried out in Classical and Hellenistic Greece had a number of basic stages. First the dye vat was prepared, then the fibres or textiles to be dyed were immersed in the dye solution. They were then removed from the vat and the excess dye solution was squeezed out. After this, fibres could be dyed again, either with the same colour (to produce a deeper or stronger shade) or with a different colour (to produce a new colour from the mixing of the dyestuffs on the fibres). The processes within these stages were not as simple as this however, and could vary in a number of ways for a number of reasons. Some of these were touched on in chapters 2 and 3, and they will be discussed in greater detail below. A number of the variations in dyeing processes resulted from particular ingredients used, whether dyestuffs or other ingredients. In order that these variations are properly addressed,

different processes will be discussed in more detail in sections 4.1.1 and 4.1.2 below. Before this it will be necessary to look at the dyeing process in a more general way, since whatever the variations of different processes, a number of the basic features were common to all types of dyeing.

It is likely that across the ancient Greek world of the Classical and Hellenistic periods there were a number of different dyeing processes carried out. There are hints of this variation in dyeing practices in ancient literary evidence. Plato (*Republic* 429D-E) mentions a stage of the dyeing process which involved the preparation of the fibres to be dyed in order to make them colourfast, although this was not always carried out. Fibres that were dyed without this treatment did not retain their colour after washing, and appear laughable:

> Οὐκοῦν οἶσθα, ἦν δ' ἐγώ, ὅτι οἱ βαφεῖς, ἐπειδὰν βουληθῶσι βάψαι
> ἔρια ὥστ' εἶναι ἁλουργά, πρῶτον μὲν ἐκλέγονται ἐκ τοσούτων
> χρωμάτων μίαν φύσιν τὴν τῶν λευκῶν, ἔπειτα προπαρασκευάζουσιν
> οὐκ ὀλίγῃ παρασκεύῃ θεραπεύσαντες, ὅπως δέξεται ὅ τι μάλιστα τὸ
> ἄνθος, καὶ οὕτω δὴ βάπτουσι· καὶ ὃ μὲν ἂν τούτῳ τῷ τρόπῳ βαφῇ,
> δευσοποιὸν γίγνεται τὸ βαφέν, καὶ ἡ πλύσις οὔτ' ἄνευ ῥυμμάτων οὔτε μετὰ
> ῥυμμάτων δύναται αὐτῶν τὸ ἄνθος ἀφαιρεῖσθαι· ἃ δ' ἂν μή,
> οἶσθα οἷα δὴ γίγνεται, ἐάν τέ τις ἄλλα χρώματα βάπτῃ ἐάν τε καὶ
> ταῦτα μὴ προθεραπεύσας; Οἶδα, ἔφη, ὅτι ἔκπλυτα καὶ γελοῖα.

It is possible that this refers to the treatment of fibres with levelling agents (see section 3.2.1), which made them more receptive to the dye. The *Papyrus Holmiensis* (see for instance ιε) also refers to this stage, which is referred to as στρουθισμός. This involves the use of the plant soapwort, which is ground and placed in warm water. Pliny (*NH* 34. 96) states that this plant is used to prepare wool for dyeing, while Theophrastus (*Enquiry Into Plants* 9. 12. 5) claims that it is also used to bleach linen. Wool is then immersed in this solution. This process was carried out for dyeing with both fast and non-fast colours.

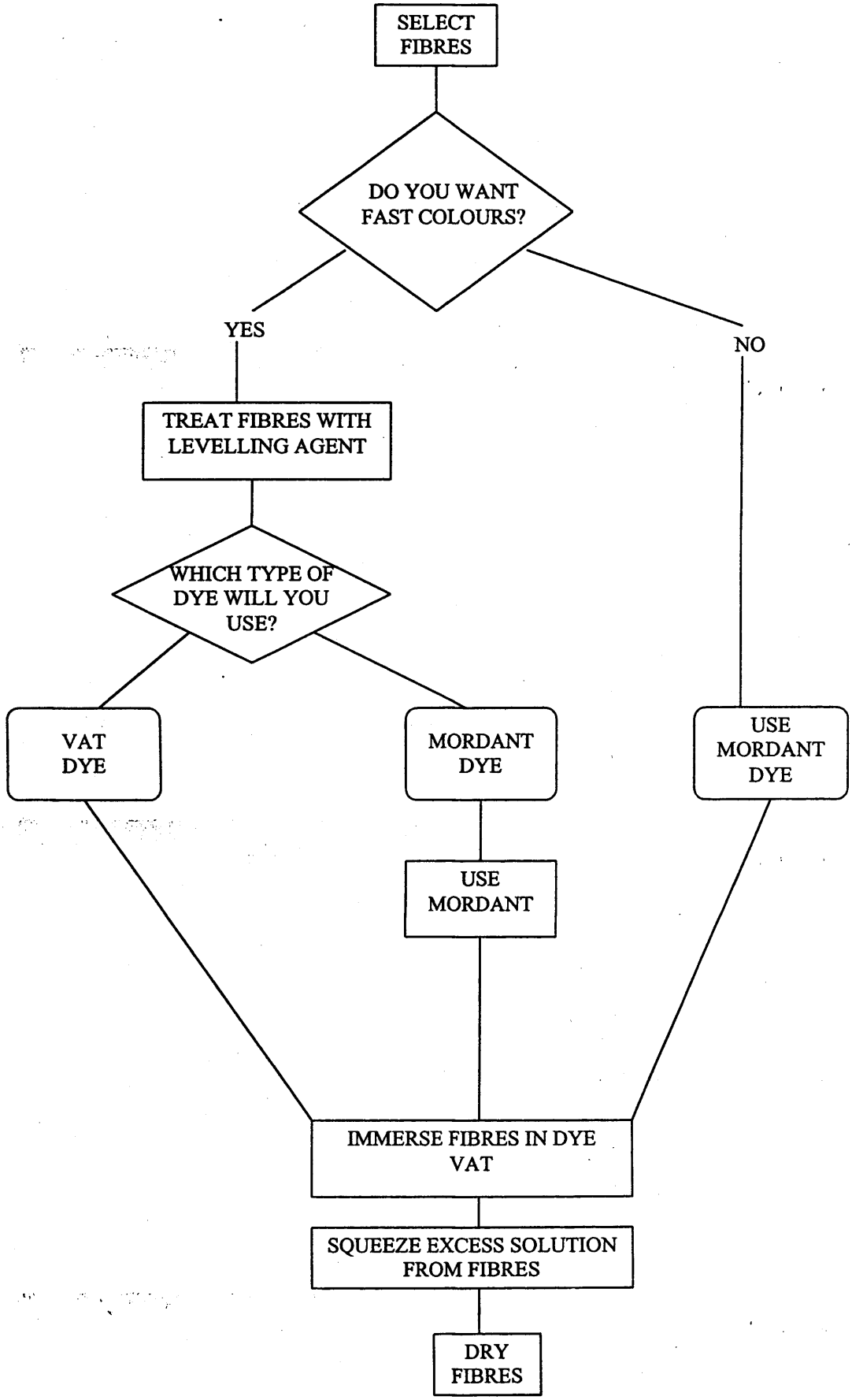
Aristotle mentions dyes being boiled in a number of his writings. In the *Meteorologica* (381a) for example, when discussing the ends for which some things are boiled, he states that:

> for instance, we speak of drugs [or 'dyes'] being boiled
> τοῖς δὲ πρὸς ἄλλην χρείαν, ἐπεὶ καὶ τὰ φάρμακα ἕψειν λέγομεν.

The Aristotelian treatise *On Colours* also contains references to dyeing, and mentions dyes being boiled (795b 7-22; 797a 3-8); these will be discussed in more detail below (see section 4.1.1).

Aristophanes also refers to the dyeing process in the *Ecclesiazusae*, giving examples of different dyeing techniques. For instance, when a woman speaks to the Athenian assembly stating why women are better equipped to run the state, she says (215-218):

Table 1: Dyeing processes



> In the first place, they [i.e. women] all, without exception, continue to use hot water when dyeing wool, as has always been the custom. I mean you won't find them experimenting with other methods [i.e. such as the use of cold water].
>
> πρῶτα μὲν γὰρ τἄρια
> βάπτουσι θερμῷ κατὰ τὸν ἀρχαῖον νόμον
> ἀπαξάπασαι, κοὐχὶ μεταπειρωμένας
> ἴδοις ἂν αὐτάς.

Later in the play, a man says to a slave girl (735-736):

> Wow! But you're black: scarce blacker had you chanced
> To boil the dye Lysicrates employs.
> νὴ Δία μέλαινα γ', οὐδ' ἄν, εἰ τὸ φάρμακον
> ἕψουσ' ἔτυχες ᾧ Λυσικράτης μελαίνεται.

A number of recipes in the *Papyrus Holmiensis* refer to heating or boiling solutions used in dyeing. Recipes for dyeing using the purple dye archil from the *Roccellae* lichen (see section 2.2.2) instruct the dyer to boil the lichen in various solutions (*Papyrus Holmiensis* κ 7-20, 21-35) for instance. Woad was also heated (*Papyrus Holmiensis* ιη 1-ιθ 30). Other recipes refer to the use of cold water in the dyeing solution. For example, purple can be made using a combination of the foam from the woad dye solution and alkanet in cold water (*Papyrus Holmiensis* ιζ 27-43).

These references may therefore indicate that in some cases the dye solution was heated, and in others it was not. There are a number of possible reasons for this. For instance, some dyestuffs may have required different treatment from others, although one cannot say which dyes are being referred to in three of the four references cited above. The reference from Aristotle's *On Colours* deals with a particular dyestuff, and will be discussed in detail below. It would seem however that apart from that, dyeing was done using both hot and cold solutions. Aristophanes seems to imply that dyeing using hot water was the old-fashioned way, and the use of cold water represented a newfangled technique only used by men (perhaps for large-scale dyeing). Since this is part of a speech from a play which is supposed to be a comedy though it is difficult to say for sure what is being implied, and what the original intended audience would have taken this to mean.

The major differences that occur in dyeing techniques relate to the types of ingredients used. The most important distinguishing factor for the methods used in classical antiquity is the use of a mordant. As stated in chapters 2 and 3, certain dyes required the use of mordants to make the fibres colourfast (so-called 'mordant dyes'), while others did not ('vat dyes'). The differences in the dyeing processes that resulted from this will be discussed in detail below.

4.1.1 'Vat dyes'

Very few dyes available to the ancient dyer did not require the use of a mordant to bind the dye to the fibres. These 'substantive' 'vat dyes' were shellfish purple and indigo. In the ancient Greek world the latter is likely to have been produced from woad. Since shellfish purple was such a mysterious and prestigious substance, it was the subject of a great deal of study and speculation in the ancient world, and there are a number of ancient accounts of its use. The major source of information for the use of purple from the period covered by this study is Aristotle, who provided accounts of the methods of the ancient purple dyer, as well as of the nature of the purple shellfish (which was cited in section 2.1.1 above). He states (*On Colours* 795b 7-22) that:

> when they have cut [the shellfish] open and drained from it all the moisture, and have poured this out and boiled it in vessels, at first none of the colours is quite obvious in the dye, ... finally all becomes purple when the boiling is complete
>
> καὶ γὰρ ταύτην ὅταν κόψαντες ἅπασαν ἐξ αὐτῆς τὴν ὑγρασίαν ἐκκλύσωσι, καὶ ταύτην ἐγχέαντες ἕψωσιν ἐν ταῖς χύτραις, τὸ μὲν πρῶτον οὐδὲν ὅλως ἐν τῇ βαφῇ τῶν χρωμάτων φανερόν ἐστι. . . . τότε ἅπαν γίγνεται συνεψηθέντων.

It is clear from this account, and from others such as Pliny's *Natural History* (9. 125-142), that dyeing with shellfish purple, involved adding water to the fermented shellfish and heating this dye solution for a number of days, until the required colour was achieved. The fibres obtained their purple colour upon oxidisation and contact with sunlight once they were removed from the dye vat (Forbes 1956:117). It is possible that fibres dyed with shellfish purple were pre-treated with levelling agents before immersion in the dye solution in order to improve their colourfastness. Plato (*Republic* 429D-E: see section 4.1 above) states that in order to achieve fast colours when dyeing with shellfish purple (ἁλουργά, literally 'sea-wrought') it was necessary to prepare the fibres (ideally naturally white wool) before dyeing.

The dyeing of fibres using woad is less well documented in the ancient source material. The *Papyrus Holmiensis* includes a recipe for dyeing with woad (Balfour-Paul 1998:124-125) as part of a process for producing a purple colour (the purple dye archil is added to the dye-vat towards the end of the process). There is no evidence from the Classical or Hellenistic period to show how it was used however. Since the basic chemistry of the reactions taking place in the woad vat has not changed, the basic processes described in this and other more modern sources can be used to show how it was used in the periods covered by this study. The recipe given in the *Papyrus Holmiensis* (ιη 1-ιθ 30) states that the woad

solution should be heated for three days in a covered vat. The fibres should then be immersed in it, for as long as the dye is usable. The papyrus states that urine and soapwort should be added to the dye vat, and that the fibres should be immersed in boiled urine containing soapwort before they were dipped in the dye vat.

Both shellfish purple and woad produce dyes which are very similar in their chemical composition. Woad produces indigo dye, while the dye produced from purple shellfish has indigo as its basic component, and differs from plant indigo because it contains bromine (it is 6,6' dibromoindigo) (Barber 1991:235). A warm alkaline solution is used to help dissolve the insoluble indigo in the dye vat, which adds hydrogen. This changes the indigo into 'indigo white' a 'leuco-derivative' of indigo. At this stage the liquid in the dye vat is a yellowish-green colour. The fibres immersed in the vat are also this colour, and become blue as a result of their reaction with oxygen (Balfour-Paul 1998:116). A similar series of chemical reactions took place in shellfish purple dyeing (Forbes 1956:117).

4.1.2 'Mordant dyes'

Most natural dyes are not colourfast in the same way that the 'vat dyes' are, and require a mordant to help them attach to the fibres in the dye vat. That ancient Greek dyers were aware of mordants and their use was discussed in chapter 3 above. The mordant substance could be added to the dye solution, or the fibres could be immersed in a mordant solution before immersion in the dye vat. The stage of the process when the fibres were exposed to the mordant was called στυψεις in ancient Greek, literally the use of any mordant substance. Aristotle (*On Colours* 794a 16-19) refers to this stage of the dyeing process, and the effects it can have on the colours produced:

> But the [mordanting] in the dyeing process produces many differences and mixtures
> πολλὰς δὲ καὶ αἱ στύψεις ἐν τῇ βαφῇ ποιοῦσι διαφορὰς καὶ μίξεις.

Plato's statement (*Republic* 429D-E: see section 4.1 above) that pre-treatment of fibres before their introduction to the dye vat was necessary to achieve fast colours may refer to mordanting rather than the use of levelling agents. Since Plato here refers to dyers using mordants on fibres which were to be dyed a purple colour usually associated with shellfish purple, which of course does not require a mordant, this interpretation may be problematic. It is possible, however, that Plato is simply confused or did not know enough about the different dyeing processes to be aware of this mistake. He may have known that dyers treated fibres with chemicals when using certain dyes, and assumed that this was also the case with shellfish purple. Another explanation may be that in order to make his simile easily understood he is

using shellfish purple as an example since it was the most well-known and (perhaps more importantly) prestigious dye available, regardless of whether or not he was correct about the details of the dyeing process. In this passage he is using the dyeing process as an analogy for the moral training and education of the guardians of his ideal *polis*. It is possible that the use of shellfish purple better expressed the implied quality of the guardians than a dye of lower status.

The use of mordants is referred to numerous times in the recipes contained in the *Papyrus Holmiensis*. One recipe (ιε 11-14), which appears to be a general instruction on mordanting, mentions the use of copper, while another (ιδ 30-36) mentions the use of a 'dyer's earth' (στυπτηρίας βαφικῆς), perhaps a variety of alum (see section 3.2.2) to produce red, sulphur to produce green, and natron. The dyes used to produce these colours are not named. The recipe for archil purple mentioned in section 4.1 above (*Papyrus Holmiensis* κ 7-20) includes an instruction to add half a mina of alum to urine and heat this solution, in which wool was immersed before being immersed in the dye vat.

All of the dyes listed in chapter 2, apart from woad/indigo and shellfish purple, therefore required the use of a mordant to make them colourfast (see section 3.2.2). Of course not all 'mordant dyes' were always used with mordants. They may not always have been readily available to all dyers all of the time, which would mean that some textiles would not be colourfast and would require re-dyeing when they started to fade. It may not always have been desirable in classical and Hellenistic Greece to have large numbers of colourfast textiles. Indeed, as suggested by Barber (1991:236), it may have been the case that dyes which were not colourfast were valued, since they allowed for textiles to be re-dyed in different colours for different occasions, thus avoiding the purchase or production of new textiles.

4.2 Other similar processes

There were a number of other production processes carried out in the ancient Greek world with features which were similar in some ways to those involved in dyeing. It is important to be aware of these processes when discussing dyeing, especially in the archaeological record. When one has a good idea of what these processes are and what they involve in terms of ingredients and equipment, one will be better able to judge the archaeological evidence for dyeing than if one was unaware of them. The processes which appear to have features most similar to dyeing are fulling and tanning, as well as oil and wine production. These processes will be discussed below.

4.2.1 Tanning

Tanning involved the preparation of animal skins or hides to produce leather, thus preserving them. This involved the use of equipment and ingredients which were often similar to those used in dyeing; indeed, as part of the tanning process hides were often dyed. Once a hide had been prepared for tanning it was immersed in a solution containing the tanning agents. These were derived from tannin-rich plant products, particularly barks, roots and fruits. A number of ancient authors provide information about some of the substances used by tanners. Alder bark, for instance, was used to dye hides red (Theophrastus *Enquiry Into Plants* 3. 14. 3), while sumach (which was also the source of a dye for textiles: see section 2.2.6 above) dyed leather white (Theophrastus *Enquiry Into Plants* 3. 18. 5). The galls of the valonia oak were also used for both tanning and dyeing (Theophrastus *Enquiry Into Plants* 3. 8. 6; see section 2.2.5 above). The immersion of hides in the tanning solution would have taken place in large watertight vessels, and it would have been necessary to dry them stretched out and pegged down in a suitable place once they were taken out of the solution. These vessels may have been similar to those used for dyeing in some cases (although it would have been less easy to tan a hide in a household pot than to dye a few lumps of wool), and the drying facilities may also have been similar.

4.2.2 Fulling

Fulling is the activity by which textile products are cleaned and bleached, removing any impurities from the fibres. These impurities included dirt, as well as naturally occurring substances such as the grease present in large quantities in wool, and the colouring substances, wax, and other impurities in flax and hemp (Forbes 1956:81). Since these impurities can affect dyeing, by preventing the dye from bonding properly with the fibre, it was often necessary to clean fibres before dyeing took place. As fibres could be dyed in a number of different stages of their production, this could be done prior to spinning (especially in the case of wool) or prior to weaving (particularly for linen). When white textiles were required, cleaning and bleaching could take place after weaving (Forbes 1956:81). Generally speaking fulling involved washing the fibres or textiles in hot water, to which was usually added a detergent substance. This could include the plant soapwort, 'with which they bleach linen' (ᾧ τὰ ὀθόνια λευκαίνουσι, Theophrastus *Enquiry Into Plants* 9. 12. 5), as well as urine and a number of minerals. There were a number of so-called 'fuller's earths' available, including natron or natural soda, and hydrated aluminium silicate, as well as potash, which

absorbed grease and removed dirt, as well as giving cloth a heavier and more lustrous appearance (Forbes 1956:81-84). These processes would require similar equipment to dyeing and tanning, namely large watertight vessels, as well as similar ingredients such as large quantities of water and minerals and plants such as soapwort.

4.2.3 Oil Production

Although olive oil production did not involve processes or ingredients which were as close to dyeing as tanning and fulling, it is close enough to dyeing to merit brief discussion here. Where dyeing and oil production are similar is in their use of large quantities of liquids, and the need for large containers to hold these liquids. For oil to be extracted from olives, they were first crushed. The olives could be ground to a pulp, or they could be very lightly crushed or bruised, depending on the desired nature and quality of the oil (Foxhall 1993:183-184). This operation would have been carried out using stone crushing equipment, including the famous Roman *trapetum*, as well as simpler apparatus such as a large stone roller used in conjunction with a flat stone base (Foxhall 1993:190-194). After the olives were crushed, the pulp which was produced was placed in bags or between cloths on a press bed, which may have been equipped with a basket or frame to hold the pulp in place. The presses used in Classical and Hellenistic Greece were 'lever presses' or 'beam presses'; that is, a beam with weights attached was fitted above the pulp, and pressure was applied by lowering the beam. The oil was channelled from the press bed into a container. Hot water was usually poured over the pulp between pressings, which resulted in the oil being mixed with water and olive juice when it emerged from the press. For this reason, settling tanks were required close to the press, so that this liquid could be allowed to separate and the oil be skimmed off the top (Foxhall 1993:184).

4.2.4 Wine Production

Wine production is similar to dyeing in the same way that oil production is; namely, it also involves the use of liquids in large quantities, and therefore requires containers for them. In order to extract the juice from grapes, which was fermented and turned into wine, they needed to be crushed. This was done soon after the grapes were collected. The first pressing of the grapes involved workers treading grapes, usually on a suitable floor area. The juice would drain from this floor into a large vessel, which may have been constructed from stone or hollowed out of bedrock (as in the possible late Hellenistic wine press at Knossos: see Carington Smith 1994), or made from wood (Forbes 1955:109-110). After this stage, more juice could be extracted by crushing the treaded grape pulp, perhaps in beam presses similar

to those used for olive oil production, although this is not essential. The grape juice was left to ferment in large terracotta pithoi for six months (Forbes 1955:110-112).

4.3 Conclusion

It can be seen, then, that there was a range of processes used by dyers in the Classical and Hellenistic Greek world. The extent to which these processes are visible in the archaeological record would depend on the nature of the ingredients and equipment used. It is important when assessing the archaeological evidence for dyeing to remember that there were other processes in the ancient world which used similar ingredients and equipment, and to be aware that they may have been carried out at some sites instead of, or alongside, dyeing. The following chapter will address the issue of identifying dyeing activity in the archaeological record using the evidence from this chapter and those preceding it.

Chapter 5

'Can You Dig It?': the Archaeology of Dyeing

The aim of this chapter is to look at the ways in which one can identify dyeing activity in the archaeologically visible remains of sites. The basic equipment needed in the dyeing process will be discussed, and illustrated with examples taken from various sites of dyeing activity. Using this information and the discussion of the dyeing ingredients and processes in chapters 2, 3 and 4 I will then attempt to set out a number of criteria which can be used in the identification of dyeworks sites in the archaeological record.

5.1 Identifying dyeing in the archaeological record

The equipment used in the dyeing process can be divided into a number of categories relating to the stages of the dyeing process in which it was used. These stages are:

- the acquisition of ingredients such as dyes and mordants
- the actual dyeing of fibres by immersion in the dye solution
- the squeezing out of the dyed fibres to remove excess liquid
- the drying of the fibres.

Evidence for dyestuffs then can include remains of the actual dyes, as plant matter, shells, or colouring on vessels, and residues in or inscriptions on containers for dyestuffs, while their preparation can be identified from tools such as presses, querns, millstones, mortars and other grinding or smashing implements. Mordants can also be identified from residues left in containers. The immersion of fabrics in a dye or mordant solution can be identified principally from the presence of vessels, either specially constructed vats, often unable to be heated and either hollowed out of the bedrock of sites or built from stone or tiles, usually covered in cement, or other vessels which were portable and likely to have also been used for other purposes.

Once one has an idea of the processes and equipment used in a dyeworks and how these are represented in the archaeological record, how then would one use this knowledge to identify a site as a dyeworks? It is possible to use the existing archaeological evidence, as summarised above, to formulate a series of criteria based on the equipment used in the different stages of the dyeing process. These criteria can be applied to the information in the archaeological record in order to aid the future identification of sites of dyeing activity, and are as follows:

1. Equipment for dye preparation or production
2. Evidence of the presence of dyes
3. Evidence of the presence of mordants
4. Presence of vessels used in the immersion of fibres
5. Facilities for water supply and drainage
6. Heating facilities
7. Area and equipment for squeezing excess liquid from dyed fibres
8. Drying facilities – loomweights
   – drying areas

The presence of these elements on a site can then be used as an indicator of the presence of dyeing activity at that site.

The ideal dyeworks site would, therefore, be one which can be seen to contain all of the above criteria. This is unlikely to be the case for the majority of sites, however, which then raises the problem of deciding which criteria are more indicative of a dyeworks. It is possible to see these criteria in a scale of importance for the identification of dyeing activity, with the most useful at the top and the least at the bottom. At the top of this scale would be those criteria representing features which appear solely in the context of dyeing activity, as these are the only ones which show without a doubt that dyeing took place at a site. This category would include the presence of dyes, obviously, and perhaps the presence of mordants, where they have been identified through scientific analysis. However, even mordants are not conclusive proof since similar substances may have been used in fulling.

Next in the scale would be criteria such as the presence of vessels for the immersion of material and areas for squeezing excess liquid out of dyed material which are major features of a dyeworks but can also be used for other purposes, such as wine and olive oil manufacture. Equipment for the production of the dyestuffs would occupy a similar place in the scale, since it is similar to the equipment used for a number of other tasks and its presence alone does not guarantee that a site is a dyeworks.

At the lower end of the scale would be criteria such as the presence of water, heating and drying facilities. Evidence for these criteria is found on a wide range of sites, and does not necessarily signify that a site was involved in dyeing. For example, loomweights which may

have been used for drying dyed material are found in fairly large quantities on many different sites, not all connected with dyeing.

The use of these criteria in the identification of dyeworks would therefore be regulated by their place in such a scale. The features near the top of the scale, particularly dyes, can by themselves serve as reliable indicators of the presence of dyeing activity. Those lower down the scale, however, are not so reliable on their own and should be associated with others in order for any judgement to be made. Vessels such as vats, for example, can be used for other purposes besides dyeing, such as oil or wine production or fulling. For a site containing vats to be identified as a dyeworks there would have to be other evidence to indicate that these vats were used in the dyeing process. Ideally this additional evidence would include evidence for dyes or mordants but other features such as evidence for water supply and drainage or heating linked to the vats can be used together to build up a picture of the activities carried out at a site.

Of course, the possibility of identifying any of these criteria at a site depends on the nature of the evidence in the archaeological record, which may differ from site to site. Preservation is a major factor in this since certain features, such as the remains of plant dyes, are not often preserved but would be important evidence in the identification of dyeing sites. On the other hand loomweights for example are often preserved in some quantity but do not offer conclusive proof of dyeing activity. Perhaps the best preserved features of a dyeworks, or at least the ones which stand out the most, are the specially constructed vats used to hold the dye or mordant solutions, although alone they do not provide conclusive proof of the presence of dyeing activity.

Another factor influencing the use and identification of the criteria is the fact that the nature of the evidence found on a site would depend on the nature of the site itself, and dyeing establishments would not have all been the same throughout both the region and the time period covered by this study. Different establishments might have specialised in different parts of the dyeing process, such as the production of dyestuffs, the dyeing of certain materials or the use of only one type of dye which may have required specialist equipment. Also, the scale of the dyeing operation would determine the size of the dyeworks as well as the quantity and quality of features in it, since a large scale dyeing operation would require a large amount of specialised equipment, whereas dyeing done on a small scale or in a domestic context would have used less specialised equipment and so would not be as easily identifiable.

A more basic problem for using these criteria for the identification of sites of dyeing activity relates to the fact that the features identified here as equipment used in the dyeing process may have had other uses. Many of these features, such as pressing equipment, baths and cisterns, are fairly generic and could equally have been used in a number of other craft production processes, in both domestic and commercial contexts, as well as in non-craft production contexts. A number of the general domestic utensils common in the ancient Greek world could have been used for dyeing, as well as for many other purposes. Another important point to note is that the use of any of these features for one particular purpose, in this case dyeing, does not exclude the possibility that they could, and probably would, have been used for other purposes by the same people but at different times. This point will be developed in greater detail in later chapters, but I will make reference to a brief example here. In an 'industry' such as dyeing, where the availability of certain materials depended on the time of year, it is likely that there would have been periods when these materials were not available. In these periods it is possible that the dyers would have resorted to other types of production (including craft production) using the same equipment in order to keep a steady income.

5.2 Basic ingredients

5.2.1 Dyes

The presence of evidence of actual dyestuffs in the archaeological record, whether plant remains, shells, containers, staining on vats, or derived from analysis of textiles is the most secure indicator of activities involving dyestuffs at a site. However, the presence of such evidence on a site does not necessarily mean that that particular site was used for dyeing. It may be the case that sites where evidence for the preparation of dyestuffs and the dyestuffs themselves but not for the dyeing process has been found were workshops where dyes were produced rather than where dyeing was done.

Plant remains are not often well preserved, and there is no great tradition of recovering plant remains in the excavation of sites in Greece. As a result, such evidence for dyestuffs produced from plants is scanty. The dye which is most easily identifiable in the archaeological record is shellfish purple. The broken shells discarded after the extraction of the dyestuff provide a durable testament to the presence of purple production at a site, although the murex was also used as a source of food. Fragments of murex shells have been found in large quantities at a number of sites such as the site at the Peribolos of Apollo in Corinth (see chapters 2 and 7, and Appendix, 3) (Williams 1968:134), the two sites on the east coast of Delos (see chapters 2 and 7, and Appendix, 4 and 5) (Bruneau 1969:769 and 1978:111), the

island of Kouphonisi off the south eastern coast of Crete (see chapters 2 and 7, and Appendix, 14) (Papadakis 1983:61), the 'Lower Town' of Lesbos (see chapter 2) (Catling 1988:60), and Skala Oropou in Attica (see chapter 2) (Dragona-Latsoudi 1985:70).

It may be the case that dyes can be identified through inscriptions on vessels used for storage, such as the clay bottle found at the dyeworks in Kolonna, East Crete (see chapter 2 and Appendix, 12) (Watrous 1980:281). In some cases the dyes used stained the dye-vats with the colour of the dye, which can at least indicate the colour of the dye used, if not the identity of the dye itself. The inside of the vats in house IIIN in the Theatre Quarter of Delos were stained (see chapters 2 and 7, and Appendix, 6) (Charmonard 1922:45). Other evidence of the presence of dyes can occur in the shape of residues in containers, vats and so on. A pottery vessel described as 'a trough-like vessel of peculiar form' was found in the basement area in the north-west of the excavated part of the Rachi settlement at Isthmia (see chapter 2 and Appendix, 10) (Broneer 1958:18) (see Figure 5). The vessel was found to contain a dark thick deposit made up of organic matter and silica, which may have been 'the remains of the ancient dye' used at that site (Kardara 1961:265-266).

A wide range of implements were used in the preparation of dyestuffs. As discussed in chapter 2, the principal methods involved in preparing most dyestuffs were crushing, fermentation, or drying. The nature of the processes involved in the preparation of a particular dyestuff or dyestuffs would therefore determine the nature of the suite of artefacts used in these processes. This would in turn determine the visibility of these processes in the archaeological record.

In the case of the production of shellfish purple, the main processes were the opening or crushing of the shellfish to obtain the dyestuff and the maceration of the animal once it had been removed from the shell. One would expect to find objects relating to these processes in the archaeological record as indicators of the production of this dyestuff. At each of the two dyeing establishments on the East coast of Delos, for example, three granite blocks were found associated with crushed murex shells (see chapters 2 and 7, and Appendix, 4 and 5) (Bruneau 1969:769-775, and 1978:110-111). It seems likely that these blocks were used in the crushing of the shells prior to maceration. Associated with the stone blocks in the southern dyeing establishment on the east coast of Delos were two large rectangular granite tanks dating from the first century BC (Bruneau 1969:769, 775-784) which could have been used for the maceration and fermentation of the dyestuff. It is possible that similar vats would have been used in the fermentation of madder and archil, the dye produced from *Roccellae* lichen

(see sections 2.3.2 and 2.2.2 respectively), although this may not have been done on the same large scale.

Tanks were also found cut into the bedrock near to the settlement on the island of Kouphonisi which appear to have been used in the production of purple dye from murex shells (see chapter 7 and Appendix, 14):

> Μία από τις λαξευμένες κοιλότητες, στα βράχια του συνοικισμού, τις σχετικές με την κατεργασία της πορφύρας (Papadakis 1983:62-63, Fig.15).

A wide range of implements could have been used in the preparation of those dyestuffs which required crushing, such as archil, madder and woad. Sparkes (1962:125-126) argues that crushing and grinding implements would have been among the kitchen utensils used in the ancient Greek household. They would have included querns and grinding stones, shallow grinding bowls used with round stones, and pestles and mortars. Pressing machinery could also have been used. There are numerous instances of crushing equipment being found in sites which can be identified as being connected with dyeing. For instance, room d of house IIIN in the Theatre Quarter of Delos contains a press (see Appendix, 6) (see Figures 43 and 45). Room 6-29 in house D in the lower town of Halieis was also found to contain a press (see Appendix) (Ault 1994a:162-163) (see Figures 55 and 57). Presses have also been found in the dyeing complex at Mycenae (see Appendix, 15), in room L of the Citadel House Area (Bowkett 1995:20) and the south west corner of room <34> of the 'Hellenistic Chambers' south of the Great Ramp (Wace 1923:70 and Pl. 1) (see Figures 75 and 76).

Pressing equipment has been found in a number of the houses in the fifth to fourth century BC city of Olynthus (see Appendix, 16). A stone press bed, consisting of a rectangular block with a circular depression around the centre and a spout carved into it, was found in house A 1, as was a millstone which may have been part of an olive crusher (Robinson 1930:43; Robinson and Graham 1938:208). House A 6 also contained parts of an olive crusher (Foxhall 1993:190; Robinson 1930:68-74; Robinson and Graham 1938:76). The excavators suggest that there was also an olive press in room j in house A xi 10. The remains here consisted of a cement floor in the south-west corner of the room. Two gaps in the cement close to the south wall of the room are interpreted as the sockets in which stood the upright beams holding the press in place. A drain led from the cement floor through the wall of the room and into the street (Robinson and Graham 1938:339-341). This feature may have been used for some purpose other than pressing olives; Foxhall (1993:187-188) argues that 'this is rather an odd press', since there is no vessel to collect the juice, nor is there a press bed, and the drainage channel would lead off the oil into the street.

Fragments of crushing implements including grinding stones, querns, pestles and pounders were found in a number of parts of the Mycenaean complex (see Appendix, 15), for instance in rooms E, F and MM in the Citadel House Area (Bowkett 1995:39) and in room YY in the buildings over the South House (Wace 1923:102). Room <34> in the building close to the Great Ramp at Mycenae contained a mortar cut out of the shaft of a column, as well as a 'flat round stone' which may have been used for crushing (Wace 1923:70) while another was found in room LL of the Citadel House Area (Bowkett 1995:26-27). A 'stone pounder' was found in the Hellenistic building at Kolonna in the Lasithi Plain in Crete (see Appendix, 12) (Watrous 1980:279). A piece of millstone was found in the western building of the Industrial Terrace of Halieis (see Appendix, 8) (Jameson 1969:323), while a 'milling trough' was found in room 6-26, the courtyard of house D in the Lower Town in Halieis (see Appendix, 9). It consisted of at least two conglomerate slabs on the floor in the north-east corner of the room; a possible dyeing installation was set up in room 6-29, the room adjacent to the court (see section 5.21 below) (Ault 1994a 161-163). Millstones and grinders were also found at the settlement on the Rachi at Isthmia (see Appendix, 10) (Kardara 1961:261). The floor of room B in house XI, at the eastern edge of the Rachi settlement had a series of furrows cut into it; it is possible that this reflected some sort of crushing or grinding function for the room (Anderson-Stojanovic 1996:85).

Crushing and grinding implements were found in a number of the houses at Olynthus (see Appendix, 16). Seven saddle querns were found in house A 6 room i, while others were found in houses A 8, A 10, A vii 9, B ii 3, B vi 5, E.S.H. 4, as well as in a number of the so-called villas (Robinson and Graham 1938:326-327; Robinson 1946:122, 196-220). Also at Olynthus a number of houses were found to contain stone 'grain mills', the lower stones of which could have been used for crushing a wide range of substances (Robinson and Graham 1938:329, 334). Stone mortars have also been found at Olynthus, for example in houses A v 9, A vi 7, A vi 10, A vii 4, house 4 on the East Spur Hill, and at Mecyberna (Robinson and Graham 208, 335-36) (see Figure 88).

Tools such as these were not used solely for the preparation of dyes, and their appearance in the archaeological record should not be taken as conclusive evidence of dyeing, or indeed any other particular, activity. However, when these features are found in association with other features which can be identified as connected with dyeing it is safe to assume that they played some part in the dyeing process, most likely in the preparation of dyestuffs.

The preparation of dyes such as kermes, saffron, safflower, weld and lykeion would be less visible in the archaeological record. The principal process in the production of these dyestuffs was the drying of the raw material, which could have taken place almost anywhere and with a minimum of equipment and may well have been done in remote areas, away from urban/town settlements. Similarly, the pressing of kermes insects and the flower heads of the safflower into cakes would require simple equipment, probably only a flat surface and heavy objects, that may not be easy to identify in the archaeological record and indeed may have been used for more than one purpose. Different stages of the preparation process of woad involved, as well as crushing and drying, the plant being left to drain and to ferment. This would not have required any special equipment, only a space, probably outdoors, to leave the leaves.

5.2.2 Mordants

As described in chapter 3, mordants were an important ingredient of the dyeing process, through their use as fixing agents for certain dyestuffs. Once again the presence or evidence of a mordant can be taken as a fairly clear sign of dyeing activity at a site, although certain substances such as 'fuller's earth' can also be indicative of fulling activity as well as dyeing. However, the presence of mordants should not be expected on every dyeworks site, as certain 'vat dyes' such as murex purple and indigo did not require their use. Evidence of mordants can come in the form of the actual substances used as mordants, perhaps as residues in vats or tanks, although the fact that mordants are soluble means that there is less chance of it being found in the vats used for dyeing. Chemical testing of the soils in and around suspected sites of dyeing activity may also prove useful in identifying the presence of substances which may have been used as mordants in the dyeing process.

A number of the cisterns excavated by Broneer in the dyeing complex on the Rachi at Isthmia contained quantities of ash (see Appendix, 10) (Broneer 1955:126 and 1958:18). Kardara (1961:266) in her discussion of the site argues that these cisterns were 'containers' for fuller's ashes which were used as a mordant. Calcined stones found in one of the cisterns may also have been used for this purpose. However, these ashes may simply have been destruction debris, as suggested by Broneer (1955:126) and Anderson-Stojanovic (1991:303-4).

In the vats of the workshop to the north of house F of the 'industrial district' of ancient Athens a 'glassy granular substance' was found which contained elements of alkali metals and alkali earth metals, which included calcium and magnesium, as well as phosphorus (see

Appendix, 1). It is possible that the presence of phosphorus was due to the presence of quantities of bone nearby, which it is suggested indicates that chemical reactions involving bones took place (Young 1951:233-234). It is also possible however that this is a substance which may have been used as a mordant.

5.3 Immersion of fibres

5.3.1 Vessels

The immersion of the textiles in the dye and mordant solutions required the use of a suitable vessel. Vessels variously described as vats, tanks or basins, as well as baths could be used for this purpose, as could more portable equipment such as cauldrons and large pots which may also have been used for other purposes. The former constitute probably the most prominent and easily identifiable feature of a dyeworks in the archaeological record, though the latter may not be as visible archaeologically or as easy to identify as indicators of dyeing activity. Once again, the presence of these features at a site is not necessarily indicative of dyeing activity, since vats could also be used in fulling and oil or wine pressing establishments, whilst baths may be found in general domestic contexts. Nevertheless, the presence of vat-like objects is a major factor in the identification of a dyeworks site.

The vats used in the dyeing process differ widely in appearance, number and size from site to site, depending on the nature and scale of the dyeing operation being carried out. Where dyeing with hot water took place, it is possible that the vats were positioned so that they could be heated, although water may have been heated and then poured into the vat, whereas if dyeing was done with cold water this would not be the case. Moreover, in 'large scale' dyeworks it is likely that the vats used would be larger and more numerous than in a 'small scale' or 'domestic' dyeing situation, where any suitable containers may have served for dyeing.

There are broad similarities between the construction of these vessels in a number of sites. Some sites have vessels which are constructed from stone or tile, while at other sites these features are cut into the bedrock. Sometimes more portable and less specialised vessels were used. It is possible that these similarities or differences in vessel construction reflect particular processes or differences in the scale of operations, with different equipment or methods being needed for particular dyes, or perhaps that they reflect similar solutions to problems posed by factors such as local geography. I think it unlikely that these similarities reflect links between different sites in different locations, primarily because the nature of the

available evidence would not support such a statement, and partly also for reasons to do with the organisation of economic activity in the Classical and Hellenistic Greek world, which will be discussed in detail in Chapters 6 and 7.

In room e of house IIIN in the Theatre Quarter on Delos, for instance, there are six vats which were undoubtedly used for dyeing (see Appendix, 6) (Charmonard 1922:43-44) (see Figures 43, 46 and 47). They are arranged in two groups of three, on the north and south sides of the room, and are constructed from poros rubble with a thick coating of hydraulic cement, with a step up from the floor to their rims. The three southern vats also have a small shelf coated with the same substance as the rest of the vats on their inside (Charmonard 1922:43-44), which perhaps served as a seat or allowed easier access for cleaning. There was also a shelf running around the wall behind them. The construction of these vats would not allow for any solutions inside them to be heated, and the differences between those on the north of the room and those on the south perhaps indicates that they were used for different parts of the dyeing process. It is unclear as to which phase of the life of this building these vats date from (Charmonard 1922:45).

Similar vats were constructed in house IIIU, also in the Theatre Quarter, close to house IIIN (see Appendix, 7) (see Figures 50 and 51). In this case there were two vats, situated in the north-eastern corner of the courtyard, which are '*de tout point semblables à celles que nous avons signalées plus haut, en* N' (Charmonard 1922:49). This suggests then that they were also constructed from poros rubble covered in hydraulic cement, and once again could not have been heated.

The third phase of the Hellenistic building constructed over the South House at Mycenae (the so-called North-West Complex) contained three basins arranged next to each other against the southern wall of the room XX (Wace 1923:97-98) (see Figure 77). They were constructed of broken tiles covered with cement and had floors of cement laid over cobbles at different levels (see Appendix, 15). In room A of the Citadel House complex at Mycenae was a basin constructed in a similar fashion, (see Appendix, 15) (Bowkett 1995:9-12) (see Figures 75 and 78). In room MM a shallow basin was constructed from stones covered on both sides with plaster and with the upper surfaces covered with tile. Two of its sides were at right angles, while the third side was curved. A similar basin was found underneath (see Appendix, 15) (Bowkett 1995:20-22) (see Figures 75, 79 and 80). Room X also contained a shallow basin in its north-eastern corner. As with the basin in room MM, a

similar basin was found beneath it (see Appendix, 15) (Bowkett 1995:35) (see Figures 75 and 82).

At Knossos, the late Hellenistic structure in the south-west of the 'Unexplored Mansion' site contained 'a small clay-lined compartment or tank' associated with a cobbled area (Sackett 1992:15) which appears similar to the arrangement in room A in the Citadel House complex at Mycenae (Bowkett 1995:9-12) (see Figure 67). The south-eastern part of the Unexplored Mansion site at Knossos contained a small basin coated with plaster (see Appendix, 11) (Sackett 1992:13) (see Figures 67 and 68).

A number of houses in the settlement on the Rachi hill at Isthmia also contained vats and tanks (see Figure 59). One of the houses, at the western edge of the excavated area, contained an installation which was laid out as follows (see Appendix, 10) (Broneer 1955:125) (see Figures 60 and 61). A rectangular tank covered on the inside with cement was associated with a larger cistern to the south. A rock-cut channel led from the tank to a circular basin, which was associated with another similar basin 1.50 metres away, with the two basins apparently arranged symmetrically in relation to the tank and the cistern. Close to these features was another rectangular cutting in the rock, with slots cut on both inner sides. Close to one of the slots was a hole cut in the rock which perhaps served to lead off liquid from the container, possibly connecting to the rectangular tank. As at the Delian sites described above, the fact that these tanks and basins are either cut into the bedrock or constructed from stone means there is no way that they could be heated.

House III, in the central part of the settlement, contained an installation which included vessels in room A (see Appendix, 10) (see Figures 59, 62 and 63). In this installation, two circular basins adjacent to each other and separated by a partition were cut out of the bedrock of the site and coated with cement. Close to the two basins was a large shallow rectangular basin, which was apparently originally deeper. It was also covered in cement. An outlet led from the northern corner of the rectangular basin into the closest circular basin; a partition separated the other circular basin from the rectangular basin. A rectangular tank was cut into the bedrock in the north-eastern part of the room, unconnected to the other basins (Broneer 1955:126). Close to house III another installation consisted of two circular basins whose tops are level with the floor of a rectangular tank to the north-east (see Appendix) (Broneer 1958:18). Another rectangular tank (or cistern) was found in the same room (Broneer 1955:126).

A similar installation was found in house IV, to the north of house III (see Appendix, 10) (see Figures 59, 64 and 65). A shallow rectangular tank had two circular basins cut into the bedrock at its north-west edge. The rims of the basins are built up, with no apparent outlet from the rectangular vat. A rectangular basin was cut into the bedrock to the north-west, and was connected to the large shallow tank by a channel leading between the rims of the two circular basins. The whole area was covered in cement (Broneer 1958:19). House XI, at the eastern edge of the settlement, had three vessels arranged in a row in one of its rooms, room A (see Figures 59 and 66). They were all at least partly cut out of the bedrock and covered in cement. The north-western vat was conical, while the middle vat was irregularly shaped and its upper part was built from poros blocks covered with cement. It was deeper than the north-western vat (although its exact depth is not known). Only the base of the south-eastern vat survives.

A similar arrangement of vats cut into the bedrock of a site was found in the 'industrial area' to the south of the ancient settlement of Korsiai in Boiotia (see Appendix, 11) (see Figure 70). Here, three rooms and a court were found to contain, among other structural remains, a set of plaster-lined pits. 'Room 1', in the middle of the three, contained four circular pits, the largest of which (A) and was linked to two of the others (B and Γ) by rock-cut channels. These pits were smaller and shallower than A. The fourth pit (Δ) was smaller still (Fossey 1981:114). Room 2, to the north-west of room 1, had a plaster floor and contained two pits also linked to rock-cut overflow channels (Z and H) (Fossey 1981:114-119). The third room was situated to the south east of room 1, and contained two more basins cut into the bedrock (K and Λ), while another basin (M) was found in the courtyard (Fossey 1986:170).

A slightly similar arrangement to a number of the workshops excavated at Isthmia is to be found in the western building on the Industrial Terrace at Halieis in the Argolid (see Appendix, 8) (Jameson 1969:323-324) (see Figures 54 and 56). In this building one of the rooms was found to contain a cement floor on two levels. The upper level contains a 'round shallow depression' from which a narrow channel leads to a sunken pithos on the lower level. Two other pithoi were sunk in the floor of the upper level on either side of the channel with their rims set above the level of the floor. In room 6-29 of house D in the lower town of Halieis a pithos was sunk into a plaster platform also containing a press bed (see Appendix, 9) (Ault 1994a:162-163) (see Figures 55 and 57). Room 6-83 in house A in the lower town of Halieis also contained a pithos set in a plaster platform (see Appendix, 9) (see Figure 55). A

second pithos was probably set in a cutting in the northern part of the room; a broken rim, perhaps from this pithos was found close by on the platform (Ault 1994a:121-122).

Room g in house A vi 8 at Olynthus contained a similar installation (see Appendix, 16) (see Figure 85). A terracotta basin was set in the floor in the south-west part of the room. Close by to the south was a raised cement pavement, and a similar pavement was also found in the south-east of the room (Robinson and Graham 1938:112). In House A-1 (see Figure 84), which was only partially excavated in 1928, one of the southern rooms contained a rectangular cement-lined bathtub made from small stones and clay. A terracotta pipe ran into it from the north (Robinson 1930:40).

'House B' in the settlement on the island of Kouphonisi contained a cylindrical stone trough (πετρινή γούρνα) associated with murex shells (see Appendix, 14) (Papadakis 1983:61 Fig.12) (see Figure 72).

In both of its phases house F in the 'industrial district' of Athens contained vats on at least three, and possibly four, sides of a central floor (see Appendix, 1) (Young 1951:230-232) (see Figures 33 and 34). These vats were long and fairly narrow, although not all of them have been fully preserved. Vat A ran along the north-west wall; vats B and C ran along the south and east walls respectively. Two smaller vats, E and F, were found in the northern and western corners of the room. In its earliest phase, dating from the later fifth century BC, the building contained one continuous vat running around a central floor area (Young 1951:232). The building to the north of House F contained a 'great tank' and a long vat similar to those of House F which connected to the big tank at a higher level. Both were lined with waterproof cement (see Appendix, 1) (Young 1951:233) (see Figures 32 and 35).

In the western half of the dyeworks at the Peribolos of Apollo in Corinth was a stone basin, while the eastern half contained a 'reservoir' (see Appendix, 3) (Williams 1967:184) (see Figures 37, 38 and 39). The dyeworks at Kolonna in the Lasithi Plain in Crete also contained a basin, although its construction differs from most of the others described above (see Appendix,12) (see Figure 69). A rectangular area of the floor of Room 3 was covered with flat stones, with larger stones placed on their sides around the border. Three boulders set in a semicircle resting on this base formed the basin (Watrous 1980:279). Although in this form the vessel may not have been watertight, it could have been lined with lead, which would probably have been removed when, or after, the building was abandoned.

Specially constructed vats or tanks were not the only vessels used in the dyeing process, although they are the most easily recognisable in the archaeological record. Any large

watertight vessels, whether ceramic or metal, could have been used to hold the dye solution while fibres were immersed in it. At a number of sites baths may have been used for dyeing. These baths all appear to have been fairly similar, and were usually made from terracotta, with one end wider than the other. They have one curved and one straight end, with a seat at the wider curved end and a circular depression in the floor at the narrow straight end (Broneer 1955:127; Robinson and Graham 1938:199-204; Wace 1923:69-70, 99-100). At Isthmia, at least two of these baths were found in the area between houses III and IV (see Appendix, 10) (Broneer 1955:127 and 1958:18-19) (see Figure 59). The presence of one was indicated only by fragmentary remains and a depression in the cement floor of a room (Broneer 1958:19), although the other was better preserved. It was constructed partly from stone and partly carved out of bedrock and was covered with cement. Adjacent to the bath, separated from it by a thin poros slab, is a small quadrangular tank also covered with cement (Broneer 1955:127).

Similar baths have been found in the Hellenistic settlement at Mycenae (see Appendix, 15). In room <32> of the building close to the Great Ramp 'a terracotta bath of the usual Greek type' was found on a floor of flat rectangular tiles (Wace 1923:69) (see Figure 76). This bath was broken, with only the lower end being preserved (Wace 1923:69), although as at Isthmia a better preserved example was found in another building in the complex. The easternmost room of the buildings over the South House also contained a terracotta bath set on a cement floor (Wace 1923:99-101) (see Figure 77). A number of the houses at Olynthus contained so-called 'bathrooms' (see Appendix, 16). These are usually small rectangular rooms with a bath in one corner. The walls and floor are plastered (Robinson and Graham 1938:199). These rooms were usually linked to the so-called 'kitchen' or '*oikos*' units of the house, that is the rooms considered to be the main living areas. Not all of the rooms described as bathrooms in the reports of excavations at Olynthus contain all of these features *in situ*, and in some instances baths were installed in rooms which were not simply 'bathrooms' (Robinson and Graham 1938:198-204). Twenty-three such rooms are listed by Robinson and Graham (1938:204) as having been found in excavations in 1928, 1931 and 1934 (one third of the houses excavated up to that point). Other bathrooms are mentioned by Robinson (1946) (see Figures 84, 85, 86 and 87).

In some cases ordinary household vessels could have been used. A wide range of terracotta vessels were common in the ancient household, including large pots for cooking stews and soups, as well as smaller bowls (Sparkes 1962:129-132). Many of these could have been used for dyeing as well as for cooking.

5.3.2 Water supply and drainage

Large quantities of water were used in the dyeing process, and it was important that a dyeing installation had good facilities for both providing water and disposing of it after use. Water supplies could be obtained from cisterns or water pipe arrangements in areas where there was no readily available natural water source, from wells or from sources such as streams, rivers or the sea. In some cases combinations of these different means of obtaining water were used. Drainage systems were usually used to get rid of excess or waste liquids.

5.3.2.1 Water supply

Cisterns have been found at a number of sites. At Isthmia, for example, a great many large cisterns and 'reservoirs' were excavated on the Rachi (see Appendix, 10) (see Figure 59). These were mostly cut into the bedrock, although in some instances they were partly built with stones (Broneer 1955:125-128 and 1958:18). The dyeworks at Anaploga in Corinth was associated with a very large cistern which was apparently too large for normal everyday use by the people of that area (see Appendix, 2) (Robinson 1963:79), while the Peribolos of Apollo dyeworks in the same city contained a large 'reservoir' which took up one half of the workshop (see Appendix, 3) (Williams 1967:184) (see Figures 37 and 38). At Olynthus, cisterns were found in eight of the houses excavated up to 1934 (see Appendix, 16) (Robinson and Graham 1938:307). They were mostly situated in the courtyards of houses (Robinson and Graham 1938:307). House A viii 2 was furnished with a pipe line running from the alley north of the house into the court, which was 'probably to supply the house with rain water' (Robinson 1946:12-13). The basin in house A-1 was fed by a terracotta pipe running into it from the north (Robinson 1930:40). A public fountain house in the agora would have provided water for a number of houses at Olynthus (Cahill 2000:499) (see Figures 83, 84, 85, 86 and 87).

In house IIIN in the Theatre Quarter on Delos there were two large cisterns under the floor of room f (see Appendix, 6) (Charmonard 1922:44) (see Figures 43 and 48), and in house IIIU there were also two cisterns, situated under the courtyard (see Appendix, 7) (Charmonard 1922:49) (see Figures 50 and 52). A similar arrangement existed in room L of the Citadel House in Mycenae (see Appendix, 15) (see Figure 75). Underneath the floor of an earlier phase of construction were two circular cement cisterns (Bowkett 1995:20). A cistern was also found in room R (see Appendix) (Bowkett 1995:44). Room 2 of the industrial area of the settlement at Korsiai in Boiotia contained a pear-shaped cistern cut into the bedrock (see Appendix, 13) (Fossey 1981:119) (see Figure 70).

Another method of providing water where there was none readily available was through the construction of piping mechanisms, such as the built water pipes and cisterns found on the islet of Kouphonisi (see Appendix, 14) (Papadakis 1983:63) and the rock-cut channel built to collect rainwater at Isthmia (see Appendix, 10) (Broneer 1958:20).

Wells are also found at a number of sites. The channel at Isthmia described above emptied into a well shaft cut into the bedrock to a depth of at least forty five metres (see Appendix, 10) (Broneer 1958:20; Kardara 1961:261) (see Figure 59). The workshop in the 'industrial district' of Athens contained two wells, a shallow one in the workshop's north-eastern corner and another north of the porous wall on the north side of the building (see Appendix, 1) (Young 1951:233) (see Figure 32).

Other dyeworks were situated near to a readily available supply of water. That near the Peribolos of Apollo in Corinth was near a stream which came from the spring of Peirene, which was diverted to bring it closer to the dyeworks (see Appendix, 3) (Williams 1968:134-135) (see Figure 36). The fact that the two establishments on the east coast of Delos were situated on the coast meant that they had access to an almost unlimited supply of seawater (see Appendix, 4 and 5) (Bruneau 1969:790) (see Figures 40, 41 and 42).

5.3.2.2 Drainage

Once water had been brought to a dyeworks and used it had to be disposed of. The dyeing complex at Mycenae was equipped with fairly elaborate drainage facilities (see Appendix, 15) (see Figures 75 and 77). On the upper terrace of the Citadel House, for instance, a cement channel connected the basin in room A to one of two converging covered drains in room B. The other drain entered the room from room U to the north-east. These drains were constructed of tile, with flat tiles on the bottom and curved or flat tiles on top, and were originally set below a plaster floor (Bowkett 1995:12). An open drain constructed of thin curved tiles also ran north from this room into room T (Bowkett 1995:12). The Hellenistic buildings over the South House also had drainage facilities. The central basin in room XX of this building had a terracotta drain running from it through the south wall of the building (Wace 1923:98) and into a sump in the street outside (Bowkett 1995:49). The bath situated in the room next to that containing the aforementioned basin also had a channel running from it into a drain under the floor. This drain consisted of a terracotta channel set between two walls of small stones and covered with flat tiles (Wace 1923:100-101), and also ran into a sump in the street outside (Bowkett 1995:30). Near to these sumps were found two sections of

terracotta drainpipe joined together (Bowkett 1995:30). There was also a drain in the eastern terrace wall of the complex from which water flowed down the street (Bowkett 1995:19-20).

The 'industrial area' at Korsiai in Boiotia contained drainage provision, with a large plaster-lined gully in the bedrock of the courtyard serving as a drain and a similarly constructed runnel leading away from room 2 towards the courtyard (see Appendix, 13) (Fossey 1981:119) (see Figure 70). Drainage channels have also been found at Isthmia (see Appendix, 10) (Broneer 1955:127) and at the Peribolos of Apollo dyeworks in Corinth (see Appendix, 3) (Williams 1968:134-135). The dyeworks in the industrial district of Athens was also equipped with good drainage facilities, being built next to the fourth century BC Great Drain (see Appendix, 1) (see Figures 32 and 33). The workshop was altered at the time that this drain was built, and as a result the east wall of the workshop was the west wall of the drain. Holes in this wall from two of the vats in the workshop served as outlets for drainage (Young 1951:231). The blocks of houses at Olynthus had an alley dividing the northern houses from the southern houses, which was used for drainage (see Appendix, 16) (Cahill 2000:499) (see Figures 85 and 86). A number of houses had pipes which led from their courtyards into these drainage alleys (Robinson and Graham 1938:307).

5.3.3 Heating

Certain methods used by the ancient Greek dyer required the use of heated water for the dyeing process. This could be provided by heating the vessels used for the immersion of the materials in the dye solution or by heating the water before it was put in the vat. A number of the vessels examined above are by their nature and construction unable to be heated. If their contents required heating, the most favourable location for heating apparatus would be in close proximity to the vat or vats used. The location of heating apparatus was not always fixed however. Hearths would therefore indicate the presence of heating when in proximity to other dyeing apparatus. Many Classical and Hellenistic Greek houses lacked hearths (those found at Olynthus are among the exceptions), and when heat was needed portable braziers were often used. These braziers were often designed to hold pots (Sparkes 1962:129-131), which means that dyeing could have been done using heat which would leave no obvious traces in the archaeological record. These braziers could also have been used to heat water which could have been poured into vats which were specially constructed.

At Kolonna in Crete, for example, a hearth constructed of small blocks arranged around a slab on the floor to provide a shallow enclosure was found in Room 3 close to the basin (see Appendix, 12) (Watrous 1980:279) (see Figure 69). Similarly, in the room in the

Hellenistic building over the South House at Mycenae charcoal was found in front of two of the three basins, thus providing evidence for the heating of water (see Appendix, 15) (Wace 1923:98) (see Figure 77) while hearths were found on various floor levels of room B close to the basin in room A (Bowkett 1995:12-14) and in room GG in the Citadel House complex (Bowkett 1995:30) (see Figure 75). House B in the settlement on the island of Kouphonisi contained a series of clay hearths (Σειρίς από πηλινές εστίες) (see Appendix, 14) (Papadakis 1983:61) (see Figure 73). Vivid red soil, possibly indicating fire, was found associated with the deposit of murex shells at Skala Oropou in Attica (έντονα κόκκινος από φωτίας χώμα) (Dragona-Latsoudi 1985:70). At Olynthus, a number of the so-called 'bathrooms' were situated close to areas where there was evidence for heating, in rooms which have been referred to as 'kitchens' or 'flues' (see Appendix, 16) (Robinson and Graham 1938:199-200, 204) (see Figures 84, 85, 86 and 87).

5.4 Squeezing out excess liquid from dyed fibres

After removing the dyed material from the dye solution, the excess liquid was squeezed out. It is likely that the excess dye solution would have been collected so that it could be used again, particularly when expensive dyes were being used. This stage of the process is fairly inconspicuous archaeologically, since it required simply a surface for the material to be squeezed on, objects with which to squeeze out the liquid, and somewhere for the squeezed-out liquid to go. One might expect to find containers linked to squeezing areas, to enable the collection of excess dye solution. At some sites this activity appears to have been carried out using specially constructed equipment, whereas at others those involved in dyeing may simply have used any available equipment which was suitable for this task.

Kardara (1961:261-263) suggests that the shallow tanks connected to circular basins in the Rachi settlement at Isthmia were used for the squeezing out of the dyed material (see Appendix, 10) (see Figures 59, 62, 63, 64 and 65). This material was laid on the platforms and pressure was applied with the large tiles found on various parts of the site in order to squeeze out the maximum amount of liquid. This liquid would then run into the basins where it could be re-used for dyeing. It is possible that the 'peculiar vessel' containing organic material found at Isthmia (Kardara 1961:265) was used for this purpose, since the upper section containing the organic deposit would have been ideal for squeezing fabric with the majority of the dye able to be collected in the lower section (see Figure 5).

The dyeworks in the Industrial Terrace at Halieis contained a similar arrangement (see Appendix, 8) (Jameson 1969:322-323) (see Figures 54 and 56). Fibres dyed in the pithoi in the higher part of the floor could have been squeezed out in the circular depression (which may in any case have been the location of a press bed). Any excess dye solution would flow down the channel and into the small ceramic basin sunk in the lower part of the floor, where it could be collected and then put back into the pithoi for re-use. In the Lower Town of Halieis, the cement platform with a raised edge containing a press bed in room 6-29 may have been used for the same purpose (see Appendix, 9) (see Figures 55 and 57). If fibres were immersed in the large pithos set into the platform, they could be squeezed out on the press bed. A ceramic basin was set in the floor under the spout of the press bed, which could collect the liquid squeezed out of the dyed fibres (Ault 1994a:162-163). House A, also in the lower town of Halieis, had a similar installation in room 6-83 (see Appendix, 9) (see Figure 55). One of the two pithoi (presumably the larger) set into a plaster platform with a raised edge could have been used for immersion, while the other could have collected the excess liquid squeezed from dyed fibres (Ault 1994a:121-122).

A number of rooms at Mycenae were found to contain cement floors with raised edges and sumps (see Appendix, 15) (see Figures 75 and 81). Fibres dyed in vessels could have been taken to rooms G, KK, JJ, GG, and possibly T and P, in the Citadel House complex where they could have been squeezed out on the plastered areas, with the excess going into the sumps in the corners (Bowkett 1995:14-16, 22-26, 27-30). Rooms L and LL, which contained presses set in plaster floors in a similar fashion to those in houses A and D in Halieis, may also have been used for squeezing and collecting liquid from dyed fibres (Bowkett 1995:20, 26-27). The plaster floor areas in rooms <31> and <32> of the Hellenistic building close to the Great Ramp may also have had the same function (Wace 1923:69-70) (see Figure 76). Similar rooms have been found in a number of the houses at Olynthus (see Appendix, 16) (see Robinson 1930; Robinson 1946; Robinson and Graham 1938) (see Figure 84), as for example in room i in house A-5, which contained a cement floor with a terracotta basin set into it (Robinson and Graham 1938:70). Room g in house A vi 8 contained a cement floor area in its south-western corner, described by the excavators as a 'treading floor'. 'A few centimetres' to the north of this were found the remains of a terracotta basin set in the floor, with a raised rim which was 'presumably intended to catch the liquid from the treading floor'. A similar cement floor which 'probably served the same or a related purpose' was found in the south-eastern corner of the same room (Robinson and Graham 1938:112). These cement areas could have

been used for pressing out dyed fibres, with the excess dyestuff going into the terracotta basin in a similar arrangement to that in houses A and D at Halieis, for instance.

The arrangement of shallow basins and channels associated with deeper basins at Korsiai may also have been used for this purpose (see Appendix, 13) (Fossey 1981:120) (see Figure 70). In room 1, the trough carved in the floor may have served to channel excess dye solution from fibres immersed in the large pit, A, into some of the shallower pits (Fossey 1981:114). In room 2 pit Z was connected with the smaller pit H in room 2 by means of a channel carved in the floor (Fossey 1981:114-120), and in room 3 pit K was linked to a small natural depression in the rock with a channel (Fossey and Morin 1986:170). These features may also have been used at this stage of the dyeing process.

The central paved area surrounded by vats in the workshop in the industrial district of Athens (Young 1951:230-232) may have been used for squeezing out excess liquid, which would then go straight back into the vats surrounding the floor (see Appendix, 1) (see Figures 33 and 34). A similar purpose could be suggested for the floors associated with drainage channels found at the Peribolos of Apollo dyeworks in Corinth and previously described as 'drying floors' (see Appendix, 3) (Williams 1968:134-135). The benches running along the south and north walls of the room containing the basin at the same site may also have served this function (Williams 1967:184), in a similar way to the bench along the south wall of room 3 of the dyeworks at Kolonna in Crete (see Appendix, 12) (see Figure 69). As well as the bench a quantity of perforated tiles similar to those from Isthmia were found at this site and were perhaps used for the same purpose in conjunction with the bench (Watrous 1980:278-281). The shelves on the front of the vats in houses IIIN and IIIU in the Theatre Quarter of Delos would have been suitable for squeezing excess dye solution from fibres (see Appendix, 6 and 7) (see Figures 43, 46, 47, 50 and 51).

5.5 Drying

Drying the dyed material would have required very little equipment, and this would have differed according to the nature of the material and the method of drying used. Drying could have been done indoors or outdoors, with the dyed material either hung up or laid flat.

Hanging would have been suitable for materials such as spun wool, linen yarn and woven material, whereas materials such as unspun wool are likely to have been dried flat. If fibres were hung up to dry indoors this would, ideally, have been done in a room with a

waterproof floor or on a roof and some sort of provision for drainage or water collection, since the water coming out of material that was drip-drying could, for instance, waterlog an earth floor. Ideally, a room used for such a purpose would have good air circulation and perhaps some sort of heating facility to aid in the drying of the material. If the material were dried outdoors, these features would not always be necessary. Any drip drying arrangement might possibly also have required the use of weights to prevent the dyed material from shrinking, especially if this material was wool or spun thread.

Loomweights would have been ideal for this purpose, and have been found at a number of dyeworks sites, sometimes in large quantities. For instance, one hundred and seventy-six loomweights were found in the Hellenistic levels across the Citadel House Area at Mycenae (see Appendix, 15) (see Figure 28). Most were conical or pyramidal, and made from terracotta, although two stone loomweights were also found (Bowkett 1995:40). 'Many' pyramidal terracotta loomweights were found in the Hellenistic building near the Great Ramp (Wace 1923:71), while fifteen pyramidal and one round looweights were found in the 'North-West Complex' (Wace 1923:101). Sixty six loomweights were found in the building at Kolonna in the Lasithi Plain in Crete (see Appendix, 12) (Watrous 1980:280-281), fifty eight of which (including pyramidal and biconical loomweights) were found in room 3, which contained the dyeing equipment (Watrous 1980:279). Loomweights have also been found in the buildings in Halieis containing dyeing equipment (see Appendix, 8 and 9) (Ault 1994a:242-244; Jameson 1969:323-324), and at a number of buildings in the Rachi settlement at Isthmia (see Appendix, 10) (Anderson-Stojanovic 1996:90; Kardara 1961:261) (see Figure 29). Loomweights were found in almost all of the houses excavated at Olynthus, in some cases in large quantities (see Appendix, 16) (Robinson 1930:118-128; Robinson and Graham 1938:209).

There are also a number of buildings which contain features which may have been suitable for drip-drying dyed fibres. Rooms G, KK, JJ, GG, and possibly T and P, in the Citadel House complex at Mycenae, which contained areas consisting of plaster floors with raised edges and holes to collect liquid, would have been suitable for this purpose, as well as for squeezing out liquid from dyed fibres (see Appendix, 15) (Bowkett 1995:14-16, 22-26, 27-30) (see Figures 75 and 81). Interestingly, these rooms contained around thirty loomweights out of the total found at that site. The similar rooms in the Hellenistic buildings near the Great Ramp at Mycenae (Wace 1923:69-70) (see Figure 76) could have been used for the same purpose. The pits and troughs coated with plaster in rooms 1, 2 and 3 of the building in the Industrial Area at Korsiai would also have been suitable for drying (see Appendix, 13)

(Fossey 1981:114-120; Fossey and Morin 1986:170) (see Figure 70). The channel in room c of house IIIN in the Theatre Quarter of Delos (Charmonard 1922:43) could also have been used for catching the drips from drying material (see Appendix, 6) (see Figures 43 and 44).

There are number of features which might indicate the potential for drying outdoors. The sites at Isthmia (see Figures 58 and 59) and the Industrial Terrace at Halieis (see Figure 53), and possibly Mycenae (see Figure 74), were situated in breezy locations at the tops of hills, which will have been beneficial for drying (Kardara 1961:263; Jameson 1969:324; Bowkett 1995:45). Laying dyed material out to dry flat would probably have been best done outside, perhaps on a flat roof or a specially constructed drying area, where the power of the sun could be harnessed by the dyers of Greece. The dyeworks at the Peribolos of Apollo in Corinth, for example, was equipped with a series of outdoor 'drying floors' (see Appendix, 3) (Williams 1968:134-135) where this method of drying may have been employed. It may also have been possible to leave fibres to dry in the courtyards of houses, and it is likely that all of the buildings discussed above had these.

5.6 The use of this information in the identification of dyeing sites (Table 2)

It can be seen then that the different stages of the dyeing process are associated with various features which can be identified in the archaeological record. These include the remains of dyestuffs (including equipment needed for their production) and mordants, vessels in which fabric was immersed, the provision of water supply and drainage facilities, equipment for squeezing out the excess dye solution from the dyed fabric and drying facilities. As we can see from the evidence above, these things are far from uniform, coming in different shapes and sizes, and not necessarily all looking the same.

If one were to apply the criteria set out in section 5.1 to the sites discussed above (see Appendix and Table 2) it can be seen that, where the evidence allows, it is possible to place them in the scale of identification. The most securely identifiable dyeworks sites are house IIIN in the Theatre Quarter on Delos, the Peribolos of Apollo site in Corinth, the workshop at Kolonna on the Lasithi plain in Crete, and the site on the island of Kouphonisi near Crete. If the organic residue found in the 'peculiar vessel' from the complex on the Rachi at Isthmia is to be identified as the remains of a dyestuff (Kardara 1961:265-266), then this site would also fit in this category. These are all sites where evidence for dyestuffs has been found, along with some of the other equipment used in dyeing such as mordants, vats or tanks, water supply and drainage, and heating, squeezing and drying facilities.

Other sites have evidence of dyestuffs but no evidence of dyeing, as opposed to for instance dye production. It is therefore impossible to say in what ways these dyestuffs were used, and whether dyeing was actually carried out there or not. These sites include the 'North' and 'South Establishments' on the east coast of Delos, and also the sites at the Lower Town of Lesbos and Skala Oropou in Attica.

Sites where there is no evidence for dyestuffs, but evidence for dyeing equipment, are the most numerous of the groups included in this chapter. The sites in this group contain evidence from a number of different criteria, most notably specially constructed vats or tanks of some description, along with a combination of other features such as dye production equipment, water supply and drainage facilities, and heating, squeezing and drying facilities. A number of the sites contain evidence for the presence of mordants. An important feature of these sites is that their production facilities are in specific areas, whether separate 'workshops' or in areas within houses. Sites in this category include: house F in the 'Industrial District' of Athens; the dyeworks at Anaploga in Corinth; house IIIU in the Theatre Quarter on Delos; the building or buildings of the 'Industrial Terrace' and houses A and D in the Lower Town in Halieis; the Unexplored Mansion in Knossos; the 'Industrial Area' in Korsiai; the Citadel House complex at Mycenae.

Sites at the lower end of the scale of identification contain very little evidence of dyeing, although there are also no concrete indicators that they were used for this purpose. What evidence there is usually comes from one or possibly two of the criteria which are not themselves conclusive proof of dyeing activity. At these sites, the dyeing equipment is not specially constructed, and can often be used for a range of different activities including craft production and other non-craft production activities. The dyeing equipment is not found in a separate 'production area', but is within a part of the house which could have been used for many purposes. These sites are all places where there is the potential for dyeing to have been carried out, since they contain the necessary equipment; whether dyeing was in fact carried out there is impossible to say with certainty. The houses at Olynthus would fall into this category, since it is possible that dyeing was carried out in them, but it is impossible to say with any certainty whether it actually was.

It will be possible in future then to use these criteria in the identification of new sites, in order to find out both their function and the scale on which they were operating. The evidence set out above will be used in chapter 7 to aid in the discussion of the economic and social factors relating to dyeing in the Classical and Hellenistic Greek world.

Table 2: The presence of dyeing evidence at sites discussed in this study

	CRITERIA FOR IDENTIFYING DYEWORKS							
SITE	1	2	3	4	5	6	7	8
Athens 'Industrial District'			poss	Y	Y		Y	
Corinth - Anaploga area				poss	Y		poss	
Corinth		Y		Y	Y		poss	Y
Delos East Coast 'North Establishment'	Y	Y			Y			
Delos East Coast 'South Establishment'	Y	Y		Y	Y			
Delos Theatre Quarter House IIIN	Y	Y		Y	Y		Y	Y
Delos Theatre Quarter House IIIU				Y	Y		Y	
Halieis - 'Industrial Terrace'	Y			Y			Y	Y
Halieis - Lower Town	Y			Y	Y	Y	Y	
Isthmia - Rachi	Y	poss	poss	Y	Y		Y	Y
Knossos - Unexplored Mansion	Y			Y	Y			
Kolonna	Y	Y		Y		Y	Y	Y
Korsiai				Y	Y		Y	Y
Kouphonisi	Y	Y		Y	Y	Y		
Mycenae	Y		poss	Y	Y	Y	Y	Y
Olynthus	Y			Y	Y	Y	Y	Y

Criteria:

1 Equipment for dye preparation or production

2 Evidence of the presence of dyes

3 Evidence of the presence of mordants

4 Presence of vessels used in the immersion of fibres

5 Facilities for water supply and drainage

6 Heating facilities

7 Area and equipment for squeezing excess liquid from dyed fibres

8 Drying facilities - weights

- drying areas

Chapter 6

Studying Craft Production in its Economic and Social Context

The aim of this chapter is to provide a theoretical backdrop for the discussion of the role of dyeing in the economic and social spheres of classical and Hellenistic Greek society. This will begin with a brief discussion of previous scholarship regarding the nature of the ancient Greek economy, and the role and nature of craft production therein. This review will serve to set out the parameters of the following discussion of the use of different models and frameworks with which to analyse craft production, and also the major issues relating to this study. The final sections of this chapter will set out a model for looking at the economic and social contexts of craft production in classical and Hellenistic Greece, which will then be applied to the archaeological and historical evidence of dyeing in the following chapter.

6.1 Studying ancient economies

Any discussion of a particular area of the economic and social spheres of any society requires some background knowledge of the broader economic and social issues relating to that particular society. As Hopkins stated in his introduction to a study of trade in the ancient economy,

> 'in order to understand the ancient economy, we need to know the part played in it by trade and traders; in order to understand the role of trade and traders, we need to hold some view of the ancient economy' (Hopkins 1983:ix).

The same is true for the study of craft production. Therefore, before looking in depth at the issues relating specifically to craft production activity, and particularly dyeing, it is necessary then to explore the general nature of the economy in Classical and Hellenistic Greece. This section will therefore seek to summarise and assess previous scholarship, both archaeological and historical, regarding the ancient economy. It is not appropriate here to discuss every aspect of this debate, including its history and possible future directions, in exhaustive detail. I will look only at the principal issues relevant to this study, and will conclude the section by giving my view of the nature of the ancient Greek economy and how best to study it, which will serve to inform the following discussion.

A wholly original account of the protracted debate over the ancient economy is impossible, given the fact that most works dealing with some aspect of it start with a critique of previous work. I am forced to rely on such works, primarily those of Austin and Vidal-Naquet (1977), Finley (1985) Davies (1998), Garnsey, Hopkins and Whittaker (1983) and

Morris (1994 and 1999) for much of the data dealing with this. However, I would hope that the opinions and conclusions expressed below are my own, or at least have been given a personal slant, particularly since my purpose and focus are different from those of previous scholars.

Perhaps the best starting point in a critique or summary of the previous scholarship relating to the ancient Greek economy is to provide suitable definitions of the principal terms, particularly the phrase 'ancient Greek economy'. This is not as straightforward as one might hope. Indeed part of the problem is the lack of a single unified and universally accepted theoretical framework for the study of the ancient economy, which stems from the fact that different scholars have in the past applied different definitions to similar phenomena, such as an economy, depending on their particular theoretical backgrounds. There are some main streams of thought, however. Here, then, I will attempt to set out a fixed set of definitions based on previous scholarship which will then be applied throughout the remainder of this study.

Finding a suitable definition of the term economy is a difficult and controversial task. This is of immense importance to any study of this nature, since it is this term which encapsulates all of the preconceptions which will influence and inform any consequent discussion. In *The Ancient Economy* for example Finley regards the economic system as an enormous conglomeration of interdependent markets (Finley 1985:22), and his study is then founded on this definition. Osborne (1996:31) also refers to this definition in his discussion of the role of trade in the archaic Greek economy.

But is this definition of an economy suitable for use in the study of Classical and Hellenistic Greece? Finley (1985:22-23) acknowledges that the use of the word 'markets' in an abstract sense cannot be translated back into ancient Greek or Latin, and applies to a modern system, not to the ancient world. However, he proceeds to evaluate the evidence for the economies of the ancient world in relation to this definition. Similarly, Osborne's argument is directed towards proving the existence of interdependent markets in the ancient Greek world (Osborne 1996). If such a system did not exist in the ancient Greek world, however, it is perhaps inappropriate to look at the ancient world in these terms. Davies (1998:243) defines the word economy as 'the essential movements, ... of goods, services or money'. This is a more vague and non-committal definition, and it may be that its strength lies in its breadth. These movements can include exchange within a capitalist market system or organised in a more 'primitive' situation of reciprocity. It is this definition which I will use in

this study, since it is vague enough not to be too linked to any anachronistic notions such as those linked to capitalist economies, for instance.

I do not intend to imply that everywhere in Classical and Hellenistic Greece shared the same economic system. Much of the work done on the ancient economies in the past has tended to cover the whole of the classical world, from Archaic Greece to the Roman Empire. Surveys such as Finley's *Ancient Economy* treat the whole of the ancient world as a single entity, with a single economic system. It can be argued that Finley's general model was suitable for a discussion of the high-level structures and differences of ancient, medieval and modern economies (Morris 1999:xxxvi-xxxvii). Morris (1999:xxxvi-xxxvii) has argued that more detailed models are less interesting to 'large communities of social scientists and comparativists'; however, it would seem more important to produce an account of ancient economic activity that reflects the situation in a particular setting. A huge geographical area and chronological span such as the classical world contains within it a number of different social and economic systems. The differences between Greece and Rome are too great to collapse both together and generalise about the nature of economic activity in them. It is necessary then to look in more detail at more suitable units for study.

One must bear in mind the fact that what we call ancient Greece was in fact a group of separate states, often with different political and social organisations, which would in turn have resulted in differing economic systems. There are likely to have been broad similarities, just as there were broad similarities in language and culture, but on the whole it would be dangerous to presume that because of this Greece would have been a single unified economic area. On the other hand, it has been argued that there is a level at which individual Greek economies (i.e. of individual *poleis*) are clearly linked into a 'Mediterranean' economic system from late Archaic and Classical times (see Foxhall 1998b; Osborne 1996). Moreover, this problem is amplified when taking into account change over time. The study of any aspect of craft production in ancient Greece entails investigating societies over a period of time lasting roughly three and a half to four centuries. Over such a long period the political, social and economic situations in the states of the Greek world changed in a number of ways, and economic activity must have changed as well.

A similar note of caution is sounded by Davies (1998:241), who stresses the need to acknowledge the existence of 'a possible extreme diversity of types of activity within the same society'. It is important to be aware of the fact that within ancient Greece

> an 'economy' ... does not have to be *monocolore*, does not have to be labelled according to its 'predominant pattern', and does not have to be more than a loosely articulated *mélange* of separate systems each with its own rules, purposes and ideology (Davies 1998:241).

In this study therefore, the model ultimately proposed for the archaeological study of the organisation of craft production in Classical and Hellenistic Greece will aim to be broad enough to cover the geographical and chronological range and socio-political diversity of Greek societies and their economic systems.

I will turn now to the evidence for economic activity in classical and Hellenistic Greece, and the ways in which previous scholars have used literary and archaeological material to construct differing accounts of the ancient Greek economy. A great deal of documentary evidence has been used in the study of the ancient Greek economy, including material from philosophical and historical works, drama and poetry, as well as epigraphic material. While these varied sources have provided valuable information for studies of this type, their use is problematic, which stems in part from the nature of the sources themselves and partly from the ways in which they have been used.

Detailed discussion of the nature of the evidence used specifically for this study has been covered in chapter 1. The most obvious problem with the use of ancient literary evidence in the study of the ancient Greek economy in general, or indeed any aspect of ancient society, is the fact that most, if not all, of the works offer a limited view of their world. All of these authors are men, usually from the higher echelons of society, and often have viewpoints not necessarily in line with the prevailing currents of contemporary society. Any discussions of economic matters by these authors are likely to be coloured by these prejudices, resulting for example in the dismissal of certain types of economic activity as unfit for citizens, or dismissing certain types of people from particular types of activity.

In addition, much of the surviving literary source material was written by Athenians, and was either about Athens or dealt with other areas of the Greek world filtered through Athens-tinted spectacles. While this could be useful if one were attempting only to look at the economy and society of classical Athens, the relevance of these sources for the study of other areas of the Greek world is uncertain. It is therefore important to be aware of this, and to avoid the automatic application of these types of evidence to different Greek societies as much as possible, given the need to recognise the social and economic diversity of Greek states in space and time.

A further problem is the way in which this evidence has been used by modern scholars with preconceived ideas about the nature of an economy, and how it should be studied. Some scholars have searched the ancient literary sources for evidence of an awareness of economic activity in a modern sense, and judged them, and by extension the society which produced them, in these terms. Finley highlighted the lack of economic analysis by authors such as Xenophon (Finley 1985:19), based on his definition of an economy as a conglomeration of interdependent markets, and economics as the scientific study of the workings of these markets. Meikle (1979) has argued to the contrary, stating that the work of Aristotle displays a knowledge of certain concepts used in economic theory, such as value theory.

There are a number of weaknesses to this approach. Not least is the problem that if one accepts that the ancient economy was not like that of the modern world, one should not expect ancient writers to be aware of theoretical concepts formulated for the study of the modern economy. Once again, there is a need to study these texts in relation to an idea of the economy which does not relate solely or directly to global systems such as capitalism. With this in mind, it is possible to identify in ancient literary source material a number of passages relating to economic aspects of society. Using this approach Pomeroy is justified in seeing Xenophon's *Oikonomikos* as an economic work, dealing as it does with the organisation of agricultural production and labour within the household (Pomeroy 1994:41-46). Other sources contain information relating to production techniques and the organisation of both agricultural and non-agricultural production, the legal frameworks for economic activity, the workings of the public economies of Greek states, and so on.

I will now turn to the archaeological evidence, briefly highlighting particular issues relating to the use of archaeological data in the study of the economy. Unlike the huge volume of work dealing with the historical evidence for the ancient Greek economy, archaeological evidence has not been exploited to its full potential in this area. There has not been a large-scale archaeological overview of the ancient Greek economy such as that produced by Greene for the Roman world (Greene 1986), although it may be argued that given the fragmented nature of the ancient Greek world, without a single overarching administrative framework of control, producing a work such as this is not possible. There have been attempts to study particular regions however, such as McClellan's (1997) archaeological perspective on the economy of Hellenistic Egypt and Syria. Generally in Classical and Hellenistic Greek archaeology, material has not been discussed in its economic context. Thus discussions of craft production sites tend to concentrate on the technology involved, rather than the

organisation and scale of production in economic terms. There are exceptions to this (such as Arafat and Morgan 1989), and this study will aim to join them in redressing the balance slightly.

One area in which archaeological evidence has been used extensively is the study of trade in the ancient economy. This is perhaps due to the fact that large numbers of pots of Greek origin have been found on sites across the Mediterranean, and indeed much of the scholarly discourse has dealt with the question of trade in ceramics (see for example Osborne 1996; Gill 1994). Moreover, the durability of pottery in the archaeological record has meant that in most cases it is the only ancient product available for study in large quantities. Another area in which there has been a lot of recent work is in the archaeology of agriculture, especially since a number of large-scale field survey projects have recently been carried out in Greece (see for instance Alcock 1993; Cavanagh et al. 1996; Jameson, Runnels and van Andel 1994; Mee and Forbes 1997). These projects have enabled archaeologists to gain new insights into the subsistence strategies of ancient peasants, and by extension the role of agricultural production in the wider context of the *polis* economy (Morris 1994:363-364).

6.1.1 The 'ancient economy' debates

The debate over the nature of the ancient economy has been characterised by a series of disagreements between scholars of opposing views on the nature of ancient economic activity and the best way to investigate it. This debate began from theoretical divisions between modernists and primitivists, and formalists and substantivists. I will briefly discuss the main features of these views, and their implications for this study, starting with the modernist-primitivist debate. This situation developed the early twentieth-century work on the ancient economy, and is based on its perceived level of organisation. The modernist viewpoint, developed from the work of Meyer, Beloch and others, held that the ancient world (from the Archaic and Classical Greek city states to the Roman Empire) was analogous to the medieval city state, with wealth derived from long-distance trade and largely in the hands of corporations of entrepreneurial merchant princes. This large-scale trade was facilitated by the presence of markets, and surplus products provided by large-scale industrial production carried out in factories, of which there was mass consumption. State economic policy was characterised primarily by controlling and promoting export activity (Davies 1998:234-5).

The primitivist position, formulated by Bücher and restated by Hasebroek and Weber (Austin and Vidal-Naquet 1977:4-7), held that ancient Greece (and Rome) were comparable

to the non-western 'primitive' societies. Trade and production were on a much smaller scale than that claimed by the modernists. The principal source of elite wealth in the ancient Greek city state was not trade but land, through which citizenship was defined and which thus connected wealth with political power. The dominant mode of production was agriculture (Parkins 1998:4), reinforcing this emphasis on land ownership as the basis for status and power. Trade and production were carried out mostly by non-citizens (either free or slaves), and was to a great extent geared towards the provision of local needs, large-scale long-distance trade operating only in exceptional circumstances. State economic policy was not geared towards regulating and profiting from exports; the prime concern was to ensure that the state imported all of the essential materials for the city to function, and also to secure revenues, through such mechanisms as taxation and war (Austin and Vidal-Naquet 1977:6-7).

In order to resolve the impasse in this debate, scholars dealing with the ancient economy have looked further afield, and a number of other disciplines have provided useful frameworks of analysis which can be applied within the fields of archaeology and ancient history, primarily anthropology. In a subject such as this, where the evidence is so heavily biased towards certain places (such as Athens), or towards certain types of products or buildings, or even towards certain aspects of the economy (such as trade for archaeology), models formulated for other (primitive) societies can be extremely useful when applied to ancient Greece. Perhaps the most influential comparative approach has been that of Karl Polanyi. Humphreys (1978) has provided a useful summary of Polanyi's work, and its uses in the study of Greek society. This work is rooted in another clash of -isms, in this case formalism and substantivism, different approaches to the study not only of ancient economies, but of all non-capitalist, non-market, primitive economies. The formalists define the economy as 'the allocation of scarce means to alternative ends' (Humphreys 1978:58), and regard it as:

> a functionally segregated and independently instituted sphere of activity with its own profit-maximizing, want-satisfying logic and rationality (Cartledge cited by Davies 1998:233).

A further feature of this approach is the application of modern economic concepts to all economies, primitive or modern, with the belief that these concepts are universal to the study of all types of economy (Humphreys 1978:58).

Substantivists, on the other hand, regard the economy as:

> an instituted process of interaction between man and his environment which results in a continuous supply of want-satisfying material means (Polanyi, cited by Humphreys 1978:57).

According to this view, primitive economies are not only less developed than their modern counterparts, but are embedded in the social and political framework of their respective societies. It follows from this that they cannot be studied in isolation, but must be considered in relation to these political and social frameworks. As a result of this, terminology and concepts designed with modern economies in mind are inapplicable to these primitive societies (Austin and Vidal-Naquet 1977:8). The Russian economist Chayanov, writing in the 1920s, highlighted the problems of using economic theories derived from capitalist economies in the analysis of non-capitalist economies, either ancient or contemporary (Thorner 1966:xiii; Chayanov 1966:1-28). He argued that:

> the future of economic theory lies not in constructing a single universal theory of economic life but in conceiving a number of theoretical systems that would be adequate to the range of present or past economic orders (Chayanov 1966:28).

Polanyi offered a framework for the study of the movement of goods and services in primitive economies based on four categories: reciprocity, redistribution, householding and market exchange (Humphreys 1978:63).

The appeal of the Polanyian substantivist position to scholars dealing with the ancient economy is summed up by Davies (1998:236-237), who highlights attractions such as its ability to capture the flavour of the non-market or non-economic exchange transactions in the Greek world, to appear in accordance with perceived Greek attitudes towards money-making, profit and coinage, and to explain the apparent absence of capitalist institutions from Greek society. This approach has influenced the recent work of scholars such as von Reden (1995) and Seaford (1994), who have discussed ancient Greek trade and exchange within the framework of Polanyi's concept of 'reciprocity'. They therefore seek to minimise the economic aspects of ancient Greek exchange, seeing it as embedded in the political and social spheres of society. This approach has its problems however. As Foxhall (1998b:300) argues, it is inadequate as an explanation for ancient Greek trading activity and, as with other substantivist approaches, primitivises ancient Greek societies. Approaching the study of ancient economic activity in these terms 'fails to deal with the complexity or the volume of the phenomenon' (Foxhall 1998b:300). Others have approached the ancient economy from a formalist position. Meikle (1979, 1995, 1996) seeks to identify modern economic theories in the writings of Aristotle and others. This approach is also undesirable, given the fact that it fails to properly recognise the differences between ancient Greek economic activity and that in the modern Western world. Where such differences occur (as they undoubtedly do between

ancient Greek and modern economies), the use of modern theories and terminology to explain them would obscure rather than highlight them.

Conducting the ancient economy debate in terms of primitivist or modernist and substantivist or formalist views has become widespread. Much of the current debate is involved with altering Finley's substantivist model slightly (see for instance Hopkins 1983 and Burke 1992), rather than completely overhauling it, or offering an entirely different view (although Osborne 1996 offers a revisionist view arguing for the existence of large-scale trade in the archaic Greek world). It is perhaps necessary however, given the problems with these approaches, to avoid this polarised debate altogether. Such a policy may avoid the broad arguments which seek to characterise a society or its economy as either modern or primitive; in terms of studying ancient Greece, this may avoid tarring all states across a long period of time with the same brush. It would seem obvious that the economies of ancient Greece are not like modern western economies, nor are they like those of so-called 'primitive' societies. As Cartledge (cited by Davies 1998:233) states:

> not even the most ardent primitivist would deny that actually quite a lot of extra-household economy went on in Greece. Not even the most ardent modernizer would deny that some quite basic aspects of ancient Greek economy were really quite primitive.

Moreover, by avoiding the use of such judgmental terms, it may be possible to gain insights into the nature of ancient economic activity which are not coloured by outdated and prejudiced ideas of modernity and primitivism.

In terms of studying the ancient economy, it would also appear that the polarised nature of the substantivist-formalist debate causes problems. On one hand, it is reasonable to suggest that when discussing the economy of a particular society it is desirable to use terms which are applicable to that society, as far as this is possible. It could be argued that this is to an extent impossible, since it would require a modern scholar to unlearn all of his or her knowledge of economic matters, and to learn to think in a completely different way. On the other hand, this view can be seen to regard other non-western societies as primitive in the same way as the primitivist view, and it can be seen to be similarly prejudiced. Moreover, defining primitive societies by the embeddedness of their economies obscures the similarities and differences between modern and primitive societies. It can be argued that not all economic activity carried out in today's western society is disembedded from social factors: people make economic decisions based not only on economic rationalism but also on factors including family and ethnic ties, and for status and aesthetic reasons. It is similarly unlikely

that there were no economic decisions carried out in primitive societies (including ancient Greece) taken purely for economic reasons.

Perhaps the best way forward for the debate is to follow a Third Way, since as Parkins (1998:4) states, 'neither of these models is entirely adequate nor necessarily helpful'. This Third Way would seek to address issues relating to ancient economic activity without the use of such prejudicial concepts as primitivism and modernism. It is acknowledged that the economies of the ancient Greek world were different in a number of ways from modern western economies, and therefore it is not desirable to seek to analyse them in a way more applicable to the latter. The study of ancient economies may be achieved by conducting the study of economic activities in terms of the framework within which they were carried out in a particular society; in the ancient Greek world, this would mean looking at economic activity in the framework of the household.

6.1.2 The household economy

For the purposes of this study, then, it is necessary to look at the role of the household in economic activity. Comparative approaches to the study of the household in the economy, drawn from the work of Polanyi and others, can be very useful for this purpose. For Polanyi, the household was a social entity with some degree of self-sufficiency, which could also redistribute goods (Humphreys 1978:64-65). A number of economic models based on the household or family group have been produced, with varying applicability to the Greek economy. I will consider here two models, firstly that of the Russian economist Chayanov and secondly that of the anthropologist Sahlins.

Chayanov's study of Russian peasant farms in the early part of this century led him to produce a theory of peasant economy, based on the family labour unit. This theory was not based solely on agriculture, but also on the income of the family from crafts and trades (Thorner 1966:xv). Peasant family labour units were defined as employing no hired labour, and not operating within the framework of a capitalist economy (Chayanov 1966:1). As a result of this, Chayanov argued that it is impossible to measure economies of this sort in terms of the economic categories of price, capital, wages, interest and rent, which are used in the analysis of capitalist economies (Chayanov 1966:3-13). Instead, Chayanov proposed that such economies should be analysed in terms of what he referred to as the labour-consumer balance, whereby:

> the degree of self-exploitation [of the family labour unit] is determined by a peculiar equilibrium between family demand satisfaction and the drudgery of labour itself (Chayanov 1966:6).

According to this, the family labour unit would only extend its economic activity up to the point where this equilibrium is reached; any further work becomes pointless, since its economic effects serve no purpose as a surplus for sale is not required (Chayanov 1966:6).

This model is expressly formulated in relation to Russian peasant farms, which are regarded as embodying a pure family labour unit, and Chayanov did not attempt to set out a theory for all peasant farms or all non-capitalist economies (Thorner 1966:xxi). Other types of economic unit were compared to the natural family labour unit, such as the slave economy and the serf economy (Chayanov 1966:13-22). It must be stressed however that Chayanov himself cautioned that the *oikos* of ancient Greece would not fit directly into any of the ideal economic types he described (Chayanov 1966:22), although this does not mean that his analysis is entirely useless for the study of the Greek economy. Pomeroy (1994:44-45) has argued that Chayanov's arguments can be adapted in order to make them more applicable to the Greek situation. She advocates combining Chayanov's family labour unit and slave economic unit to provide a model relevant to the domestic economy of Greece. This would be flexible enough to take into account those farms worked by free leaseholders, as well as small peasant farms or workshops or larger slave establishments, which to some extent operate outside the capitalist system.

The domestic mode of production proposed by Sahlins is influenced by the work of Chayanov, and also by that of Polanyi. This substantivist model was formulated with primitive societies in mind, and is illustrated with examples from the anthropological study of such societies. The domestic group here is loosely defined as the family, although as Sahlins acknowledges this term can cover a range of forms (Sahlins 1972:76). The domestic mode of production set out by Sahlins is categorised by a number of features: the principal division of labour is by sex (Sahlins 1972:78-79); the relation between human and tool is primitive, with the balance in favour of human (Sahlins 1972:79-82); production is oriented towards use values, and therefore is geared towards livelihood rather than profit (Sahlins 1972:82-86). Chayanov's theory of the labour-consumer balance therefore applies to the domestic mode of production (Sahlins 1972:87-92): property rights are characterised by the right of chiefs to things which are realised through a hold on persons, rather than the bourgeois hold on persons realised through a hold on things (Sahlins 1972:92-94); goods and resources are pooled within the domestic circle (Sahlins 1972:94-95). The domestic mode of production is a species of

anarchy, where the unity of society is sacrificed to the autonomy of its production, although this anarchy remains in the background (Sahlins 1972:95-99).

As with Chayanov's model, Sahlins' domestic mode of production cannot be applied directly to the Greek economy, primarily since it was formulated with reference to a particular form of society, in this case to non-state societies, either in prehistory or the modern world. However, both models share certain features which can be adopted for an analysis of the Greek economy. The most important feature of these models is the way in which they bring to the fore the role of the domestic unit in economic activity, as recognised by Pomeroy (1994:44-45), and as such they provide a potentially useful framework for the analysis of craft production. The household unit (the *oikos*) was the basic unit of Greek (or at least Athenian) society, and as such all activity in the *polis*, both economic and political, was carried out in the framework of the *oikos* (Booth 1993:8). The *oikos* aimed at self-sufficiency in order to ensure that as far as possible the *polis* could be self-sufficient, and production, whether agricultural or non-agricultural, was carried out within the framework of an *oikos*.

One should be careful, however, not to regard the Greek household unit as essentially the same as those defined by Chayanov and Sahlins. The *oikos* unit is structured differently from both Chayanov's family labour unit and Sahlins' domestic group, since it includes both family members and slaves; indeed the family members may not necessarily have taken much direct part (if any) in economic activity. There is also evidence of the limited use of hired labour, at least in Athens (Wood 1988:71-72). Moreover, any model of domestic production for ancient Greece must take into account the possibility of production of a surplus for sale in external markets, at least in some cases. Since all craft production was carried out by members of an *oikos*, this model of primarily domestic production (however the domestic group is defined) can be seen to provide a useful framework of analysis for the study of craft production in the ancient Greek economy.

When applying this idea to ancient craft production, then, it is suggested that every craft production enterprise was carried out within the framework of an *oikos*, and that the only means of craft production was household production. It must be stressed that the term 'household production' as used here does not refer solely to production carried out in the home. Pomeroy appears to concentrate principally on this area of household production when highlighting the lack of coverage of the domestic economy in accounts of the ancient Greek economy, which 'preferred to discuss industries, banking and trade-routes' (1994:41). This domestic production, which includes activities such as textile manufacture carried out in the

home, is as much a part of the household production system as production by slaves working in a separate large workshop away from the home. What is important to this discussion is that all of this economic activity was rooted in the domestic sphere (that is, the sphere of the *oikos*). It is for this reason that the sort of model which concentrates on the productive economic role of the *oikos* is so useful for the analysis of ancient craft production.

6.1.3 Craft production in the 'ancient economy'

How then has craft production been incorporated into this economic framework? In previous accounts of the ancient Greek economy, this question does not appear to have been addressed in any great detail, and the study of craft production has been to some extent neglected. The prevailing view of craft production appears to be that it was mostly small-scale (such as the 'workshops' mentioned by fourth century Athenian orators) with no central state organisation, for mostly local consumption (with some exceptions, such as Attic fine painted pottery), and carried out in the main by either lower-order citizens or non-citizens (see for instance Finley 1985:60). Offhand statements such as 'all Greek industry was small scale' (Jameson 1990:102) seem to judge craft production in the ancient world in relation to modern industrial activity, and indeed seen in this light all activity would appear small scale. However, by including all craft production activity in such a simple statement, this attitude fails to acknowledge the understandable differences that existed in the organisation of ancient Greek crafts, and thus produces an over-simplified account of the nature of such activities in ancient society. This section will consider this problem in more detail, and will suggest ways in which archaeological evidence can be used to shed more light on this neglected area of the ancient economy.

It is perhaps necessary first to make clear what is meant by 'craft production' in the following discussion. This study will be concerned primarily with those activities whereby products are manufactured, and with the people involved in them. These 'manufactured products' can include durable items such as ceramics, metals and textiles, as well as 'ephemera' such as dyestuffs and perfumes. This study will not include crafts such as building or sculpture, nor will it look at the production of foodstuffs, including wine and olive oil. This does not mean, however, that people who took part in these activities will necessarily be excluded from consideration, since there is every possibility that they were involved in the part-time production of other commodities which fall under the umbrella of this study. As a result, I will not follow Burford and study only the craftsman who 'depended on the exercise of his craft for a living' (Burford 1972:13), since this could potentially exclude a wide range

of people with a possible involvement in craft production activity. Rather, given the difficulty in identifying full-time or part-time production from the available evidence, all those potentially involved in craft production will be considered, regardless of whether or not this activity was their principal source of income. This will form a major part of the discussion in section 6.3 below.

Previous approaches to the study of craft production have concentrated on a number of different features of this area of economic life, but not to any great degree the organisation and scale of production. A number of studies have been conducted using largely historical evidence, and have addressed issues such as perceived social attitudes towards craftsmen and their activities as indicated in the literary source material, the nature of the craftsman's work, and the role of slavery in production (see Burford 1972; Finley 1985:*passim*; Hopper 1979). Where archaeological evidence is used in such studies, it is mainly referred to in order to illustrate arguments derived from other kinds of evidence (see for instance Hopper 1979). This primarily historical approach has resulted in discussion being confined mainly to Athens, with the rest of Greece being neglected. While these are important issues and need to be addressed, this should not be done in isolation but should be linked to wider questions about the economic aspects of craft production. Emphasis has also been placed on the technology of craft production, with accounts using both historical and archaeological evidence to describe in great detail the equipment and methods used by ancient craftsmen, with little theoretical attempt to place this in its economic setting (see for instance Forbes 1964, 1965, 1966; Burford 1972:68-123; White 1984).

This focus on the technology of craft production and the perceived attitudes towards it has been accompanied by a concentration on the products themselves, particularly those products which have survived in the archaeological record such as pottery and sculpture. Since much of this material is judged to be of high quality and many pieces are regarded as fine art, there has been an emphasis on the quality of craftsmanship involved in the production of these '*objets d'art*', compared to the production of ordinary goods, which are often regarded as of little worth in comparison. This concentration on the techniques of manufacture and the skill and work involved in producing fine specialist goods has been reflected in an emphasis on such products of craft production in the economy, with a great deal of study being carried out in relation to the question of how and why they were exchanged. This has led to the formulation of a great many theoretical models dealing with the mechanisms by which products changed hands. The concentration on exchange has resulted in a concomitant

paucity of in-depth studies of the production of basic commodities and their role in the economy. A more theoretical approach to the study of the actual production of goods is needed.

It can be seen then that there is a need for a more theoretical and archaeologically based study of craft production in Classical and Hellenistic Greece which, while taking full advantage of the range of literary and epigraphical source material, fully covers the whole of Greece in a way which studies with a heavier emphasis on the historical/literary evidence have not. Recently there has been a move towards addressing economic and social issues relating to craft production. Volumes such as Mattingly and Salmon's (2001) *Economies Beyond Agriculture in the Classical World* contain a number of papers which aim to shed new light on the economic aspects of non-agricultural production in Classical and Hellenistic Greece. Rihll (2001), for instance, uses information about the technology and processes involved in the production of silver at Laurion in Attica to gain insights about the organisation of this production. Elsewhere, Harris (in press) uses evidence of job titles from Classical Athens to look at the organisation of production, in particular addressing issues of the level of specialisation and the role of the *oikos* in production. In order to further redress the imbalance the following section will suggest ways in which the archaeological evidence for craft production in Classical and Hellenistic Greece can be used to address social and economic issues relating to craft production from an organisational point of view.

6.2 Modelling craft production: methodologies from ethnoarchaeology and pottery studies

Work carried out in the field of pottery studies, particularly drawing upon ethnographic and ethnoarchaeological evidence, may provide useful insights into the social and economic organisation of ancient Greek craft production. Using analytical frameworks inspired by this body of material, it may be possible to address such issues as the organisation and scale of craft production, particularly as they relate to dyeing, in a new and exciting way. This will form a background for the detailed discussion of ancient Greek craft production.

The most important work carried out in the field of pottery studies for my purposes is that dealing with the economic and social aspects of pottery production, rather than simply the manufacturing techniques and decorative aspects. Methodologies from this work can be applied to other areas of craft production, in order to study their economic and social roles. However, it is necessary to sound a note of caution. As these methodologies derive from the

study of pottery production, they may contain features which are not applicable to other crafts. Not all crafts were the same, with different processes requiring different techniques and technology, which would make different demands on the workforce. Moreover, they were formulated with the study of pottery production in contemporary societies in mind, and may contain elements which do not apply to the study of Classical and Hellenistic Greece. It is therefore necessary to make sure that any models are broad enough to cover different types of craft production activity, while acknowledging circumstances specific to Classical and Hellenistic Greece.

Prudence Rice has highlighted some of the problems with approaches to the study of pottery production in the fields of ethnographic and archaeological research (see Rice 1984b and 1987). One major problem is the lack of common analytical concepts or units for the study of the economics of production (Rice 1987:170). She argued that in order to fully understand production, one must confront a number of related issues, which include environmental, social, economic, organisational and aesthetic components (Rice 1984b:46). Rice's comments on the methodology of the archaeological and ethnographic study of pottery production will be briefly summarised and discussed below. Four aspects of the ancient production process which benefit from the use of ethnographic studies are:

- the scale of production, which is tied to questions of manufacturing technology, and the distribution and use of products;
- the mode of production, which is linked to labour and organisational arrangements as well as manufacturing technology and distribution;
- variability of products, which can provide evidence for the mode and scale of production;
- changes in any of these (Rice 1987:170-172).

Rice suggests that the two most important variables are the scale and mode of production (Rice 1987:180). 'Scale of production refers to levels of labour and resources used and quantity of output' (Rice 1987:180), and can be studied in a number of ways. Rice suggests that as well as an initial intuitive approach, equating higher levels of social complexity with more complex and specialised arrangements for both agricultural and non-agricultural production (Rice 1987:180), important questions relating to the scale of production such as the level of output, and by inference demand, can be addressed through the use of archaeological evidence. This includes looking at such features as the numbers of production areas, their level of nucleation, their size (which can provide an indication of the

possible size of the workforce and output) and the nature of the facilities for production (including the kind and amount of specialised equipment). The variety and quantities of the products are also significant to the study of the scale of production (Rice 1987:181), although when applied to dyeing this is more difficult to identify archaeologically.

Approaches to the study of the mode of production are based on the issues of the:

> manufacturing technology, the role and status of producers, the integration between tasks, the organisation of producing units and their relation to the overall economic organisation, and the relation between producers and consuming groups (Rice 1987:182).

Once again these issues can be partially and indirectly investigated through the study of the production areas, with reference to the size of these areas and the nature and amount of equipment associated with them. Other issues are more difficult to study archaeologically, including the social role and status of producers and the division of labour involved in production, and can be investigated through ethnographic parallels or even evidence from the products themselves (at least in the case of ceramics) (Rice 1987:182) or (as in the classical world) historical evidence.

An important issue related to the study of the organisation of production concerns identifying the presence of craft specialisation, which can be defined as a situation where:

> a particular occupation is restricted to a relatively small number of skilled practitioners who make it their primary livelihood (Rice 1987:188).

Craft specialisation can be divided into two forms. Site specialisation refers to situations where particular locations have limited functions or are the site of intensive production activity, whereas producer specialisation is defined by the time devoted to an activity by individuals as a part of gaining their livelihoods (Rice 1987:189). This could be full- or part-time, involving either year-round manufacture or concentration on one type of economic activity for a livelihood (Rice 1987:189).

Differing methods have been used to identify the presence of craft specialisation in the ethnographic and archaeological records. Ethnographic criteria have tended to include such factors as the proportion of time devoted to an activity, the amount of income gained from that activity, and the existence of some sort of title or name for the particular activity. Certain aspects of craft specialisation may however prove difficult to identify archaeologically. Site specialisation may be indicated by the presence of particular manufacturing equipment at a production site, perhaps linked to the presence of particular resources used in the production activity (Rice 1984b:48). Identifying producer specialisation in the archaeological record is

more problematic, since it is almost impossible to reconstruct the labour arrangements of a production site from its archaeological remains. Evidence from floral or faunal remains at production sites may help to identify for instance seasonal occupation at sites, which may give an idea of the organisation of production. Rice (1984b:51-52) suggests that the variability in the products themselves can provide some indication of whether their production was specialised or not, although this method of analysis may prove difficult for an activity such as dyeing where very few products survive. In this case historical evidence can prove valuable, as can comparative ethnographic data.

The ethnoarchaeological study of ceramic production may also inform the construction of relevant models for the analysis of the mode and scale of production. A number of these models are broadly similar in structure, referring to such categories of evidence as economic, organisational and technological factors, and containing a hierarchy of modes of production. A brief summary of the main points of two models, those set out by Peacock (1982:6-11) and van der Leeuw (1984b:720-724), along with a discussion of their applicability to this study, will follow. These models derive from the ethnographic study of pottery production in the Philippines (van der Leeuw 1984b) and the archaeological study of Roman pottery production (Peacock 1982), and as a result they have features which do not correspond with Classical and Hellenistic Greek craft production. The production categories in these models with possible parallels in the Greek world are household production, household industry, individual workshop or workshop industry, nucleated workshop or village industry, and manufactory. Categories with no Greek parallels include van der Leeuw's large-scale industry and Peacock's factory, which both apply to production on a much larger scale than any ancient Greek craft production. There are also a number of categories constructed by Peacock with special reference to Roman pottery production, namely estate production and military and other official production, which refer to situations specific to the Roman world. Classical and Hellenistic Greek production was not carried out on large estates to the same degree as during the Roman period, nor were Greek states as directly involved in production as the Roman Empire. There was no central state organisation of craft production, nor were the armies of Greek *poleis* organised in the same way as the Roman army.

The criteria postulated for each of these categories are as follows:

- Household Production: each household produces the pottery it needs for its own consumption. Production is done by members of the household (usually female) with no outside help, and is essentially occasional, with pots made as the need arises; because of

this no specialised equipment will be used (Peacock 1982:8, van der Leeuw 1984b:722 figure 1).

- Household Industry: again production is occasional and part-time, and is carried out by predominantly female household members. However, the potters are skilled, or at least of semi-specialist status, and are potting for profit (albeit for a very limited local market), although not as an activity generating substantial income for the household. Some limited equipment may be used (Peacock 1982:8, van der Leeuw 1984b:722 figure 1).

- Individual Workshop/Workshop Industry: this is similar to the previous category, although here pottery production is a main source of subsistence. As such it is likely to be carried out by men rather than women. It can be carried out full-time for a large part of the year or in conjunction with agriculture. Production will be geared towards the market, and as a result there may be more than one specialist craftsman at work, using specialised equipment such as the wheel and kiln (Peacock 1982:9:, van der Leeuw 1984b:723 figure 1).

- Nucleated Workshop/Village Industry: a number of workshops group together forming an 'industrial complex', where ceramic manufacture is the major means of income. Production will be full-time and carried out all year round, perhaps with the aid of hired labour. A wide range of specialist equipment will be used, and the products will be of high quality. Products may be distributed over a wide area, perhaps with the help of a middleman (Peacock 1982:9, van der Leeuw 1984b:723 figure 1).

- Manufactory: this refers to the situation where a number of craftsmen are grouped together in a single building and produce a single specialised product, often with some division of labour. The manufactory is similar to the workshop, but is organised on a larger scale, and can be distinguished archaeologically by the size of the premises, the degree of both worker and product specialisation, and the large scale of output (Peacock 1982:9).

A model like this has been applied to pottery production in Athens and Corinth during the archaic and classical periods by Karim Arafat and Catherine Morgan (Arafat and Morgan 1989). They consider sites of ceramic production in terms of their technology and their relationship with sources of raw materials, agricultural land, markets and domestic sites. Archaeological data from production sites are used in conjunction with analysis of the iconography of pot decoration and historical source material to produce an account of ceramic

production in its economic and social context. Following Peacock, Arafat and Morgan place fine pottery production in Athens in the 'nucleated workshop' category, reflecting:

> the close relationship between workshops and local communities, the involvement of extended families, the integration of pottery production with other economic activity (especially agriculture), and the absence of high level specialisation (Arafat and Morgan 1989:323).

Corinthian pottery production, although technologically similar to activity in Athens, was smaller in scale and organisation, signified by:

> differences in the location and spatial concentration of production sites in relation to settlement and market areas, and the location and abundance of clay sources (Arafat and Morgan 1989:323-325).

Arafat and Morgan suggest that it be placed in the 'workshop industry' category (Arafat and Morgan 1989:323-325).

In order to assess the scale of Athenian and Corinthian fine pottery production, particularly the extent to which production in these cities was full- or part-time, Arafat and Morgan suggest that four archaeologically traceable factors can be used to assess the level of personal investment in production. These are the availability of clay sources, and their proximity to work sites; the acquisition and transfer of the required skills for making and decorating fine pottery; the level of equipment used in a production site; and the spatial organisation of production sites (Arafat and Morgan 1989:327-328). The relationship between production and the agricultural calendar is significant; it is suggested that there was little overlap between the demands of agriculture and pottery production. The busy agricultural periods during winter would have been unsuitable for pottery production due to the wet weather, which would have slowed drying rates of pottery and hindered the extraction of clay. The drier months of spring and summer were not periods of busy agricultural activity, and could have been occupied by the manufacture of pottery. Moreover, the question of production for export must take into account the short sailing seasons which also occupied slack periods in the agricultural calendar. In this way pottery production could have been incorporated into the general subsistence strategies of classical and Hellenistic Greek societies, although it is difficult to assess with any certainty the extent to which either activity was a principal subsistence activity (Arafat and Morgan 1989:328-9).

Although these methods and models appear extremely useful for the study of ancient Greek dyeing, they cannot simply be applied without taking into account their inherent limitations. Perhaps the principal benefit of applying such an approach to the study of dyeing

is the focus on the archaeological remains of production sites, since very few dyed textiles survive in the archaeological record. As a result, the methods of assessing certain features of the economics of craft production using products, such as assessing the scale and level of specialisation through the standardisation or variability of products, may be unsuitable for this study. However, although the actual products of dyeing themselves do not always survive, information regarding their nature and use is available in the iconographic and documentary records. The methodology suggested by Rice (1984, 1987) and applied by Arafat and Morgan (1989) to study the mode and scale of production, and the level of specialisation among producers, could be applied without too much difficulty to the study of other crafts, where evidence for production sites exists.

The application of models such as those of Peacock or van der Leeuw could also be a useful methodological tool in the study of other types of craft production, although they do raise a number of problems. Identifying or differentiating certain categories from the archaeological evidence alone would appear to be extremely difficult. 'Household production', for instance, in its purest form requires no specialised equipment or production area and is done within the domestic setting, and so might well be archaeologically invisible. The differences between 'household production' and 'household industry' would also be difficult to identify archaeologically. It is, as Rice (1987:186) also suggests, perhaps more suitable to an archaeological study to refer to only two basic types of production, 'domestic' and 'workshop', although the latter could also be separated into 'medium scale workshop' and 'large scale workshop' categories. Levels of production within these two bands could then be differentiated according to factors such as the size of the production area, the nature of manufacturing technology and evidence for the size of the workforce.

Furthermore, these models do not appear to take into account the use of slaves (or other forms of unfree labour) as a form of labour outside the domestic family unit. Hence, increases in scale are indicated in these ideal models by the presence of hired labour. In Classical and Hellenistic Greece, however, the basic family domestic production unit would probably have contained some slave labour, especially in the case of households which engaged in craft production. In production on a larger scale, the majority of the workforce are likely to have been slaves, whether skilled or unskilled (although this does not totally discount the presence of other kinds of labour, including free hired workers). Overall, however, the methodology outlined above provides a valuable framework for studying a range of craft production practices in their social and economic context, and aspects of this methodology

will be applied in the following discussion of craft production in general, and dyeing in particular, in classical and Hellenistic Greece.

6.3 Classical and Hellenistic Greek craft production in its economic and social context

With these models in mind, I will now turn to the main section of this chapter, a discussion of a number of important issues relating to the study of Classical and Hellenistic Greek craft production in its economic and social context. These will include assessing the mode and scale of craft production, and looking at the identity and status of all those involved in craft production. Another important issue relates to the seasonal nature of craft production, and how this was affected by factors such as the agricultural calendar, which could have had an impact on the availability of both raw materials and labour, along with the implications of this for its organisation. I also propose to look in more detail at issues relating to craft production and the household, which is linked to the questions of the mode and scale of production and the nature and identity of the workforce.

6.3.1 Organisation

How then would one go about constructing a model for the archaeological analysis of the organisation of craft production in Classical and Hellenistic Greece? This section will deal with the formulation of a methodological approach capable of encompassing many different types of craft production, and will be used to assess the organisation of dyeing in the following chapter. Perhaps the most important factor to be taken into account is the existence of historical evidence, which can indicate (for some areas at least) some of the methods of craft organisation. This is particularly useful for the analysis of those situations where very little specialised equipment or production areas are used. In line with the approach outlined above, the mode and scale of production will be assessed with reference to factors such as the nature and size of a production area, the amount and sophistication of production equipment present, and the possible size of the workforce. Each site could then be placed in one of a number of categories relating to these criteria. It was stated above that the categories used in the models of Peacock and van der Leeuw may be unsuitable for a study of this kind. It is perhaps more desirable to use fewer categories which are broader in scope, since the nature of the archaeological record is in most cases unable to reflect highly refined categories such as the 'household industry' and 'workshop industry' for example. These small differences could

then be inferred from other sources of evidence and the relevant categories subdivided accordingly.

The range of evidence derived from historical sources, inscriptions and pictorial representations can be useful in illustrating the kinds of settings in which craft production took place. These can be used when defining the different categories used in a model of craft production. Examples of craft production given in ancient historical sources, for instance, cover a range of different modes and scales of production in Athens in the fifth and fourth centuries BC. We hear of workshops manufacturing furniture and knives in which over fifty slaves worked (Demosthenes 27. 9); in another workshop slaves ground drugs or colours, perhaps producing dyestuffs or paint, while in another case a man employed slaves to make sails in the house in which he lived (Demosthenes 48. 12-13). Another man had three workshops which produced and sold perfume, in which slaves made up at least part of the workforce (Hypereides *Against Athenogenes* 5.6, 9, 10, 19 cited in Finley 1973:68-69). Workshop scenes are also depicted on painted pottery and gravestones (for a small selection see Burford 1972:pl. 3-4, 13-18, 29-31, 35, 38-40, fig. 1). Other evidence refers to the production of goods in the home by the domestic personnel, either for use within the household or for sale outside it. Socrates is claimed to have persuaded one Athenian man who had fallen on hard times after the Peloponnesian War to set the free womenfolk of his household to work in the home producing textiles for sale (Xenophon *Memorabilia* 2. 7. 2-12), although this is more moral idealism than reality. Other sources contain numerous references to women producing textiles in the home (see for example Euripides *Orestes* 1431-1433), and there are many depictions of such scenes (see Figures 24, 25 and 26) though their exact interpretation is problematic.

It can be seen then from a brief survey of the historical evidence that in Athens at least craft production activity was characterised by a range of modes and scales of production. These include production within the home by the domestic personnel, either for consumption within the household or outside it, and specialised production carried out either in the home or in workshops with workforces of varying sizes and statuses. These observations can be useful in the construction of a model for studying the organisation of craft production using archaeological evidence. The categories to be used in a model of craft production organisation will therefore be as follows:

- Small Scale or Domestic Production:

This would include production in the domestic setting mostly done by the domestic personnel (including the family unit and domestic slaves). It is likely that no specialised production areas or equipment were used, and the products would be for mostly domestic consumption (although this does not rule out a very small proportion of products being consumed outside the household); craft production would not be a major source of income or subsistence.

- Medium Scale Production:

  This could be carried out in the domestic setting by domestic personnel but would have had a specialised production area and some specialised equipment; the workforce may also have included some specialised labour. Products would be intended for consumption both within and outside the household, with a fair proportion of the household's income or subsistence coming from this production. This category is very broad and would include Peacock and van der Leeuw's categories of 'household industry' and 'individual workshop/workshop industry'. In an ancient Greek setting any differences would be difficult to identify archaeologically, and therefore they are grouped together.

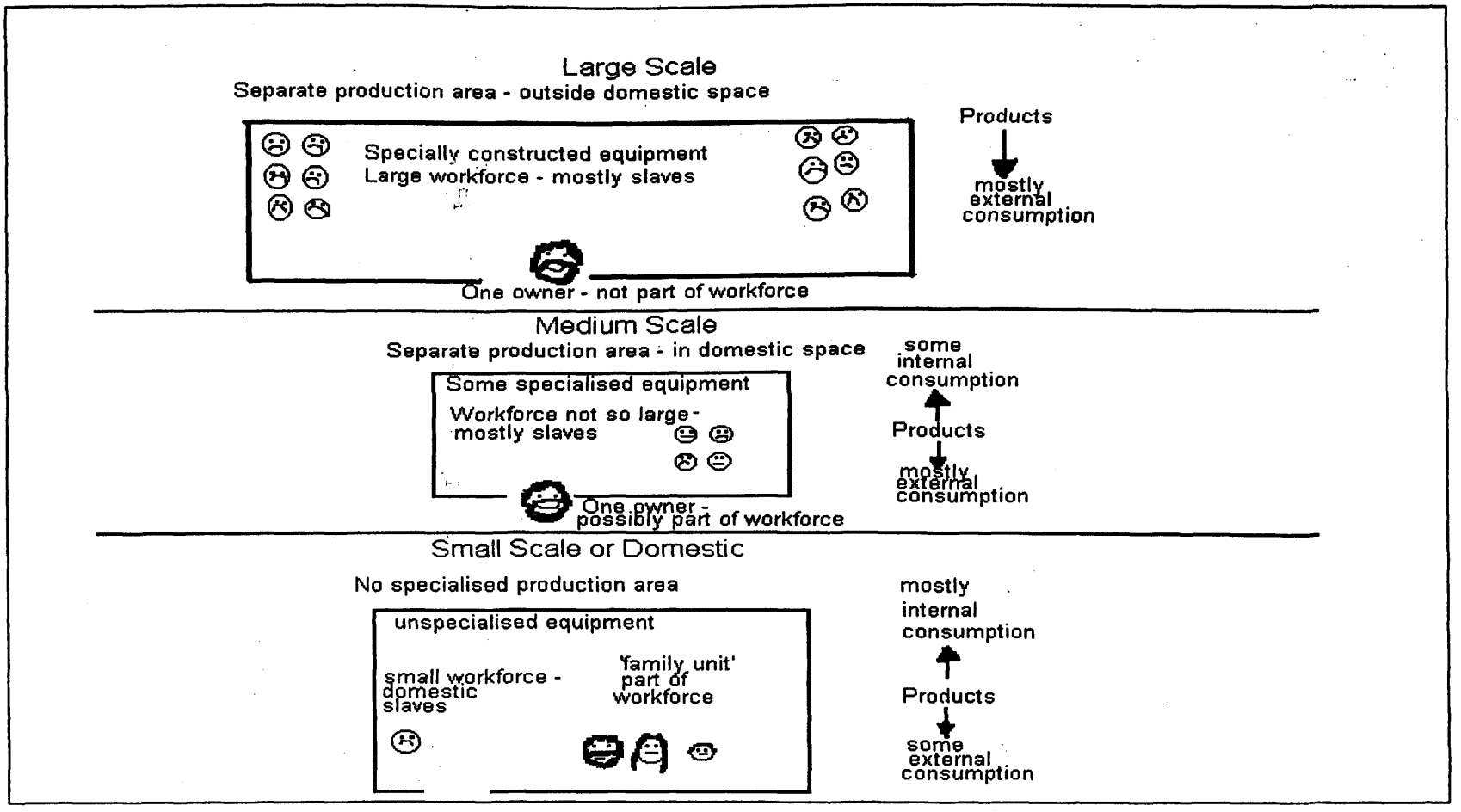
- Large Scale Production:

  This would have involved the use of specialised equipment and production areas which would have been outside the domestic setting. The workforce would have been large and would have included mostly specialised labour. Products would have been intended largely for consumption outside the household, with the majority of a household's subsistence being derived from this activity. This category can include what are referred to elsewhere as 'nucleated workshops', where there is evidence for centralised organisation in situations where whole areas are geared towards the production of the same product or range of products. This can also include areas where a number of similar workshops are grouped together without any obvious evidence for centralised organisation, for example specialised 'craft quarters'.

6.3.2 Identifying specialisation

Identifying craft specialisation archaeologically in sufficient detail to assign particular archaeological sites to particular categories can be difficult, which can cause problems when trying to apply models such as this. The following sections will discuss ways of identifying

Table 3: Model for studying the organisation of craft production in Classical and Hellenistic Greece



craft specialisation in Classical and Hellenistic Greece using both archaeological and historical evidence.

6.3.2.1 Archaeology

General difficulties of identifying the presence of craft specialisation in the archaeological record were highlighted above, but there are other problems which should be at the very least pointed out, if not definitively solved, here. As indicated in chapter 5, site specialisation can be identified through the presence of specialist production equipment, although a number of production activities could have been carried out using the same, or at least very similar, equipment, a good example of this being the similarities in and probable overlap of the equipment used in dyeing, fulling, tanning, and oil and wine production. This can have a number of implications. Firstly, sites which are involved in specialist production may not be identified as such due to the presence of fairly generic equipment which could have been used for a number of tasks at different times or seasons and does not necessarily signify the presence of only one craft production activity.

The other side of the coin is that if one is forced to rely on generic equipment to identify specialist production, then it may be the case that sites where a number of different types of production were carried out could be identified as being sites of specialist production due to the archaeologist's failure to acknowledge the possibility that this equipment could or would have been used for a number of different purposes at different times. In this instance it may be necessary to identify the presence of relevant raw materials, as well as to look for references in the historical evidence which may be able to identify certain areas as being involved in specialist production activities. This in itself is problematic, and one must guard against the temptation to assign a particular interpretation to an archaeological site simply because there may be a passing reference in a literary source to that activity going on somewhere in the general vicinity.

A further problem relates to the identification of specialist production areas in the archaeological record. While the literary evidence may indicate to a certain extent the settings in which production activities were carried out, the nature of the equipment used, particularly if it was portable, may make it difficult to assign a fixed use to a particular area of a site. Small and medium scale production, particularly those activities falling into the 'domestic' category, could have been performed in a number of different areas depending on the weather, the time of day or year, and the nature of the workforce, and so any attempt to locate activities

simply with reference to the location of excavated equipment or small finds may be misleading. Of course this does not apply to all production equipment; that which is not portable may prove to be extremely useful in highlighting the location of certain production areas.

A further point related to the presence or absence of craft specialisation and its implications for the study of the organisation of craft production is the fact that in the classical Greek world there was a possible difference or discrepancy between the levels of specialised production and specialised products. A wide range of different specialised products are known from classical and Hellenistic Greece, from many different types of crafts. The range of different types of ceramic vessels is vast, for example, and a similar situation would have existed for products made from, for instance, wood or metal. Examples of this can be provided by both archaeological and historical evidence: Sparkes (1962) gives details of the many different ceramic utensils used in the ancient Greek kitchen. Given the prevailing view of most craft production, particularly in the classical period, as organised predominantly on a small scale, this would suggest a number of scenarios for the relationship between the specialisation of production (or the production process) and the specialisation of products which were produced. It is possible then that production was carried out mainly at the domestic level, but with each producer specialising in one particular product which would then be exchanged or sold with other equally specialised producers so that each household had access to all the equipment necessary for life. On the other hand, it may also have been the case that all households produced the basic general items needed for their day-to-day existence, with the very specialised products produced by craftspeople working on a medium or large scale, each one produced by a different specialised producer. It will be possible to test this issue in the following chapter by looking at the range of evidence for dyeing.

6.3.2.2 Terminology

The identification of producer specialisation, however, is made easier for ancient Greece by the presence of the literary evidence. It is possible to identify specialist occupational titles and other terminology of craft production in both literary and epigraphical evidence, which can provide insights into the range or extent of producer specialisation if not at a particular site then at least in society as a whole. This information can be used to address questions relating to the organisation of craft production, such as the extent to which levels of craft specialisation can be identified from the way in which craftspeople are referred to in ancient historical material; this would include not only specialisation in the production of

particular products but also the extent to which people were seen as 'full-' or 'part-time' craft producers. It is also possible in some cases to identify the context in which different levels of producer specialisation occurred; thus a reference to a particular type of craftsman in a particular setting can illustrate the way site and producer specialisation fitted together into the wider framework of economic activity in Classical and Hellenistic Greece. An important point to note is that the information for this comes mainly from Athens, and therefore cannot be automatically regarded as applying to the rest of Classical and Hellenistic Greece.

Harris (in press) has recently undertaken a study of occupation titles in Classical Athens in terms of their implications for the wider study of the economic and social aspects of craft production. He has identified one hundred and eighty occupation titles in the literary and epigraphical evidence from Athens between 500 and 250 BC (Harris in press:127). The occupations he has listed are those which involved the production of goods and services which were intended for exchange for cash, either in the agora or elsewhere (Harris in press:128). Thus, Harris's list contains a number of occupations outside the scope of this study; this includes sellers of goods, and also those involved in building, transport, education, the performing arts and other services (Harris in press: Appendix 2). It is possible however that those taking part in these activities were also involved in craft production, as argued in section 6.1.3.

It is important to be aware of what Harris (in press:128) has referred to as a 'nominalist fallacy'. This is 'the mistake of assuming that each name must refer to a separate and distinct occupation'. As Harris (in press:128-130) argues, it is extremely likely that a number of occupation titles referred to the same occupation. For example there were two terms for those who cook food, *mageiros* and *opsopoios*, which are 'virtually synonymous'; in a similar way the two terms for baker, *artopoios* and *artokopos*, 'are obviously synonyms' (Harris in press:129). There were also general terms which cover a range of more specialised occupations. For example, there are general words for 'seller' (*kapelos* and *kapelis*), while there are also numerous terms referring to sellers of particular goods, such as sausage-seller (*allantopoles*) and charcoal-seller (*anthrakopoles*), among others (Harris in press:129-130, 170).

Harris suggests that this indicates that there was a high level of 'horizontal specialisation' or 'specification of function' in Athenian craft production. Producers are not producing goods as part of a complex production process; rather, they carry out all of the tasks in the production of particular products (Harris in press:132-134). On the other side of the coin, Harris (in press 132-134) argues that there was relatively little 'vertical specialisation' or

'specialisation of function', the situation where parts of the production process are broken down and separate people carry out particular tasks in the production of a single object. This may reflect the fact that Harris has looked solely at occupation titles in his study, and this type of specialisation may be better identified by looking at accounts of craft production activities in order to see how they are carried out. It may be however that production processes were broken down differently in the ancient world, and also that they were not concentrated in one place in the same way that, say, the production of a car in a modern factory today is. In terms of the production of bread, for instance, a number of the stages of this process have different titles. Grain processors (*mulothroi* and *sitopoioi*) are different from bakers (*artopoioi* and *artokopoi*), although they were parts of the same process.

6.3.3 The seasonal nature of craft production

Much craft production may have been seasonal. This can have a range of implications for the organisation of production, relating to the degree of specialisation and the way craft production and producers interact with other spheres of the economic life of the ancient Greek world. It can be useful to assess how far the demands of different types of production related to seasonal factors, and to what degree they overlapped or clashed, thus allowing (or not) craftspeople to be involved in more than one type of craft production, or in craft production and agricultural work. It may then be possible to make an estimate as to the relative reliance on these sorts of activities as sources of subsistence income, and therefore to judge the levels of specialisation of ancient Greek craftspeople.

In this section therefore I will look first at the seasonal demands of agriculture in classical and Hellenistic Greece, in order to assess which parts of the year were busiest and would have left least time for other activities. I will follow this by discussing which times of the year may have been busiest for different types of craft production, and will also look at seasonal factors affecting trade, such as the sailing season for ships, and possible effects of the religious calendar on production. I will then look at the extent to which these parts of the year overlap, or do not overlap, in order to try and assess the likelihood of different types of craft production or craft production and agriculture being carried out by the same people as part of their subsistence strategies at different times during the year.

Before doing this however it is necessary to sound a note of caution. The discussion in this section will be conducted in very general terms, since its purpose is merely to raise issues which will be discussed in more detail in relation to the evidence for dyeing in the following chapter. As a result, it will be impossible to cover in great detail here the different situations

relating to the many different areas and periods of the classical and Hellenistic Greek world which any survey of the seasonal factors affecting the organisation of craft production would require. Different regions may have different climatic conditions, which would affect the timing of agricultural and craft production activity. Furthermore different communities may have differing needs and so would be affected by seasonal factors in different ways as a result of this. However, it is beyond the scope of this study (or indeed any study) to undertake a survey of every community or region in the classical and Hellenistic Greek world. Although this sort of detailed coverage would be necessary for any account of the whole range of craft production in the classical and Hellenistic Greek world, it will suffice here to present the main issues in a general context here, before applying them to the evidence for dyeing in the following chapter.

A number of accounts of the ancient Greek agricultural calendar have been produced, based mainly on Hesiod's *Works and Days*, along with other material from ancient literary sources, and also modern data. Particularly useful discussions of the agricultural calendar are provided by Osborne (1987:13-16), Isager and Skydsgaard (1995:160-168) and Foxhall (1998a:109-113), and the calendar produced at Table 4 is derived from their accounts. As Isager and Skydsgaard (1995:161) state, these calendars do not necessarily apply to every farm or estate in Classical and Hellenistic Greece, and they are not used as such here. It is important to note also that with one exception, they do not contain references to animal husbandry, nor do they cover the full range of crops available in antiquity and so do not provide a comprehensive guide to the timing of all agricultural operations. Rather, they provide a useful guide to the times of the year when a variety of agricultural operations may have been carried out.

It is possible then to identify potential busy periods and slack periods in the agricultural year. According to Foxhall (1998a:109-113) the period of the ancient Greek agricultural year roughly between late May and early July, when the grain harvest took place, was busy, although the busiest period was from September to November when the vintage was gathered and arable land was ploughed and sowed. Deepest winter and high summer were the least busy times, during which people involved in agriculture would have been free to carry out other tasks.

It is necessary then to find out if certain times of the year were more suitable than others for carrying out different craft production activities (or indeed any other non-agricultural work), and if so to what extent they correspond with the agricultural calendar. For

Table 4: The ancient Greek agricultural calendar. After Foxhall 1998:Table 6.1

Agricultural Jobs	January	February	March	April	May	June	July	August	September	October	November	December
Fallow fields		fallow ploughing					fallow ploughing					
Manuring									manuring & field clearing			
Cereal production			weeding		cereal & winter legume harvest					ploughing & sowing cereals & legumes		
					barley	wheat						
							threshing & crop processing for storage					
Vine production		vine digging & pruning			earthing up vine trenches				vintage & pressing		trenching, manuring, pruning	
Trees		tree digging & pruning			earthing up trees & tree trenches				trenching, manuring, pruning fruit trees & planting new			
				grafting								
Figs					fig fertilizing				fig harvest			
								fresh	dried			
Olive production										olive picking & pressing (everyother year)		
										trenching, manuring, pruning olive trees		
Watering				watering young trees		watering young trees & vines			watering			
Animal Husbandry		lambing & kidding									lambing & kidding	
		sheep & goat milking & processing			milk & milk processing							

example, Osborne (1987:15-16) shows that building work at the sanctuary of Demeter and Kore at Eleusis in Attica took place mainly in slack periods in the agricultural year. The records of expenditure on building from the sanctuary show that the period of highest expenditure and by extension most building activity was from mid-July to September, and that expenditure was also quite high in February. The periods of lowest expenditure were December to January and June to July. Osborne suggests that building activity in general was mainly carried out in the late summer, due to the heavy demand for casual labour which was only available during slack periods in the agricultural year.

Assessing whether or not other non-agricultural craft activities were practised at particular times of the year is more difficult. Arafat and Morgan (1989:328) suggest that pottery production is less efficient during the winter months, when weather conditions would have been less than favourable for the extraction and drying of clay. The drier summer months, however, would have been more suitable. Thus, 'the degree of fit between the demands of agriculture and pottery production is very good' (Arafat and Morgan 1989:328). Other crafts do not seem to rely so much on seasonal factors for their performance, whether in terms of the production of raw materials or through favourable conditions for carrying out the craft. Metalworking and stonemasonry, for instance, would appear to be crafts which could be carried out at any time of the year, since their raw materials do not grow and/or are not suitable for exploitation only at certain times of the year, nor are they best carried out in certain climatic conditions. This can have a number of consequences for the study of these and other crafts of a similar nature in relation to the issue of specialisation and the impact of seasonal factors on this. Firstly, it is possible that they can be carried out all year round by craftsmen who derive the whole of their subsistence from this activity and buy in agricultural products. On the other hand, crafts such as this could have been carried out by anyone with the necessary skill and equipment who happened to have the time on his or her hands during periods when labour demands relating to agricultural activity were not so heavy.

The seasonal factors affecting the organisation of craft production may not always have been related to agriculture. The above discussion does not include the possibility that people may have practised more than one craft, rather than a craft and agriculture, and that seasonal factors relating to the craft could have led to different activities being practised by the same craftspeople at different times of the year. These could include the fact that a number of raw materials were only available at certain times of the year. This may be because they were agricultural products, or they may have required certain conditions (such as weather

conditions) for people to extract or produce them. It is possible also that the different levels of demand for different products at different times of the year may have resulted in craftspeople doing other production activities (including agriculture or casual labour).

One factor which may have affected the level of demand for particular products at particular times of the year was the organisation of the religious calendar. There were religious festivals throughout the year (often corresponding to events in the agricultural calendar (Isager and Skydsgaard 1995:165-167)); some were fairly universal throughout the Greek world and were held in local sanctuaries, while others were only held in particular locations, which people travelled to from outside the immediate area (such as the Eleusinian Mysteries). One might expect demand for certain products relating to these festivals to be high up to and during the time when they were held. In the case of those festivals which attracted a large number of people from outside the immediate area in which they were held, such as the Eleusinian Mysteries, demand for all sorts of goods, not just those relating to the festival itself, would have been high, due to the influx of people. It may be the case that production of commodities would in some cases have been geared towards these festival occasions. This could have taken the form of fairly specialist craftspeople concentrating on producing certain goods over long periods of time in readiness for the festival, or general craftspeople abandoning their usual activities in the immediate run-up to a particular festival to produce specialised goods purely for that occasion. Arafat and Morgan (1989:328-9) mention the production of distinctive types of pottery found at the sanctuary of Artemis at Brauron in Attica, and large numbers of amphorae given as prizes in Panathenaic festival held every four years in Athens.

A similar factor may relate to production for trade outside the immediate local area in which the craftsperson worked. The sailing season was a fairly short and well-defined period, lasting from spring to autumn, when the weather conditions were suitable. As with production relating to festivals, it may be the case that certain products were produced especially for overseas trade, and their production may have been carried out by specialists producing certain goods over a long period of time, or by a number of craftspeople only producing certain types of goods in the period leading up to the sailing season especially for overseas trade, and reverting to other different subsistence activities at other times during the year. The existence of seasonal trade would also have affected the ability of craftspeople to produce certain goods. Goods requiring the use of particular materials from outside the local area can only have been produced when these materials were available, and this would depend on the

times when it was possible to import them. If these materials were perishable or were only produced at certain times of the year then this would further restrict the ability of the craftsperson to concentrate on the production of goods requiring such materials all year round. This could lead to craftspeople being involved in different activities during the year in order to make a living.

It may be possible (although extremely difficult) to identify evidence of the existence of different seasonal craft production activities through the study of the archaeological remains of production sites. It would be necessary first to look at features such as the evidence for production equipment, the location of a production site, and so on, if one were to try and assess this. One possible way of approaching this problem would be to see whether there is evidence for more than one type of craft production activity at a site. This may come in the form of a range of different products being found at one site, or it may be possible to identify equipment that can be used in the production of more than one type of product. Of course this is likely to prove very difficult, given the often generic and perishable nature of a large amount of equipment used in craft production, especially at lower scale production sites.

Moreover, in the absence of any evidence of the actual products from a site, deciding which activities were carried out there moves into the realm of conjecture and (albeit educated) speculation, the more so when one then attempts to make a judgement as to when the supposed activities were carried out. The very existence of 'all-purpose' generic equipment may however be enough to suggest that more than one type of production was carried out at a site. In any case, it is enough to keep an open mind and at least highlight the possibility that different tasks may have been accomplished, rather than assume that a site can only have been used for one purpose (often the one which the excavator assigns it).

Assessing the nature of the links between agriculture and craft production at a site relying only on archaeological evidence can prove altogether more difficult. The assumption that most people in the ancient Greek world, whether 'farmers' or 'craftspeople', were involved in agriculture in some capacity is one which permeates all discussion of ancient Greek society and economy, and is to some extent generally supported by literary evidence. In order to produce a full archaeological assessment of this, it would be necessary to consider production sites in relation to areas of agricultural activity, whether rural field systems or urban gardens. However, due to factors governing the survival of such things in the archaeological record, this may prove extremely difficult, if not impossible. In such cases one

is forced to rely for the most part on the literary evidence, and once again resort to conjecture to fill in the gaps in an account of this nature.

6.4 Craft production and the household

It has been suggested above (see Section 6.1.2) that the basic unit of economic and social activity was the household; for the purposes of this study, then, it is necessary to look at the way craft production was organised in relation to the structure and subsistence strategies of the household. This section will deal with issues relating to the role of the household in craft production, and the implications of this for studying the organisation of production. First, I will look at the nature and composition of the ancient Greek household (*oikos*), and the ways in which the household is involved in economic activity. Second, I will consider ways that craft production within the household can be identified, both archaeologically and historically.

It is necessary to establish what the ancient Greek household was, in terms of its composition and the roles of its members, or (since in the Classical and Hellenistic Greek world the household had a wide range of meanings and functions (Pomeroy 1997:17), at least to define what will constitute 'the household' for the purposes of this study. The ancient Greek household (or *oikos*) is not the same as the family, for which different legal and demographic definitions existed. The family (put simply) could consist of people connected by relationships of blood and/or marriage, based around the basic nuclear family unit (of husband and wife, plus their parents and children, and also siblings and extended family). The *oikos* on the other hand refers not only to people related by blood, marriage and adoption, but also to the family's property which included slaves, animals, land and other possessions (Pomeroy 1997:21). This could include a husband and wife, their house and one slave, or it could be extended to include the husband and wife, their children and aged relatives, numerous slaves, plots of land, the family dwelling, and separate agricultural or craft production establishments.

The *oikos* has been described as 'the fundamental building block of ancient Greek society' (Foxhall 1989:22), and it was the basic unit of social and economic activity. Each member of the household, whether free or slave, male or female, made a different contribution to the subsistence of the household, and it is necessary here to consider their economic and social roles within the household structure in relation to the organisation of craft production activity. There are a number of perceived divisions within the structure of the *oikos* which affect the way in which these aspects of the household have been studied in the past. The most basic divisions are binary in nature, between public and private and male and female (Foxhall

1989:23-24). The male members of the household are seen as inhabiting the public world of ancient society, while the female members of the household inhabited the private world of the domestic sector of society.

This view has affected not only the way in which economic activity within the household has been discussed, but also the way in which the archaeological evidence for the activities and structures of the household (for example the remains of domestic architecture) has been interpreted. Generally speaking, men's work is seen as being outdoors (or at least in a place which is accessible to the public), where it is assumed that it would involve some contact with people from outside the household, and that it would involve activities which were geared towards producing things for use outside the household (i.e. in such quantities that products would be sold). Women's work, on the other hand, is seen as taking place indoors, in private, away from the possibility of contact with people from outside the household. The activities carried out by women were geared mainly towards producing things for use within the household, such as cooking and weaving. Men worked out in the fields, or in buildings such as shops or workshops where they produced goods mainly for use outside the household (i.e. for sale and exchange).

This account based on the generally accepted picture painted by the literary source material is however rather simplistic and is unlikely to reflect the wide range of circumstances and situations that prevailed in the ancient Greek world. It is likely that the social and economic status of a particular household would have determined the ways in which production was organised. Therefore higher-status households may have resembled those outlined in the literary source material, where the male head of the household did not do any manual work himself but oversaw the labour of others, while his wife was involved in some domestic production (such as textile production) which did not contribute directly to the subsistence of the household, and most of the manual labour was done by slaves, either in the domestic arena or outside it (for example in external workshops or agricultural labour on farms where the family did not live).

In households of lower social status, the family members would probably have taken more of an active role in the household subsistence activities, and these activities are more likely to have taken place largely in the domestic arena rather than outside it. For example, the male head of the household would probably be involved personally in agricultural labour or craft production, or both; his wife may have taken part in production activities with her husband, or may also have been involved with other types of production activities for

consumption both inside and outside the household (of which textile production is again probably the best example); other family members, such as children and aged relatives, may also have taken part in production activities, as would slaves. The number of slaves and the extent of the work carried out by the family members (and thus the organisation and scale and level of production) would have been determined by the exact social status and level of wealth of the household.

Archaeological evidence can also be used to look at the economic aspects of the household. A great deal of work has been carried out on the study of domestic architecture and the uses of domestic space, and the methodologies used can be useful when studying production, both inside and outside the domestic arena. For example, Sparkes (1962) has studied the Greek kitchen using the evidence for kitchen implements. Many of the kitchen utensils identified in the archaeological and historical record are portable and multi-functional and this, allied with the fact that specialised kitchens cannot always be identified by architectural features (although a possible exception may be the houses from Olynthus: see Appendix), has led Sparkes (1962:129-132) to conclude that the 'kitchen, when applied to ancient Greek homes, indicates less location than function'. More recently, studies such as those by Ault (1994a, 1994b, 1999, 2000), Ault and Nevett (1999), Goldberg (1999), and Jameson (1990a; 1990b) have argued that domestic space was not rigidly defined and regulated, contrary to the ideal set out in the literary source material. Rather, the study of the archaeological evidence combined with the use of historical material has shown that domestic space was not fixed according to ideals, and that rather than, for instance, there being strictly separated men's and women's quarters, different areas of the house could be used for different purposes by different people at different times.

Approaches such as this can be useful for the study of craft production in the domestic setting. While this may not apply to large-scale production using specialised equipment carried out outside of the domestic arena (i.e. in separate workshops), the identification of work areas in the domestic architectural remains can aid the study of the organisation of production on a smaller scale. In the same way that it can be argued that different parts of the house may have had different functions at different times, it is possible to suggest that production activity could be carried out wherever was convenient, depending on the nature and scale of production (Jameson 1990b:184-187). Therefore, activities requiring portable equipment, such as weaving, may have taken place wherever was convenient, while other

activities for which less portable equipment was necessary, may have been carried out in particular rooms in the house which were not generally used for any other purpose.

It may be possible to identify production carried out in the domestic arena either through the remains of equipment, or through the presence of production debris. The nature and location of the evidence for production in relation to the other features of the building can then be assessed regarding the organisation of production activity. For example, a room in a house containing a certain amount of production equipment or debris which does not occur anywhere else in the house (but is not too specialised and is not outside the house) would indicate production on a larger scale than that suggested by a pile of loomweights found in a room containing no other evidence of production activity. Of course any attempt to assess the evidence for production in the domestic arena in this way is hampered by the nature of the archaeological remains of production activities of different scales.

However, it is possible to use this evidence to assess the role of the household in production of different levels of organisation. The organisation of production would be determined by the social and economic framework whereby the household unit was the basic unit of economic activity. Differences in the organisation of production would lead to differences of the roles of the members of the household and the use of the household space in the production activity. The degree to which the members of the household were involved in production activity would relate to the scale and mode of this activity. In cases where production was organised on a fairly large scale, the members of the family unit would not participate a great deal, with most of the work being done by slaves or other labour, and production would not be carried out within the family dwelling. Medium scale production would see some involvement by family members and slaves and the use of the family dwelling (or at least parts of it, which may have been specially equipped for that purpose); while small scale production would be carried out by household members (free and slave) and could take place anywhere in the family dwelling, with no restrictions for specially equipped work areas. It can be seen then that it may be possible to identify certain types of production within the archaeological record relating to domestic architecture, particularly medium and small scale production.

6.5 Towards a framework for the study of ancient craft production

In summary, then, it is possible using the theoretical framework discussed above to gain a new perspective on the study of craft production in Classical and Hellenistic Greece. In this study I propose to use a framework based on approaches to the study of pottery

production which considers production in terms of its mode and scale. To this end, it is necessary to look at four areas of the economic and social aspects of craft production. Rather than simply repeating the dictum that 'all ancient production was small-scale', if one looks at production in terms of its organisation it is possible to see that it was not all the same scale. By using a model with three levels of scale of production (domestic or small scale, medium scale, and large scale) and applying it to the archaeological as well as literary evidence for production a much fuller picture can be produced. Linked to the organisation (and partly an influence on it) is the issue of the level of specialisation of craft production. It is possible to study the archaeological evidence for production areas and equipment on one hand, and the historical evidence for the terminology of all aspects of production on the other, in order to gain insights into both site and producer specialisation. Production in most cases was not carried out in isolation, and it is important to take into account the ways in which it interacted with other aspects of ancient life. Perhaps the aspect of this with the most bearing on the organisation of production was the existence of seasonal factors, which can be identified (or at least inferred). Once these can be identified for a particular craft, it is possible to use the information to look at the nature of the production activity and how its level of organisation and specialisation may have been affected by these factors. The organisation of craft production was to some extent influenced by the role of the household as the basic unit of economic activity, although the level of organisation would influence the roles played by different household members in production. Archaeological evidence from the primarily domestic arena can be used to shed light on the ways in which craft production activity fitted into the household framework, particularly on the lower levels of organisation.

The use of such a framework has the potential, I believe, to produce a much fuller account of Classical and Hellenistic Greek craft production in its social and economic context than has for the most part been previously undertaken. In the following chapter, I will use this approach to study the evidence for ancient dyeing, a craft production activity whose study has previously lacked any such social and economic focus.

Chapter 7

Dyeing in its Economic and Social Context

The aim of this chapter is to produce a picture of dyeing in its social and economic context. The information and ideas included in chapters 1 to 5, relating to the materials and equipment used by the ancient dyer, the processes involved in dyeing, the archaeological evidence for dyeing, will be brought together and analysed according to the methodological framework set out in chapter 6, in order to gain some idea of the social and economic framework within which dyeing was carried out. The main focus of this chapter will be to look at the scale and mode of dyeing activity. To this end, the first section will deal with a discussion of the organisation of dyeing, with reference to the archaeological and historical evidence, based on the organisational framework set out in the previous chapter. The second section will look at the ways of identifying specialisation, and will be integrated with the discussion in chapter 6 in so far as it will refer to factors relating to the people involved in dyeing, the seasonal factors which may have affected dyeing and the role of the household in dyeing.

7.1 Studying the organisation of dyeing activity

This section will consider the ways in which the methodology set out in chapter 6 can be applied to the dyeing evidence. The framework for analysing the level of organisation of craft production activity will be applied specifically to the organisation of dyeing activity. The results will be exploited to provide a picture of the organisation of dyeing activity.

In chapter 6 the organisation of craft production was modelled with reference to the archaeological evidence, and this methodology will be followed in this chapter. The archaeological evidence for dyeing, including production equipment, the remains of ingredients, and the buildings in which dyeing was done, along with literary evidence relating to dyeing, will be used for this purpose. Where possible, attempts will be made to analyse the sites of dyeing activity in relation to potential sources of raw materials, agricultural land and markets, as well as domestic areas, as suggested for the analysis of pottery production by Arafat and Morgan (1989:323). These factors can provide valuable information relating to the potential activities of dyeing operations, and therefore their level of organisation and scale, as well as to issues of specialisation which will be discussed below. The sites of dyeing activity will then be allocated a place in one of the three levels of production organisation set out in the model proposed in section 6.3.1.

The archaeological evidence for dyeing includes a range of features which have been discussed in chapter 5. Whereas that discussion focused on the equipment itself as an indicator of dyeing activity at a site, here each site will be discussed as a whole, in order to assess the level of organisation of the dyeing activity taking place there. The classification of each site into a particular level of organisation will be based on the size and nature of the equipment and the production area in which it is situated at the site, as well as on the relationship between production areas and their surroundings. This can relate to other areas concerned with production, non-production areas and possible sources of raw materials, where these can be identified. Of course this analysis depends on the nature of the preserved archaeological evidence. Since not all sites of dyeing activity have been subject to the same conditions of preservation, excavation and study, as well as the fact that a wide range of different types of sites and equipment were used for dyeing in the ancient world, the ability to identify sites, let alone to analyse them in this way, would be affected by the level of organisation. Thus, a site of production organised on a large or medium scale would be easier to identify, analyse and classify than small-scale domestic production.

None of the sites referred to in this study are sufficiently well preserved in terms of all of the criteria for assessment set out above for them to be fully analysed in this way. Nevertheless, it is possible to look at a number of sites in terms of different combinations of these criteria, and fill in the gaps where necessary. In the following discussion, there are two broad types of site. Some sites appear to have been single workshops, where production was carried out if not in isolation, then at least without any obvious similarities in function to other sites situated in the immediate vicinity. Other sites, however, appear to have consisted of a number of production areas grouped together in a more obvious way (at least to the modern observer), suggesting a community of craftspeople. When this latter type of site is discussed here, rather than consider each individual workshop, the group of production areas will be regarded as a single site. This does not presuppose any unity of organisation, nor is it assumed that only one type of activity was carried out there, so it must be stressed that on no account is my grouping of some sites into a single entity intended to imply that. Rather, this has been done for reasons of clarity, particularly since these sites have been published as single entities.

7.1.1 Identifying large and medium-scale dyeing

One such site is the settlement on the Rachi hill overlooking the sanctuary of Poseidon at Isthmia (see Figures 58 and 59). The site consists of a number of structures, some of which have been interpreted as house-workshops, built onto the bedrock of the eastern end of the

ridge running south-west to north-east to the south of the sanctuary (Anderson-Stojanovic 1996:60). The houses were laid out along three parallel streets with the same alignment as the hill itself, which are crossed by two streets running north to south (Anderson-Stojanovic 1996:91). Access to the settlement from the north-western foot of the ridge was provided by a set of stairs, while other stairs linked the settlement to the southern slopes of the hill (Anderson-Stojanovic 1996:62). The settlement appears to have been established during the second half of the fourth century BC, and it was destroyed some time around 200 BC (Anderson-Stojanovic 1996:62-63).

A number of the houses contained similar (although not always identical) sets of installations that can be identified as dyeing equipment. The basic form of the equipment found in these house-workshops can be summarised as consisting of vats cut into the bedrock and lined with cement linked to a cement working floor. It is likely that the houses had an upper storey, and a number of basement areas have been found, which Anderson-Stojanovic (1996:67) suggests were used for storage, with sleeping and living areas situated above. It is not clear whether all of the rooms in all of the houses had upper storeys. In some cases it is impossible to assess the relationship between these installations and the rest of the houses of which they were a part, since not every house has been excavated and published in its entirety.

Broneer (1955:125) records one such installation discovered in 1952 at the western end of the Rachi settlement which consisted of a rectangular tank lined with cement close to a larger cistern and two circular basins, (see chapter 5 and Appendix) (see Figures 59, 60 and 61). At the eastern end of the excavated part of the settlement, House XI also contained dyeing equipment consisting of specially constructed tanks (see Figures 59 and 66). Two rooms from this house have been excavated, and there are indications that at least one more room extended towards the east (see chapter 5 and Appendix) (Anderson-Stojanovic 1996:84-85, 87).

One room in House III (room A) contained a rectangular basin, with an outlet at its north-east corner leading to one of two circular basins at its eastern edge (see chapter 5 and Appendix) (Broneer 1955:126) (see Figures 59, 62 and 63). Two other rooms in house III have been excavated, although the extent of the building to the east appears unclear. It is therefore impossible to judge the relative sizes of the rooms, since room A is the only one whose walls are all known. It seems however to have been smaller than room B and bigger than room C (see Figure 59). To the north-east of house III, house IV contained a similar arrangement of tanks and basins (see chapter 5 and Appendix) (see Figures 59, 64 and 65).

The ground plan of the house shows two rooms, the larger of which contains the dyeing equipment. The western half of the southern room contained two circular basins connected to a cement floor, with a channel running between the basins to a rectangular basin to the north. The eastern half of the room, which is separated by a low partition wall, also has a cement floor in which are three small rectangular cuttings (Broneer 1958:19). It is impossible to say whether this building extended to the east (see Figure 59).

In a long room or court north-west of house III and close to house IV, two baths were found which were constructed from stones covered with cement (see chapter 5 and Appendix) (Broneer 1955:127 and 1958:18-19) (see Figure 59). It is unclear whether this space formed the courtyard of House III or was more public. If it was the courtyard, one would expect the entrance to be from the north-west, in the gap between houses II and IV, which would mean that the court was L-shaped. This scenario would give the inhabitants of house III more potential dyeing equipment than those of other houses on the Rachi, and would also mean that there were potentially two workrooms in the house. If however the court was smaller and rectangular, this area with two baths would be accessible to more than just the inhabitants of house III, and could have been for communal use.

Although these are the only instances where installations of dyeing equipment have been found in the remains of the settlement on the Rachi, it is likely that other houses were equipped with similar installations. For example, the remains of a cement floor were found in room C of house III, and Anderson-Stojanovic (1996:68) suggests this may have contained the installations found in the other houses. Room A in house X at the eastern end of the settlement contained a large trapezoidal tank cut into the bedrock and lined with cement (Anderson-Stojanovic 1996:81) (see Figure 59); this may have been used for different parts of the same process as the equipment described above, or as part of a different purpose.

Other equipment of a more everyday and portable nature could also have been used by dyers in the Rachi settlement. Pottery vessels, for instance, could have been used for the storage of dyestuffs, and for dyeing in the absence of specially constructed equipment. Grinding and crushing equipment would have been required for the production of a number of dyestuffs. A great deal of pottery has been found during the Rachi excavations, as well as things like millstones and other grinding equipment (see for instance Kardara 1961:265). Moreover, large numbers of loomweights were found, indicating the presence of some sort of textile production (Anderson-Stojanovic 1996:92) (see Figure 29). Seventy-eight were discovered in 1989, with the greatest quantities being found in the basement rooms of the

houses (Anderson-Stojanovic 1996:87-90). In excavations on the Rachi in 1955 and 1956 over sixty loomweights were found in the basement of one house, south-west of House III (Broneer 1958:32). There is no direct evidence for the presence of dyestuffs however.

What does this evidence suggest regarding the level of organisation of craft production at the Rachi settlement? In line with the categories set out in Chapter 6, I would classify the house workshops in the Rachi settlement as a whole as being involved in large-scale production, although taken individually they can be classed as medium-scale. There are specialised working areas with (in some cases) specially constructed equipment, although these are clearly in domestic settings. All of the working areas are part of buildings with other rooms which were not primarily craft production areas, and also the likely presence of upper storeys in at least some of the houses suggests that other activities, probably of an everyday 'domestic' nature, went on in them. It is clear from the specially constructed equipment that production was not simply for the use of the household; such installations suggest that production would be mostly for consumption outside the household. This can be seen on a community level as well as a household level, since the number of workshops in the settlement would seem to suggest production was geared towards consumption not only outside the household but also outside the community (as also suggested by Anderson-Stojanovic 1996:91).

One feature which might suggest the presence of large-scale production is the fact the settlement as a whole (or at least most of the excavated houses) seems to be geared towards craft production of some sort. This need not necessarily be just dyeing or, as Anderson-Stojanovic would have it, oil production (Anderson-Stojanovic 1996:91-92; *AR* 1996-7:18), but could have covered a range of activities. The installations, although specially constructed and fairly specialised, could still have been used for a range of such activities as fulling and tanning, wine production, and oil production, as well as dyeing, either exclusively or (as is more likely) several, but at different times. The layout of the streets, would also have benefited a community involved in craft production, since it would make the movement of goods in and out of workshops easier, as would the location of these working areas and the courtyards of the houses adjacent to the street (Anderson-Stojanovic 1996:91). Perhaps the most important feature of large-scale organisation in terms of a community is the existence of central organisation and control of production, and it is impossible to say for certain whether this was the case at Isthmia. It is possible that the workshops in the settlement were owned by one individual or institution, and then worked in by slaves or other dependent labour, or lessees; equally, they may have been owned by individual free craftspeople. The evidence for

the moment does not indicate central ownership and control. Moreover, since the whole settlement has not been excavated, it is impossible to say for certain whether the whole community was involved in craft production or only a small number of houses.

Although craft production here does not appear to be centrally organised, it does seem that this part of the Rachi settlement, if not all of it, was involved in similar craft production activities, and can be seen at least as a craft 'quarter'. The number of house workshops apparently set up for similar types of production in such a small area would seem to be unusual; one might expect a high concentration of craft production establishments in an 'industrial quarter' of a city such as Athens, but not necessarily in such a small settlement. To have a whole settlement apparently geared towards production primarily for outside consumption on such a scale would seem to require further explanation. The location of the settlement may offer some pointers to the possible reasons for this. The isthmus was a busy place, in both religious and commercial terms (Anderson-Stojanovic 1996:92), and the settlement on the Rachi would appear to be well placed to take advantage of the markets provided by the location.

A major factor in this is the sanctuary of Poseidon located near to the northern foot of the Rachi hill (see Figure 58). The precise nature of the relationship between the sanctuary and the Rachi settlement is unclear, although it is clear that the sanctuary would have provided a valuable source of income for the settlement. The visitors to the sanctuary would have provided a ready market for goods produced by the people of the settlement, particularly on occasions such as the Isthmian games. The sanctuary officials may have set up the Rachi settlement specifically to provide 'essentials' for the sanctuary, and to generate income from the visitors. On the other hand, the Rachi craftspeople may have established their settlement in order to take advantage of the ready market provided by the sanctuary, and furnish the needs of the officials and visitors alike (as also highlighted by Anderson-Stojanovic 1996:92). Either way, it is likely that at least part of the large volume of goods produced, as indicated by the nature of the installations on the Rachi, would have been intended for consumption by people associated with the sanctuary of Poseidon and it is perhaps this that led to the construction of the production facilities in the settlement on the Rachi. There was also a temple on the Rachi itself. It seems that a shrine, perhaps of Demeter (a patron of wool and woolworking) which was established before the fifth century BC and abandoned around the same time as the settlement (Anderson-Stojanovic 1988:268-269). Whether this temple had some sort of control over the workers and their activities in the Rachi settlement or not is unclear.

A similar grouping of a number of workshops has been found at Mycenae. The Hellenistic settlement at Mycenae was located on and around the citadel, and in the area to the west/south-west; the dyeworks were located in the Citadel House Area, on the western slopes of the acropolis (see Appendix) (see Figures 74, 75, 76 and 77). A number of the rooms contained shallow basins lined with cement: these included rooms A, MM and X (see chapter 5 and Appendix) (Bowkett 1995:9-10, 21-22, 35) (see Figure 75, 78, 79, 80 and 82). Other rooms contained floors of plaster/cement, which often extended up at least one of the surrounding walls In some cases the floors had a sump-hole in the corner, with no drainage outlet (see chapter 5 and Appendix) (Bowkett 1995) (see Figure 75).

Other features in the Citadel House complex could also have been associated with dyeing. Room L, in the southern section of the second terrace, contained a the base of a press set into a plaster floor in its north-east corner (see chapter 5 and Appendix) (see Figure 75). A depression in the floor led from the press to a pithos set into the floor to the west (Bowkett 1995:20). A wide range of pots, some of which could have been containers for substances used in the dyeing process, were found in the Citadel House Area, as were grinding tools. Large numbers of loomweights were also found all over the site (see chapter 5 and Appendix) (Bowkett 1995:39-40) (see Figure 28).

Other Hellenistic buildings in Mycenae associated with the Citadel House Area also contained similar evidence of dyeing activity, and will be considered along with the evidence from that area. The Hellenistic building over the South House contained three basins set against its southern wall (see chapter 5 and Appendix) (Bowkett 1995:47-49; Wace 1923:97-102) (see Figure 77). Close to the Citadel House Area, to the north of the north-east complex and slightly above it, north of the 'Little Ramp', were a set of four 'Hellenistic chambers' with some similar features to the other Mycenaean dyeing establishments (see chapter 5 and Appendix) (Bowkett 1995:45; Wace 1923:69-70) (see Figure 76). Other Hellenistic remains found around Mycenae have included presses, and another room with a plaster floor and walls (Bowkett 1995:49).

The craft production equipment in and around the Citadel House Area could have been used for dyeing, as well as for other purposes. The basins in rooms A, AA and MM, although shallow, could have been used for one of the stages of the dyeing process requiring immersion, as could the deeper basins in room XX and also the baths in rooms YY and <32>. The rooms with plaster floors could have been used for drying dyed material; the sumps in some of them would serve to collect dye dripping from the material for re-use. Presses and

other grinding equipment may have been used for the preparation of dyestuffs. There is also evidence for elaborate drainage provision at the site. Rooms A, B, D, T and U in the upper terrace contained a series of interconnected drainage channels (Bowkett 1995:9-14), as did the 'North West Complex' (Bowkett 1995:47-49). Whether all of the buildings equipped with basins also had plaster floor areas, and vice versa, cannot be answered due to the nature of the excavated material. As a result, it is impossible to assess the full scale of the dyeing operations at the site. As at Isthmia, it is possible that the installations at Mycenae were used for other craft production activities, either instead of or (more likely) as well as dyeing.

The organisation of the Hellenistic dyeing activities at Mycenae is similar to those at Isthmia. This site would appear to be organised on a large scale, with a number of small workshops grouped together within a small area. It is clear that most of the buildings were involved in craft production, with a range of specially constructed similar equipment. As with Isthmia, one can only speculate on whether production here was centrally organised; the workshops are grouped together sufficiently to justify their classification as large-scale on the basis of their resembling a craft production 'quarter' or settlement. The level of specialisation of craft production equipment at the site, and the numbers of workshops, once again indicate that consumption was intended primarily to go outside the household, and possibly outside the community.

It is difficult to say however whether this was a grouping of medium-scale workshops (as was the case at Isthmia), or whether this was one large production complex. The relationship between production and non-production areas here is difficult to assess. Bowkett (1995:36) suggests that the houses of the Citadel House Area 'do not give the impression of having been of domestic use', although the finds do not seem to support this interpretation (Anderson-Stojanovic 1997:245). Not all of the rooms contained equipment associated with dyeing (or other craft production), and it is possible that there were upper stories for which evidence would not survive. If, as Bowkett (1995:52) suggests, the site was gradually abandoned, it is possible (or likely) that any re-usable material (including domestic artefacts and wooden material from for instance an upper storey) would have been removed. This could have taken place at the time of abandonment, or afterwards. It is possible then that this was a series of house-workshops, with the living areas situated in an upper storey, which individually would have been medium-scale.

It is equally possible however that the Mycenaean dyeworks were one large complex, under central organisation. All of the dyeing equipment was installed at roughly the same

time, during the second century BC, as part of the same construction phase. This could have been done at the order of the person or persons who owned and controlled the production activity. It would then be possible to view the set of rooms without any production equipment, rooms H-K and M-N on the second terrace, perhaps as the living quarters of the workforce for the whole complex (the extent of which is not known). Certainly the yard area in the northern section of the upper terrace, room V, appears to have been L-shaped and thus open to the street running east to west, of which it formed the eastern end; at any rate there is no mention of any sort of wall separating it from the street area (Bowkett 1995:15). Of course this does not mean that this area was not open to the street, and the wall separating the two areas was simply not preserved. However, the lack of any concrete evidence for central organisation would lead to the conclusion that this site consists of a grouping of medium-scale house-workshops, which can be classified as a large-scale operation on account of their being grouped together.

Other sites do not appear to be grouped together in such a way, although there are places where a number of dyeworks are situated in the same general area. The Hellenistic settlement on the island of Delos contained a number of dyeworks (see Figure 40), although not concentrated in one area as at Isthmia or Mycenae. Two houses in the Theatre Quarter of the town were equipped with specially constructed dyeing equipment, while the east coast of the island was the site of another establishment involved in dyeing activity. House IIIN in the Theatre Quarter, for instance, was a large house with thirteen rooms situated on the *rue du Théâtre* (see Figure 43). Some of these rooms contained dyeing equipment (see chapter 5 and Appendix). The function of the other rooms without specially constructed dyeing equipment is unclear. It is possible that the courtyard, f, and rooms close to it, g-m, were living quarters (see Figure 49). It is also possible that rooms a-c were originally a shop (Charmonard 1922:45), since they face onto the street and may not have been part of the original plan of the house. They may have gone out of use as a shop once the dyeing equipment was constructed or, as seems most likely, they may have either been added to the plan at the same time, or at least adapted to act as the public access and shop for the dyeworks. Other, more private entrances were located at the western end of the building, into room k, and from the alley to the north of the building. Here, a raised paved platform, with a doorway opening into room c, was separated from the alleyway by a wall. Trümper (1998:278) argues that this was the foundation for an outside staircase leading to an upper storey.

Close to house IIIN was house IIIU, which was also situated on the *rue du Théâtre* (see Figure 50). It was considerably smaller than IIIN, with four rooms and a small hallway on the

ground floor. In the north-east corner of room c, the courtyard of the house, were two vats very similar to those in room e of house IIIN (see chapter 5 and Appendix) (Charmonard 1922:49) (see Figure 51). The courtyard also contained two independent covered cisterns (Charmonard 1922:48) (see Figure 52). The other three rooms may have been living quarters; it is likely however that the south-east room was a shop, as was room b (Charmonard 1922:209). As with the proposed shop in house IIIN, it is possible that this shop could have been used for the sale of dyed material. The entrance to the house was via an alley to the south, while the shop opened onto the *rue du Théâtre*. A staircase may have led from the hallway (room a) up to an upper storey.

Both of these dyeworks can be classed as medium-scale. They are clearly equipped with specialised equipment, which seems to indicate that production would have been on such a scale as to be surplus to the everyday requirements of the household. The existence of shops which were possibly linked to the dyeworks would seem to suggest strongly that the goods produced there were destined for sale outside of the household. The existence of living/non-production areas in both of the houses would suggest however that these are not large-scale establishments, with space used purely for production activities, but rather that they are house-workshops of the type seen at Isthmia and perhaps Mycenae. There are no other dyeworks in this area which would suggest a whole community or 'quarter' involved in the same activity, and the two houses are not close enough to justify their classification as any sort of nucleated workshop organisation. This is not to say that these are the only craft production or commercial establishments in the area however. In certain parts of the Theatre Quarter, shops (like those identified in houses IIIN and IIIU) opened onto the street, particularly on the busier streets with access to the port such as the *rue du Théâtre* especially between *rue 2* and *rue 5* (Charmonard 1922:207). There is also evidence for the production of bronze, in house VIL (Charmonard 1922:213), and perhaps pottery production (Charmnonard 1922:213-214). A wine press was located at the southern end of *rue 5*, while oil production took place in house IIIO, immediately to the west of house IIIN (Charmonard 1922:214-215; *AR* 1997-8107-108). This would seem to indicate that the Theatre Quarter was to some extent a busy commercial district, although not specialised to the same degree as Isthmia or Mycenae, and the craft production activity was not of a single type.

Further evidence of dyeing activity was found on the east coast of Delos (see Figure 40). Two areas have been identified, the so-called 'North' and 'South Establishments'. The South Establishment consisted of a number of walls situated very close to the sea, which form at least five rooms along with granite blocks and tanks (see chapter 5 and Appendix) (see

Figure 41). The 'North Establishment' had similar features (see Figure 41). Three granite blocks were found, similar to those in the 'south establishment' (Bruneau 1978:110-111). To the east and north-east of these blocks, by the edge of the sea, layers of large quantities of broken murex shells were found (Bruneau 1978:111). Both of these sites appear to be related the production of purple dye from murex shellfish (see chapter 5 and Appendix). Whether dyeing was also done in these sites is unclear. Indeed, without thorough excavation it is impossible to fully assess the function and level of organisation of these sites. Their extent is unclear, as is the relationship between the features themselves (Bruneau 1969:789-791). It does appear, however, that this equipment was fairly specialised, even in terms of dyeing equipment, and that the production of purple dye from shellfish would have been a complex process requiring specialised techniques and knowledge. The sites are situated close to a good supply of raw materials; indeed, close to the 'North Establishment' is an inlet where small boats could bring supplies of murex shells (Bruneau 1978:111). The fact that purple dye was being produced and/or used here would therefore suggest that this site should be classified as either medium or large-scale production, due to the specialised nature of the process, although it is impossible to say with any certainty.

It is possible that, as at Isthmia, the presence of a powerful temple organisation at Delos (in this case the temple of Apollo) had an effect on the level of organisation of dyeing activity on the island (for the effects of the sanctuary, and the Hellenistic Delian economy in general see Reger 1994). As an island that was visited by large numbers of pilgrims, Delos was a thriving commercial centre, with a large potential market for the products of any sort of craft production activity. The island was also famed for a large slave market (Reger 1994:261-263). In addition to this, however, the sanctuary of Apollo played a part either as a consumer of goods or sponsor of craft production activity. The inscriptions recording the temple accounts refer to dyeing and its products on a number of occasions and in different contexts. There are references, for example, to the purchase of purple goods by the priests of the sanctuary (see for example *IG* XI² 159 A 23), in some cases with references to a *himation* for the goddess Leto:

> ΠΑΡΑ ΑΓΑΘΩΝΟC ΠΟΡΦΥΡΑC ΕΙC ΙΜΑΤΙΟΝ ΤΗΙ ΛΗΤΟΙ (*IG* XI 2 203 A 73)
> ΕΙC ΙΜΑΤΙ–?]ΟΝ ΤΟ ΤΗC ΛΗΤΟΥC ΠΟΡΦΥΡΑC (*IG* XI² 204 75-76).

Providing garments for the cult statues, and perhaps also for the priests, or for worshippers to wear or dedicate, would seem to indicate the existence of a (possibly lucrative and) captive market for a dyer, and thus an incentive for a high level of organisation of dyeing activity.

That purple was an important product of Delos is further highlighted by the fact that tax was collected on purple (although at what stage in its production and use is not clear) (see for instance *ID* 291 d 52-53; *ID* 316 63-64; *ID* 353 A 30-31 and 35). The temple of Apollo derived revenue from purple production and dyeing in another way; at least one of the sacred houses owned by the temple was leased out to one Pyrrhos, a purple dyer, in 192 BC (*ID* 400 7). It is not known whether this house was one of the sites of dyeing activity discussed above. This evidence points to well-organised dyeing activity on Delos, at least in the case of shellfish purple production. That production was generally intended for sale outside the household is indicated not only by the nature of the installations at the sites discussed above, but also by the presence of the markets provided by the large numbers of visitors to the island and also the sanctuary of Apollo. It is perhaps the relationship between the sanctuary and purple production, in terms of both consumption and the revenue it derived from dyeing activity, that is the major factor in the scale of the dyeing activity here.

The Hellenistic and Graeco-Roman settlement on the island of Kouphonisi, off the south-eastern coast of Crete, was excavated in 1976. One house, house B, was also the site of the production and/or use of murex purple dye (see chapter 5 and Appendix) (Papadakis 1983:61-62) (see Figure 71). While the published report does not provide all (or even most) of the information necessary to assess the level of organisation of this site, it is still possible to attempt this on the basis of what evidence there is. The fact that shellfish purple was being produced would itself suggest at least medium-scale organisation, since, as mentioned above, the skills and equipment required are very specialised. It is unlikely also that given the prestige nature of murex purple, dyers using it would keep their products within the household. Given the level of specialisation required for this particular dye, and the fact that it was an expensive and desirable product, it is unlikely that any production of it would not be destined for consumption outside the household. The fact that the settlement may have been primarily geared towards fishing may lead one to suggest large-scale production, on the basis that this was a community-wide operation. However, it is unlikely that murex was the only target for fishermen; there are plenty more fish in the sea. Moreover, given the nature of the published evidence it is impossible to assess fully the relationships between not only house B and the rest of the community, but also between all of the rooms in the house itself. The most that can be said therefore is that it is likely that dyeing activity here was at least medium-scale, as indicated by the presence of specially constructed equipment and the nature of the activity.

At the site of ancient Korsiai, in south-western Boiotia, dyeworks similar to those at Isthmia was found. In a terraced area outside of the south wall of the ancient acropolis a

Hellenistic 'industrial area' was discovered (Fossey 1981:113; Fossey and Morin 1986:169). The remains here consisted of a building with three rooms and a courtyard which contained a number of vats and channels cut into to the bedrock of the site (see chapter 5 and Appendix).

It is possible then that pit A in room 1 was used for the immersion of material in a dyestuff; the troughs and pits linked to it could then be used to collect re-usable liquid once the excess had been squeezed out of the dyed material. The pits and channels in the other rooms could have been used to catch the dripping liquid from dyeing material. Material could also have been lain out to dry in the courtyard (Fossey 1981:121). No evidence of dyestuffs was found at the site. Given the fact that no evidence of any non-production areas has been found at the site, it would seem that production at this site could be classified as large-scale. The complex contains specially constructed equipment, and presumably products would have been intended for consumption outside the household. Furthermore, the location of the site, just outside the city walls, would seem to suggest a special place for this particular craft production operation, perhaps due to the unpleasant smells produced as part of dyeing processes.

At Corinth, a dyeworks was found to the north-east of the Peribolos of Apollo, consisting of a two-roomed, partially subterranean structure and associated 'drying yards' (see chapter 5 and Appendix) (Williams 1967:184; 1968:134-135) (see Figures 36, 37, 38 and 39). There is no mention of any non-production areas in the published record of the site, and as a result it would be classified tentatively as a place where large-scale production activity was carried out. The site is not published fully, however, and it is possible that further information would alter this analysis. The presence of specially constructed equipment would suggest that production was intended for consumption outside the household of the owner/workers, and its position near to the agora of ancient Corinth would seem intended to provide access to customers. If murex purple was the main product of this dyeworks for the whole of its working life, it would be even more likely that production would be specialised, and possibly carried out away from the domestic sphere. Another possible influence on the level of organisation is the presence of the temple to the south. It has been noted above that the sanctuaries at Isthmia and Delos may have had an important relationship with the dyeworks close to them, as consumers of goods and possibly patrons of production activity; it is possible that a similar relationship existed here.

At Kolonna on the northern edge of the Lasithi plain in western Crete a dyeworks was excavated by J. D. S. Pendlebury in the late 1930s (Watrous 1980:269-270). This consisted of

one building, whose facade faced south onto a cobbled road (see chapter 5 and Appendix) (Watrous 1980:278) (see Figure 69). There are few details about the nature of the settlement in which this building stood. To the west was another building, which was separated from room 4 in the fifth century BC, when a doorway in the adjoining wall was blocked up (Watrous 1980:278-279). At this site craft production appears to have been organised on a medium scale, although it falls towards the lower end of the scale compared to some of the other sites discussed here. The dyeing equipment, including the basin, hearth and bench (possibly for squeezing excess liquid from dyed material) was not constructed with the same degree of specialisation as that at Isthmia, Mycenae, or the Theatre Quarter in Delos, although it was still specially constructed, and did not consist of, say, a portable metal or ceramic vessel. There is evidence that the dyeing may have linked to weaving, with the presence of loomweights in the building. The non-production areas in the building, including rooms 1, 2 and 4, and a possible upper storey or flat roof, indicate that this was not a large-scale dyeing operation. The full extent of the building is not clear however. The relationship between the dyeworks and the other buildings in the area is also unclear. To the west of room 4 was another room (room 5), which was originally part of the dyeworks building. In the fifth century BC the doorway in the wall between rooms 4 and 5 was blocked up, room 5 becoming part of a separate building (Watrous 1980:279-280). As only a small part of this building has been excavated, the activities carried out in it cannot be ascertained and it is therefore impossible to say whether this was a craft 'quarter' or not.

Also on Crete, evidence for a Hellenistic dyeworks, consisting of a plaster-lined basin associated with a cistern, was excavated at Knossos (see chapter 5 and Appendix) (see Figures 67 and 68). It is impossible to comment on the relationship between these installations and other areas of the building of which they were a part, since these are the only parts of the building to have been revealed by excavation. It is possible that there were links between this building and others that were apparently in use at a similar period, which included a possible craft production establishment to the south-west (Sackett 1992:13-16). In light of this, it can be suggested that dyeing here was medium or large-scale, based on the specially constructed basin close to a cistern, and the clay-lined tank close to the cobbled area and the mud-brick platform. The two buildings appear to have been constructed in the same general time period, although it is not possible to say whether there were any links between the activities carried out in them in terms of organisation. Given the nature of the evidence, however, more than that cannot be said.

In an area of ancient Athens at the north-western foot of the Areopagus, between Areopagus Street and the Street of the Marble Workers, a number of houses and workshops were excavated (see Figure 32). These houses were first built in the fifth century BC, but after the building of the Great Drain which ran through this area many were altered or rebuilt (Young 1951:187-188). At the northern end of the Street of the Marble Workers stood house F, a trapezoidal building, narrower at the north than at the south, containing a number of long thin tanks constructed around a central cement floor area (see chapter 5 and Appendix) (see Figures 33 and 34). Another similar 'workshop' was excavated to the north of house F (see chapter 5 and Appendix) (see Figure 35). This 'workshop' appears to date from the same construction phase as the later phase of house F, since the east wall of the large vat formed the west wall of the drain (Young 1951:233). It is possible then that the same person or people were responsible for the construction of this building as for the reconstruction of house F. It is not clear whether the two 'workshops' were in fact part of the same building, although there is no indication from the ground plan that there was direct access between them. The fact that most of the buildings in the area were altered at the same time, and as a result of the building of a large drain, might mean that there need not be any other link between their constructions.

These 'workshops' can be classed as large-scale establishments. They contain specially constructed equipment, and there is no evidence for any non-production areas connected with them. Although there are no other dyeworks in the area, this part of Athens seems to have contained a number of craft production establishments. Indeed, the excavation report is entitled *An Industrial District of Ancient Athens*, and the fact that the street has been called the 'Street of the Marble Workers' gives an indication of the activities which took place. Other craft production activities identified in this small area include marble working, bronze production, and terracotta production (Young 1951:271-272).

There are a number of installations in the buildings excavated in the fourth century BC city of Halieis in the southern Argolid which may have been used for dyeing. These include a building on the 'Industrial Terrace' and houses A and D in the Lower Town (see chapter 5 and Appendix) (see Figures 54-57). It would seem that the building on the Industrial Terrace was the site of medium-scale dyeing. It contains specially constructed equipment in what was apparently a craft production area. The fact that it was connected with other rooms which do not seem to have contained similar equipment, particularly that to the south, would suggest that production took place within the domestic setting. This was not therefore a large-scale separate workshop. Houses A and D would also be classified as sites of medium-scale dyeing activity. The dyeing equipment including the installation in room6-29, and the crushing trough

in room 6-26 in house D, and the installation in room 6-83 in house A, were clearly specially constructed. It would seem that rooms 6-29 and 6-83 were specialised production areas. This production clearly takes place in the domestic setting however, since the production areas are part of domestic buildings and are not separated from them in any way. The other houses excavated at Halieis, particularly those close to houses A and D, do not contain evidence for craft production, which would suggest that these houses are not situated in a 'craft quarter'.

The above discussion highlights the usefulness and the inherent limitations of using this model to look at the organisation of dyeing activity in classical and Hellenistic Greece. It has been shown above that it is possible to look at the evidence of dyeing equipment not only in terms of its technological aspect but to go further. Using this model the evidence of dyeing equipment can be discussed in relation to the surrounding production and non-production areas and used to give interesting insights into the organisation of classical and Hellenistic Greek dyeing activity. Individual sites can be compared and contrasted, although not solely on a technological level. Whereas in the past, for instance, sites were compared on a very basic technological level, and a site may be described as containing an installation 'similar to those on the Rachi at Isthmia', it can be seen that it is possible to look at sites on an organisational level.

There are however a number of limitations to this approach which are highlighted by the discussion. It will be noted that all of the sites discussed above have been classified as either medium or large-scale. It is extremely unlikely that this demonstrates that all dyeing activity was organised on this scale. Rather, this indicates that the use of this model for discussing the organisation of dyeing activity relies on the nature of the visible equipment at a site, and its level of preservation, as well as the nature of the excavation and publication of the site. This is perhaps a reflection of the origins of the model in ethnographic studies of pottery production, where craft production is carried out in the present, or where craft production can be observed as it takes place. In the case of the ancient world, however, the person investigating craft production cannot always view the conditions at a site as they were when they were in use. Although in most cases it is possible to judge dyeing equipment in relation to other parts of the building in which it was situated, it is often very difficult to carry out the other methods of assessment. It is extremely difficult for example to analyse sites in relation to sources of raw materials for dyeing, since apart from the murex shellfish dyestuffs were mostly derived from plants and it is almost impossible to pinpoint exactly which plants grew where in the Classical and Hellenistic periods. This is particularly problematic in the case of dyeing, especially for identifying small-scale production (as it is defined in the model above).

It is likely that most dyeing activity in the Classical and Hellenistic Greek world would have been what is referred to here as small-scale or domestic, taking place in areas which were not solely used for craft production and using equipment which was also multi-purpose and fairly generic in nature. Identifying this in the archaeological record is almost impossible, unless there is direct evidence for the use of dyes, for example from staining on vessels or the remains of dyestuffs. This cannot of course be proven, since it is an argument based on a lack of evidence. We do know however that dyed textiles were used in large quantities in the classical and Hellenistic periods, and that they must have been produced somewhere. There is comparatively little evidence for their production. This may be because archaeologists have not looked for evidence of small-scale Classical and Hellenistic dyeing activity, but it is also due to the fact that easily identifiable specialised equipment and production areas were not used.

7.1.2 Identifying small-scale dyeing

It is necessary therefore to attempt to find some way to identify small-scale dyeing in the archaeological record. As this would have been done in the domestic setting, it would seem that the most useful way of looking at this would be through the examination of evidence from ancient Greek houses. Since any craft production activities carried out on this scale would not have required specialised equipment or production areas, being one of a number of activities carried out in the household. Any equipment used would have been multi-purpose, and it is likely that there would also have been everyday domestic installations which could be converted temporarily for use as dyeing equipment. One must therefore look for evidence of such equipment in areas of the house that were not used exclusively for a craft production activity.

Only in a small number of ancient Greek *poleis* have housing areas been excavated and studied to the degree which would permit such a study. Large areas of housing in the city of Olynthus in Chalkidiki have been excavated and studied in great detail (see for instance Cahill 2000, Nevett 1999, Robinson 1930 and 1946, Robinson and Graham 1938) (see Figures 83, 84, 85, 86 and 87). This has provided valuable information for the study of craft production in the domestic arena in Classical and Hellenistic Greek cities. Many of the houses contained equipment which could have been used for different parts of the dyeing process (see chapter 5 and Appendix). The grinding equipment in the houses could have been used for the production of those dyestuffs which require crushing, while immersion could have been done in any household vessel or in a bath. As Cahill points out (2000:500), different parts of the

houses were used for different purposes at different times. Many of the processes involved in dyeing which involved portable equipment could have been done in any of the rooms with no visible specialisation of purpose. Some rooms, however, would have been more suitable for dyeing than others. The rooms with cement floors would have been suitable for activities involving liquids, such as the immersion of fibres in the dye solution, squeezing the excess dye solution out of the dyed fibres, or drip drying. The bathrooms in particular would have been ideal for dyeing. The drainage provision would have enabled the Olynthians to dispose of any unwanted liquids. The 'treading floors' could have been used for squeezing out excess liquid from dyed fibres. Many areas of the houses would have been suitable for drying, including the courts as well as the rooms with cement floors.

This could therefore be an indication of the existence of small-scale dyeing, using non-specialised equipment (which would have been used for other purposes at other times) in non-specialised areas of the domestic space. There is no evidence that the equipment described above was used exclusively for dyeing, or that it was organised to such a degree that dyeing was the major subsistence activity for the households involved. Cahill (2000:504-505) refers to a number of craft production activities organised on at least a medium scale at Olynthus, including stonemasonry, baking, and terracotta and weapon manufacture. He argues that the grinding equipment represents processing of agricultural products, and that the large quantities of loomweights represent medium to large scale weaving. Any dyeing that took place using this equipment would not have been the main subsistence activity of these households, and would have involved the use of equipment which was multi-purpose. Similarly, the spaces in which dyeing took place would have had many uses: bathrooms for instance could have been used for dyeing, but their main function would have been bathing. This is similar to the many functions of bathtubs in houses today even in western society (indeed, I have known baths to be used for mixing dough, washing clothes and as overflow refrigerators).

In terms of organisation of dyeing activity, then, it is possible to suggest that most activity was carried out on a small scale, with very little evidence of this surviving in the archaeological record. A number of sites can be described as medium-scale, with specially constructed dyeing equipment which was situated in, or linked to, non- production areas; these include houses IIIN and IIIU in the Theatre Quarter on Delos, house D and the buildings of the 'Industrial Terrace' at Halieis, and the dyeworks at Kolonna in Crete. Other sites containing dyeing equipment with no apparent links to non-production areas can be described as large-scale; these include the dyeworks at Korsiai, Corinth and Athens, as well as the 'dyeing quarters' at Isthmia and Mycenae. This discussion also raises a number of important issues

relating to the levels of organisation identified at these sites. An important feature of dyeing equipment noted above was the fact that it is generally of an unspecialised nature. The extent to which the tasks carried out using this equipment were specialised, and to what degree, has implications for the level of organisation. The ways in which the level of specialisation of dyeing equipment and the tasks carried out using it was linked to, or affected, the level of organisation of dyeing activity, will be discussed below.

It is also possible to look at the issues of specialisation and multiple uses of dyeing equipment in a number of different ways, in order to assess the full extent of this practice and its implications for the organisation of dyeing activity. It may be possible to use documentary sources to look at the ways in which dyers, their equipment, particular tasks which they carried out, and their products, were referred to. This could indicate the levels of specialisation among craftspeople and the equipment they used, and how this affected their products. It may also be possible, by looking at seasonal aspects of dyeing, to gain an idea of how it could have related to other craft production activities, and therefore whether it would be possible to use dyeing equipment for other purposes at different times. It is possible to gain more insights into the nature of small and medium-scale dyeing, in particular the relationships between production and non-production areas, by looking in greater depth at the nature of the role of craft production in the household, through archaeological and documentary evidence.

7.2 Identifying specialisation

As mentioned above, this discussion raised a number of issues relating to the level of specialisation of the processes and equipment involved in ancient dyeing, and the ways in which this can affect the level of organisation of dyeing activity.

7.2.1 Archaeology

This section will seek to address these issues by looking at the extent to which the nature of the dyeing processes is reflected in the equipment used by ancient dyers. An important point to be addressed is whether the degree of specialisation in the dyeing process is reflected in the nature of the equipment, or whether generally unspecialised equipment was used for a range of specialised tasks. Of course different processes may require different types of equipment, and it will be necessary to examine the ways in which this is reflected in the archaeological record. It may then be possible to say whether or not the level of organisation of dyeing activity is related to the level of specialisation required to carry out a particular activity.

The processes involved in dyeing were described in detail in chapter 4. Different processes required varying levels of specialisation of knowledge, skills and equipment. The use of shellfish purple, for example, involved a number of processes which may have required specialist knowledge or equipment (see sections 2.1.1 and 4.1.1). It would have been desirable to site a dyeing operation using this dye close to the sea, or to a harbour, in order to provide easy access to a supply of raw materials, in this case the shellfish. Equipment for smashing the shell of the animal, retaining the creature itself and disposing of the shell fragments would also have been necessary. Fermenting the creature in order to prepare the dye solution would have required containers, which need not have been heated but would ideally have been large and well insulated (Balfour-Paul 1998:119). A large vat full of fermenting shellfish would have smelled particularly unpleasant, especially in a hot climate, even in a society not used to the levels of sanitation and general public cleanliness which we take for granted in the West today. It may have been desirable to keep this process away from domestic areas, perhaps in a separate production area. Considerable knowledge and skill would have been required to achieve the desired colour, which would have involved knowing whether or not to add any ingredients to the dye solution, and judging the optimum time for fermentation.

Another dyestuff requiring fermentation as part of its production was woad (see sections 2.3.1 and 4.1.1). Once again, specialist equipment may have been required for the preparation of this dyestuff. Crushing equipment was needed, and, depending on the quantities of dye produced, special areas may have been set aside for drying the leaves. It may also have been the case that the fermentation would have been carried out away from domestic areas, given its unpleasant nature. The majority of other dyestuffs were produced by drying and/or crushing the raw material, which may not have required any specialist equipment or production areas, beyond crushing implements and areas set aside for drying, or expertise. The use of mordants with dyestuffs also requires at least a degree of specialist knowledge. Different combinations of dyes and mordants produce a range of different colours and shades, and knowledge of all (or a large number) of these combinations may have been restricted to a relatively small number of specialists. Heat was often required to produce the best results when using dyes with mordants, which would have meant that vessels used for this purpose would have to be able to be heated.

Access to certain dyestuffs or mordants may also have been restricted to those 'in the know', or with sufficient funds, particularly those which were less commonly available and were imported. Certain dyestuffs, of which shellfish purple is the most obvious example, had attached to them great prestige, and as a result were extremely valuable. It is unclear whether

this prestige stemmed in part from the fact that specialist knowledge and skills were required to produce the dye, or whether the opposite is true. It may be that the prestige and value attached to the dye acted to restrict access to it, and since access was restricted in this way only specialists were able to use it.

Of course not all dyeing activity would have involved specialist equipment and knowledge. A wide range of dyes would have been readily available, whether as raw materials to be processed or as the actual dyestuff. These would have included walnut husks and onion skins, as well as a number of other plant dyes which would have grown wild or could have been cultivated on farms or in gardens. Basic operations, where expensive or difficult to achieve colours were not required, could have been carried out by almost anyone aware of the most basic principles of the dyeing process. In a society where textile production was so widespread, and textiles were often a significant part of the wealth of the household, this would probably have covered a substantial part of the population. In instances where it was not necessary for textiles to be colourfast, for example for very rough work clothing, mordants were not always needed, thus removing a complicated part of the dyeing process. In fact, if mordants were not used, textiles could be dyed a succession of different colours for different occasions, thus highlighting an advantage of dyeing being done by the non-specialist. These basic operations could have been carried out using any suitable equipment, such as vessels and crushing equipment that were also used for other purposes.

Is this level of specialisation of the dyeing processes reflected in the equipment needed to carry them out? An important question to be addressed here is the extent to which the archaeological evidence for the equipment reflects the differences in the levels of specialisation of different processes, and whether particular features can be associated with particular processes. Once again, it is not necessary to go into the nature of the equipment used in the dyeing process in great detail, since this was covered in chapter 5. As we saw in chapter 5, there would be a basic suite of equipment which would be used by ancient dyers. This would include implements for preparing the dyestuffs, such as crushing equipment and areas for drying, and vessels for immersion of material in the dye solution. Implements for squeezing excess dye solution from the dyed material would be necessary, as would drying facilities. Access to water supplies would also have been necessary, and it may be the case that some dyeworks were situated to take advantage of raw materials.

Within this basic suite of equipment however there would have been variations, with differences in the equipment used relating partly to the nature of the processes carried out.

Some processes may have needed different combinations or arrangements of features, which may then be identifiable in the archaeological record. Furthermore, equipment in sites of specialised production may have been used only (or mostly) for a particular dyeing process, and so would have been constructed with a degree of permanence. In such a case, the area in which the equipment was constructed would give the impression of being a special production area. This is in contrast to non-specialised production, where dyers could use any available implements and carry out production in any available and suitable area.

Some of the archaeological evidence for the production and use of shellfish purple would seem to indicate that there was special equipment used for shellfish purple. The sites on the east coast of Delos, for instance, would appear to have been set up with the special requirements of purple production and use in mind (see chapter 5 and Appendix) (Bruneau 1969:768; Bruneau 1978:110-111) (see Figures 41 and 42). The equipment seems to be geared towards the use of dyes such as purple; the vats do not appear able to be heated (although they may have been lined with a metal which would have remained hot if hot water was added), and the granite blocks are not the usual crushing equipment one would associate with the production of plant-based dyestuffs. The lack of information on the layout of the buildings does not permit a full assessment of the uses of all of the rooms in the buildings which make up these sites, and so the possible relationships between production and non-production areas cannot be gauged. The fact that these sites were not situated in a residential area would seem to indicate that production was kept away from areas where the smell may cause offence.

Other sites do not seem to contain equipment constructed with such a degree of specialisation, even those where shellfish purple was used. The dyeworks near to the Peribolos of Apollo in Corinth contain evidence of purple production and use (see chapters 2 and 5, and Appendix) (Williams 1968:134-135), but there is no indication of the presence of specialised apparatus for breaking the shells. The dyeworks did contain a specially constructed basin (Williams 1967:634), and does not contain evidence for the presence of non-production or domestic areas. It was situated perhaps to take advantage of the water supply (Williams 1968:134-135), and also the commercial opportunities provided by its location. Some sites contain similar installations of specially constructed equipment which do not appear to have been used for dyeing with shellfish purple. Houses IIIN and IIIU in the Theatre Quarter on Delos, for instance, both contain specially constructed vats (see chapter 5 and Appendix) (see Figures 43, 46, 47, 50 and 51), in what would appear to be special production areas, in a location which would take advantage of commercial opportunities (see section 7.1.1) (see Charmonard 1922).

It would appear that in the case of these two sites the actual equipment itself is not so specialised as to restrict dyers using it to a particular type of dyestuff. However, the fact that these sites, and the others discussed in section 7.1 above, contained equipment that was specially constructed, and situated in some sort of production area, would seem to imply a degree of specialisation in the processes which were carried out there. In a great many of the sites discussed above, the equipment is such that it could have been used for a number of dyeing processes, as well as for other craft production processes. Within this broad band of specialised dyeing sites, the level of specialisation is related to the use of the equipment, not the equipment itself.

How then does the specialisation of dyeing processes or equipment affect the level of organisation of dyeing activity? For instance, are highly specialised processes likely to have been carried out in a generally non-specialised setting (i.e. at a medium or small scale, in the terms of the discussion above) or would they have been reserved for well-organised large-scale operations? In view of the evidence for dyeing, one would expect that the level of specialisation of a particular process would affect the level of organisation of the dyeing activity carrying it out. A highly specialised process, such as the production and use of shellfish purple, would be organised on large scale, due to the level of specialist knowledge and skill required, and the nature of the process itself. The equipment used for such a process may not be specialised in itself (it is for instance very difficult to identify shellfish purple production and use archaeologically without evidence provided by broken shells). Rather, the specialisation comes with the uses of the equipment and the nature of the production area as a whole, which would be organised to cope with the demands of a particular process, which indicates once again the value of considering the production site as a whole, rather than restricting analysis to the nature of the equipment found there.

Due to the specialist nature of the process, the skills and knowledge required to carry it out would not be available to everyone. Any production activity would therefore be a specialist operation dealing with production for consumption outside the household to a large degree, and so would be either large or medium-scale, with specially constructed equipment and special production areas. Production of an unspecialised nature, using fairly basic processes which would require a minimum of specialist knowledge, would not be so restricted. Production would have been widespread, and would not have required such specialised equipment; any suitable everyday household equipment would suffice. Since this production would be so widespread, production for consumption outside the household would not be so important, since the majority of households would be able to meet their own dyeing

requirements themselves. It is likely then that this unspecialised production would be mostly small-scale.

7.2.1 Terminology

It can be seen then from the archaeological evidence that the specialised nature of certain of the processes involved in dyeing is not reflected in the nature of the equipment used. This was generally of an unspecialised nature: there are no tools which are exclusively used for dyeing to be found on sites of dyeing activity. The level of specialisation is mainly related to the processes themselves. The purpose of this section is to investigate to what extent different levels of specialisation and organisation can be identified in the literary evidence for dyeing activity, and how this compares with the conclusions drawn from the archaeological evidence. To this end, this section will commence with a discussion of the general range of terms used to refer to different aspects of dyeing activity: those who took part in it, the equipment and ingredients used, the processes carried out and the products. Instances of specialist terminology will then be discussed, and the ways that different levels of organisation and specialisation are reflected in the terminology will form the main part of the discussion in this section.

There were a number of terms in ancient Greek used to refer to people involved in dyeing, some of which are provided by Harris (2001) and Kardara (1974) Since Kardara (1974) does not provide references the original sources of this information are not always clear, although many of her terms seem to derive from the *Papyrus Holmiensis*, and it is unclear how relevant they would have been to Classical and Hellenistic Greek dyeing. A dyer could be called a δευσοποιός (that is, 'one who makes things deep or fast') or an ἀνθοβάφος ('one who dyes with flowers or bright colours') (Kardara 1974:447). Dyers were also βαφεῖς (Plato *The Republic* 429d). A φαρμακοτρίβης produced dyestuffs (literally 'ground colours', or 'drugs') (Demosthenes 48. 12-14), and a φαρμακοπώλης sold them (Aischines 3. 162). The ῥιζοτόμος (Theophrastus *Enquiry Into Plants* 9. 1. 7 and 9. 8. 1) and the ῥιζοπώλης (Harris 2001:180) may also have been involved in dye production and sales: they are a 'root-digger' or 'gatherer' and a 'root-seller' respectively. Another person involved in the production and sale of dyestuffs may have been the καρυο[-] (*IG* II² 10B 10; Theophrastus *Characters* 11. 4), who was a nut seller. It is possible that his or her wares may have included walnut rinds, perhaps separately from the nuts themselves. Similarly, the κρομμυοπώλης (Aristophanes *Plutus* 167) was an onion seller who would have sold the skins of onions along

with the edible part, or perhaps separately. The fruit sold by the τρυγήτρια (Demosthenes 57. 45) may have included berries used for dyeing.

Dyeworks were referred to as βαφεῖα, and workshops where dyestuffs were produced were φαρμακῶνες (Kardara 1974:447). Equipment in the dyeworks included the πύελος (an oblong trough, vat, or bath) and the πλυνός (a trough or tank, which could be used for washing dirty clothes) (Kardara 1974:448). Aristotle (*On Colours* 795b 7-22) describes the boiling of dye solution in χύτραι (pots for boiling).

A number of words were used to refer to dyes, including χρώματα colours), βάμματα (dyes), φάρμακα (dyes, or drugs), and ἄνθη ('blooms' or flowers) (Kardara 1974:449; Plato *Republic* 429D-E). Mordants were referred to as στυπτηρία (that is, an astringent substance or earth, probably alum) (Kardara 1974:448; Pittinger 1975:192-194). They included νίτρον or λίτρον (natron), and a substance referred to by Plato as χαλαστραῖον λίτρον, which was from Egypt (Kardara 1974:449). The range of fibres available for dyeing included wool, for which there were a number of terms. The standard Ancient Greek word for wool is ἔριον, although there were often terms referring to the many different types of wool. These could include names derived from centres of production, such as Miletos (see for instance Aristophanes *Lysistrata* 729-730), or for grades of wool. Demosthenes (47. 52-53) mentions 'soft-woolled sheep' (πρόβατα ... μαλακά) for example. The word Ταραντῖνα referred to woollen goods from the city of Tarentum (see for example *IG* II² vol.3 1517 B II 141; 1518 B II 49). Other fabrics were not always differentiated in such a way. Linen, for instance seems to have only been called λίνον, while hemp was κάνναβις. Aristotle (*H.A.* 551b 10-15) does not give a name for the wild silk produced on Cos, it is possible that the name *Amorginon* was used, if this fabric is to be identified as a type of wild silk.

There were a range of words for the people involved in the production and use of fabrics, which may have included dyeing. An ἔριθος was a wool worker (Demosthenes 57. 45), as was a ταλασιουργός (see for example *IG* II² 1553 35-37; 1554 32-35, 48-51, 71-73; 1555 14-20; for a full list of references see Harris 2001:181). Wool could be bought from an ἐριοπώλης (*IG* II² 1568 7-8). A λινουργός (Harris 2001:176) was involved in linen production, while a στυππειοπώλης (Aristophanes *Knights* 129) sold a range of plant fibres

including flax and hemp. A woman skilled in the production and/or use of *Amorginon* is mentioned by Aischines (1. 97).

There are a number of general terms which refer to the use of these ingredients in the different stages of the dyeing process. The preparation of the fibres before dyeing sometimes included cleaning, known as στρουθισμός, and mordanting, known as στύψις or προυστυφή (Kardara 1974:448). The immersion of the fibres in the dye solution was indicated by the verb βάπτω. As seen in chapters 2 and 3, a wide range of colours were produced by dyers. Shades of red and purple were referred to as φοίνικος (Euripides *Helen* 181), πορφύρα (Euripides *Orestes* 1457) and ἁλουργά (*IG* II² 1514 27, 46, 51). Κροκος was usually used to refer to yellow textiles (*IG* II² 1514 54, 58; Aristophanes *Lysistrata* 44), while β[α]τραχίδα was used to describe a 'frog green' garment dedicated to Artemis at Brauron in Attica (*IG* II² 1514 16-17). Derivatives of λευκός (*IG* II² 1514 16, 20) and μέλας (Euripides *Orestes* 457) were used to refer to white and black textiles respectively. In the *Papyrus Holmiensis* φαιων is used to refer to grey or dusky wool, although it is unclear whether this word would have had the same meaning in the period covered by this study.

The main area of dyeing where a specialised vocabulary existed was for shellfish purple. Purple-dyers were known specifically as πορφυροβάφοι (Kardara 1974:447; see for instance *ID* 400 l 7); purple-fishing was referred to by the verb πορφυρεύω (see for instance Euripides *Iphigenia in Taurica* 260-263; Herodotus 4. 151). Bruneau (1979:83-88) argues that the catching of purple shellfish around the coasts of Delos and its associated islands was famous enough throughout the ancient Greek world for the expressions Δήλιος κυρτεύς (Herondas 3 51 cited by Bruneau 1979:83) and Δήλιος κολυμβήτης (Diogenes Laërtius 2 22 and 9 12 cited by Bruneau 1979:83, 86) to refer specifically to the nets or baskets used to catch the shellfish and the divers who swum around the coast to retrieve them (Bruneau 1979:88). As well referring to the baskets as κυρτοί, Aristotle (*H.A.* 547a 25-30) also refers to the baskets as φορμίδες (*H.A.* 547a 1-5). Purple-sellers were called πορφυροπῶλαι (Kardara 1974:451). Workshops where purple dye was produced and sold were called πορφυρεῖα or πορφυροπωλεῖα (Kardara 1979:450), and purple-dyeworks were called πορφυροβαφεῖα (Kardara 1979:451).

Of the numerous words used to refer to the range of colours produced by dyers, some seem to have been used only to refer to products which had been dyed using shellfish purple. Among the words referring to shades of red and purple, ἁλουργής and its variants (which

literally mean 'wrought in the sea') (see for instance *IG* II² 1514 12-13 for just one example out of many) and the words based on πορφύρα (see for instance *IG* IX² 204 75-76) seem to specifically refer to textiles dyed using shellfish purple rather than just to particular shades. This is not limited to purple however. It is possible that the terms used to refer to some yellow textiles based on the word κρόκος (saffron), such as κροκωτά (from Aristophanes *Lysistrata* 44) and κροκοβαφῆ (Kardara 1974:451) were applied specifically to textiles dyed with saffron, rather than any yellow coloured cloth.

How then does this terminology reflect the levels of specialisation of dyeing? It can be seen firstly that different parts of the dyeing process had their own names, with job titles for those carrying them out, which may reflect the fact that there existed craftspeople who were only involved in parts of the process. There are colour-grinders producing dyestuffs in colour-grinding workshops, and dye-sellers selling dyes, as well as dyers. This would seem then to reflect a certain level of specialisation. If all dyers produced their own dyestuffs, one would not expect to come across job titles referring to dye producers as well as dyers. Similarly, it would seem that in some cases different people were producing dyes and selling them. It is possible then that there would have been workshops which were involved in the production of dyestuffs (as well as perhaps of 'drugs', perfumes and other colouring substances), whose products then went to salespeople, who then sold their dyes to dyers and the general public. This level of specialisation would be likely to have occurred in situations where dyeing was organised on a medium or large scale, where there was likely to have been specialised labour and these activities were the main subsistence activity of the household.

An important point to note is the possibility that this terminology covered a range of activities. It has been noted, for instance, that the word for 'colour grinders' also referred to the production of 'drugs'. It is possible that these activities were separate, but were linked in the terminology because they used similar ingredients and processes, and also probably equipment and skills (a number of the raw materials for dyestuffs had medicinal properties, and were used for this purpose as well as for dyeing in the ancient Greek world). Equally, colour grinders may have produced a range of products including medicines and dyestuffs, which were then either sold to the general public as products with a number of uses, or to specialist dealers, either healers or apothecaries on one hand or dye merchants on the other. The distinction between the products would therefore have arisen at this stage. Also, there is the possibility that the dye-seller may also have sold medicines and other similar products, and the title used to refer to him or her may have been related to the products which were either

available at a particular time, or were required by a particular person at a particular time. Therefore, if a person wanted to acquire dyestuffs, they went either to the establishment they knew as the dye producer, or to the person they knew as the dye seller. Another person requiring medicines, for instance, might go to the same establishment, but regard it as the drug producer's workshop, or to the same salesperson whom they regarded as the drug dealer. This makes the identification of specialisation using terminology extremely difficult, but it also gives a valuable warning, that one should not expect any of the terminology for craft production and job titles to give clear-cut meanings.

The names given to dyers may also reflect a degree of specialisation. Barber (1991:275-276) suggests that dyers' different titles related to the ingredients they used. Ἀνθοβάφοι for instance may have been associated primarily with the use of dyestuffs produced from flowers, while the other terms may have referred to dyers who were less specialised, or less well-known for particular products. This possible level of specialisation is not seen in the range of equipment used, where very general terms relating to vessels with a wide range of uses are used to refer to the vats and tanks used in the dyeing process. Whether there were special terms for vats which were made from different substances is not clear; the words for vessels given above seem to relate primarily to ceramic vessels, and may not have been applied to vats and tanks made from stone such as are found on the east coast of Delos, on the Rachi at Isthmia and at Korsiai for example. There do not appear to have been special words for equipment used for different purposes.

In the specialised vocabulary of purple dyeing, there are shellfish purple dyers and sellers, and dyeworks. This sort of specialist terminology is not used for any other dyestuffs; there are for instance no references to 'onion skin dyers' or 'madder dyers' for instance. Even woad, which has a fairly long and elaborate production process, does not have a number of words relating particularly to its use for dyeing. As was suggested in the previous section, this is likely to have been linked to the prestigious and valuable nature of textiles dyed with shellfish purple, and the elaborate and unpleasant process used to produce it which required specialist knowledge and skills. Not every dyer could dye well with shellfish purple, and access to it would have been limited to those living close to the sea. The highly-skilled nature of shellfish purple dyeing, and its valuable nature, would have differentiated it from other dyes, as would its nature as the product of a shellfish and not a plant. Thus, dyers able to use it well would have been differentiated from other dyers, with only a portion of all ancient dyers able to use it. The specialised terminology may reflect the fact that shellfish purple dyers only

used this dyestuff; it may also be the case that they used the full range of dyes available, but their additional use of purple marked them out as different from other dyers.

Another area where shellfish purple use is shown as specialised is in the terms used to refer to the dyers' products. The majority of descriptive terms for textiles refer to their colour and sometimes the nature of the textile (for instance with wool from places like Miletus or Tarentum). Purple and red textiles were referred to by a number of names, mostly relating to the particular colour or shade. There were however specific terms indicating that a textile had been dyed with shellfish purple. Once again this reflects the high-status nature of this product; it was not any ordinary colour. This situation also occurs in the use of saffron, where textiles are referred to specifically as being dyed with saffron. This dye (or the colour it produced) was associated particularly with women (especially in ritual), and it is used in ancient Greek literature as a particular indicator of female status. Thus, when in Aristophanes' *Thesmophoriazusae* for instance men try to disguise themselves as women they do not wear any old colour of women's clothing, but saffron. Designating a textile as saffron, rather than just as yellow or orange, would serve a particular purpose and have a specialised meaning. It is worth noting that the production of saffron dye and its use in the actual dyeing stage is not regarded as specialised; there is no special term for a 'saffron dyer' or 'saffron dealer', although the dye itself was expensive. This is perhaps because no special skills comparable to those of the purple dyer were required to produce favourable results.

It can be seen then that the literary evidence for dyeing produces a similar picture to the archaeological evidence. Specialised production activity is not reflected by the terminology for the equipment, which appears to have been fairly unspecialised. There is however a degree of specialisation in the tasks which were carried out as part of the dyeing process. This may occur as people only carrying out certain tasks, such as producing dyestuffs, or people only using certain substances. The area with the highest level of specialisation is shellfish purple dyeing, which has a number of specialised terms. Another area where specialisation is reflected is in terms related to the products themselves, which is related to the consumption of dyed goods rather than their production. In this case certain products, for a number of reasons, are differentiated from others by using terminology which differs from the general descriptive terms. Again, this inferred level of specialisation is likely to reflect higher levels of organisation of production.

7.3 The seasonal nature of dyeing

The previous sections of this chapter concentrated on the level of specialisation of dyeing, and its identification using either archaeological or literary evidence. This section will look at the ways in which dyeing may have been integrated with other subsistence activities, whether agricultural or non-agricultural production. Following the corresponding section in chapter 6, the seasonal factors affecting dyeing will be analysed, and the demands of the 'dyeing calendar' will be compared with those of other production activities in order to assess the degree to which they correspond. These seasonal factors will include the availability of dyestuffs, and the times of year during which they were produced. It is important also to consider the availability of other ingredients used in the dyeing process, the fibres/fabrics and substances used as mordants. The availability (or lack of it) of these ingredients would have affected the ability of the dyer to carry out any dyeing activity.

The different periods marked/set out in the 'dyeing calendar' are not intended to be rigid. Weather conditions for instance can in different areas and in different years affect the availability of some plants. Moreover, plants do not all develop together, and for instance a plant which is said to flower in the autumn has a period of between two and three months in which to appear, which can vary according to local conditions or variations in the weather. The following discussion, then, and Table 5 are intended as mere guidelines which can at least give an idea of the times of year when, for instance, dyestuffs were produced. This 'calendar' of course cannot be regarded as governing all dyeing activity, since not all dyestuffs were used as soon as they were produced. That a number of dyes were dried could mean that their use was not restricted to a particular time of year, but whenever was desirable or convenient. Of course their production was still limited to a particular period.

A further point which should be highlighted at the outset of this discussion is the fact that the times when plant or animal products grow/develop is not the only way in which seasonal factors affect their availability to and use by ancient dyers. Not all of the ingredients were 'agricultural' in origin (that is, were grown). Murex is a shellfish and its collection would depend not only on the sailing conditions but also on the way it fitted into the fishing strategies of those who caught it. The extraction of minerals which may have been used as mordants is likely to have been an important non-agricultural craft activity in its own right, and the availability of these substances would have been reliant on the rhythms of the working year of those engaged in this activity. Also, the availability and use of certain ingredients

would have been regulated by the time when trade, either short- or long-distance, was possible, since they would only have been available in certain areas as imported goods.

What then was the 'dyeing calendar'? I shall set out below the seasonal factors relating to the availability and use of the dyes identified in chapter 2 and the fibres and mordants identified in chapter 3. In the case of animal products, this will include the times of year when they were gathered and processed; in the case of plant products, this will include the time of year when they were sown, gathered and processed (see Table 5).

The production of shellfish purple dye would appear to have been limited to certain times of the year (see section 2.1.1). The production of kermes, another animal dye, was also limited to a particular time of year (see section 2.1.2), although the dyestuff could be used at any time after the insects were collected. Many of the plant dyes were also available only at certain times of the year (see sections 2.2 and 2.3).

I will now turn to the fibres which were used by dyers. While their production and processing were not necessarily always carried out by dyers, their availability may have affected the ability of dyers to dye. Once again, there are seasonal factors potentially limiting their availability and use. In terms of the fibres, they would have been produced at particular times of the year but once produced could have been used by dyers at any time of the year. The chemicals and minerals used in the dyeing process are unlikely to have only been produced at particular times of the year. However, there are seasonal factors which would have affected their availability. The production or collection of minerals such as alum, metal salts and natron was limited to certain areas of the ancient Greek world, and as a result their availability to other areas would have been regulated by the seasonal rhythms of trade and exchange. For example a dyer in the Peloponnese requiring 'earth' from Melos in the Cyclades would only be able to obtain it at a time of the year when the conditions were suitable for sailing.

An important point to note when discussing the possible relationships between dyeing and other production activities is that the lines dividing these activities are often very blurred. When talking about the 'dyeing calendar' and how it relates to those of other production activities, it must be remembered that a number of the features described above can be classed as part of these activities. Growing plants is an agricultural activity, while the collection of shellfish is achieved by fishing. The minerals and other substances used as mordants are provided by activities such as mining. The aim of this section is to look at the ways in which it is possible to analyse the extent to which production activities such as dyeing were integrated

Table 5: The Ancient Greek Dyeing Calendar

Dye	January	February	March	April	May	June	July	August	September	October	November	December
Shellfish Purple	shellfish caught			honeycombing'			shellfish hidden		shellfish caught during autumn and winter			
Kermes			eggs	max. size		insects harvested						
Saffron									blooms in autumn - picked immediately			
Safflower									blooms in autumn			
Weld					flowers appear - picked immediately - harvested until september							
Pomegranate						flowers appear			fruit develop			
Woad						plants picked in summer			fermenting took at least 6-8 weeks			
Madder									picked in autumn			
Alkanet									picked in autumn			
Greek bean tree									picked in autumn			
Onions					produced in early summer - skins dried							
Walnut									fruit appears in autumn			
Oak galls						appear in late June						

into wider subsistence strategies in Classical and Hellenistic Greece. This point illustrates however the extent to which all production activities, whether agricultural or not, were not carried out in a vacuum. The archaeologist or ancient historian investigating these activities must be aware of this and any discussion of dyeing (or indeed of any other production activity) must take this into account. Furthermore, it is not implied that all dyers produced or used all of these dyestuffs. There were undoubtedly regional differences in the types of wild and cultivated plants grown, and also in tastes which would have governed the use of different dyes. It is impossible to discuss the activities of every individual dyer, or indeed by region, and therefore it is necessary to look at this in general terms.

When I refer to the way that dyeing activity corresponds with agricultural activity I will therefore mean agricultural activity that does not involve products used in the process of dyeing, for instance growing food crops such as vines or olives. It is therefore entirely possible that dyers would have been involved in agricultural activity, for example by growing plants which they used for dyeing, and so there would have been instances where dyeing was intrinsically integrated with agricultural activity. The main focus of this discussion however is the way in which dyeing activity relates to the demands of other unrelated activities. Of course, as well as recognising the fact that not all dyers would have used all of the above dyestuffs, it is necessary to state the fact that not everyone would have been involved in every agricultural activity. As with dyers, it is impossible to cover individual agricultural activity, and so when discussing the way dyeing could be integrated with agricultural tasks, it must be made clear that this is also in general terms. As stated in section 6.2.3, any analysis of this sort comparing the 'agricultural year' to the 'dyeing year' can only be conducted in the broadest sense. It must suffice to state the general ways in which activities could be carried out, looking at the widest range of agricultural activities in relation to the widest range of dyeing activities.

In terms of busy periods for the production of dyes then, it would seem that the majority of dye producing plants were available for harvest during spring, summer and early autumn. Most of these plants would require very little processing to produce the dyestuffs, so in most cases the dyes would be available from these periods onwards. One exception to this general rule is woad, whose processing took a number of months after its harvest in summer, although the process would not require constant attention and other activities could have been carried out while this was going on. It is likely that a number of these plants would have been growing wild, so the sowing of these plants may not have caused great demands on the labour force. Of the animal based dyes, kermes also fits in with this timetable, with the insects harvested and processed in late spring and early summer. It is possible that the collection of

dyestuffs such as these would have been done by people who would not have been involved in the main jobs. These people may have included children or the elderly. It is also possible that these dyestuffs could have been collected while people were doing other jobs, such as herding animals.

In most cases with these dyestuffs, it was not necessary to use them as soon as they were produced. The majority were dried, and could be retained for use at other times. These 'busy periods' for dye production then were not necessarily busy periods for dyeing; since it was not always necessary to use dyestuffs as soon as they were produced, dyeing activity was not always restricted to certain times of the year. Of course dyestuffs do not keep indefinitely; some dried dyestuffs may lose their potency over time, and their availability to the dyer may be restricted to the periods immediately following their production. Nevertheless, in most cases dyeing activity cannot be classified in terms of general 'busy periods', or otherwise, which would affect the way it was integrated with other activities into the subsistence strategies of households. It is worth noting that these busy periods for dyeing listed above all appear to be during periods of warm weather, which would in some cases be beneficial for dyers. Since dyeing could be unpleasant, it may have been that in some situations it may have been desirable to do it out of doors. This may apply particularly to small-scale dyeing done in the domestic arena, since as was suggested in section 7.1 this did not require specialised production areas and could have been done in the courtyard of a house to take advantage of the warm weather and fresh air, especially for drying.

How then would this relate to the agricultural calendar? As stated in section 6.3.3, the busiest periods of the agricultural year are ploughing, sowing, harvesting and processing of cereals and legumes, and picking, pressing, trenching, manuring and pruning of olives and vines (see Table 4). These activities took place mainly in the early summer and autumn (Foxhall 1998:110-111). The least busy times were in spring and high summer (Osborne 1987:13-14). As stated in chapter 6, it has been suggested that other craft activities took place in these slack periods in the agricultural calendar. Indeed, it seems as if these slack periods can be regarded as times when any other necessary tasks were carried out, when the demands of agriculture on the household workforce were not too great. Of course this assumes that agriculture was the most important subsistence activity to the household, and in some cases this would have been so. However, this simple framework does not account for differences in the scale of production. Certainly in households where dyeing was done on a small scale, as and when necessary, it would seem likely that any convenient time would have been suitable for dyeing. At times when the primary subsistence activity of the household (whether

agriculture or some other craft) did not require the participation of all of the household personnel, it may have been possible for some of them to have been involved in dyeing.

Where dyeing was done on a larger scale, however, it seems likely that it would be more prominent in the overall subsistence strategy of the household, which would have an impact on the way in which such activity was carried out with regard to other activities. A similar sort of arrangement to that described above for small-scale dyeing may also have taken place in households involved in medium-scale production. In this case it would seem likely that there would have been specialist dyers, who could have been assisted by other workers when they were not so busy, or could have helped with other activities when there was not so much dyeing work. In the case of large-scale dyeing, it is likely that dyeing would have been the major subsistence activity, with other crafts or agriculture carried out only when there was very little dyeing activity being done.

Of course in the case of medium and large-scale dyeing, it is possible that if a household was involved in other types of subsistence activities, these were also related to dyeing. In terms of agriculture, then, dyeing households may have grown dyeplants which they then processed and used in their dyeing activity. The production of food and other staples may have been of secondary importance in the subsistence activity of the household, since these could have been acquired using the proceeds of the dyeing activity. These households could then have been involved in intensive 'agricultural' labour when sowing and harvesting dyeplants, and then processing them to produce the dyestuffs. Dyeing could then have been done during the rest of the year.

It will have been noted that the preceding discussion concentrated on plant dyes, with no mention of animal dyes. Although kermes production and use can be included in the general argument above, the other prominent animal dye, shellfish purple, can be classed as an exception which may not have been so easily integrated into the general subsistence strategies of households. The most basic difference, and the one with the most relevance for this particular section, between this dye and the others discussed above is the fact that shellfish purple is used 'fresh' (although since the dye is a solution of rotten shellfish this word is used in a very loose sense). The shellfish are processed up to fifty days after they are caught, and the dye is not dried but used as soon as it is produced. It cannot therefore be retained for use at a convenient period later in the year, whenever members of the household have time free from other tasks. There does seem to be a fairly long season for catching the purple shellfish, and the main slack periods in the purple-fisher's calendar would appear to be during spring and

summer. During these periods purple-fishers may have fished for other sea creatures. Purple-dyers could have carried on using purple dye during these periods, since the shellfish can be kept alive in containers, or they may have been involved in dyeing with other dyestuffs or other subsistence activities. Since it is likely that most, if not all, purple-dyeing activity would have been either medium or large-scale (see sections 7.2.1 and 7.2.2 above), these other subsistence activities would have been of secondary importance to the household, and are likely to have been carried out only when there was not a great demand on labour for dyeing.

Other seasonal factors had an impact on the organisation of dyeing and its relation to other activities and areas of ancient life. These were not necessarily linked to agricultural activity, or indeed with the integration of dyeing with other craft activities in the ways discussed above. These factors could have been even more dependent on geography, and the regional differences between different *poleis*. One such factor was the timing of religious festivals, in particular ones which involved the use of textile products. Textiles of many different types were an important part of religious activity in the Classical and Hellenistic Greek world. A number of festivals were associated with textile products, perhaps the most famous being the *Panathenaia* which took place in the Athenian month corresponding to late July and early August (Foxhall 1995:98-99). In this Athenian festival a peplos with designs representing Athena's part in the battle of gods and giants in saffron and purple woven by maidens of high social status was dedicated to Athena (see for instance Euripides *Hecuba* 466-469). The Greater *Panathenaia* took place every four years, and for this festival the peplos took the form of a large sail attached to a ceremonial ship used in the procession through the city. It is possible that this 'sail' was woven by male 'professionals', at least after the fifth century BC (Barber 1992:112-114; Parke 1977:38-41). The weaving of the peplos started at the festival of the *Chalkeia*, nine months before the *Panathenaia* in late October or early November (Parke 1977:38). Dedications of textiles were not always as formal as this. Many textiles were dedicated to Artemis at her temple at Brauron in Attica and on the Acropolis, as indicated in the inscriptions found on the Athenian Acropolis listing dedications to Artemis in the mid-fourth century BC (see Foxhall and Stears 1998; see also *IG* II² 1514-1531). Dedications of textile products are also known from the temple of Artemis Orthia in Sparta (Foxhall and Stears 1998), while inscriptions from Delos mention the dedication of purple *himatia* to the goddess Leto (*IG* XI², 203 A 73; *IG* XI² 204 75-76).

Other festivals were associated with particular kinds of clothing worn by worshippers. At the *Thesmophoria*, the women's festival held in autumn before the start of sowing (Foxhall 1995:102-103), it seems that the women attending wore clothes died with saffron.

Aristophanes' fanciful account of the proceedings of this festival includes a number of references to the use of saffron-dyed clothes, particularly as worn by men wishing to infiltrate the women-only festival (see for instance Aristophanes *Thesmophoriazusae* 253). Another festival associated with saffron clothing is the Attic festival of Artemis celebrated at the sanctuary of Brauron in the month corresponding to late April and early May (Parke 1977:139-140). Every four years it was organised by the *Hieropoioi*, the Athenian officials also responsible for the *Panathenaia*, and was celebrated with particular pomp. A major part of the ritual involved young girls acting the part of bears, which seems to have involved dressing in saffron clothes (which were shed at some point) (Parke 1977:139-140). In Aristophanes *Lysistrata* (645) a woman refers to the occasion when she played the 'yellow Brauron bear'. It is also likely that many people attending festivals, particularly large public ones, would want to look their best. This would apply to people from all levels of society, who may have bought new clothes or simply re-dyed old ones to make them look new and impressive to others.

It must be noted that these dyed textile products would not necessarily need to be made immediately before a particular festival. Textiles could be dyed long before they were required and then left until they were required, and not all textiles used in a religious context were new. The inscriptions listing dedications at Brauron refer to 'ragged' or unfinished textiles, while only one piece is described as new (Foxhall and Stears 1998). The thread for the robe dedicated to Athena may have been dyed close to the time when it was required, perhaps as part of the ritual production of the robe by the women chosen to weave it; it could on the other hand have been purchased from dyers as required. It can be seen then that this religious activity would not necessarily have a seasonal impact on dyeing, but it would create a demand for dyeing at all levels of organisation. This could include, for instance, dyers producing large quantities of saffron thread, or clothing, in readiness for high levels of demand in the periods before the *Thesmophoria*, as well as people re-dyeing old clothes to give them a new lease of life in time for a big public festival such as the Eleusinian Mysteries.

Another factor which may have been limited to particular regions was the seasonal aspect of trade. Although trade over short distances would not have had such a great effect on the availability of dyeing ingredients (at least not much greater than that of the times of production and processing of ingredients), over long distances the impact would have been greater. Not every region would have had immediate access to all of the dyestuffs, fibres and mordants used by ancient dyers; certain minerals for instance are very localised in their availability, and the differences in climate and terrain in different parts of Greece would have

meant that not all plants grew in the same areas. Some ingredients then would only be available through trading contacts outside the immediate region (the exact mechanism by which exchange took place is not the important issue here, and 'trade' will be used hereafter to save convoluted explanations), over a wide range of distances. Not all dyestuffs and other ingredients would be available at the same times in the same places (if at all). As the majority of dyestuffs were dried, the length of time it took for them to reach their destination would not matter too much, although there was the likelihood that they would not produce such good colours if this took too long, which may have been a factor limiting trade of dyestuffs over very great distances (or at least over routes which took a long time).

Most trading activity would have taken place between spring and autumn, when the weather was most suitable for sailing and/or travelling over long distances on foot. Of course this would depend on the conditions at any particular time and place; the weather could very well have varied so that the general trading season was shortened in some years, and lengthened in others. It is possible then that some dyestuffs which were produced during spring and summer could have been traded over long distances, so they could have been generally available fairly soon after their production in areas where they were not readily available to dyers. Other dyestuffs, for instance those produced during the autumn, may not have been suitable for trade, being produced too late in the year, and may not have been worth keeping for the start of the following trading season. This would have had more of an impact on dyeing operations organised on a medium or large scale. Small-scale dyers may not have been too concerned with acquiring the most desirable or exotic dyestuffs, and would simply have used what was readily available at the time when it was convenient for them to dye. Medium and large-scale dyers however would have had more need to have access to sources of exotic dyestuffs, and so in some areas may only have used certain dyes at those times when they were available through trade. At these times, production may have been particularly intense, with large quantities of fibres being dyed using these imported dyestuffs in order to cope with demand at other times of the year. Of course in certain areas certain dyestuffs may not have been available at all, and dyed fibres or textiles may have been imported rather than the dyestuffs themselves.

Chapter 8

Conclusion: Dyeing and the Household

The discussion in chapter 7 has illustrated different aspects of the organisation of dyeing in Classical and Hellenistic Greece. It is necessary now to bring the different strands of this discussion together in order to produce a picture of the role of the household in dyeing activity, given that as argued in chapter 6, the household was the primary unit of economic activity. This chapter will therefore address a number of issues which are important in the consideration of the role of dyeing in the subsistence strategies of the household. These will include issues such as the use of space within the household for dyeing activity, the household personnel involved in it, and the time devoted to dyeing at different levels of organisation and specialisation.

An attempt to assess the role of the household in any sort of production activity using archaeological evidence can be made by looking at the relationship between domestic and work areas in the architectural remains of the ancient world. Both domestic architecture and the remains of apparently specialist dyeing workshops can be used in this way. However, given the rather unspecialised nature of most dyeing equipment, and the poor preservation of most other indicators of dyeing activity, this can prove difficult, especially in situations where dyeing was done on a small scale. Nevertheless, the discussion above, particularly in those sections related to the organisation and specialisation of dyeing activity, offers a number of insights into this particular issue.

It would appear from the discussion in sections 7.1 and 7.2 that the relationship between production and domestic space differed according to the level of organisation of dyeing activity. As we can see from the evidence discussed above, a major feature of large and medium-scale dyeing was the existence of specialised production areas. At sites such as the settlement on the Rachi at Isthmia and House IIIN on Delos, for instance, there are areas with specially constructed dyeing equipment which are likely to have functioned as areas primarily concerned with production activity. This activity would have included dyeing, as well as other activities perhaps. In cases such as this, it is possible to identify a separation between space which was primarily 'domestic' on one hand (represented here by space with no specially constructed production equipment), and space primarily used for craft production activities (in this case dyeing) on the other. Some of the dyeworks discussed above contained areas which were apparently not used primarily for dyeing; these may have been the 'domestic areas', where other activities not concerned with dyeing were carried out.

The distinction between medium and large-scale dyeworks, in terms of assessing the use of space, is indicated by the presence of these 'domestic areas'. The majority of sites discussed above are classified individually as medium-scale dyeworks; that is, they contain production areas within the domestic setting. The areas containing dyeing equipment are separate from non-production areas, usually in different rooms or courtyards. However, they are still within the domestic space as a whole. In large-scale dyeworks (in terms of individual structures, as opposed to arrangements such as 'craft quarters') such as those at Corinth and Korsiai, there is no evidence for non-production areas. This would indicate the complete separation of domestic space and that used for craft production, which would suggest the existence of separate workshops for dyeing, implying a certain level of specialisation.

This situation differs from that of small-scale dyeing. Here, the use of space was more flexible, with more overlap between 'domestic' and 'production' space. Indeed, since this is essentially 'domestic production', it could be said that in this case domestic space was production space. In the evidence from the houses at Halieis, for instance, it can be seen that in houses space was used for a number of different purposes. The 'press room' in House D and the similar feature in House A, for instance, were not separated from the rest of the domestic space. The numerous 'wet rooms', usually interpreted as bathrooms, were also part of the domestic space. That dyeing could have been carried out in these areas illustrates the generally flexible and non-specialised nature of domestic space. Small-scale domestic dyeing could have been carried out in these spaces when they were not in use for anything else, along with a range of other activities. The lack of specialised production areas would indicate that products were intended to remain in the household.

The degree of involvement of different members of the household in dyeing activity can also be seen to be linked to the level of organisation and specialisation. The standard view of the organisation of the personnel involved in textile production in the ancient Greek world is that this was generally 'women's work', particularly in domestic situations. Men were involved in textile production, but usually only when this was highly specialised and carried out on a large scale, and involved prestige goods of high value (see for instance Thompson 1982). It is difficult to say for certain whether this is the case for dyeing, given the nature of the available evidence. It is likely however that the situation was not as straightforward as this, and that the divisions would have been along the lines between slave and free rather than being based primarily on gender.

In large-scale dyeing situations then the personnel would have mostly have been slaves, and many were probably fairly specialised and highly skilled. It is possible also that

these specialised personnel would have only been involved in parts of the dyeing process, as indicated in the discussion of the terminology of dyeing. The involvement of free workers, whether members of the family who owned the dyeing operation or not, would depend on the economic and social status of the dyer. The same is true of the numbers of workers, whether slave or free. Where dyeing operations were run by wealthy, high-status people, it is likely that members of the family would not be involved in production but would leave it to slaves and low-status non-slaves. As the scale of organisation, as well as the economic status, of the dyer decreases, the level of involvement of family members is likely to have increased. This may be through the inability to afford to keep large numbers of slaves, thus necessitating involvement by non-slave family members. Also, those further down the social scale did not necessarily share the low opinion of craft production as an occupation, and so would not necessarily restrict their involvement. Men who were skilled dyers may have taken younger relatives as apprentices, for instance.

There would have been most involvement of all members of the household in small-scale dyeing. As production was unspecialised and was likely to have been carried out whenever necessary, there was no need for highly-skilled dyers. This dyeing activity would still have required special skills, at least to produce reliable results, however, and it was likely to have been done by people who were experienced dyers. It may have been that small-scale or domestic dyeing was part of the general textile production undertaken by female members of the household. Dyeing was not necessarily restricted to women however, and male members of the household, whether adults, children or slaves, could also have taken part. Given however that dyeing was less pleasant than spinning or weaving, which were apparently done by the free female members of households, the involvement of household members may have been similar to that in larger scale dyeing operations. In larger, more wealthy households, this activity is more likely to have been carried out by slaves than by the free members of the household. Further down the social and economic scale, however, households would be smaller, with fewer slaves to do all of the work. In these cases, the free members of the household would be more involved in the general household jobs, including dyeing textiles which did not require specialist craftspeople or equipment.

As with the factors discussed above, the amount of time devoted to dyeing by the members of the household would depend very much on the level of organisation of the dyeing activity, and the economic and social status of the household. Of course the amount of time devoted by anyone to dyeing would have been affected by the seasonal factors discussed in section 7.4 above. Dyeing activity could not always have been carried out all year round

everywhere as a result of the seasonal availability of certain materials. This would not have affected all dyers, since the majority of dyestuffs were dried and could have been kept for long periods. Those for whom dyeing was the major form of subsistence activity throughout the year could have organised their activity to be able to work all year round, or may have produced enough in the period when materials were available to cope with periods when they were not. However, as seen in section 7.3, dyeing was also affected by trade, and in many cases would have been a seasonal activity, possibly carried out in conjunction with other activities at different times of the year.

It is necessary then to take this into account when discussing the time devoted by households to dyeing activity, and recognise that even in large-scale dyeing operations other subsistence activities may have taken up as much time as dyeing. However this discussion is more concerned with the time spent on dyeing in relation to other activities carried out by the household. The amount of time devoted to dyeing would have been related to the importance of dyeing in the subsistence strategy of the household. Dyers operating on a large scale would devote a large part of their time to dyeing activity since it was the major source of subsistence for the household. Further down the scale, where dyeing was less important to the subsistence of the household, less time would be devoted to it. For instance, if a household was involved in dyeing on a medium-scale in conjunction with agricultural activity, it may have spent time dyeing when not involved in agricultural activity, and vice versa. In terms of small-scale dyeing, this would only be done when necessary and when there was time available between activities which were more important to the subsistence of the household.

This study has a number of implications for the way Classical and Hellenistic Greek craft production is studied. I hope to have shown that archaeological and historical evidence can be used to provide information not only about the technological aspects of craft production but also about its levels of organisation and specialisation. It can be seen that there were a range of levels of organisation of dyeing activity in Classical and Hellenistic Greece, which can be identified through evidence of the size and nature of production areas. Dyeing, as with many craft production activities, required varying degrees of specialist knowledge and skills to produce favourable results. This is not always reflected by the equipment used however, as in many cases this was not restricted solely to dyeing. Dyeing equipment could also have been used for other activities such as oil and wine production, fulling and tanning for instance. The terminology of dyeing would seem to indicate that there was a certain degree of craft specialisation, since there were often different terms for different parts of the dyeing process, the people who carried them out and the products they produced. This would

seem to indicate that dyeing (as with other Classical and Hellenistic Greek craft production) was characterised by a degree of horizontal specialisation (see Harris in press). It would also seem to be the case that higher levels of specialisation reflect higher levels of organisation. The fact that dyeing activity may have been largely seasonal, as identified through the evidence for the times of year when dyeing was most likely to have been carried out, can also provide an insight into the way craft production fitted into wider subsistence strategies.

This study can therefore provide a useful framework for studying Classical and Hellenistic Greek craft production in terms of the wider debate about the nature of the ancient economy. Rather than showing that all Greek craft production was small scale, a study such as this can highlight the differences in organisation and scale which undoubtedly existed. By applying the framework set out in this study to the study of ancient Greek craft production as a whole, it will be possible to look at the way it was integrated into wider subsistence strategies. In this way it will be possible to achieve a fuller appreciation of the role of ancient Greek economies.

Appendix

Site Catalogue

The following descriptions of the archaeological sites referred to in this study have been written using only published material. As a result, the levels of detail in different accounts of sites will differ, since some have been published in great detail, while others have not. The differences in the accounts of sites in this catalogue do not therefore reflect any perceived differences in the relative importance of the sites on the part of the author; rather, they are simply a reflection of the state of the published data available. Sites have only been included in this Appendix where there is sufficient detail in the published report to enable their features to be determined (although not always with any great accuracy). The sites discussed below range from single buildings (or in some cases features) to groups of buildings within a larger settlement area. They all contain potential evidence of dyeing activity; that is, they all contain some possible dyeing equipment. Sites where there is only evidence for dyes have not been included, since they do not necessarily imply dyeing activity at a particular site. Also, when they are published, it is invariably as a short statement in a much larger report, which does not always have any further information about other relevant features. Therefore, sites where deposits of purple are found, namely the Lower Town of Lesbos (Catling 1988:60) and Skala Oropou (Dragona-Latsoudi 1985:70), are not included here. Where a number of dyeworks sites are found in a single settlement, they have been grouped together, so that for instance the house-workshops in the Rachi settlement at Isthmia are discussed below under one heading, as are the buildings in the Citadel House Area at Mycenae. The intention in doing this has not been to imply any unity of use or ownership between the different buildings (although this may have been the case, and the issue is raised in chapter 7). Rather, I have done this for the sake of convenience, and it seems appropriate in these cases given the fact that there are a relatively large number of dyeing installations grouped together in a relatively small area. In those sites with large numbers of excavated houses, it is impossible to give detailed descriptions of every house. Entries for sites such as Olynthus will contain a general description of the site as a whole, with examples relating to the evidence for the presence of dyeing activity. For more detailed accounts of sites such as this the reader is referred to the published material, particularly the excavation reports.

The criteria heading in this catalogue refers to the criteria for the identification of dyeing sites in the archaeological record, which were presented and explained in section 5.1 (p. 51). The numbers refer to the numbers given to the criteria there.

1 Athens 'Industrial District'

Location

The north-western foot of the Areopagus, Athens

Date

Classical, with two phases: the first dates to the fifth century BC; the second to the early fourth century BC.

Description

A number of buildings were excavated in an area of Ancient Athens to the north-west of the Areopagus, between the Street of the Marble Workers to the north-west and Areopagus Street to the south-east. Through this area ran the Great Drain, which was constructed in the early fourth century BC; this resulted in the reconstruction of the buildings situated close to its path (Young 1951:187). House F, which stood half way along the Street of the Marble Workers south of its junction with Piraeus Street, contained evidence of possible dyeing activity. This trapezoidal building seems to have consisted of one room, with long thin vats surrounding a central floor area on three sides. It was entered from the north. A Hellenistic pit was found to have been cut through the northern part of the building, with the result that the precise layout of this part of it is not known (Young 1951:229-231).

In its earliest phase, the building was 3.90 metres long on the inside, and 3.25 metres wide at its southern end. The outer walls of the building were of rubble (these walls formed the inner walls of the vats in the later phase: see below). It seems that in this phase the central floor area was 2.55 metres wide along its southern side, and was surrounded on the east, south and west by one continuous vat. This was 0.36 metres wide and 0.40 metres deep, and traces of waterproof plaster were found on its bottom and the inner faces of surrounding walls (Young 1951:232).

In the later phase this building was extended to the east, south and west (Young 1951:232). New outer walls were constructed: the eastern wall formed the west wall of the Great Drain, while the western wall fronted onto the Street of the Marble Workers. The new south wall of the building also formed the north wall of house E. These changes gave the building a length of 8.70 metres, and a width at the north of 4.50 metres and at the south of

6.40 metres (Young 1951:230). The rubble walls which had formed the outer walls of the building in the earlier phase were now the inner walls of vats A, C, D and G. Vat A, which ran along the western side of the building, was 0.44 metres wide and 0.38 metres deep; a wall divided it from vat G to the north, while its southern end is not preserved. Vat B (which was 0.40 metres wide and 0.46 metres deep) ran parallel to the south wall of the building; a small square vat, F, with sides of 0.30 metres, was close to its western edge. Its eastern edge is not preserved. Vat C ran along the eastern edge of the building, and was 0.40 metres wide and 0.50 metres deep, with a preserved length of 4.10 metres. Its northern and southern ends are not preserved, however; it may have connected with B to the south and vat D to the north. This vat is badly preserved, but appears to have been wider than C. Openings in the eastern wall of the building served to drain vats C, D and perhaps B into the Great Drain. A small square vat, E, of similar dimensions to F, was found to the east of G. The vats in this phase were also lined with waterproof plaster which extended up the inner walls of the building, while the central floor area had a fine pebble surface with a raised edge (Young 1951:231). There was a well in the north-east corner of the building, and another to the north of it. Large quantities of animal bone were found in the fill over the building (Young 1951:233).

To the north of house F stood another workshop which also contained plaster-lined vats. The south wall of this building was the north wall of House F. It was constructed after the building of the Great Drain, although the precise date is unclear; it was some time between the early fourth century BC and the early Roman period in Athens. This workshop contained a large tank in its southern part. This tank was 3.40 metres long and 1.53 metres wide from north to south, and was deeper than the vats in house F. It was lined with plaster, and its east wall formed the west wall of the Great Drain. To the north of this tank was a long vat similar to those in house F. Its southern end connected with the large tank at a higher level, as its floor level was 0.50 metres above that of the large tank. The sides and bottom of the large tank were covered with a 'curious glassy granular substance' which may have been a residue from the craft production carried out there. After scientific analysis this residue was found to consist of the alkaline metals sodium and potassium, and the alkaline earth metals magnesium and calcium, which was found in considerable quantity. Large amounts of phosphorus were also detected. A well was situated in the western part of the building (Young 1951:233-234).

Criteria

3; 4; 5; 7

Publication Details

Young 1951

Illustrations

Figures 32-35

2 Corinth, Anaploga area

Location

A few miles away from the village of Old Corinth

Date

Fourth century BC

Description

This site is described in the brief report as 'an industrial establishment ..., probably a cleaning and dyeing works comparable to the ones at Isthmia' (Robinson 1963:79) located to the north of a road running east to west. This would suggest that it was a house-workshop, with a specialised production area containing two circular vats hollowed out of bedrock close to a larger rectangular tank constructed in a similar fashion (see the entry for Isthmia below). A cistern was found 'a short distance' away; its main chamber was 30 metres long, 3 metres wide and 3.25 metres high, and four manholes provided access. It is suggested in the report that this cistern was too large for normal everyday domestic use, and perhaps supplied water for an industrial establishment (possibly another cleaning and dyeing works) (Robinson 1963:79).

This site has been published as a very brief report, without a detailed description of the archaeological remains and accompanying plans.

Criteria

Possibly 4; 5; possibly 7

Publication Details

Robinson 1963

Plans and Illustrations

None

3 Corinth

Location

North-east of the Peribolos of Apollo, centre of ancient Corinth

Date

Earliest structures date from the late-sixth/early-fifth century BC; there is evidence for dyeing earlier than this. Area continued in use until the early Roman period.

Description

This building has a long and apparently very complex history. It is situated to the north-east of the Peribolos of Apollo close to the agora of ancient Corinth. A stream from the sacred spring of Peirene runs to the west of the building. It is described in the report as 'a partially subterranean rectangular structure, composed of a room with a stone basin ... and an adjoining reservoir' which was built during the third quarter of the fifth century BC (Williams 1968:134-5). 'Drying floors' or a 'drying yard' were situated to the west of the building.

The western room, which contained the basin in its southern section, also had benches running along its north and south walls (Williams 1967:184), and a flight of steps leading up to the drying area to the west (Williams 1968:134-5). A later unstuccoed wall was built in the western half of this room as a result of changes in the drainage channel of the Peirene spring; this reduced the size of the room almost by half (Williams 1968:134-5).

The 'drying area' to the west of the building consisted of a series of 'drying floors'. The earliest contained stone drain channels running along its north and east sides, and underneath it were found pottery and murex shells 'in relative profusion', indicating the existence of a dyeing operation before the construction of this floor (Williams 1968:134-5). This floor was limited to the south by a temenos wall. It was possibly built around 550 BC, was apparently in use for at least 100 years before the construction of the building. In the second half of the fourth century BC a pebble drying platform was built immediately south of the temenos wall. A new polished cement drying floor with an enclosure of stone posts and panels was built 'slightly later' immediately west of the building (Williams 1968:134-5).

This site has not been very well published at all, apart from two extremely brief reports by Williams, from which the others are derived, with no plans or photographs.

Criteria

2; 4; 5; possibly 7; 8

Publication Details

Daux 1967; Daux 1968; Megaw 1968; Williams 1967; Williams 1968

Plans and Illustrations

Figures 36-39

4 Delos – East Coast North Establishment

Location

Situated on the east coast of Delos.

Date

Unclear

Description

This site is located east of the Stadium Quarter close to the sea on the east coast of Delos. A colonnaded street runs east from the Stadium Quarter and borders the edge of the excavated area, and five metres east of the cleared part of this street were found three granite drums similar to those in the South Establishment (see below). They are aligned east to west, and when found were partially buried, so their full dimensions could not be measured. Only one flat surface of the western block was visible; its diameter was 0.99 metres. The middle block was partially buried, and was visible to a height of 0.71 metres; its diameter was 1.04 metres. The eastern block was not buried, and was 0.91 metres high and 1.02 metres in diameter. Twenty eight metres further east, a large deposit of crushed purple shells was found on the rocks at the sea shore. Another similar deposit was found to the north of this one. It is suggested that these blocks were used to crush purple shells prior to the fermentation of the shellfish and the production of the dye; the shells were then disposed at the shore. Close to the installation is a small inlet, suitable for boats bringing their catch of shellfish to shore (Bruneau 1978:110-111).

Criteria

1; 2; 5

Publication Details

Bruneau 1978

Plans and Illustrations

Figures 40-41

5 Delos – East Coast 'South Establishment'

Location

Situated on the east coast of Delos.

Date

Hellenistic period - sometime earlier than the first century BC.

Description

This site is located in the area to the south of the 'synagogue', very close to the sea; in fact parts of the complex are now under water. It consists of a number of walls (whose date is not specified), possibly forming at least five rooms, although it is unclear whether these were all part of the same building. Within this complex of walls were found three circular granite blocks aligned from west to east, apparently outside the walls of the complex to the south (Bruneau 1969:768). North of these blocks, and in different rooms or parts of the complex, were two large rectangular granite vats (Bruneau 1969:769). The southernmost vat, D, had a drainage outlet at its eastern end (Bruneau 1969:777), and the northernmost vat, E, had one at its southern end; a bowl was cut out of the bedrock underneath this outlet, although its relationship to the vat is unclear (Bruneau 1969:781, 785). At the same level as the vat to the south-east of it evidence of a hearth was found (Bruneau 1969:781). Excavations around the blocks and vats revealed that they were set in place late in the life of the complex: the blocks and vats were set in place no earlier than the beginning of the first century BC, and were not used after this century. Large numbers of crushed murex shells were found all over the site and in the surrounding area (Bruneau 1969:769). Their abundance in the levels underneath the blocks and vats suggests that purple dye production was carried out at this site for a long period before the vats and blocks were set in place, perhaps using less specialised equipment (Bruneau 1969:785). It would seem that the surviving equipment at this site was used in the production of shellfish purple dye. It is likely that the granite drums were used for crushing murex shells, with the granite basins serving as fermentation tanks (Bruneau 1969:767-791).

Criteria

1; 2; 4; 5

Publication Details

Bruneau 1969

Plans and Illustrations

Figures 40, 42

6 Delos - Theatre Quarter House IIIN

Location

The Theatre Quarter, Delos

Date

Hellenistic

Description

Situated on the *Rue du Théâtre*, with an entrance at number 35, house IIIN has thirteen rooms in its present state. Not all of these rooms and their features were built at the same time; the house seems to have undergone a number of construction and use phases, although the number is unclear. Charmonard (1922:45) suggests two phases: in the first, the entrance to the house was at room h, and rooms a, b and c were a separate 'shop complex'; the second phase saw their integration with the rest of the house. Trümper has suggested (1998:278) that this house had three broad building and use phases. The house originally consisted of rooms d-h, and was enlarged with the addition of rooms i, j, l and m. It was perhaps in this phase, or in the third phase, that the shop complex a-c was added to the house. She argues for a possible rebuilding of this complex in the third phase. The external landing outside the entrance to room c on *Ruelle* γ perhaps served as the base for a staircase, therefore indicating perhaps the presence of an upper storey.

It is unclear to which phase the dyeing equipment belongs. Both Charmonard and Trümper seem to imply that all the features associated with dyeing were later additions to the house, although they do not specify when (apart from to suggest the later phases of use and building). A number of the rooms in the house contain dyeing equipment. Room c contains a channel 0.9 metres deep and 0.85 metres wide running from roughly north to south, and in room d is a small built feature of uncertain purpose (perhaps an oven or press?). Room e contains six vats, three constructed against the north wall and three against the south wall, which apparently contained colouring material used for dyeing (Charmonard 1922:45). They are made from poros stone covered with hydraulic cement. Those on the north side of the room are all 1.40 metres deep, and measure 1.10 metres, 1 metre and 1.60 metres by 1.10 metres. The southern vats measure 0.70 metres, 1.15 metres and 1.20 metres by 1 metre. The

first (i.e. easternmost) vat is 0.80 metres deep, and the other two southern vats are 1.15 metres deep (Charmonard 1922:43-44). The southern vats contain a protruding shelf-like feature coated with hydraulic cement which Charmonard (1922:44) claims may have been used as a seat. A shelf also ran around the back of the southern vats, with stairs leading up to it (Charmonard 1922:43-44), and both sets of vats were accessible from a platform at the front (Trümper 1998:278). The courtyard f contained two large covered cisterns. Of the rooms in the house which do not contain dyeing equipment include the complex of rooms i, j, k, l, m and n. Charmonard (1922:45) refers to room l as the latrines, and room i contained a mosaic pavement.

Very little mention was made in the report of the finds from the house, particularly small finds. Charmonard (1922:45) refers only to the remains of a large decorated marble basin and its stand, a large round table, fragments of column shafts and a small marble herm, but does not say which rooms they were found in. The remains of interior decoration were found in this house, although it is not mentioned exactly where or what form they took, apart from the statement that they attest to refined tastes.

Criteria

1; 2; 4; 5; 7; 8

Publication Details

Charmonard 1922; Trümper 1998

Plans and Illustrations

Figures 40, 43-49

7 Delos - Theatre Quarter House IIIU

Location

The Theatre Quarter, Delos

Date

Hellenistic period

Description

Situated on the *Rue du Théâtre*, with an entrance on *Ruelle δ*, house IIIU has four rooms, and possibly a shop facing on to the street which may or may not have been accessible from the rest of the house. The house had a second storey, judging by the presence of the beginnings of a staircase in the hallway (a) leading from the street to the interior rooms. In the north-east corner of the court are two rectangular vats, constructed from poros rubble covered with hydraulic cement, in a similar fashion to those in house IIIN in the Theatre Quarter on Delos (see above). The report states that the court contains two separate cisterns (Charmonard 1922:48-49); there appear also to be four long thin covered cisterns in the western half of the court.

The description of the house given by Charmonard (1922:48-49) is very brief, and has no information regarding the history of the house (i.e. relating to different phases of construction and use) and the finds from it.

Criteria

4; 5; 7

Publication Details

Charmonard 1922

Plans and Illustrations

Figures 40, 50-52

8 Halieis 'Industrial Terrace'

Location

Terraced area on the eastern slopes of the acropolis of Halieis, in the southern Argolid

Date

Later fourth century BC

Description

Evidence for several building units was found on a terraced area on the eastern slopes of the acropolis at Halieis. Three of these building units, aligned north-east to south-west and each divided by a north-east to south-west central wall, were excavated and one, the westernmost unit, contains evidence of dyeing activity. The central room in the eastern part of the building measured 4.5 metres by 4.5 metres and was found to contain a cement/plaster floor on two levels. The western part of the floor (roughly 2.50 metres wide) was between 0.03 and 0.06 metres higher than the eastern part (which was roughly 2.00 metres wide) (Jameson 1969:323). A circular depression (roughly 1.25 metres in diameter) in the higher part of the room was connected to a small ceramic basin which had be sunk in the floor of the lower part of the room by a channel (Ault 1994a:41). Two larger pithoi were sunk into the floor of the higher level, one on either side of the channel. Their rims (only one of which was preserved) were set above the level of the floor (Jameson 1969:323). A rectangular depression in the floor in the western corner of the upper level was flanked by two square holes, which correspond to holes in a block of limestone set beneath the floor (Ault 1994a:41-42). In the room were found an anta capital (which had been turned upside down), a piece of millstone, a conch shell, a lead weight and an unspecified number of loomweights (Jameson 1969:323-324).

This room was connected to an alley to the east by a doorway, and to a smaller L-shaped room to the south by two steps leading up to a doorway. This room contained fragments of several large storage vessels. (Jameson 1969:323). The other buildings on the 'Industrial Terrace' were poorly preserved but do not appear to have contained evidence for dyeing activity.

A great deal of attention has been devoted to the study of Halieis, which has meant that this site has been well-published, with detailed plans and photographs accompanying all of the reports.

Criteria

1; 4; 7; 8

Publication Details

Ault 1994a; Ault 1994b; Ault 1999; Jameson 1969

Plans and Illustrations

Figures 53-54, 56

9 Halieis Lower Town

Location

Lower Town of Halieis, southern Argolid

Date

Fourth century BC

Description

A number of houses in the eastern part of the Lower Town of Halieis were found to contain features which may indicate the presence of dyeing activity. All are situated in 'Area 6' of the excavated part of the Lower Town (Boyd and Rudolph 1978:347-351). House A is situated in the north-east of this area, with an entrance on Avenue B. It has an area of roughly 133 metres^2 and consists of eight rooms. Room 6-83, in the north-eastern part of the house, is the largest in the house with an area of 16.00 metres^2. Its northern half was covered with a platform coated with plaster, which sloped from west to east and had a raised curb made from cobbles along its edge. In the eastern corner of the platform, a small pithos (with a diameter at its mouth of 0.43 metres and an internal diameter of 0.56 metres at its largest point; its depth was 0.69 metres) was found in situ set in the platform with its mouth at the level of the floor. A large circular cutting (diameter: 0.90 metres), probably for another vessel, was found in the centre of the north side of the platform. A pithos rim (diameter: 0.73 metres; height: 0.34 metres), possibly from this pit, was found laying across the south-eastern edge of the platform and the earth floor next to it to the south. Traces of plaster were found on the north-east and south-west walls of the room. An earlier plaster floor was found in the east central part of the room. Room 6-84, which was accessible from a stepped doorway in the south of room 6-83, was also plastered on its walls and floor (Ault 1994a:120-124). The majority of the finds from room 6-83 were tiles, and also pottery, for the most part drinking and cooking vessels (Ault 1994a: tables 4, 5 and 6). None of the other rooms in the house contained evidence of dyeing activity.

House D is situated in the south-western part of Area 6 on the northern side of Street 3, which ran from south-west to north-east. It was a large house, and although only three quarters of the house has been excavated it is estimated that it had an area of 204 metres^2. The

excavated area consists of almost all of the south-western half of the building, and the northern part of the north-eastern half of the building (Ault 1994a:157-158). Room 6-29, in the central part of the south-western half of the building, contained a similar feature to that in house A described above. In the eastern part of the room was a plaster platform with a curving edge. A limestone press bed with a spout (diameter: ca. 1 metre; thickness: 0.30 metres) was set on the northern part of the platform. Underneath the spout a ceramic basin (diameter: 0.41 metres; depth: 0.29 metres) was set into the plaster. Close to the press bed to the south a large pithos (diameter: 0.70 metres; depth: 0.78 metres) had been sunk into the platform. A limestone block containing two cuttings, possibly the weight block for a press mechanism, was found in situ four metres from the platform to the east, in line with the press bed. A rectangular depression was found in the wall behind the press bed (Ault 1994a:162-163).

Room 6-26, the courtyard of the house, was situated adjacent to 6-29 to the south. In the north-eastern corner of the court portions of at least two conglomerate slabs were found running parallel to the wall separating the court from 6-29 (Ault 1994a:161). It is suggested that this feature was a milling trough (Ault 1994a:163). A well was situated in the north-western corner of the court, and a large pit with a surface area of roughly 5.00 metres^2 and an average depth of just over 1 metre, was found to the south of the well (Ault 1994a:159-160). Finds from room 6-26 consisted mostly of tiles, and pottery connected with food and drink were also found (Ault 1994a:tables 10 and 11). Other rooms in the house did not contain evidence of dyeing activity.

The houses in the Lower Town of Halieis were excavated between 1974 and 1979. As mentioned in the description of the 'Industrial Terrace' of Halieis, this area has been studied and published in great detail.

Criteria

1; 4; 5; 6; 7

Publication Details

Ault 1994a; Ault 1994b; Ault 1999; Boyd and Rudolph 1978

Plans and Illustrations

Figures 53, 55, 57

10 Isthmia, Rachi Settlement

Location

The Rachi hill, to the south of the Sanctuary of Poseidon, Isthmia

Date

Later fourth century to late third/early second century BC

Description

The settlement at the eastern edge of the Rachi hill overlooking the Sanctuary of Poseidon at Isthmia contained a number of houses and other buildings, twelve of which have been excavated. The settlement was laid out along three parallel streets, which ran south-west to north-east along the line of the ridge. Two streets were found crossing them in a roughly south-east to north-westerly direction, and stairs linked the settlement to the feet of the hill. Many of the houses appear to have had upper storeys, and some had basements (Anderson-Stojanovic 1996:60-91). Three of these houses contained evidence for the presence of dyeing activity, with another installation lacking evidence for an associated structure. This latter installation was located at the western edge of the excavated area, and consisted of a rectangular tank cut out of the bedrock of the hill, with a width of 0.58 metres, a length of 0.66 metres and a depth of 0.75 metres at its deepest point. The inside was coated with plaster. A channel (0.12 metres wide) cut out of the bedrock led from the tank to a circular basin with a diameter of 0.66 metres at its top. The bottom of a similar basin was found around 1.50 metres to the south. A cutting was made in the rock to the east of the tank. It was 1.20 metres long, 0.34 metres wide in the middle, 0.22 metres wide at the ends, and 0.84 metres deep. There were slots halfway down the walls of the cutting, with a hole extending from the east end of the north slot northwards through the rock. To the south of the tank were traces of a cistern which was 1.70 metres long and at least 0.80 metres wide, and was set 0.65 metres higher than the tank (Broneer 1955:125).

Another house containing dyeing installations was House III, situated in the central part of the settlement on the north side of Street 3 at its junction with Street 1. The dyeing installations were found in room A, the southernmost room of the three that make up House III. They consisted of a large rectangular basin, which was only a few centimetres deep in its

surviving state, but had apparently been much deeper, and two circular basins adjoining it to the north-east. An outlet led from the northern corner of the rectangular basin to the northernmost circular basin; the southern circular basin was separated from the rectangular basin by a partition. The two circular basins were also separated from each other by a partition 0.12 metres wide (at the narrowest point) which was preserved to its top, and was covered with cement. The three basins also appear to have been covered with cement. The bottom of a large terracotta storage vessel (perhaps a pithos) were found close to the rectangular basin (Broneer 1955:126). Adjacent to the rectangular basin to the north-west a large rectangular stone block with two small rectangular holes cut out of it appears to be set in the floor of the room. A rectangular tank was cut into the bedrock in the north-east corner of the room. Two other rooms in House III have been excavated, although neither seem to contain evidence of dyeing activity, and the precise extent of the house is unclear. Room A is not the largest room in the house; it is smaller than room B but larger than room C.

Roughly four metres to the south of House III a similar installation was found, consisting of a rectangular cistern constructed on a high level, and two circular basins whose tops are roughly level with the floor of the cistern to the north-east (Broneer 1955:126). The diameters of the two circular basins are 0.69 metres and 0.80 metres (Broneer 1958:18). North of this, apparently in the same room, is a rectangular cistern (Broneer 1955:126).

House IV, to the north of House III, also contained a similar installation. Two rooms in the house have been excavated, although it is impossible to say whether or not it extended eastwards. The south-western half of the south-eastern room, the larger of the two, contained the dyeing installation. Like that in House III, there was a rectangular area (measuring 1.72 metres in width and 2 metres in length), which may have been deeper in its original state. Along the north-west edge of the rectangular vat were two circular basins cut out of the bedrock. Their rims are built up, and it appears that there was no access from the rectangular vat into the basins. A channel led between the basins into a rectangular basin to the north-west. The whole installation was covered in cement. The north-eastern part of the room, which had a thin cement pavement, contained three small rectangular cuttings in the bedrock, which may have been part of a press mechanism. Two of the cuttings were filled up with stones, which appear to have been specially cut (Broneer 1958:19).

House XI, situated at the north-eastern end of the Rachi hill, consisted of at least three rooms, two of which are preserved. The floor of room A, in the north-western part of the house, was roughly 1.50 metres above the floor of room B. Room A contained three vats

arranged in a row roughly north-west to south-east. The north-western vat was conical, with a preserved upper diameter of 0.70 metres and a depth of 0.60 metres, with the rim protruding above the floor level to a height of roughly 0.20 metres. The middle vat was of irregular shape, with a length of 1.40 metres and a width of 0.70 metres. The upper part of this vat was constructed using poros blocks covered with cement. Its depth is unclear, although it was much deeper than the north-western vat. Only the base of the south-eastern vat has been preserved. All three vats appear to have been covered with cement. A working floor was located to the north-east of the vats. Room B, which was entered from street 5 through two openings in its south-west wall, did not contain any vats, but the rock-cut floor of the room 'resembles the surface of a rough washboard or a series of alternating furrows' (Anderson-Stojanovic 1996:85), and may have been used for some sort of grinding activity. The third room of the house apparently extended to the north-east. Finds from the house mostly consisted of domestic pottery (Anderson-Stojanovic 1996:84-87).

Large amounts of mostly domestic pottery and amphorae were found in settlement, as well as lamps and also loomweights, seventy eight of which were discovered in 1989. The greatest quantities of loomweights were found in the basement rooms of the houses (Anderson-Stojanovic 1996:87-90). Similar types of finds were discovered in excavations on the Rachi in 1955 and 1956. In the basement of one house, south-west of House III, over sixty loomweights were found, and also an unusually shaped pottery vessel. It was trough-like in form, and divided into two compartments, an upper and a lower. The lower compartment was wider at one end than the other. At the narrow end, the upper compartment sat on the rim of the lower compartment. It was circular, with a flaring rim and an opening 0.102 metres wide and 0.04 metres high at the bottom connecting with the lower part. The inside of the vessel was blackened and contained a thick dark deposit which was found to be of organic matter with a high silica content. It showed no signs of being exposed to fire on the outside (Broneer 1958:32).

A number of other houses in the settlement contained rock-cut cisterns, and an area between houses III and IV contained two baths, one constructed from rock and covered with cement, and another made from terracotta. A number of the cisterns from the settlement were found to contain large quantities of ash, which may have been used in the dyeing process, or may have resulted from the destruction of the settlement (Kardara 1961:266).

As with Halieis, a great deal of study has been carried out on the Rachi settlement, over a period of almost fifty years. This has resulted in a great deal of detailed published material, with accompanying illustrations.

Criteria

1; possibly 2; possibly 3; 4; 5; 7; 8

Publication Details

Anderson-Stojanovic 1988:268-269; Anderson-Stojanovic 1991; Anderson-Stojanovic 1994; Anderson-Stojanovic 1996; Blackman 1997; Broneer 1955; Broneer 1958; Kardara 1961; Kardara 1970

Plans and Illustrations

Figures 5, 29, 58-66

11 Knossos, The Unexplored Mansion

Location

Unexplored Mansion site, Knossos, Crete.

Date

Hellenistic – second to first centuries BC.

Description

The dyeing remains are situated in the south-eastern part of the site. They consist of a cistern and a basin associated with it. The building in the south-eastern area of the site had two phases of construction and use. In its second phase, the area around the cistern was plastered, and a small basin coated with plaster was constructed close to the cistern. A raised kerb served to direct water into this basin. A number of walls are associated with these features (Sackett 1992:11-13).

In the south-western sector of the site a rectangular building appears to have consisted of walls 'el', 'da', 'fa', and 'fc'. In the south-east of this building was a small tank or compartment lined with clay, with a cobbled area adjacent to it in the south-west of the building. A partition wall made of clay separated these features from an area with an earth floor in its northern part and a mud-brick platform in the corner near the 'tank' (Sackett 1992:15).

Criteria

1; 4; 5

Publication Details

Sackett 1992

Plans and Illustrations

Figures 67-68

12 Kolonna, East Crete

Location

Lasithi Plain, eastern Crete

Date

Third century BC

Description

This site consists of a building situated on the northern edge of the Lasithi Plain, close to an archaic building. It was excavated by Pendlebury in 1937 and 1938, although not in its entirety (Watrous 1980:269). The building has a long history of occupation and use, dating from the archaic period. The remains relating to dyeing are from the final phase of occupation, which was dated to the third century BC (Watrous 1980:280). The dyeing remains were found in room 3. In the north-western corner of the room, a basin was made from three boulders which formed a trough against the wall. It was set on a rectangular area of floor covered with small flat stones, with larger stones placed on their sides defining the border of this area. A hearth, which was in the centre of the room, consisted of a slab set on the floor with small blocks arranged around its edges. Along the southern wall of the room ran a stone bench (Watrous 1980:279). In the room was found a bottle inscribed with the words NIKIAC ΛYKIOC in third-century characters (Young 1938:233), perhaps signifying that it once held the yellow dye lykeion (Watrous 1980:279). Other finds in the room included fifty-eight loomweights, found in a small cupboard-like recess in the north wall, three clay figurines, iron objects (an arrowhead, a vessel handle, and a fragment of a nail), a steatite bead and vessel lid, a stone pounder and a conch shell (Watrous 1980:279).

The other rooms in the house did not contain dyeing equipment. One room, room contained steps pointing to the existence of an upper storey or to access to a (possibly flat) roof. Loomweights were found in other parts of the building (making a total of sixty-six for the whole site (Watrous 1980:280-281). Burnt roofing material found in rooms 2, 3 and 4 leads Watrous (1980:280) to suggest that the building was destroyed by fire during or after the third century BC.

Criteria

1; 2; 4; 6; 7; 8

Publication Details

Watrous 1980; Watrous 1982; Young 1938

Plans and Illustrations

Figure 69

13 Korsiai, Boiotia

Location

South-western Boiotia

Date

Hellenistic

Description

The dyeworks site is situated in a terraced area outside the southern wall of the ancient acropolis of Korsiai, referred to by the excavators as the 'south industrial area'. It consists of one building aligned from north-west to south-east, which contained three rooms facing onto a courtyard (see Plan). The evidence for dyeing consists mostly of a number of vats and channels cut into the bedrock of the building. Room 1, the central room of the three, measured 4.25 metres by 3.50 metres, and contained a large circular pit (pit A) 0.74 metres in diameter and 0.60 metres deep in the centre of the room. Two channels connected this pit to a shallow trough 1.22 metres long situated to the south. Two further pits, B (0.40 metres in diameter and 0.41 metres deep) and Γ (0.32 metres in diameter and 0.07 metres deep) were connected to the trough by channels. Another pit (Δ), with a diameter of 0.20 metres was also found in the northern corner of the room, and a further channel was located to the north-east of pit A (Fossey 1981:114).

In room 2, the north-west room, which measured 3.14 metres by 3.50 metres, were more pits and channels. Pit Z, in the southern corner of the room, measured 0.50 metres in diameter and was 0.46 metres deep, and was apparently linked to channels running into it from the north-west and north-east. Pit H in the northern part of the room had a diameter of 0.40 metres and was 0.13 metres deep. A large pear-shaped cistern was cut into the floor in the north-east corner of the room. At the top its diameter was 0.80 metres, and at its widest part its diameter was 1.33. metres. It was found to be 1.60 metres deep, and had footholds carved into its sides, possibly to aid in cleaning. The north-west corner of the room was marked by a rock 'table' close to a large channel which was cut into the bedrock and led from north-east to south-west along the edge of the court (Fossey 1981:114-119).

Room 3, in the south-east part of the building, measured 5.30 metres by 4.00 metres, and was found to contain two more basins. K, situated halfway along the south-western wall, had a diameter of roughly 0.70 metres, and was connected by a small channel to a natural cavity in the surface of the rock. Pit Λ was situated in the south-east corner of the room, and had a similar diameter to that of K (Fossey and Morin 1986:170). The court, whose precise dimensions are not known, also contained features cut into its surface. A large drainage channel led from outside room 1 towards the south (Fossey 1981:119), and a pit (M) with a diameter of 0.50 metres was found in the area outside room 3 (Fossey and Morin 1986:170). It seems that these features were coated with plaster: the floor and features found in room 2 were all coated with plaster, and traces of plaster were found in pit A in room 1 and the court. This may suggest that other areas of the building were coated in plaster in a similar fashion to room 2 (Fossey 1981:119).

A fairly large number of finds were recovered from this building, including a total of thirty seven loomweights, as well as Hellenistic pottery consisting of bowls, plates and storage vessels (Fossey 1981:119-120; Fossey and Morin 1986:170).

The site was excavated in 1980 and 1983, and the results have been published in detail with informative photographs and plans.

Criteria

4; 5; 7; 8

Publication Details

Catling 1981; Fossey 1981; Fossey and Morin 1986

Plans and Illustrations

Figure 70

14 Kouphonisi, East Crete

Location

Islet off the south-eastern coast of Crete

Date

Hellenistic/Graeco-Roman period

Description

The remains of a possible purple production establishment were found in a house, House B, in the ancient settlement of Lefki on the islet of Kouphonisi. The settlement is located close to the sea (see Figure 71). House B has nine rooms, some of which contained evidence of dyeing activity. An apparently cylindrical stone trough was found (see Figure 72), and the house was found to contain large quantities of shells, the majority of which were from the shellfish that produce purple dye. Close to the settlement a number of vats cut into the bedrock were found, possibly for use in the production of purple dye. Other finds in House B, in which there was 'a shortage of luxuries' include a number of clay hearths (see Figure 73), and various items related to fishing such as lead weights and copper needles (Papadakis 1983:61-63).

A number of other houses were found in the settlement on Kouphonisi, along with a theatre two hundred metres away. Excavations were carried out on the islet between 1976 and 1978. The report on these excavations cited below is somewhat lacking in detail, and gives not indication of the precise location of the features found in the houses. There are no plans of the sites, so it is difficult to get a precise idea of the layout of the site, and the photographs included with the text are not very informative. There is also a lack of precise information on the dating of the houses; we are informed that the settlement was Hellenistic or Graeco-Roman, and was destroyed in the fourth century AD, but all other dates are unclear.

Criteria

1; 2; 4; 5; 6

Publication Details

Papadakis 1983

Plans and Illustrations

Figures 71-3

15 Mycenae

Location

The south-western part of the citadel/acropolis of Mycenae

Date

Hellenistic – second century BC

Description

The remains of the Citadel House Area consist of a number of buildings constructed on a terraced area on the south-western slopes of the acropolis of Mycenae. Close by this area, to the north-east, were more Hellenistic remains known as the Great Ramp chambers. These two groups of remains are discussed here together. The Citadel House Area contained a number of buildings, nine of which have been excavated. They were laid out orthogonally on four parallel terraces which ran north-west to south-east, with each terrace apparently being divided into two buildings (at least in the excavated area). These buildings seem to face either north-west or south-east, and consist of a number of rooms grouped around a courtyard. A street ran at right angles to the terraces in the north of the excavated area, and separated the northernmost rooms in the Citadel House Area from the so-called 'North-West Complex' of Hellenistic rooms over the South House (Bowkett 1995:2). Two building phases have been identified in the Citadel House Area: XIVa, of which only scant evidence remains, dates from the fourth to second centuries BC; XIVb covers the second century BC. The structures discussed below date from this period (Bowkett 1995:51-52).

The northern building unit on the first (i.e. the highest) terrace consisted of rooms A, B, C, D, T, U and V. Room V was apparently the courtyard of the building. Room A, the central room in the southern suite of three rooms in the building, contained a rectangular cement basin measuring 0.90 metres long, 0.75 metres wide and 0.35 metres deep in its northern half. A cement channel led from the southern edge of the basin through the western wall of the room into a drain in the adjacent room (room B). The southern half of the room was taken up a plaster pavement, separated from the basin by a line of rough stones. There was a small square hole in the south-east corner of the plaster area (0.08 metres long, 0.08 metres wide, 0.10 metres deep). A layer of tiles, both whole and broken, lay over this floor;

whether this was a later floor or whether it was destruction debris is unclear (Bowkett 1995:9-12). Room D was apparently associated in function with room A to the south-east, and the north-west wall of room A may have simply been a step up to D, or a working platform for the structures within it. These consist of two large blocks set south-west to north-east, with a gap inbetween. This gap was partly filled with a smaller block, and may have been covered by slabs; one formed the northern boundary of the gap, while others were found in the fill. This feature was set on tiles and flat stones, with a piece of slate beneath the gap. There was a possible run-off into an uncovered drain in room B to the south-west. Room B, to the west of room A, contained traces of a plaster floor. Below this floor were two covered terracotta drains, one coming from room A to the east and another entering the room in its northern corner from room U. Both drains converged near the western wall. An open drain built from curved tiles, entered the room from room T in the northern corner, crossing the northern covered drain, and disappeared in the south-eastern part of the room. Here a hearth was found, which had three thin porous orthostat slabs at its north-east corner and tiles possibly part of the open drain) forming its eastern boundary. It contained burnt mud-brick, animal bones, and ash. Earlier floor levels contained a hearth in the north-eastern corner of the room and a clay receptacle in the south-eastern corner (Bowkett 1995:12-14). An open drain ran from the north-west wall of room T into room D. Rooms T and U had plaster floors, and that in room T sloped towards the open drain. Room C contained two pithoi, one of which contained iron fragments (Bowkett 1995:14-15).

Other evidence for the presence of dyeing activity was found in the building unit comprised of the rooms F, G, JJ, KK and MM in the north-western part of the third terrace. Room MM, the northernmost room, contained in its southern corner a small basin made from squared stones covered with plaster. The top surface of the rim was covered with tile. The basin had an unusual shape. It was built up against part of a 'T'-shaped wall, so that its north-east and north-west sides (preserved to lengths of 0.66 metres and 0.34 metres respectively) were straight and at right-angles, while the third side (facing south) was curved. The basin was 0.14 metres deep. Another basin almost exactly the same was found beneath it. In the same building, rooms G, JJ and KK all contained areas of floor covered with plaster which sloped towards a sump hole in the corner and a raised edge along one side (Bowkett 1995:20-26). A total of seventy-four loomweights was found in the building, along with twelve spindle whorls and ten spools. Other finds included metal fragments including iron, bronze and lead, stone grinding equipment, and coins (Bowkett 1995:38-41).

There was also evidence of dyeing activity in the 'North-East Complex', at the northern end of the excavated area. Room X contained a shallow basin (length: 1.40 metres; width: 0.60 metres) made from plaster. The floor of the basin sloped towards a hole in the northern corner. In a similar situation to that in room MM, there was an identical basin underlying it (Bowkett 1995:35).

A similar floor to those described above was found in room GG on the lower terrace, next to a hearth (Bowkett 1995:29-30), and thirty two loomweights were found in the building of which it was a part (consisting of rooms E, EE, FF and GG) (Bowkett 1995:38). Room L, in the south-eastern section of the third terrace, was found to contain a similar floor in its north-eastern corner, with a receptacle set into it. A Mycenaean stone mortar was found in situ on the floor to the south (Bowkett 1995:26-27). Room L on the second terrace contained pressing equipment. This consisted of the base of a press set into a plaster floor in the north-eastern corner of the room, and a depression in the floor led west from it to a pithos set in the floor (Bowkett 1995:20).

Immediately to the north-west of the Citadel House Area were the remains of Hellenistic structures over the South House, known as the 'North-West Complex'. The southern wall of this building fronted onto street CC which ran south-west to north-east along the northern edge of the Citadel House Area. A number of construction phases were identified similar to those of the Citadel House Area, and the latest corresponds with phase XIVb in the Citadel House. Four rooms (WW, XX, YY and ZZ) were excavated, one of which, room XX, contained three basins constructed at different levels against its southern wall. The basins had cement floors, laid on a cobble foundation, and the sides were made from tiles covered with cement. The easternmost basin, which was just above the floor level, measured 0.35 metres long and 0.90 metres wide, and had a round bowl (diameter: 0.15 metres) set in a circular hole at its southern end. This bowl did not communicate with a drain. The central basin was not well preserved, although it appears to have been 1.10 metres long and had a drainage pipe running from it through the southern wall of the room to a sump in street CC. The floor level of this basin seems to have been higher than that of the eastern basin, but lower than the western. The best preserved of the three, the western basin measured 0.80 metres long and 0.60 metres wide, and its floor level was roughly 0.30 metres above the floor of the room. A large amount of charcoal was found in front of this basin. Room YY, to the east of XX (and without any apparent means of access between the two) contained a terracotta bath set on a plaster floor area in its north-western corner. A channel in this floor led from the bath to a drain in the centre of the room, which then led south through the southern wall of the room to

a sump in street CC. Broken querns and one or two stone pounders were found close to the bath, and the building also contained a pottery (both fine and coarse wares), a stand for a terracotta basin, and around sixteen (mostly pyramidal) loomweights (Bowkett 1995:47-49; Wace 1923:97-102).

To the north-east of the Citadel House Area, and slightly above it, south of the Great Ramp, was a Hellenistic building consisting of four rooms (<30>-<35>) arranged on a north-west to south-east alignment. Room <31>, the second from the north, had a plaster floor in its western half. A raised edge ran along the eastern side of this floor, and in its north-east corner a channel ran into a pit 0.60 metres deep with a diameter of 0.45 metres. A pithos stood in the north-east corner of the room, and room <30> to the north also contained a number of pithoi. The dividing wall between room <31> and room <32> to the south ran from the eastern wall only as far as the start of the plaster floor area in <31>. In the south-west corner of <32> a terracotta bath stood on a tile floor, in a similar fashion to the arrangement in room YY. Room <34> apparently had a cement floor in its eastern part, while the south-west corner contains a large foundation of worked poros blocks, one of which was a press bed. A mortar cut out of a column shaft was found against the centre of the south wall, and a flat round stone was found to the west of this. Finds from this building include pottery (bowls and storage vessels) and many pyramidal loomweights (Wace 1923:68-71).

Criteria

1; possibly 3; 4; 5; 6; 7; 8

Publication Details

Bowkett 1995; Wace 1923

Plans and Illustrations

Figures 74-82

16 Olynthus

Location

Chalkidiki, northern Greece

Date

Seventh to mid-fourth centuries BC – the relevant houses are all fourth century BC

Description

From the seventh to the fifth centuries BC the city of Olynthus consisted of a relatively small walled settlement on the South Hill of the site. This part of the city was laid out along a rough grid plan, and contained a number of public buildings. The city was enlarged after 432 BC, when the Chalkidian cities banded together and moved to Olynthus. The new part of the city was walled, and was laid out along a so-called 'Hippodamian' grid on the area known as the North Hill. This part of the city continued to expand during the fifth and fourth centuries BC, with houses being built on the plain to the east of the original walled areas of the North and South Hills (the so-called 'Villa Section'). The city was destroyed in 348 BC by the armies of Philip of Macedon, and most of the inhabitants were sold into slavery. Save for some limited reoccupation of parts of the site, the city was abandoned after this destruction (Cahill 2000:497-498).

The parts of the site which have seen most detailed excavation and study are the North Hill, which may have contained three hundred and sixty houses, and the Villa Section. Detailed excavation of large areas of the North Hill and Villa Section have revealed a standard layout for housing at Olynthus. Most of the houses were built in blocks of ten, with a drainage alley separating two rows of five (Cahill 2000:499). These blocks were not found all over the site however: a long row of houses (row A) was built against the city wall along the western edge of the North Hill for instance. Many of the houses excavated have broadly similar plans, so it is possible to give a general description of 'the Olynthian house' (while being aware that not every house fits in with this generalisation exactly). Most contain a courtyard, often in the southern part of the house, which seems to have been the central area of the house around which other rooms were organised. A covered area, usually referred to in the excavation reports as a portico or pastas, usually opens onto the courtyard to the north. The rooms in the

house usually open off the court or pastas; in many houses there is a suite of rooms in the northern part, with other rooms arranged around the court on the east and west (Cahill 2000:499-500). Some of houses contain evidence of an upper storey (Cahill 2000:500).

A number of rooms seem to have had fairly specialised features. So-called '*androns*', or specialised dining rooms, for instance were identified in a number of houses from the presence of cement floors with raised borders, off-centre doorways and in some cases entry through an anteroom (Cahill 2000:500). Other rooms contained features of more relevance to this study, and will be discussed with examples below. The excavators identified a suite of rooms which they called a 'kitchen' or '*oikos* complex' in a number of the houses. This consisted of a large room which in some cases contained a hearth (the 'kitchen'), with two smaller rooms opening off it. One of these, the so-called 'flue', has been interpreted as an area for cooking (Cahill 2000:500). Some houses also have a so-called 'bathroom' as part of this complex. These rooms are generally small, with plastered walls and a cement floor (sometimes with an inset circular depression or basin), although some had tiled floors and others earth floors. Other 'bathrooms' have been identified in rooms rooms which are not connected to a 'kitchen complex' however. A number of 'bathrooms' contained bathtubs similar to those found at Isthmia and Mycenae (see above). These have been found *in situ* in houses A 2 room d, A v 4 room b, A v 5 room c, A vi 7 room i, A vii 5 room c, A xiii 10 room e, B ii 3, B vii 2 room h, E.S.H. 4 room d, E.S.H. 4 room i, E.S.H. 6 room a, and the House of the Comedian room c. The presence of bathtubs is also indicated by gaps in the cement floors of the 'bathrooms' in houses A 4 room e, A 6 room b, A vi 4 room d, A vii 4 room c, and B vi 2 room c. Fragments of bathtubs were found in houses A 8 room a, A 11 room c, A v 10 room c, and A vi 4 room d. Some houses contained rooms with cement floors and plastered walls which did not appear to have contained bathtubs, but were evidently used for activities which involved liquids. These are houses A vi 7 room o, A vi 9 room a', A vii 6 room m and A viii 2 room g (Robinson 1946:14; Robinson and Graham 1938:198-204).

A number of houses contained specially constructed equipment which may have been used for parts of the dyeing process. For example, a room in house A-1, on the west of the North Hill, contained 'a built-in cement bathtub made of small stones and clay' (Robinson 1930:40). This was rectangular, with a length of 1.30 metres, a width of 0.79 metres and a preserved height of 0.67 metres. A terracotta pipe ran into its centre from the north (Robinson 1930:40). As this was the only part of the house to be excavated, it is impossible to say how it related to the overall plan of the house. It does not seem to resemble the terracotta bathtubs found elsewhere at the site in form or construction, and it may have been a basin used for

purposes including dyeing. Room j in house A xi 10 contained an area of cement floor, which was described by the excavators as the remains of an olive or grape press (Robinson and Graham 1938:129, 208, 339). This consisted of a cement area measuring 0.96 metres from north to south and preserved for 1.26 metres along the western wall of the room. Two gaps in the cement were found adjacent to each other near to the south wall of the room; they were 0.39 metres long with differing widths. The western gap was 0.36 metres wide, while the eastern gap had a preserved width of 0.13 metres (it is thought that in its original state this gap would have been wider). A drainage channel runs along the cement between the two gaps and through the south wall of the room into the street. Two intact pithoi were also found in this room (Robinson and Graham 1938:129, 208, 339). Cement platforms linked to terracotta basins were found in room g in house A vi 8 and room b in house A vii 9.

More portable equipment which could have been used by people involved in dyeing was found in many houses in Olynthus. For instance, large numbers of crushing and grinding tools have been found across the site. Saddle querns have been found in a number of houses, including A 6 room i, A 8 room g, A 10 room f, A viii 9 room e, B ii 3, and E.S.H. 4 room f (Robinson and Graham 1938:326-327). The stone grinding 'boards' used with saddle querns have been found in houses A 11 room h, A iv 9 room g, A v 9 room d, A vi 7 room i, A vii 5 room i, A xiii 10 room e, E.S.H. 4 room h as well as in houses on the South Hill, among others (Robinson and Graham 1938:329, 334). These stones were also used with 'grain mills', the upper stones of which were hollowed out and had a slot in the bottom, which served to allow grain to flow through and be ground on the lower stone (Robinson and Graham 1938:327). The upper stones of these 'grain mills' were also found in large quantities at Olynthus (Robinson and Graham 1938:327-329, 333-334). Stone mortars have also been found. Some were small and roughly made, such as one found in house A vi 5 room j (Robinson and Graham 1938:105, 335); others consist of a large stone bowl on a stand. These have been found in houses A v 9 room e, A vi 7 room l, A vi 10 room i, A vii 4 room e and E.S.H. 4 room h (Robinson and Graham 1938:335-336). Large stones for crushing olives, and perhaps other things, have been found in houses A 6, A v 9, and A v 10.

Another item which could have been used in dyeing and other textile production which was found in abundance at Olynthus was the loomweight. Almost every house excavated contained at least some loomweights (Robinson 1930:118-128; Robinson and Graham 1938:209), mostly in small quantities. In some houses however larger deposits of loomweights were found. One hundred and fourteen were found in two rooms in house A iv 9 (Robinson and Graham 1938:87-88), and two deposits in room a and the pastas of house A viii 7

contained a total of two hundred and ninety-seven loomweights (Robinson 1946:39). Room c in house A xi 10 contained fifty-six loomweights (Robinson and Graham 1938:128), while thirty-nine were found in room i in E.S.H. 4 (Robinson and Graham 1938:136). Sixty-one loomweights were found in three separate deposits in rooms e, j and h in house A v 9 (Robinson and Graham 1938:96), while over fifty were found in house D vi 6 (Robinson 1946:160-167) and seventy-five were found in the House of Many Colours (f –ii 9) in the Villa Section (Robinson 1946:196-197). Also in the Villa Section, forty-three loomweights were found in a line roughly one metre long in the south-east corner of villa CC (Robinson 1946:207).

A number of the houses at Olynthus also had shops, in the form of rooms which opened onto a street, often without access to the rest of the house. Coins, weights and scales and storage vessels are common in these rooms (Cahill 2000:503). Some houses also have evidence of craft production activities other than dyeing. Two seem to have been inhabited by stonemasons (houses A 5 and A 10), and others had evidence for the production of terracotta figurines (house B i 5) and weapons (Cahill 2000:505).

Olynthus has been extensively excavated and published, with three volumes of the excavation reports dealing largely with the results of the excavation of domestic areas.

Criteria

1; 4; 5; 6; 7; 8

Publication Details

Cahill 2000; Nevett 1999; Robinson 1930; Robinson 1946; Robinson and Graham 1938

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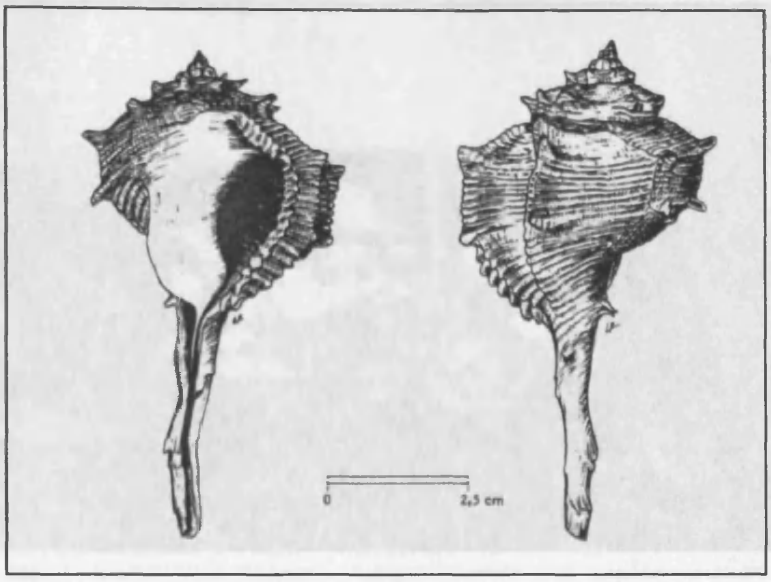

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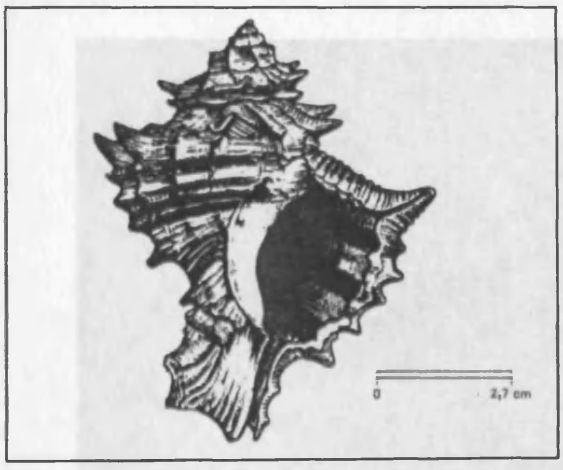

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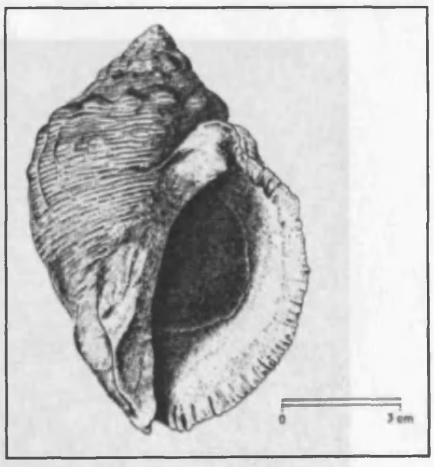


Figure 1: Diagram of *Murex brandaris*. After Fischer et al 1987:586.
Figure 2: Diagram of *Murex trunculus*. After Fischer et al 1987:588.
Figure 3: Diagram of *Thais haemastoma*. After Fischer et al 1987:589.

Figure 4: Bowl containing shells including *Murex brandaris*, Delos Museum

Figure 5: 'Peculiar vessel' possibly used for dyeing from Rachi settlement, Isthmia, in Isthmia Museum

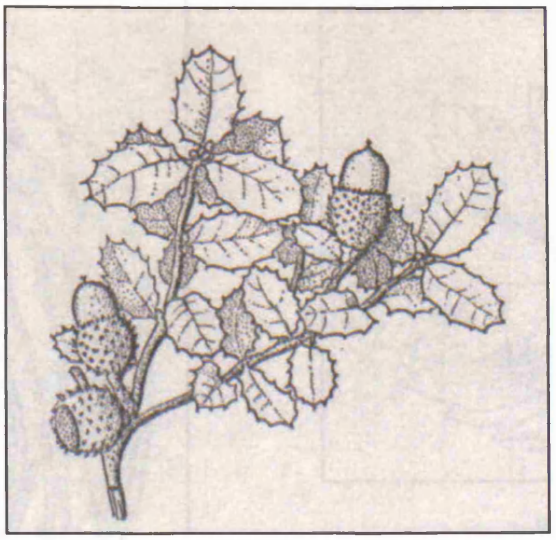
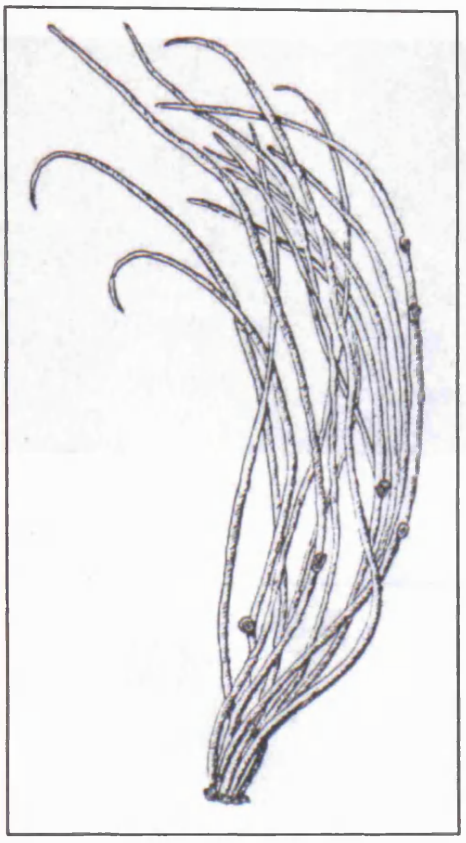


Figure 6: Drawing of *Quercus coccifera.* After Huxley and Taylor 1977:Fig. 493

Figure 7: *Crocus cartwrightianus*, a wild flower closely related to the cultivated saffron crocus (*Crocus sativus*). After Polunin and Huxley 1987:Fig. 270



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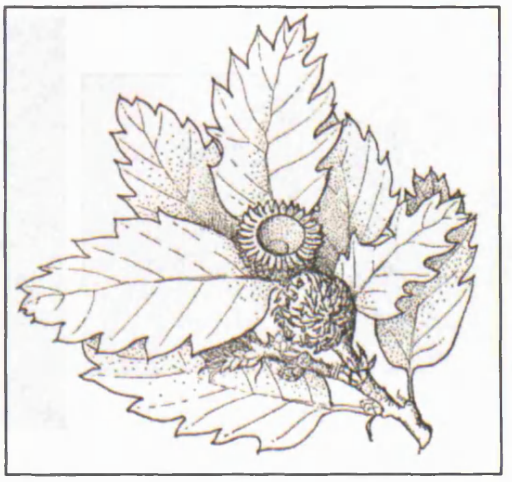

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Figure 8: Drawing of *Roccella tinctoria*. After Smith 1921:Fig. 133.
Figure 9: Drawing of *Quercus aegilops*. After Huxley and Taylor 1977:Fig. 494.
Figure 10: Drawing of *Rhus coriaria*. After Polunin and Huxley 1987:Fig. 358.
Figure 11: First year woad plants ready for dyeing. After Dean 1998:61.

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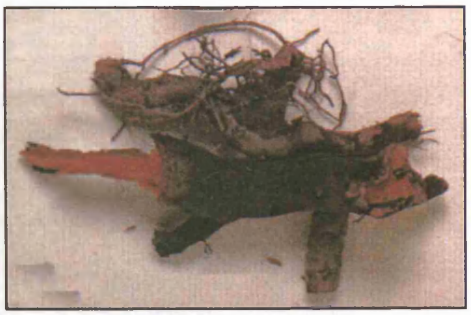

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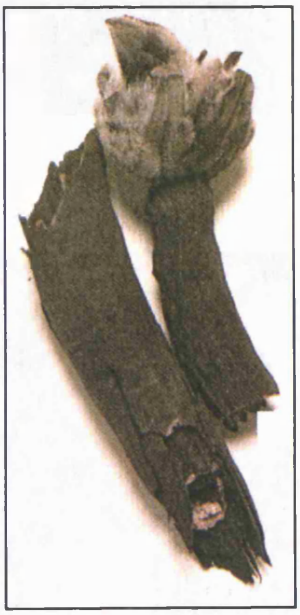

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Figure 12: Madder plant. After Dean 1998:59.
Figure 13: Madder root. After Dean 1998:34.
Figure 14: Drawing of *Anchusa tinctoria*. After Polunin and Huxley 1987:Fig. 388.
Figure 15: Alkanet root. After Dean 1998:34.

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Figure 16: Drawing of *Punica granatum*. After Polunin and Huxley 1987:Fig. 364.
Figure 17: Flowers of *Punica granatum*. After Huxley and Taylor 1977:Fig. 178.
Figure 18: Safflower flower heads ready for dyeing. After Dean 1998:63.

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Figure 19: Weld in flower. After Dean 1998:60.
Figure 20: Onion skins. After Dean 1998:35.
Figure 21: *Spartium junceum*. After Polunin and Huxley 1987:Fig. 56.
Figure 22: Drawing of young fustic. After Polunin and Huxley 1987:Fig. 357.
Figure 23: Young fustic. After Huxley and Taylor 1977:Fig. 141.

Figure 24: Scenes of wool production including spinning and weaving from an Attic black figure lekythos (c. 560 BC). After Barber 1992: Fig. 2.38.

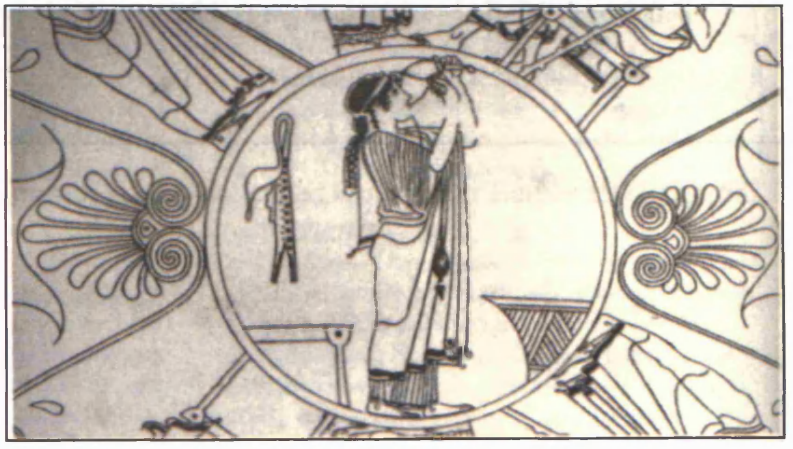


Figure 25: Girl spinning with a drop spindle with thread in her mouth from a vase found at Orvieto, Italy (early 5th century BC). After Barber 1992:Fig. 2.36.

Figure 26: Penelope in front of her warp weighted loom from a red figure vase found at Chiusi, Italy (early 5th century BC). After Barber 1992:Fig. 3.26.

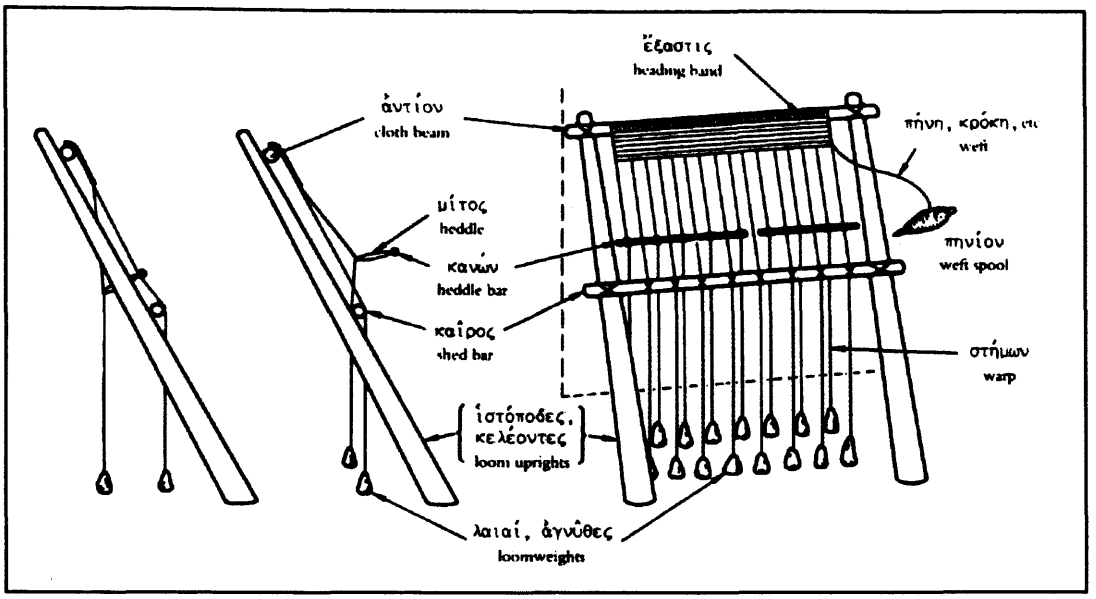


Figure 27: Diagram of a warp-weighted loom. After Barber 1992:Fig. 68.

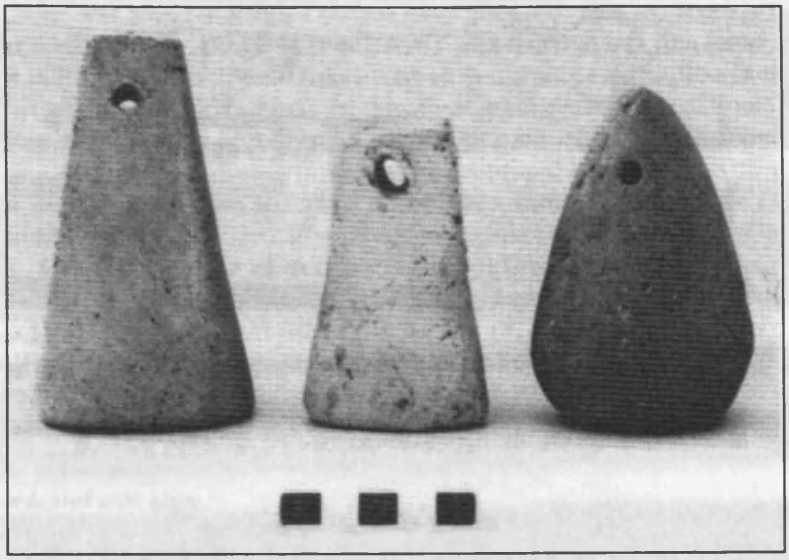
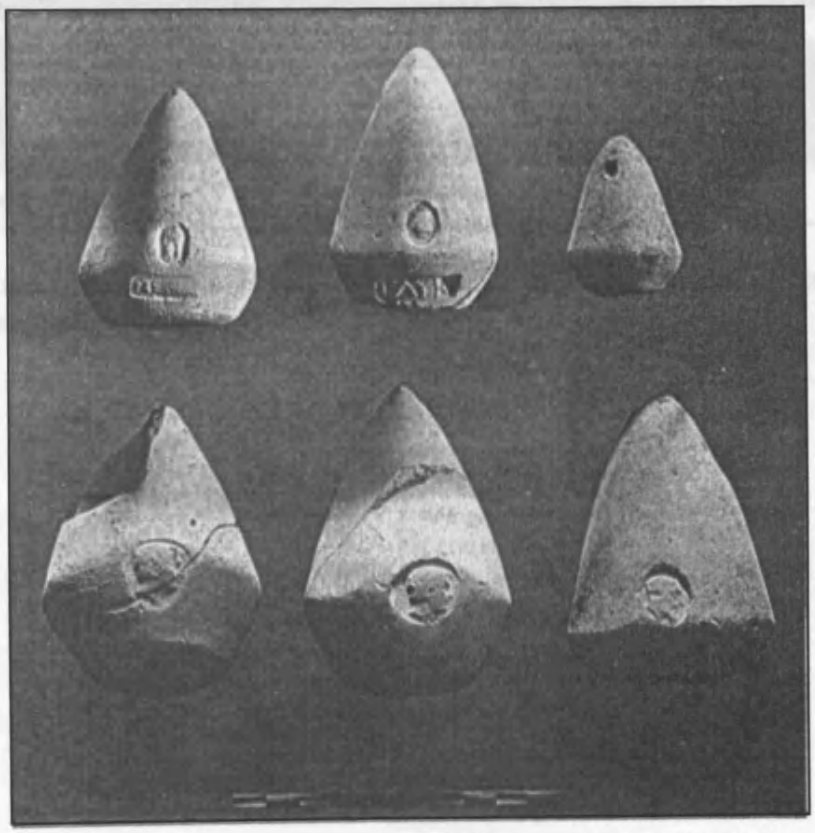


Figure 28: Loomweights from the Citadel House Area, Mycenae. After Bowkett 1995:Plate 10

Figure 29: Loomweights from the Rachi settlement, Isthmia. After Broneer 1955:Plate 56



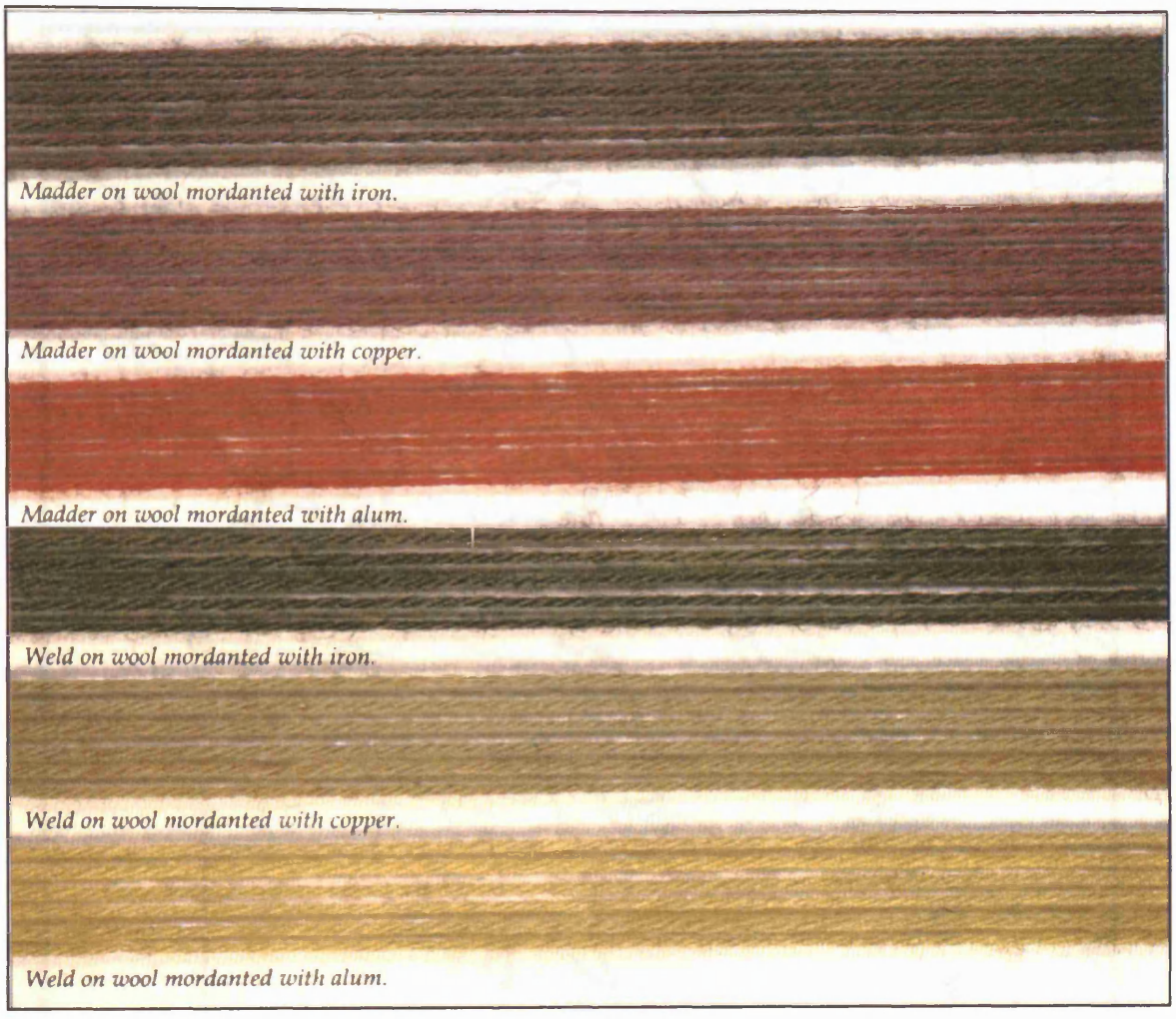


Figure 30: Examples of the range of shades and colours produced with different combinations of dyes and mordants. After Dean 1998:27.

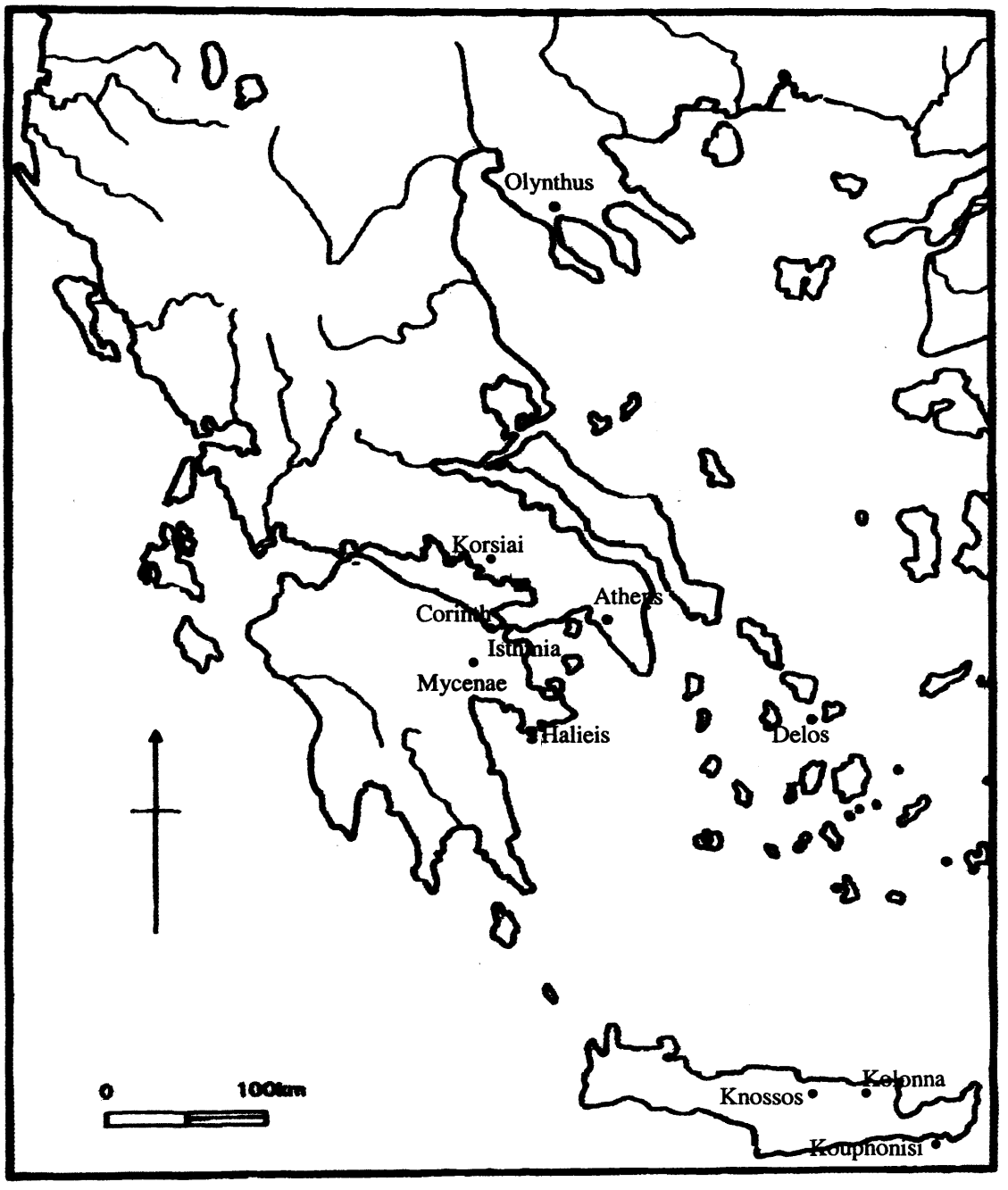


Figure 31: Map of Greece showing the location of dyeworks sites.

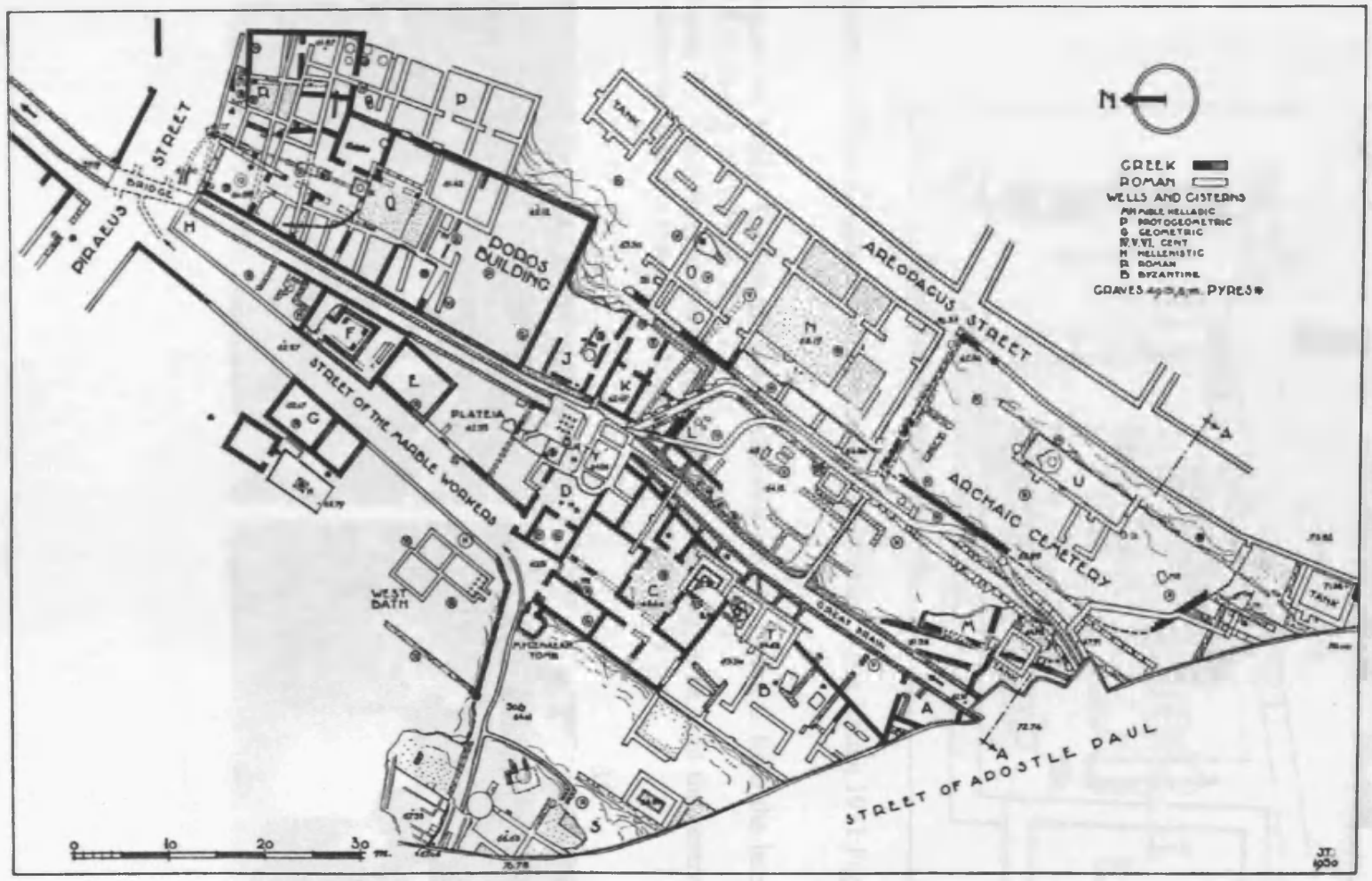


Figure 32: Plan of the 'Industrial District' of Athens at the north-western foot of the Areopagus. After Young 1951:Fig. 1.

Plate 13

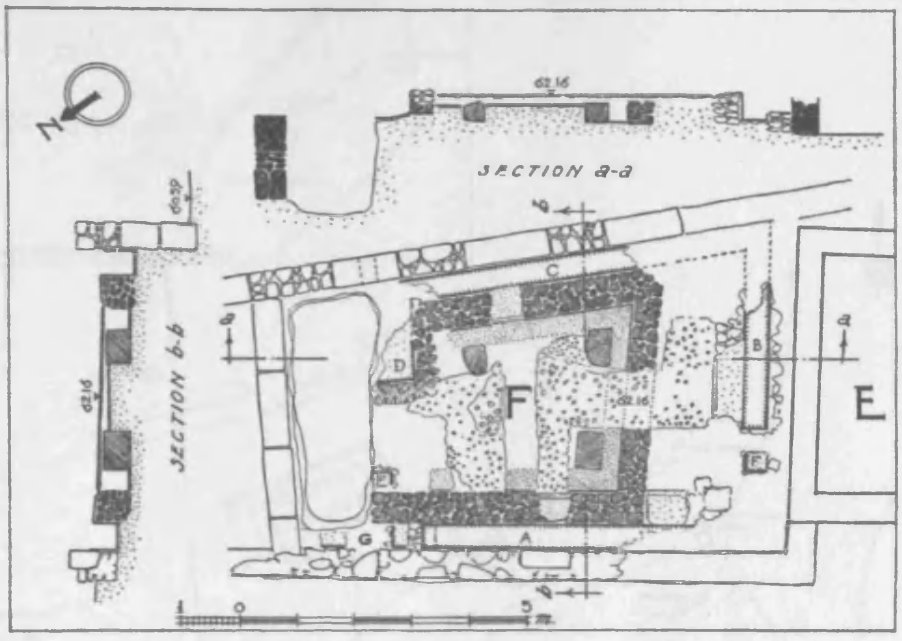


Figure 33: Plan of house F, Athens 'Industrial District'. After Young 1951:Fig. 14.

Figure 34: House F from the south, showing vats A, B and C from the later period of use. After Young 1951:Plate 74 c.
Figure 35: Workshop to the north of house F: the large tank is in the centre; the end of the smaller vat is at the lower left. After Young 1951:Plate 74 d.

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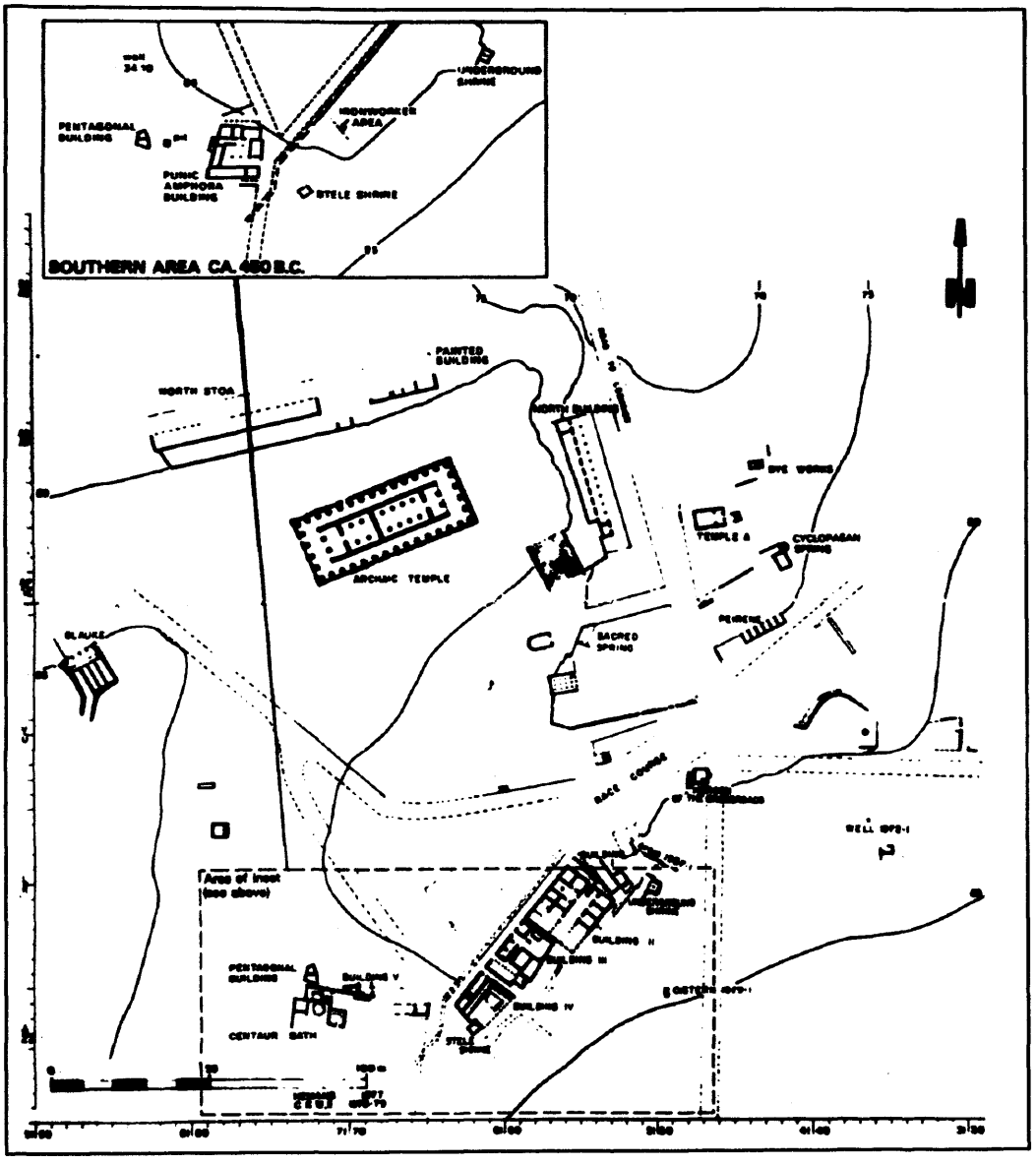


Figure 36: Central Corinth, c. 400 BC. After Salmon 1984:Fig. 16

Figure 37: Peribolos of Apollo dyeworks, Corinth, from east.

Figure 38: Peribolos of Apollo dyeworks, Corinth, from north-east.

Figure 39: Peribolos of Apollo dyeworks, Corinth: 'basin' in the western room from east.

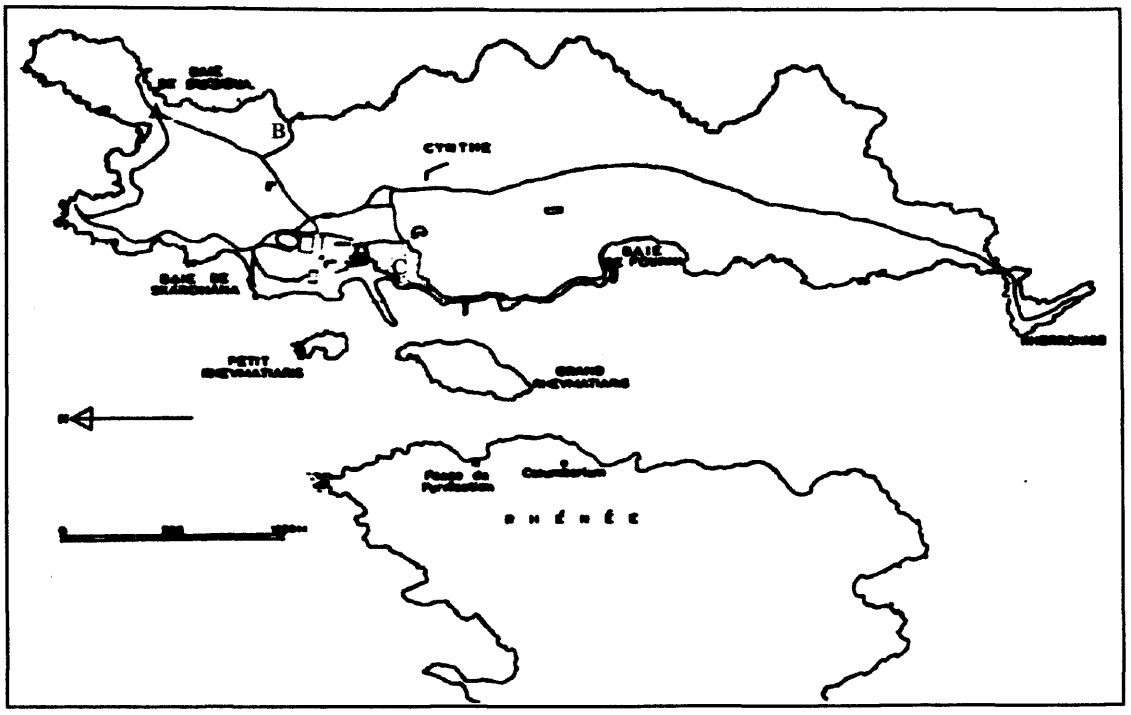


Figure 40: Map of Delos, showing dyeing sites: A – East Coast North Establishment; B – East Coast South Establishment; C – Theatre Quarter houses. After Bruneau and Ducat 1965:Fig. 1

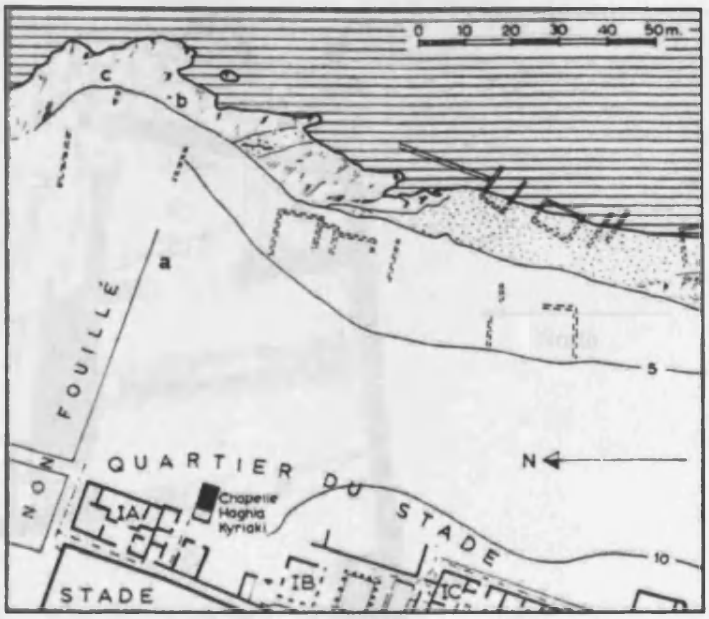
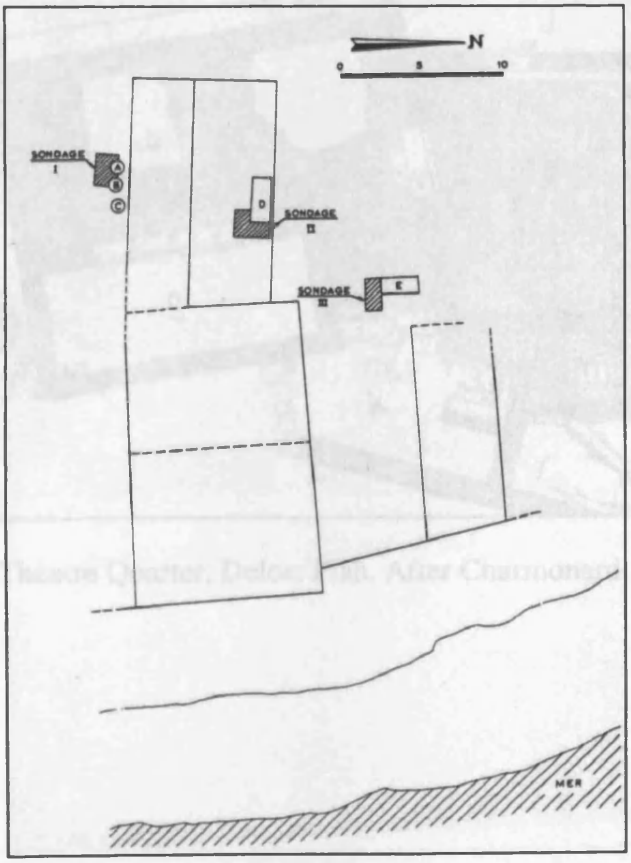


Figure 41: 'North Eastablishment', east coast, Delos. Plan showing: a - location of granite blocks; b and c – location of deposits of crushed purple shells. After Bruneau 1978:Fig. 1.

Figure 42: 'South Establishment', Delos. Plan of site showing installations and trenches. Continuous lines represent walls visible on the surface; dotted lines represent the probable courses of walls which could not be seen. After Bruneau 1969:Fig. 4.



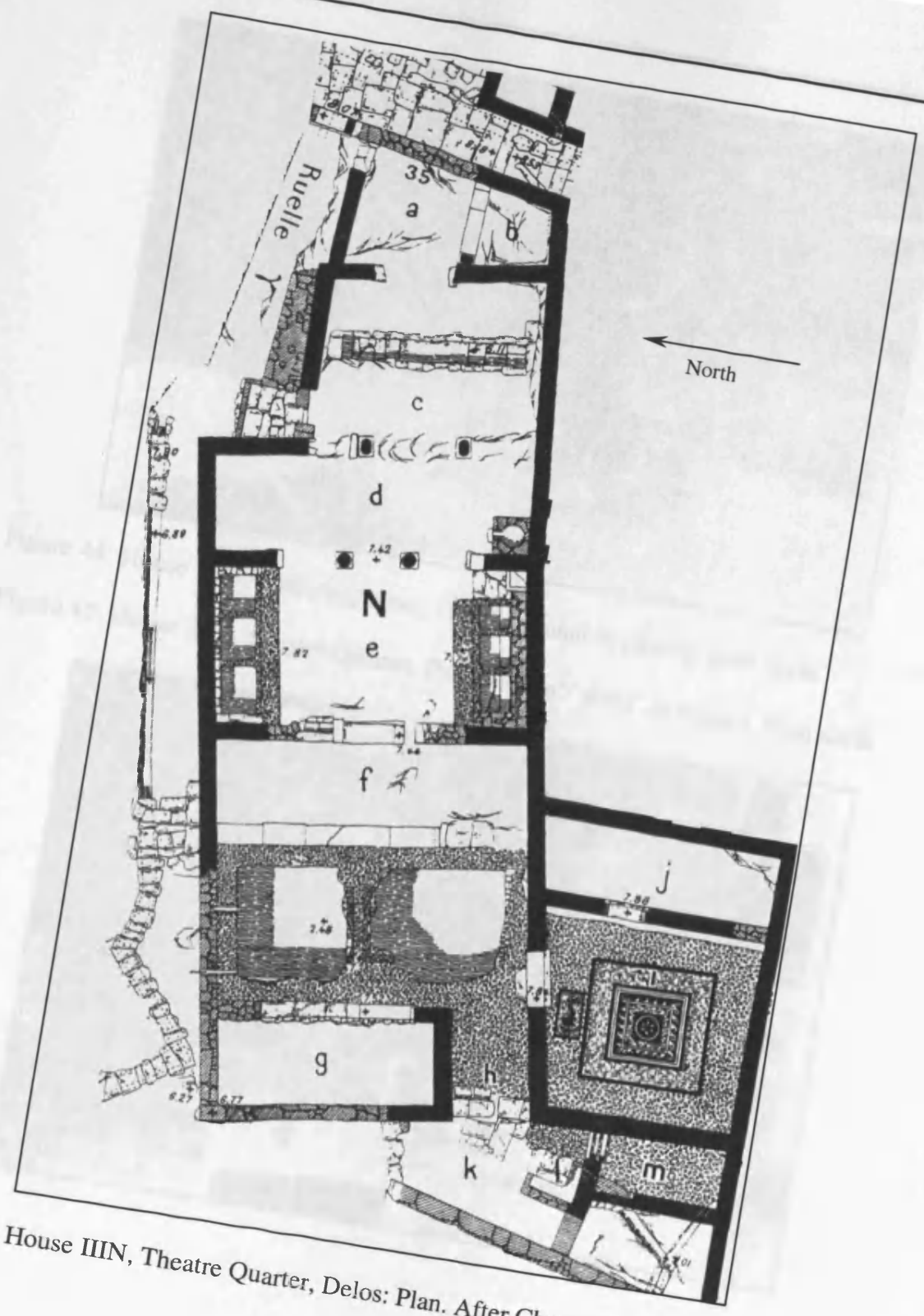


Figure 43: House IIIN, Theatre Quarter, Delos: Plan. After Charmonard 1922:Plates V-VI

Figure 44: House IIIN, Theatre Quarter, Delos: channel in room c, from north.

Figure 45: House IIIN, Theatre Quarter, Delos: 'oven'/'press' in room d, from north

Figure 46: House IIIN, Theatre Quarter, Delos: vats on the north side of room d, from south

Figure 47: House IIIN, Theatre Quarter, Delos: vats on the south side of room d, from north

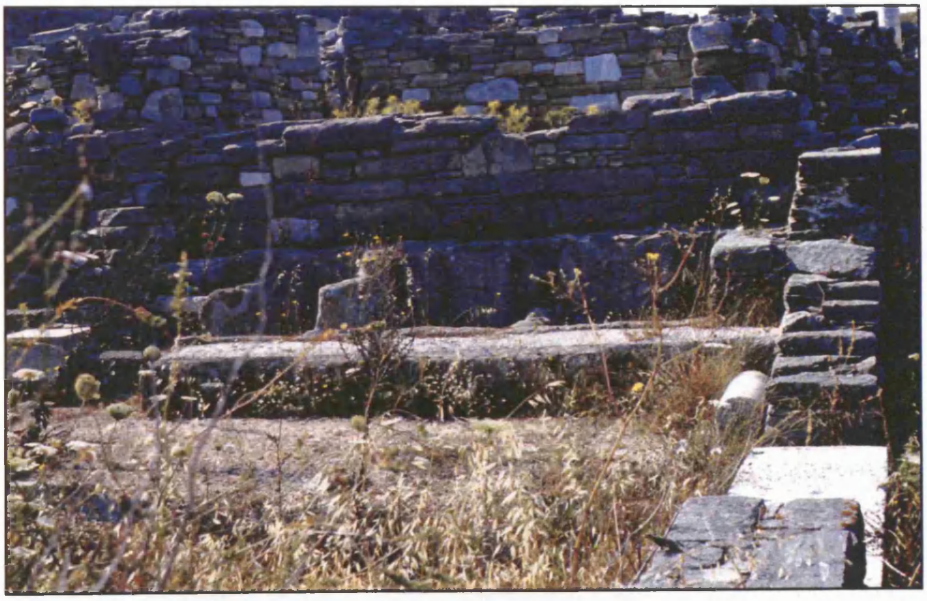


Figure 48: House IIIN, Theatre Quarter, Delos: cisterns in court f, from south-east

Figure 49: House IIIN, Theatre Quarter, Delos: rooms i (foreground) and j (background), from west

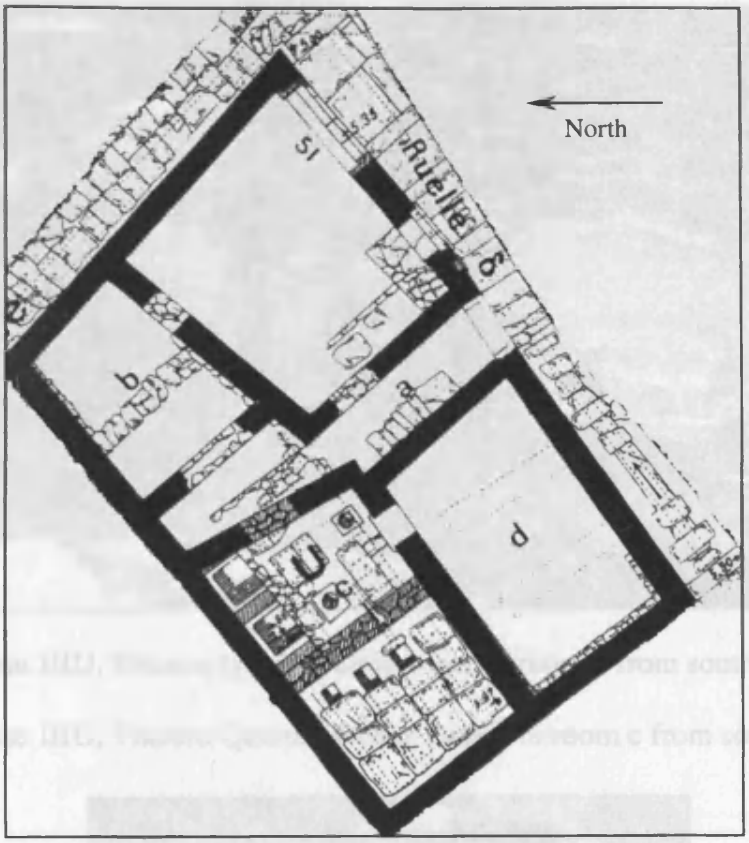


Figure 50: House IIIU, Theatre Quarter, Delos: Plan. After Charmonard 1922:Plates V-VI

Figure 51: House IIIU, Theatre Quarter, Delos: vats in room c from south-east.

Figure 52: House IIIU, Theatre Quarter, Delos: cistern in room c from south-east.

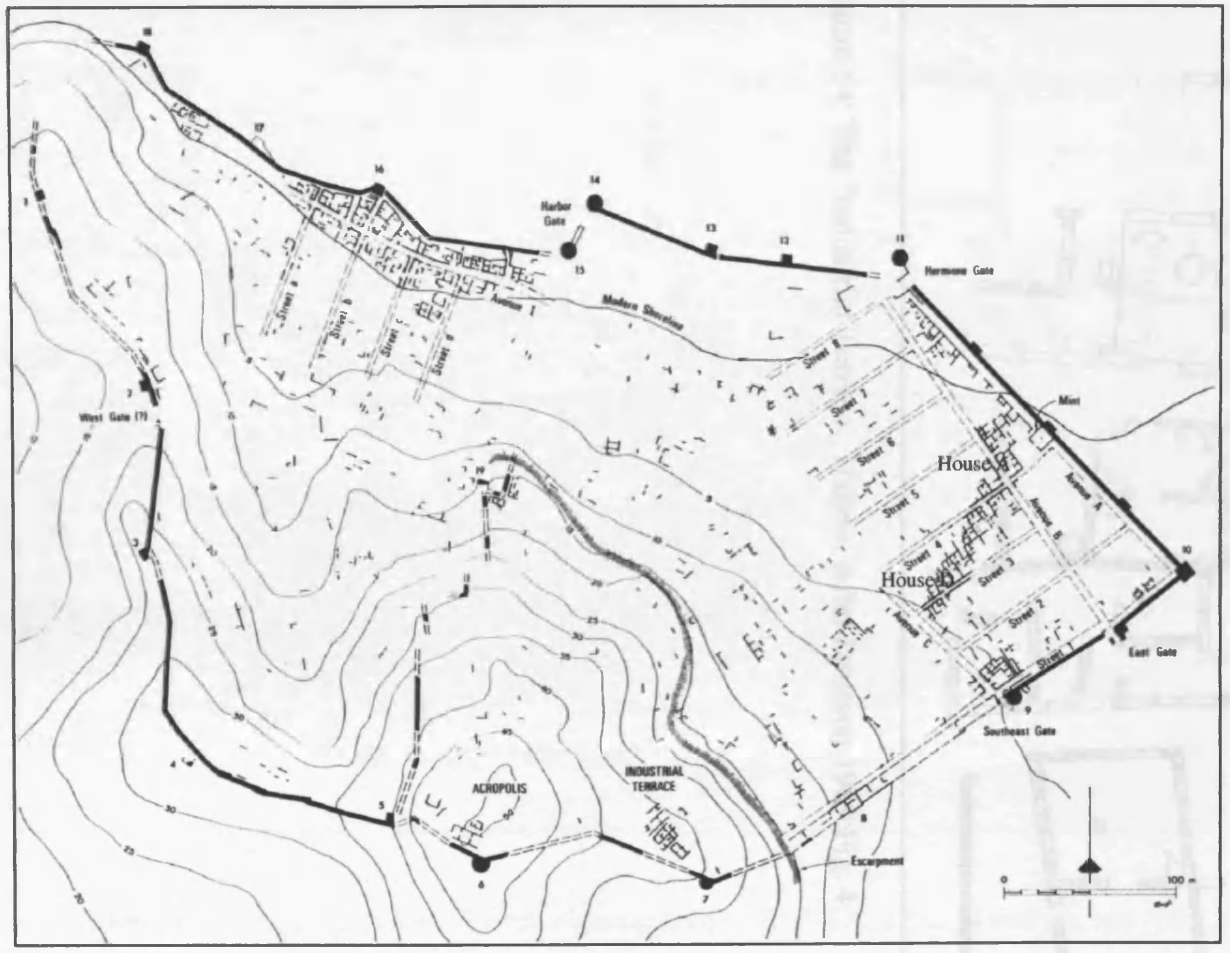


Figure 53: Ancient Halieis. After Boyd and Rudolph 1978:Plate 87

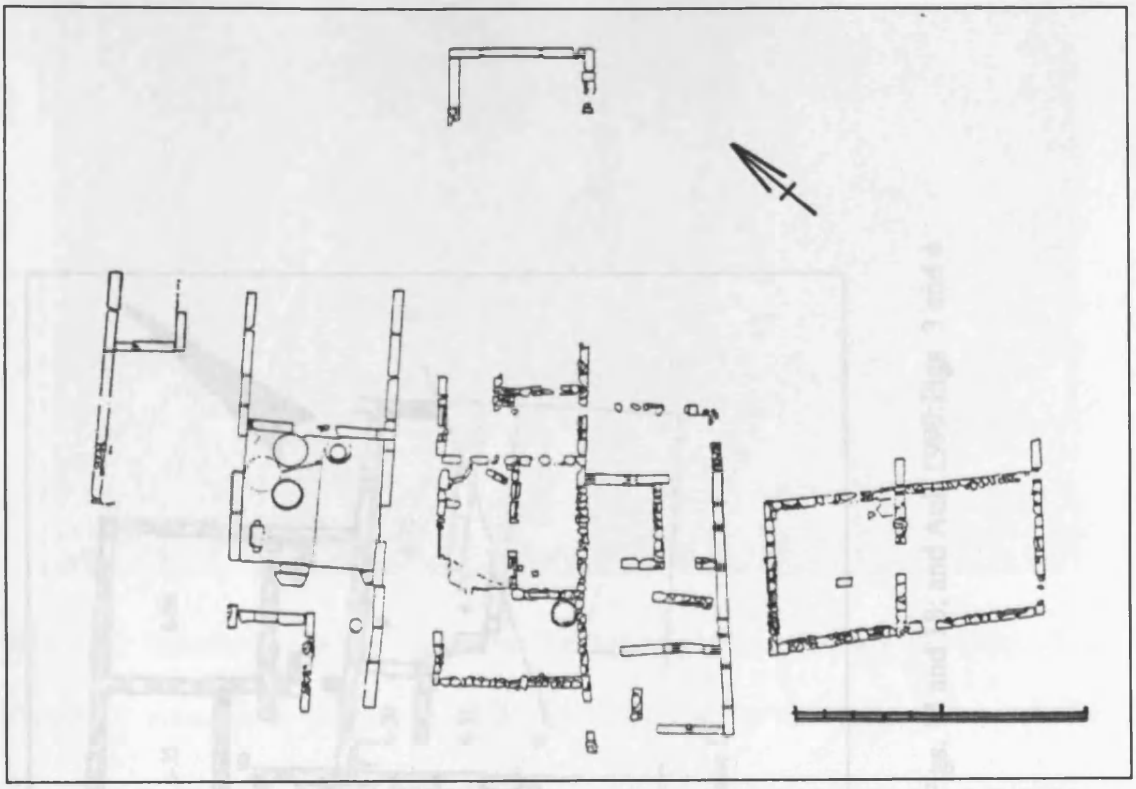


Figure 54: The 'Industrial Terrace', Halieis. After Jameson 1969:Fig. 4

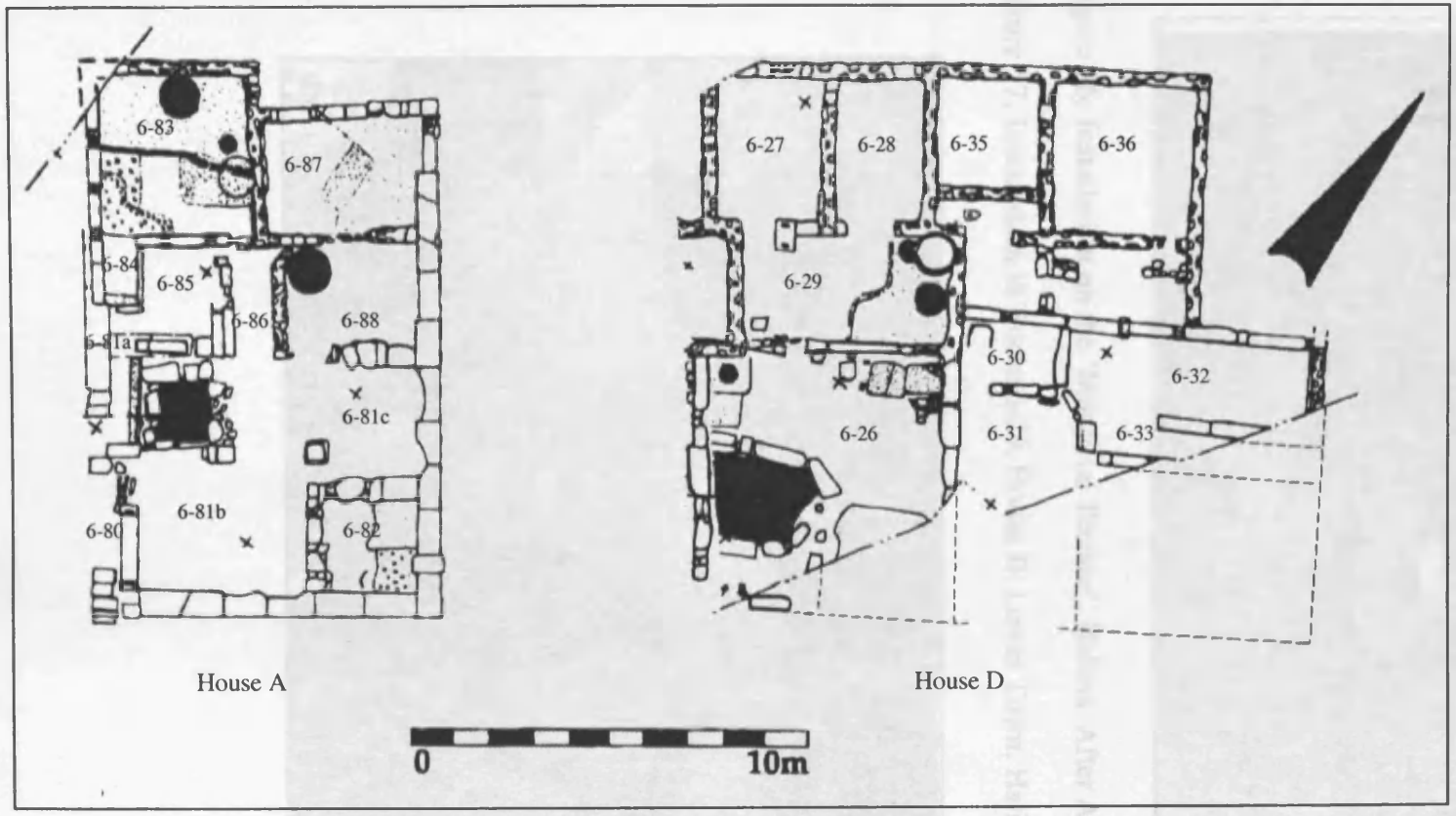


Figure 55: House A and House D, Lower Town, Halieis. After Ault 1994a:Figs. 14 and 18; and Ault 1999:Figs. 3 and 4

Figure 56: Installation on the 'Industrial Terrace', Halieis. After Ault 1999:Fig. 15

Figure 57: Installation in Room 6-29, House B, Lower Town, Halieis. After Ault 1999:Fig. 12

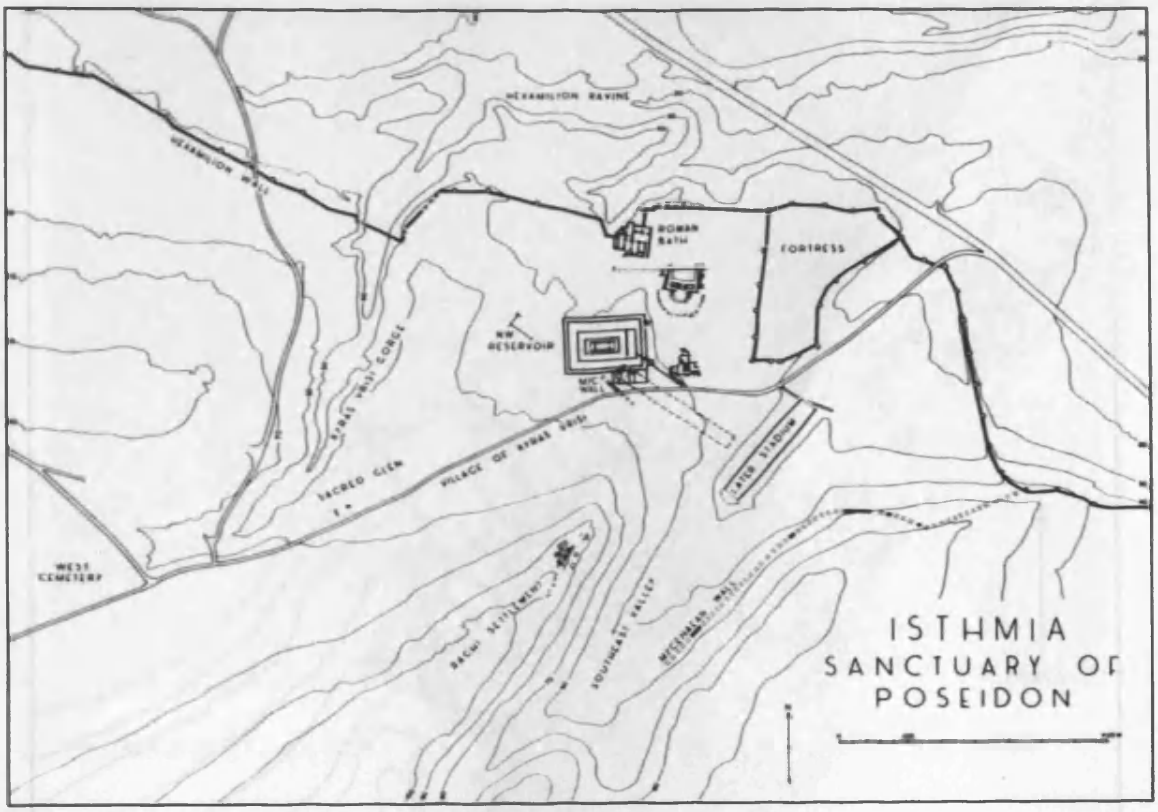


Figure 58: Map showing the location of the Rachi settlement in relation to the Sanctuary of Poseidon at Isthmia. After Anderson-Stojanovic 1996:Fig. 1

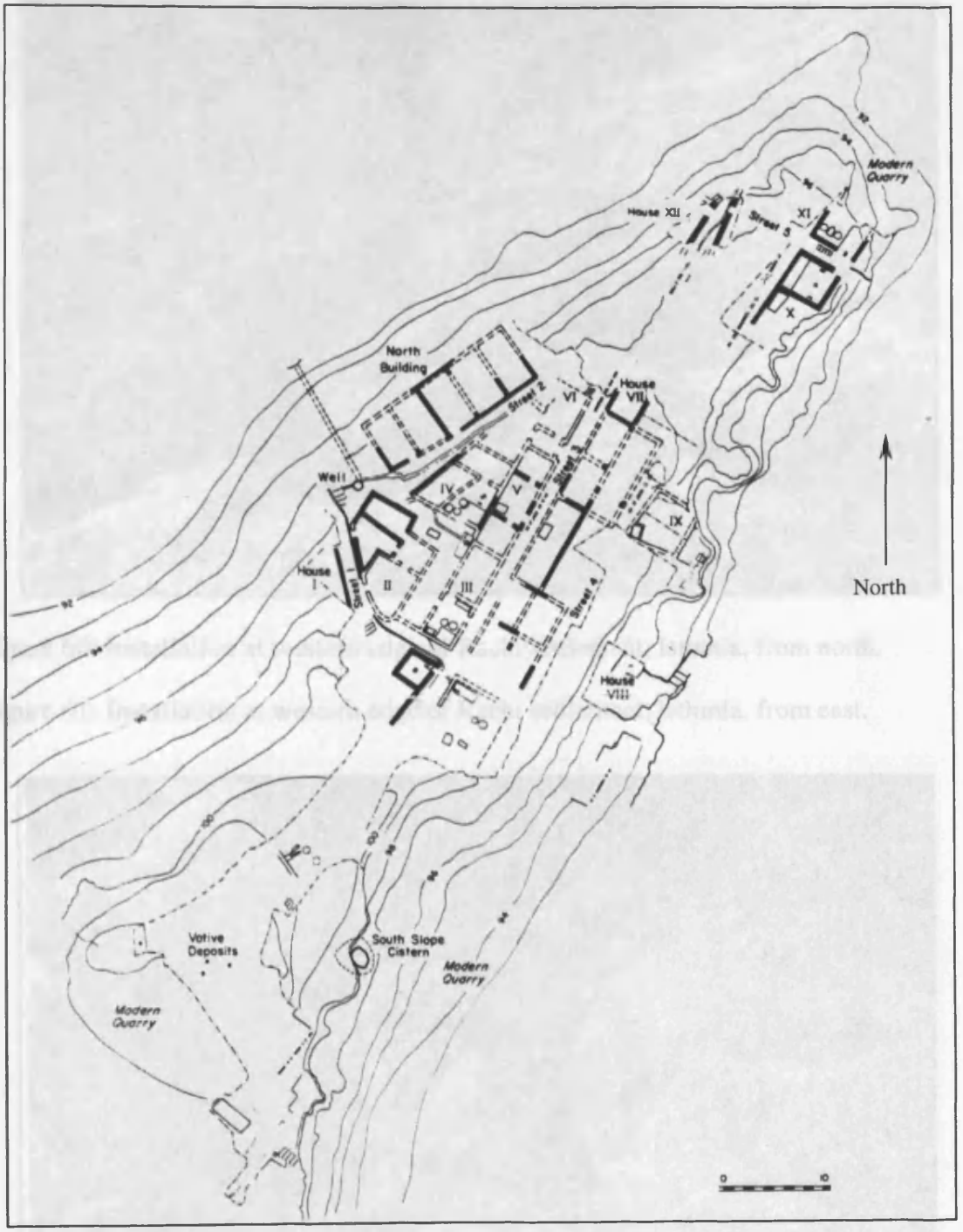


Figure 59: Rachi settlement, Isthmia: Partially restored plan. After Anderson-Stojanovic 1996:Fig. 3

Figure 60: Installation at western edge of Rachi settlement, Isthmia, from north.

Figure 61: Installation at western edge of Rachi settlement, Isthmia, from east.

Figure 62: House III room A, Rachi settlement, Isthmia, from west

Figure 63: House III room A, Rachi settlement, Isthmia, from east

Figure 64: House IV, Rachi settlement, Isthmia, vats in west part of court looking north.

Figure 65: House IV, Rachi settlement, Isthmia, court looking north.

Figure 66: House XI room A, Rachi settlement, Isthmia, looking east from Street 5

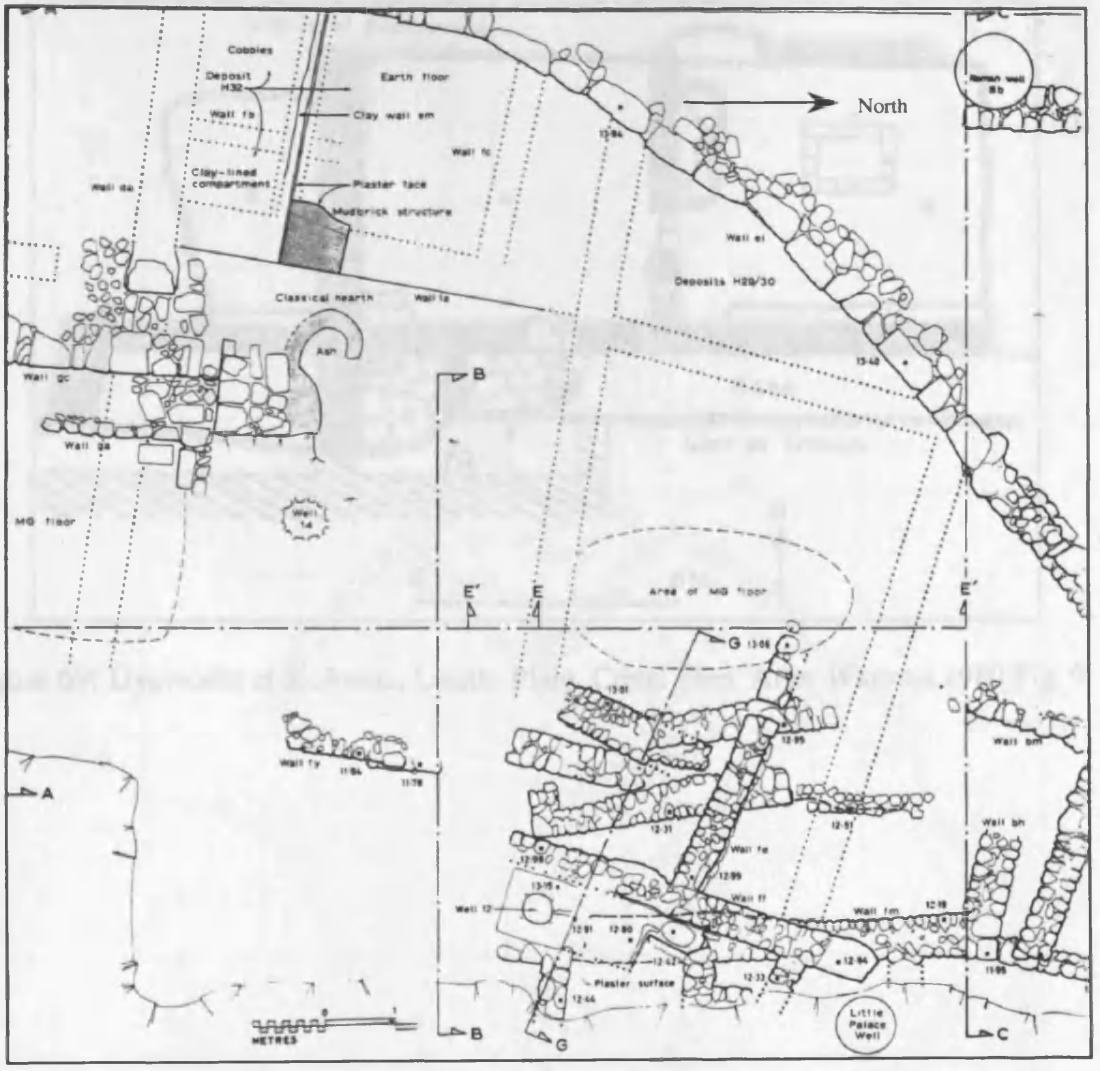


Figure 67: Unexplored Mansion, Knossos: Plan. After Sackett 1992:Plate 2

Figure 68: South-East House, Unexplored Mansion, Knossos: Cistern and Basin. After Sackett 1992:Plate 29b

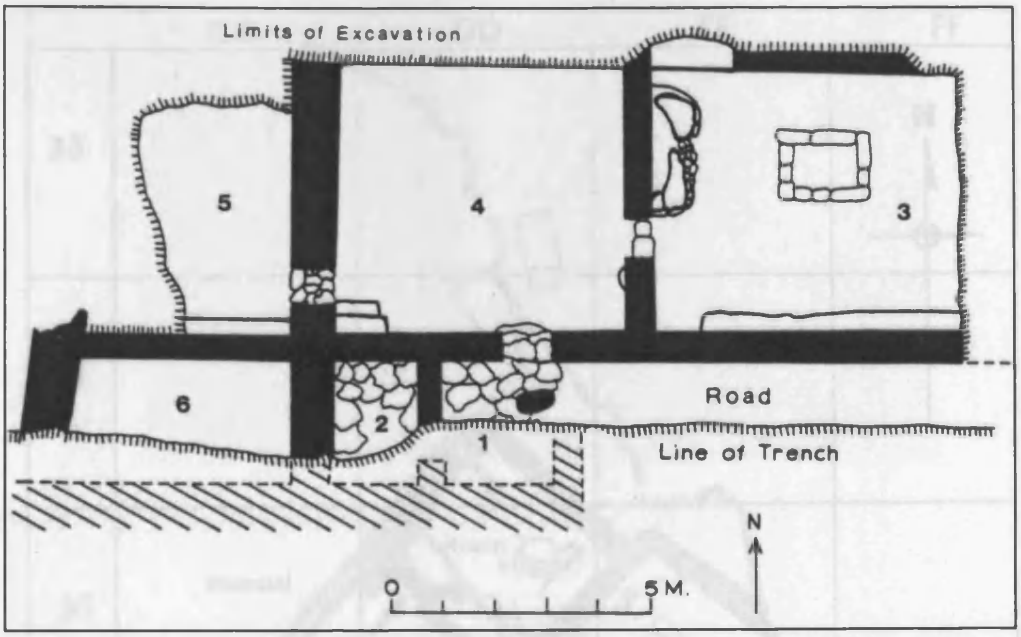


Figure 69: Dyeworks at Kolonna, Lasithi Plain, Crete: Plan. After Watrous 1980:Fig. 9

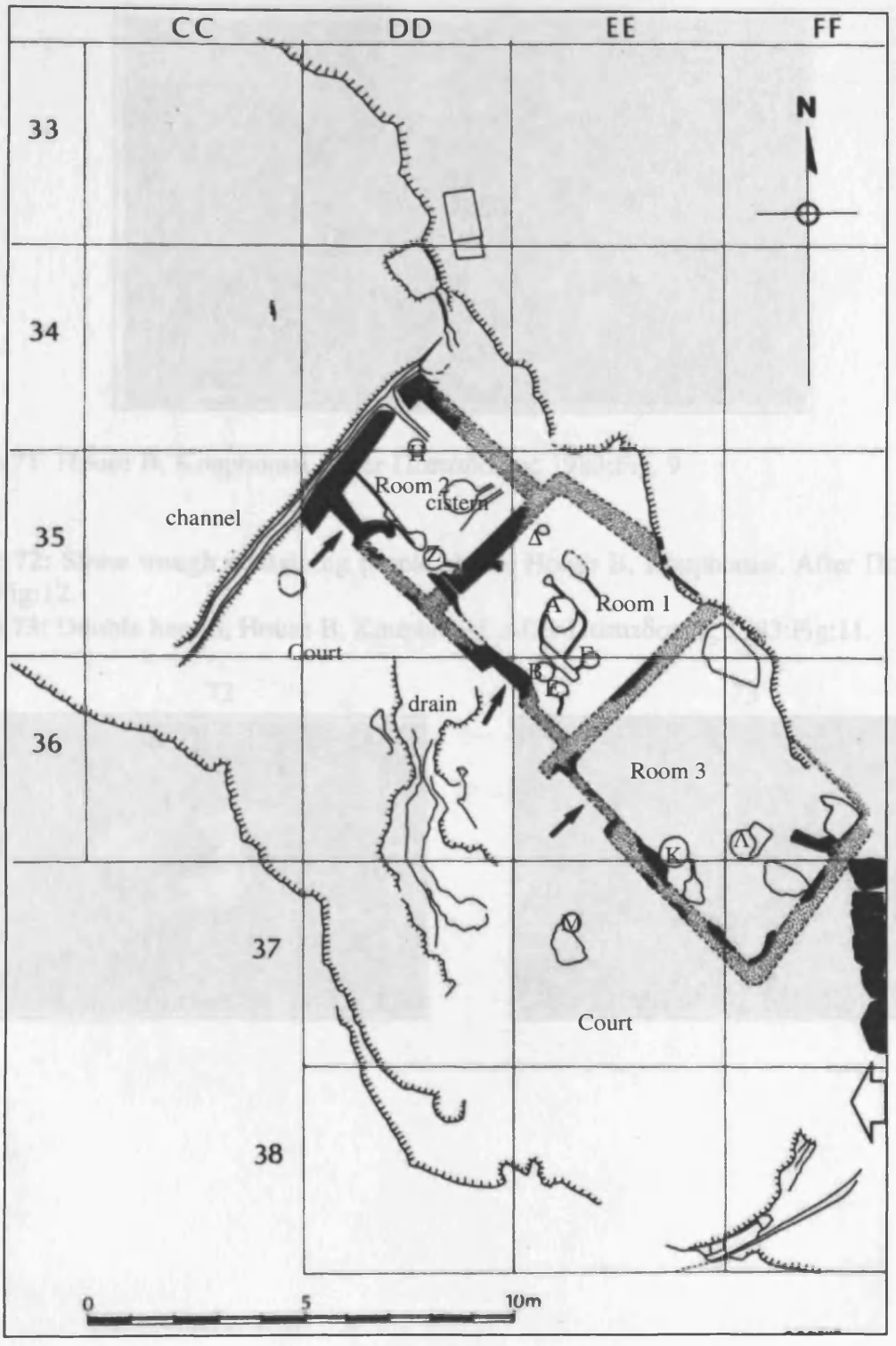


Figure 70: South Industrial Area, Korsiai: Restored Plan. After Fossey and Morin 1986:Fig. 40

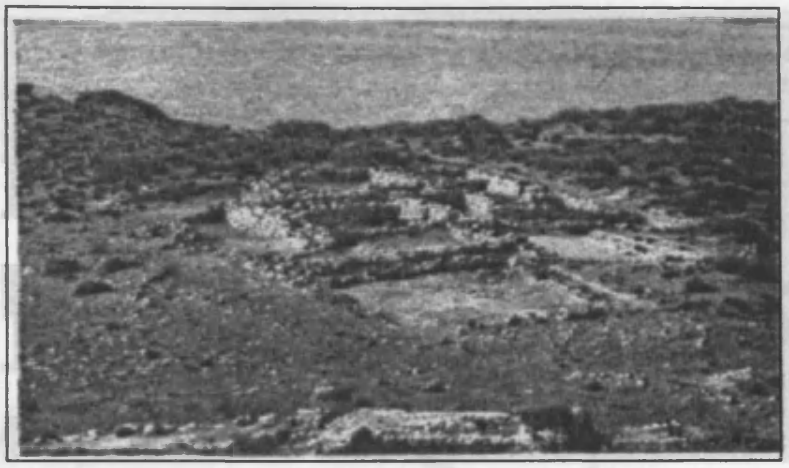


Figure 71: House B, Kouphonisi. After Παπαδακης 1983:Fig. 9

Figure 72: Stone trough containing purple shells, House B, Kouphonisi. After Παπαδακης 1983:Fig:12.
Figure 73: Double hearth, House B, Kouphonisi. After Παπαδακης 1983:Fig:11.

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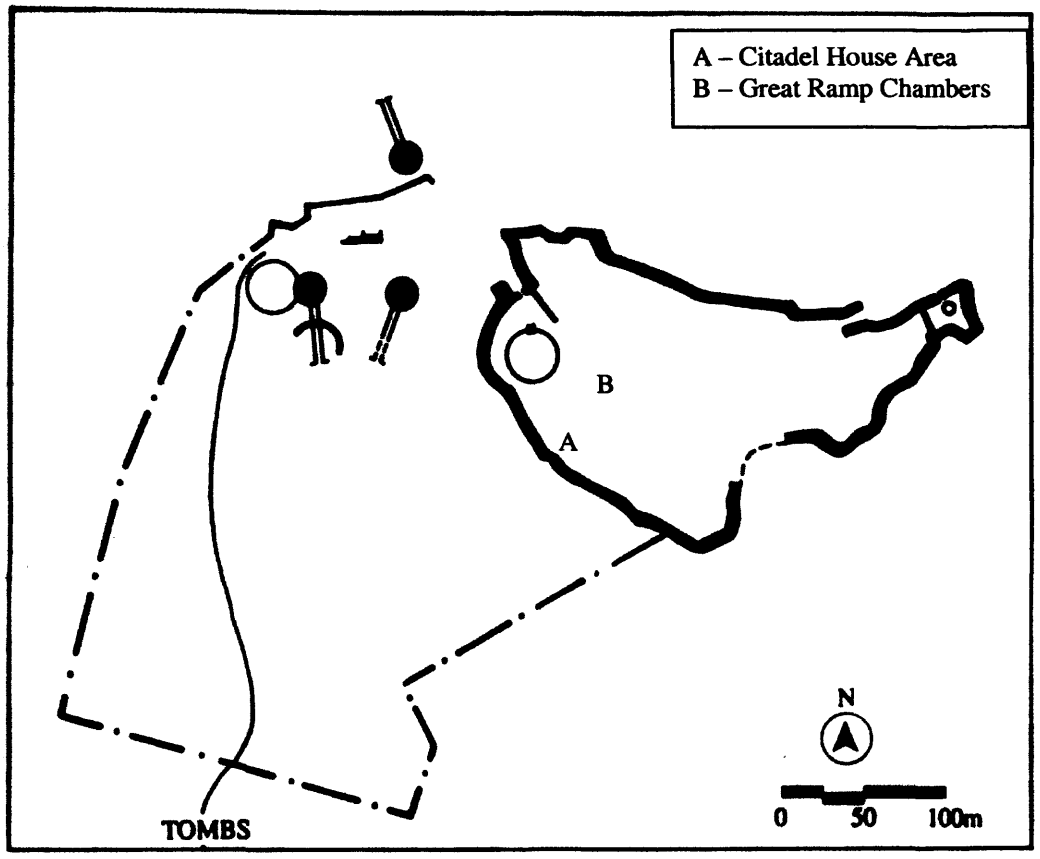

Figure 74: Mycenae, showing the location of the Citadel House Area and the Great Ramp chambers. After Bowkett 1995:Fig. 1

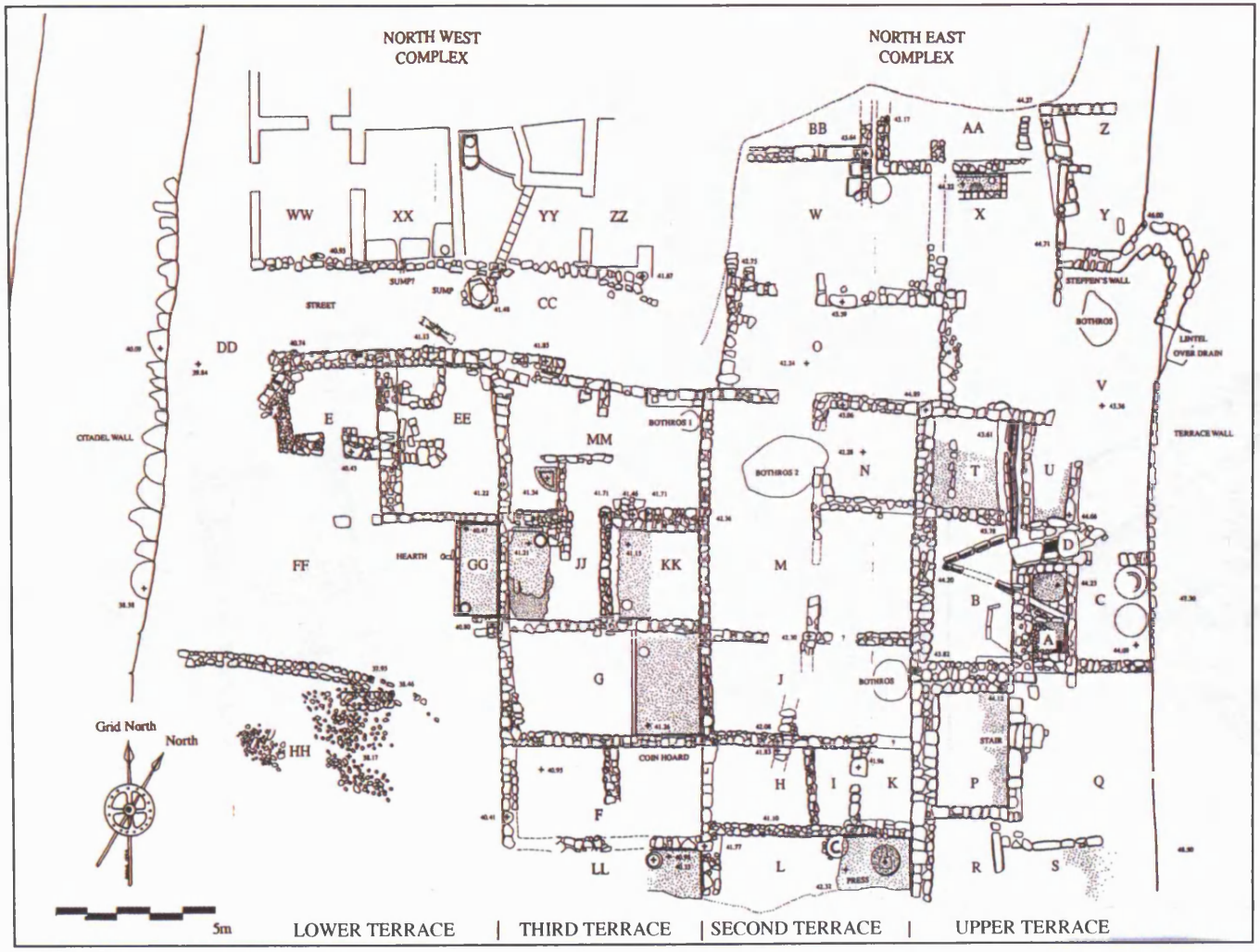

Figure 75: The Citadel House Area, Mycenae. After Bowkett 1995:Fold-out plan

Plate 41

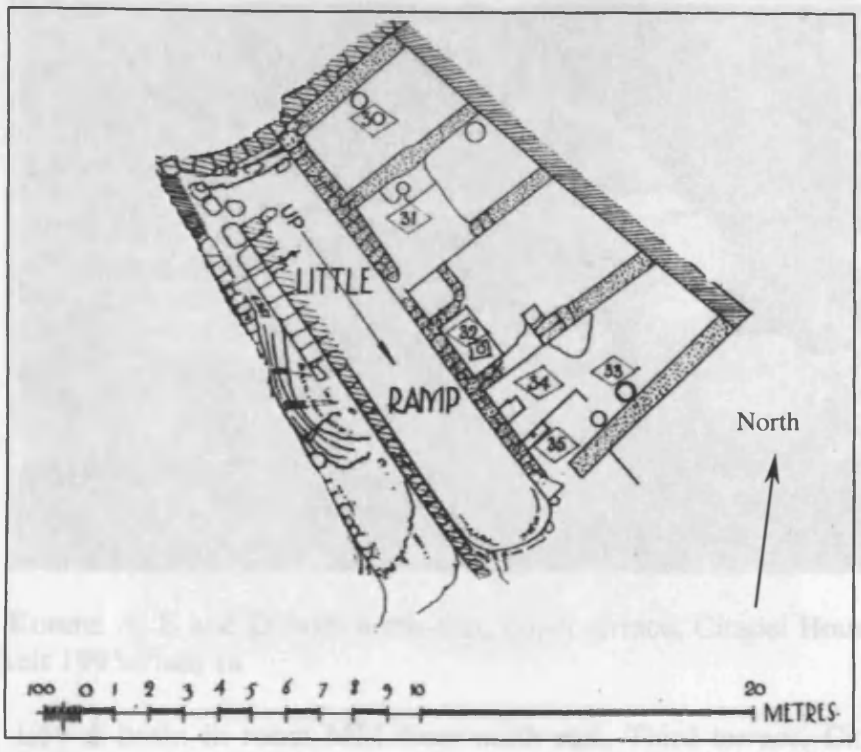

Figure 76: 'Hellenistic Chambers' close to the Great Ramp, Mycenae: Plan. After Wace 1923:Plate 1.

Figure 77: Hellenistic Buildings over the South House, Mycenae: Plan. After Wace 1923:Fig. 22.

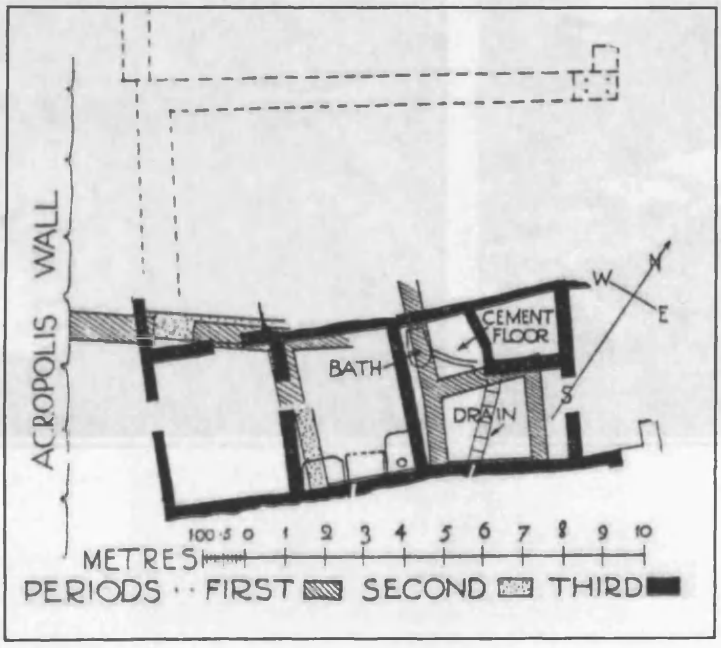

Figure 78: Rooms A, B and D from north-east, upper terrace, Citadel House Area, Mycenae. After Bowkett 1995:Plate 1a

Figure 79: Lower basin in room MM from north-east. Third terrace, Citadel House Area, Mycenae. After Bowkett 1995:Plate 4

Figure 80: Upper basin in room MM from east. Third terrace, Citadel House Area, Mycenae. After Bowkett 1995:Plate 4

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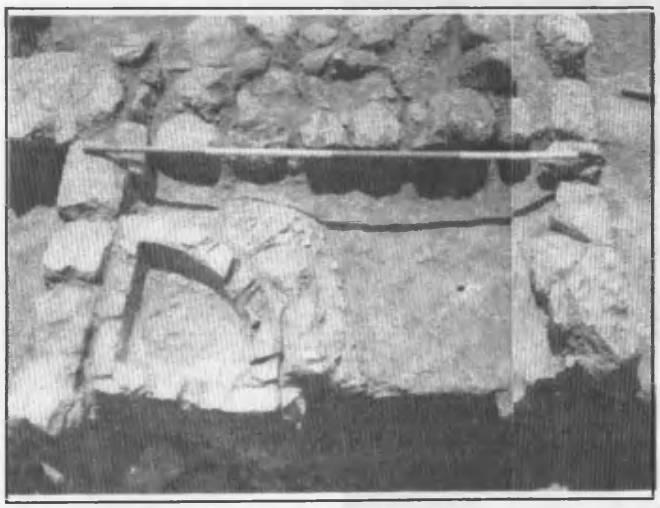

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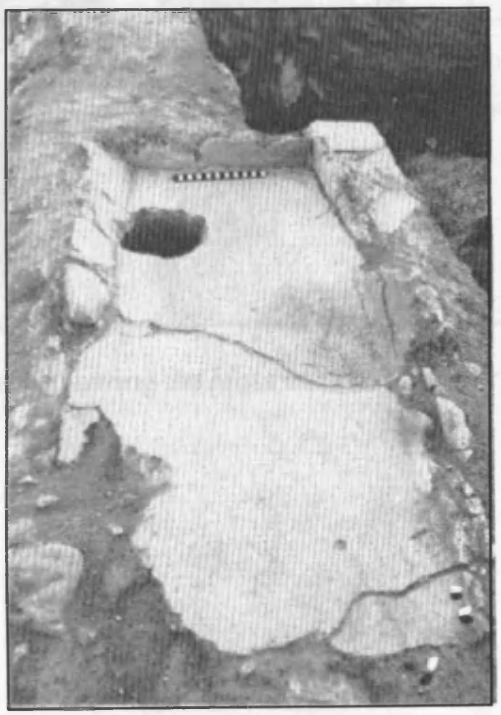
Figure 81: Plaster floors in rooms GG and JJ from north, Citadel House Area, Mycenae. After Bowkett 1995:Plate 6a

Figure 82: Plaster basin in room X from south-west, Citadel House Area, Mycenae. After Bowkett 1995:Plate 9a



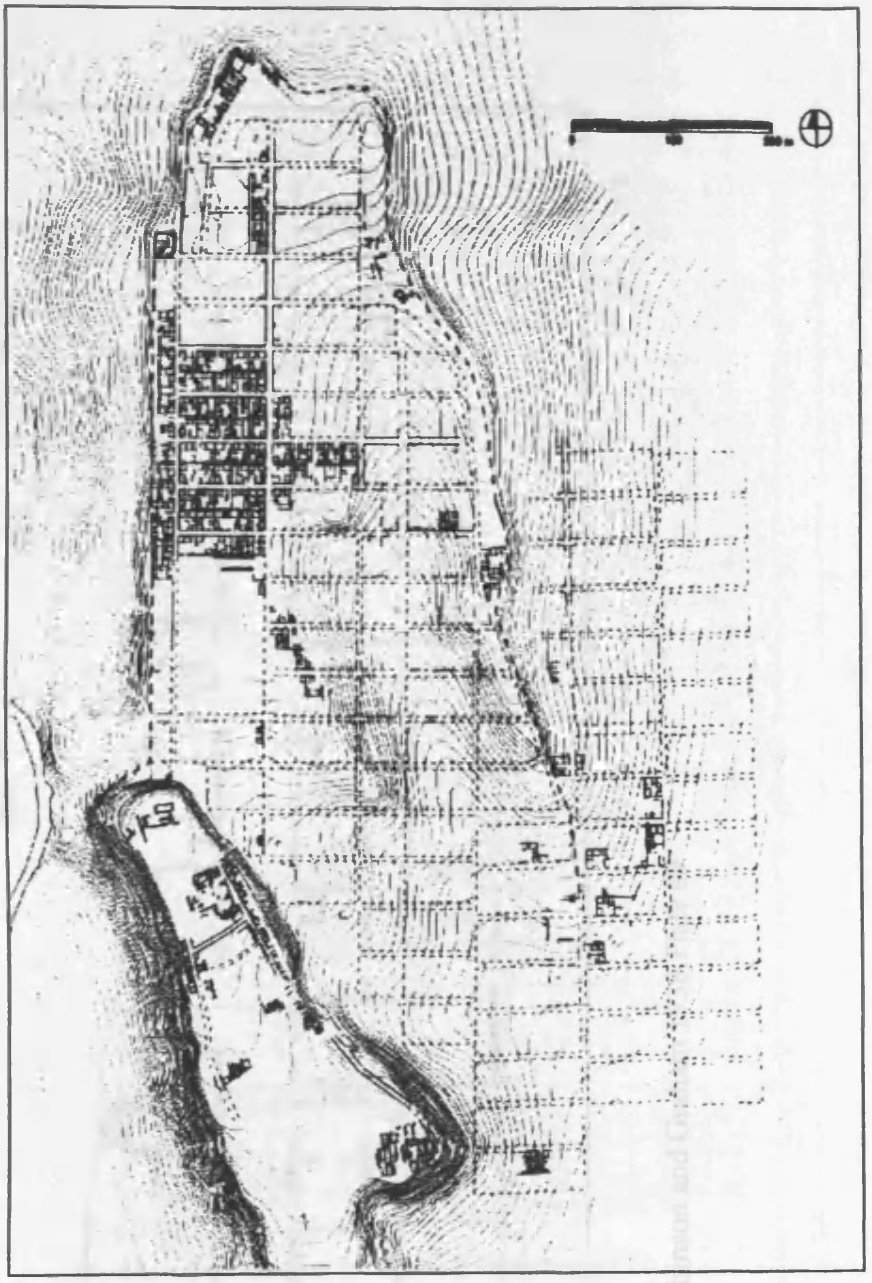


Figure 83: Plan of Olynthus, showing the areas excavated. After Cahill 2000:Fig. 1.

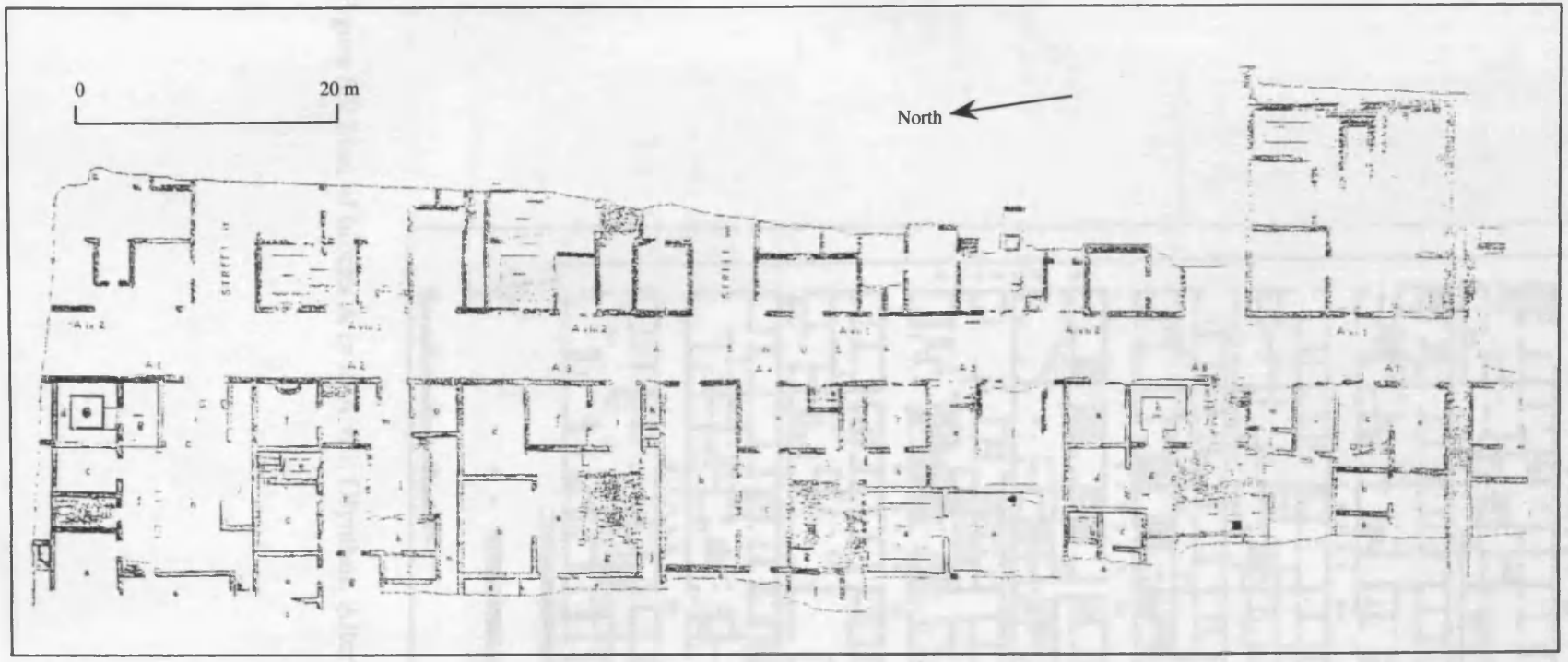


Figure 84: Row A, Olynthus. After Robinson and Graham 1938:Plate 89

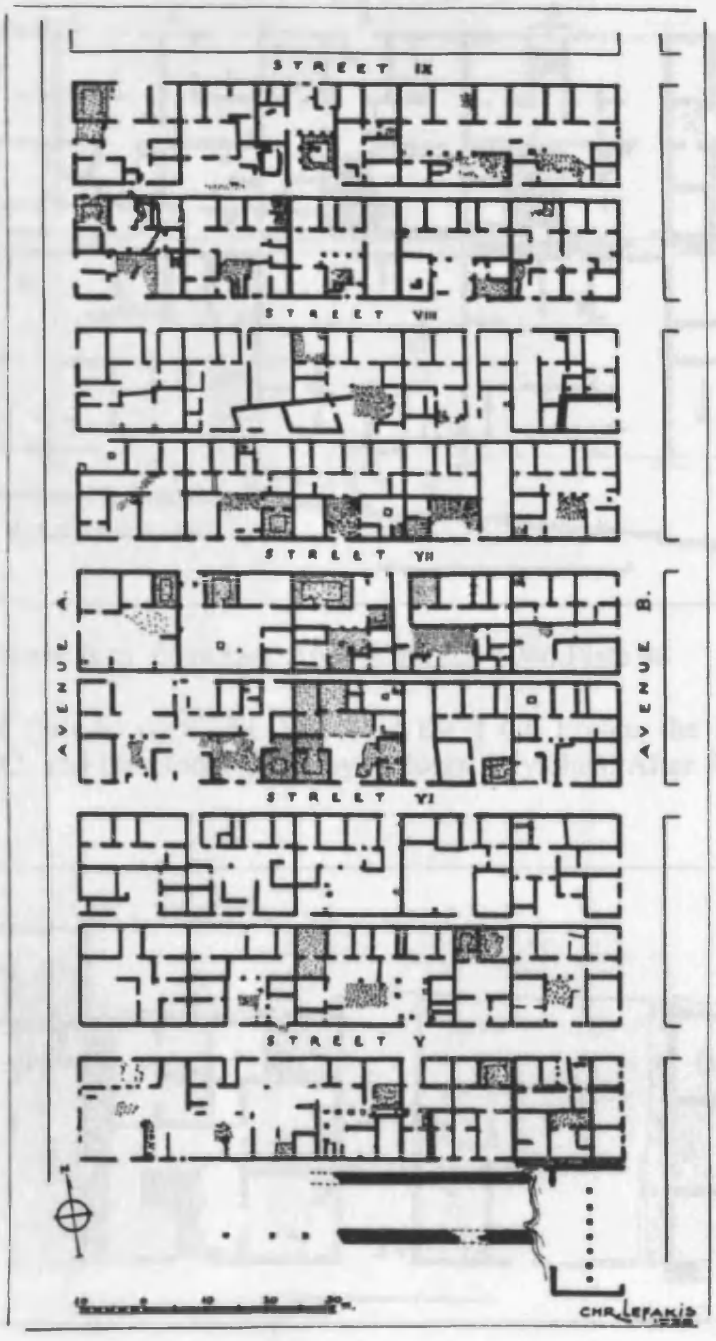


Figure 85: Plan of blocks A iv to A viii, Olynthus. After Robinson 1946:Plate 1

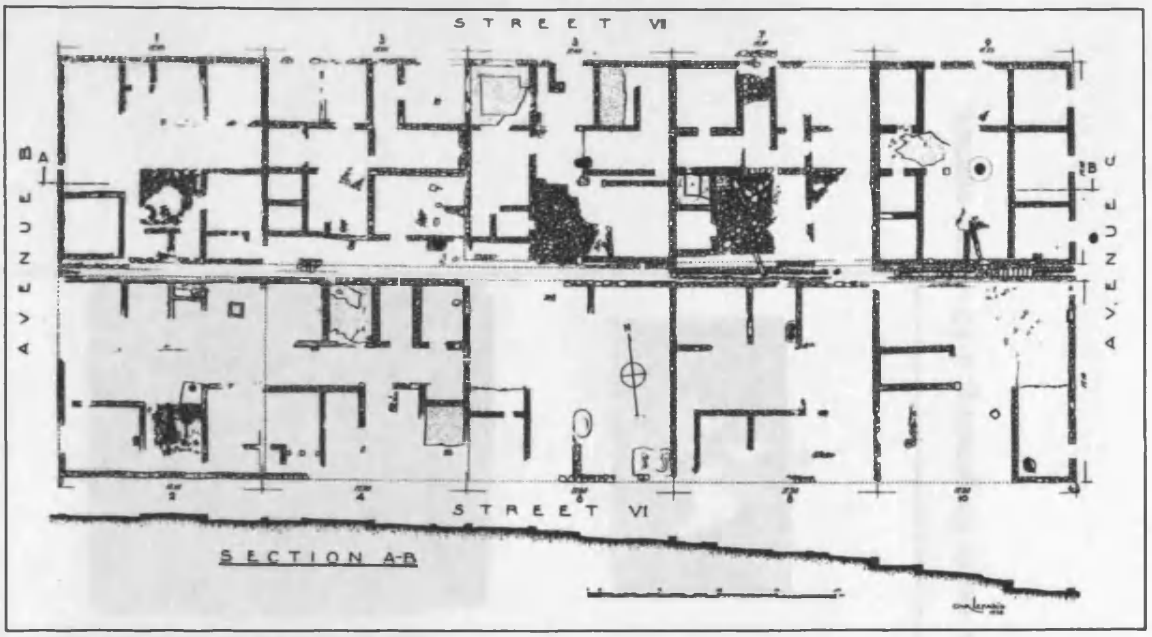
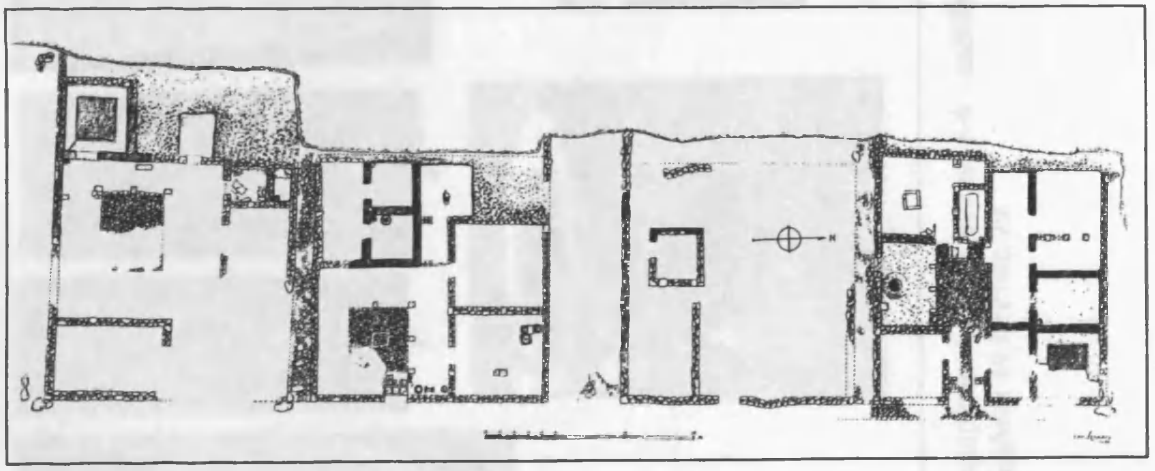


Figure 86: Plan of block B vi, Olynthus. After Robinson 1946:Plate 98

Figure 87: Plan of (left to right) the House of the Twin Erotes, the House of the Tiled Prothyron, Villa CC, and the House of Many Colours, Olynthus. After Robinson 1946:Plate 196.



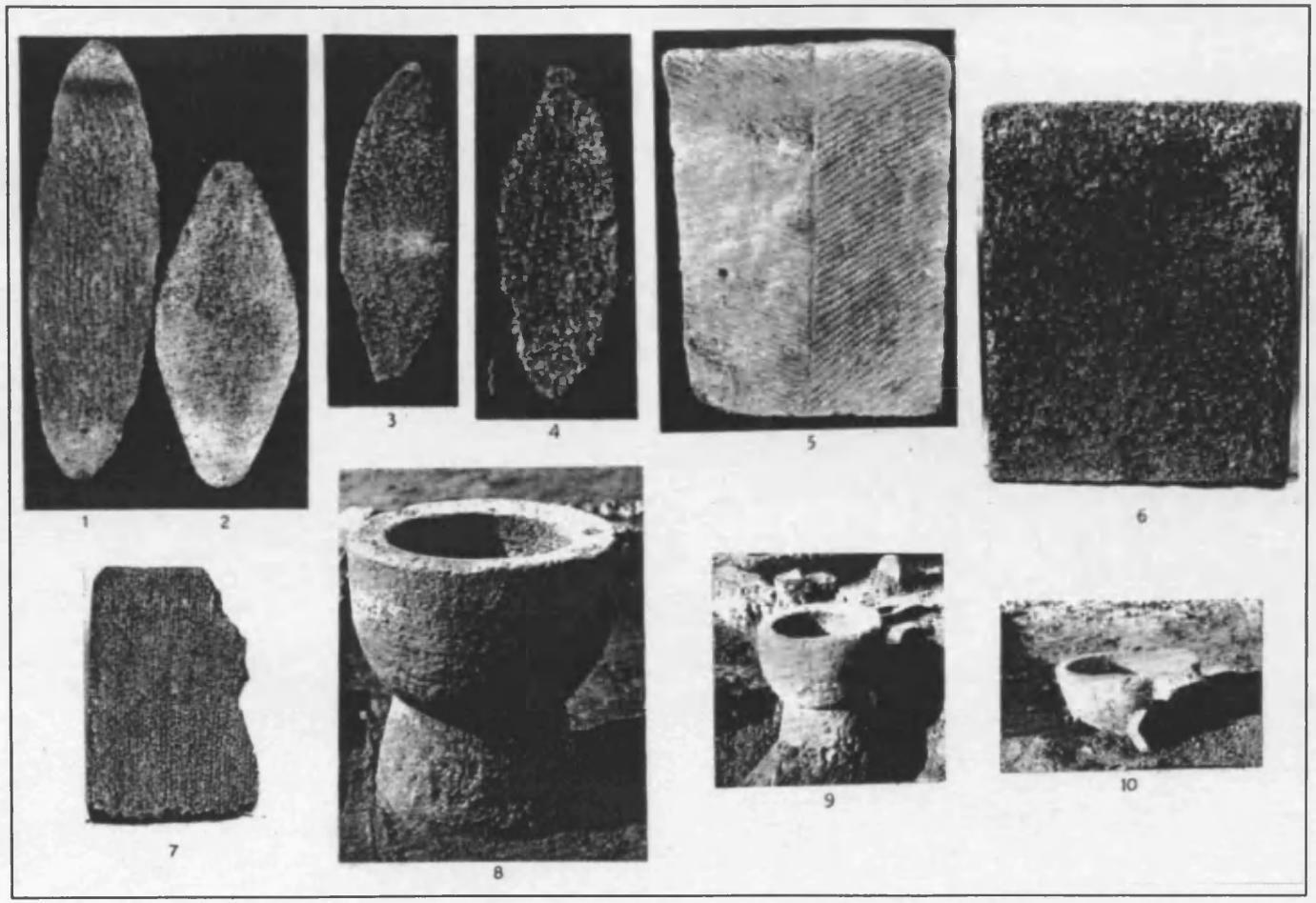


Figure 88: Grinding equipment from Olynthus: 1-4 – saddle querns; 5-7 – lower stones for grinding; 8-10 – stone mortars. After Robinson and Graham 1938:Plate 79