ABSTRACT

This thesis presents the results of charcoal analysis from the Neolithic sites of Çatalhöyük and Pınarbaşı in South-Central Anatolia. The treatment of the subject focuses on two main issues:

I. An improvement of the currently available methodological and analytical tools in the field of charcoal analysis, in order to evaluate in an objective way the taphonomic status of wood charcoal macro-remains and thus allow formulating viable hypotheses on firewood selection and consumption. For this purpose, the current state of affairs in charcoal analysis is re-assessed, aiming at clarifying the major debates within the discipline. Furthermore, the available evidence on wood charcoal taphonomy alongside firewood selection and consumption is critically reviewed. Drawing from this body of theory, some new analytical methodologies are proposed and tested on the wood charcoal assemblages from Çatalhöyük and Pınarbaşı. It is argued that through such an assessment of wood charcoal taphonomy, concentrating mainly in clarifying the impact of source and context on taxon representation, crucial information can be obtained concerning the dominant patterns of fuel use and exploitation. The results of this process are finally evaluated against other, independent lines of evidence (i.e., palaeoecology, excavation records, archaeobotany, zooarchaeology, etc.)

II. An innovative approach to vegetation reconstruction, grounded on the analysis of woodland habitats in terms of their seasonal and temporal transformations, and their potential responses to natural and/or anthropogenic disturbance. The main purpose is to identify any long-term impact of woodland exploitation on past vegetation during the Neolithic. It is argued that the dominant perceptions of the availability of landscape resources (shaped by the full range of economic and social strategies practised at the settlement level) are the major determinants in what concerns both the modes and the intensity of woodland exploitation. Finally, the charcoal data are evaluated against the available evidence for settlement evolution and subsistence strategies in south-central Anatolia during the early Holocene. The aim is to examine whether they conform to a general trajectory of temporal changes that can be traced in the local perception and exploitation of landscape resources.
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Introduction: the aims, scope and archaeological relevance of the present study

The objectives of this research project at the point of its conception were strictly defined; the analysis of wood charcoal macro-remains would form the basis for providing answers to two questions with a long "prehistory" in the field of Near Eastern archaeology and beyond. These are briefly: What can the wood charcoal assemblages retrieved from the Neolithic sites of Çatalhöyük and Pınarbaşı tell us about vegetation formations in south-central Anatolia during the Neolithic? Is it possible to make inferences about climate change and landscape transformations during this period based on the reconstruction of woodland vegetation?

Current approaches to vegetation reconstruction in the archaeobotany and palaeoecology of the Near East for the early Holocene have as their principal objective the investigation of past climate patterns as these can be reconstructed from the pollen and plant macrofossil record (e.g., Bottema 1987, 1995, van Zeist and Bottema 1991, Willcox 1992). The reasons may be found partly in the emphasis traditionally given to the study of plant food remains. As a result, woodlands are perceived mainly as the environmental (and by extension climatic) "background" in a discourse otherwise concerned with the distribution of wild progenitors and the palaeoecological settings of early plant husbandry (cf. Zohary and Hopf 1988, Hillman 1996). At the level of ecological theory, this over-emphasis on palaeoclimatic interpretations can also be explained by the fact that researchers working in this area tend to adhere to ecological concepts espoused by phytosociology (cf. Zohary 1973). In this context, past woodland composition is usually interpreted as a direct reflection of the prevailing climate conditions, with little if any reference to more dynamic aspects of community ecology (e.g.,
woodland responses to short and long-term disturbances, temporal and spatial interactions with animal populations, etc.)

It was precisely this desire to generate alternative ecological interpretations, more akin to those already available for temperate environments, whereby changes in woodland composition are not used exclusively for inferring climate change but also the human strategies for woodland exploitation (e.g., Behre 1988, Rasmussen 1989, Kreuz 1992, Willis 1995) that became the salient factor in reconsidering the aims of this project. The turning point came, however, when I started contemplating the wider implications of such an approach to vegetation reconstruction for archaeological interpretation. Clearly, if it were possible to attribute vegetation changes to human factors instead of seeing them as the effects of climatic variables alone, then a theory would also be needed for exploring the motivation behind human decision-making. Could the latter reflect established group attitudes on the perception and utilisation of natural resources? What was the relationship, if any, between the modes of woodland exploitation and the economy as a whole of the Neolithic settlements?

In defining the factors that might have influenced resource perception and exploitation, it very soon became evident that the requirement was to focus on the complex relationship of human societies with the landscapes they inhabited, rather than treat them as separate entities. Here it is necessary to identify the constituent elements of this relationship. They can be summarised as follows:

a. The natural environment, defined as the terrain in use by human groups. It involves not only the physical and biotic landscape features (i.e., landforms, water bodies, fauna and vegetation) but also the climate. Of paramount importance as well are the transformations that the environment undergoes through time.
b. Seen at a different level, natural environment actually forms part of the anthropogenic landscape. That is, it confers the raw materials and the appropriate settings for people to carry out their daily tasks. The ways through which the latter are brought into practice, however, depend also on how people perceive the potential of a specific territory. Such perceptions are in turn fundamentally linked to practical action. In other words, it is the requirement of any particular action and the constraints it poses on its subjects that lead to the perception of specific "affordances" inherent in the environmental settings:

'...the knowledge gained through such perception is essentially practical; it is knowledge about what the object affords. Depending on the kind of activity in which we are engaged, we will be attuned to picking up a particular kind of information, leading to the perception of a particular affordance ... Affordances are properties of the real environment as perceived by an agent in the context of practical action.' (Ingold 1992: 46; original emphasis)

c. Finally, with reference to the landscapes they inhabit, people formulate perceptions and avenues for action based on their previous practical experience. The core argument here is that there is always a historical dimension in the ways human societies engage in practical action. Therefore, the identification of the significant natural resources does not depend solely on the recognition of the terrain's raw potential but also, and perhaps more decisively, on the range of environments previously experienced (Davidson 1972). It follows that explanatory models viewing cultural shifts primarily as adaptive responses to environmental change, defined in terms of cause and effect, fail to account for such historical influences in settlement patterns and subsistence strategies. Furthermore, the role of the archaeological data in reconstructing past landscapes becomes fully warranted. For it is archaeology that will provide the factual and chronological evidence necessary to trace the content as well as the transformations of human decision-making in a given regional context.
The consideration of all these parameters should enable the reconstruction and evaluation of the dominant patterns of terrain/resource perception and exploitation in the past. The main difficulty lies of course with the different time scales operating for human action on the one hand, and environmental change on the other. In this respect, the knowledge of both the resource base and the settlement data available for the period prior to the site occupation can be informative as to how these might reflect on habitation patterns and subsistence strategies endorsed at a later stage. It is also of equal importance to trace the evolution of such perceptions during the lifetime of the settlement, and the ways through which such transformations may have registered in the archaeological record.

The second issue in question concerns the role of landscape resources (in our case woodland vegetation) within the broader economic and social structures. The relevance of other bioarchaeological disciplines, such as seed archaeobotany and zooarchaeology, for investigating past economies and their various cultural components is beyond doubt and has further benefited from the inputs of an extensive anthropological and ethnoarchaeological literature. Food and drink constitute essential elements of both economic and social production and reproduction. Trees, however, are a different matter. With the exception of timber and woodworking, the "economy of wood" (especially firewood) is not self-evident. Furthermore, there is no coherent theory (at least not one immediately applicable to archaeobotanical datasets) on the perception and utilisation of trees and woodlands by human societies. As a result, archaeological wood assemblages (particularly in the absence of textual records and/or waterlogged remains of wooden artefacts and structures) are mainly used for providing just one of the variables, that is the
vegetation setting, against which various theoretical schemes and ecological models about human strategies of landscape exploitation are evaluated.

Taking all these issues into consideration, the structure of the present thesis has been organised following four successive steps of argument:

a. Based on a re-assessment of the archaeological and palaeoecological information available for the area of study (south-central Anatolia), an attempt is made to put together a unified picture of the relationship between human settlement and landscape transformations. The emphasis lies in defining the potential as well as the constraints of the regional environment, and the ways through which these may have paved the way for cultural innovations and social change in this part of Anatolia during the Neolithic (Chapter 1). The synthesis of the paleoenvironmental and the archaeological data will form the background against which the observed shifts in modes of woodland exploitation will be evaluated, in terms of environmental change and the transformations in patterns of resource perception and utilisation.

b. Drawing from the existing ethnographic record, I will explore the possibility of building a body of theory that will allow the integration of woodland exploitation (with emphasis on the use of firewood resources) into a broader model of economic and social organisation. Furthermore, I will attempt a critical re-assessment of the research previously undertaken in the field of charcoal analysis, in order to propose analytical methods that can address the representativeness of archaeological wood charcoal assemblages as elements of both past vegetation and settlement economy (Chapters 2 and 3).
c. Following the presentation and analysis of the wood charcoal evidence from the Neolithic settlements of Çatalhöyük and Pınarbaşı (Chapter 4), I proceed with the reconstruction of the local “economy of wood” (Chapter 5) in its three key aspects:

i. The availability, spatial distribution and dynamics of woodland vegetation, with particular emphasis on its structure, diversity and seasonal habit and its potential responses to natural and/or anthropogenic disturbance.

ii. The human exploitation of woodland resources (as firewood, timber, fodder, etc.). Part of this process also involves the correlation of the wood charcoal data with other lines of evidence (excavation records, archaeobotany, zooarchaeology, etc.)

iii. The temporal transformations of woodland vegetation and of the human strategies for its exploitation.

d. Finally, the basic elements of this regional reconstruction are evaluated in order to test how they may fit in the model of long-term landscape evolution set out in Chapter 1. The results of the analysis are also compared to wood charcoal datasets available from neighbouring areas. The aim of this comparison is to obtain a general picture of vegetation change during the early Holocene and to explore the possibilities for inferring regional variations in the modes of woodland exploitation (Chapter 6).
Chapter One – Environment and society in south-central Anatolia during the Neolithic: the palaeoecological and archaeological evidence

This chapter starts by sketching a general picture of the environmental settings in the area of study (Konya basin, south-central Anatolia) in what concerns landforms, vegetation and subsistence activities, in order to offer a general overview of the present-day landscape and the human strategies for its enculturation. Through the co-examination of the palaeoecological and archaeological record, an attempt is made to define the potential as well as the constraints of the local environments that accompanied cultural innovations (including subsistence activities) and social change in this part of Anatolia at the onset of the Neolithic. Within this framework, the potential for the interpretation of strategies of woodland exploitation as reflecting various levels of economic and social organisation is briefly outlined.

1.1 Contemporary landscapes of the Konya basin

1.1.1 The physical setting

The Konya basin (37°30'N, 33°00'E) is situated on the southern edge of the Central Anatolian Plateau, at an elevation of c. 1000m a.s.l. Its central section is flat, comprising several secondary depressions occupying its lowest parts and separated by terrain elevations. Most noteworthy are the depressions of Konya, Hotamiş, Karapinar, Ereğli and Karaman (Fig. 1.1) (de Meester 1970: 3).

Konya basin can best be described as a closed, internally drained depression encircled by mountains: to the north and east by the Anatolides chain and to its southern fringes by the Taurus range. In between the latter and the Central Anatolian plateau lies a volcanic upland zone, with some of these volcanoes being still active in historical times. Near the centre of the basin, the isolated volcanic massif of Karadağ rises from the nearly flat plain to an elevation of 2900m. Fourteen peaks of varying
heights (1250-2900m) comprise Karadağ, covering an estimated two hundred square kilometres and separated by deep valleys and ravines. Several smaller volcanoes are situated south of Karapinar.

Numerous waterflows enter the basin from the surrounding uplands, particularly from its south and southwest fringes, giving rise to backswamps, marshes, minor lakes and extensive fans of alluvial origin. It is on these alluvial fans that some of the most important Neolithic settlements in this part of Anatolia are located: Çatalhöyük East and Can Hasan III (see Fig. 1.1) on the Çarşamba and Selerecki fans respectively (Mellaart 1962, French et al. 1972). By contrast, the early prehistoric open-air site and the rock-shelter of Pınarbaşı lie at the base of a cliff nearby the foothills of Karadağ, next to a small spring-fed lake and seasonally flooded reed marshes (Watkins 1996) (Fig 1.2).

Besides alluvial formations, the basin floor comprises a variety of sedimentary deposits. These consist primarily of limestone of lacustrine origin, formed during the Neogene and representing the now-drained floor deposits of a palaeolake; eolian sands, relict shorelines, limestone cliffs and dunes testify to its former extent (de Ridder 1965, Erol 1978: 127-128). Overlying these limestone deposits are clastic sediments (i.e., gravel, sand, clay and marl) which accumulated during the Quaternary, hence gradually infilling the basin floor (Fig. 1.1). Today these cover almost the entire surface of the basin and much of the hilly flanks on its south and southwest borders (de Ridder 1965). Towards the fringes of the basin and along the foothills of the surrounding uplands, clastics give way to steep colluvial slopes alternating with gently undulating piedmont plains and the remnants of the Neogene limestone terraces (de Meester 1971: 8) (Fig. 1.1).
1.1.2 Modern vegetation and climate

Descriptions of present-day vegetation in the Konya basin (de Meester 1970: 34-35) point to a predominantly steppic landscape, dotted with a few poplar plantations in artificially irrigated areas and narrow strips of trees along roads and watercourses. Steppe elements include *Artemisia fragrans, Noaea mucronata, Alhagi camelorum* and *Peganum harmala*. In those parts of the alluvial fans and the marl flats that are strongly affected by salinization halophytic chenopods prevail, dominated by *Halocnemum, Sueda, Salsola, Salicornea, Halimione, Petrosimonia* and *Camphorosma*, whilst reeds and rushes (*Juncus acutus, J. maritimus, Typha spp.*) flourish in marshlands. Salinization, the outcome of intensive irrigation since 1912, has rendered much of the plain infertile. Only protected sites and the better-drained marginal areas (i.e., terraces, bajadas and colluvial slopes) can support extensive, species-rich grasslands (Cohen 1970: 123, de Meester 1970: 34).

The above description concurs in its general aspects with more systematic investigations of the contemporary vegetation formations in the Anatolian plateau. According to Zohary (1973) and Davis (Flora of Turkey, vol. 1: 21-24), the area forms part of the Irano-Turanian floristic territory. Based on field research and previous travel accounts, Davis proceeded in distinguishing two major vegetation entities in Central Anatolia: a. A core area of treeless "true" steppe, the southernmost part of which lies just south of Karaman, and b. A peripheral wider zone of quasi-arboreal vegetation, consisting mainly of deciduous oak scrub interspersed with stands of park-like woodland. Steppic formations are dominated by *Artemisia*, in association with several species of *Stipa* and spiny *Astragalus, Noaea mucronata, Peganum harmala, Euphorbia tinctoria, Globularia orientalis, Poa bulbosa, Linum hirsutum, Phlomis* spp. and *Teucrium* spp.
High arboreal vegetation is restricted to the uplands. Ecological descriptions are available for the Karadag massif and the Taurus range (cf. Zohary 1973, van Zeist et al. 1975, Atalay 1986, Unal and Ocakverdi 1991). Montane forest consists mainly of fir (Abies cilicica, A. nordmanniana), black pine (Pinus nigra subsp. pallasiana) and juniper (Juniperus excelsa, J. oxycedrus). Oak-Rosaceae woodland appears at lower altitudes and on volcanic slopes (Quercus, Cerasus prostrata, Cotoneaster nummularia, Crataegus aronia, C. monogyna, C. orientalis, Potentilla, Prunus divaricata, Pyrus, Rosa, Sanguisorba minor, Sorbus umbellata), together with members of the Caprifoliaceae family (Lonicera etrusca, L. nummulariifolia), heather shrubs (Erica manupuliflora), buckthorns (Rhamnus) and leguminous shrubs (Colutea, Genista).

In the drier areas of the hilly flanks park-woodland, when not cleared altogether, is dominated by Quercus brantii and Q. cerris, in association with juniper (Juniperus oxycedrus, J. foetidissima), terebins (Pistacia), hackberries (Celtis tournefortii), dryland maples (Acer monspessulanum), xeric shrub-honeysuckles (Lonicera) and various members of the Rosaceae family, including wild pears (Pyrus eleaegrifolia, P. amygdaliformis), cherries (Cerasus microcarpa, C. mahaleb), hawthorns (Crataegus laciniata, C. orientalis) and blackthorns (Prunus spinosa). Ground flora comprises wormwoods (Artemisia herba-alba), woody chenopods (Noaea mucronata) and capers (Capparis spinosa, C. ovata), the latter being particularly frequent close to ephemeral streams, whilst in overgrazed areas spiny Astragalus predominates (Flora of Turkey, vol. 1: 23, Kayacik and Yaltirik 1971, Zohary 1973: 341-378).

Mean annual precipitation on the Konya plain varies on average between 250 and 300mm (depending on the distance from the surrounding uplands, with less than
200mm towards its centre), being almost evenly distributed through autumn, winter and spring. Rainfall is more frequent during spring months, whereas snowfall marks the winter season. In general, evaporation exceeds precipitation on the plain itself, whereas higher elevations enjoy a moister regime, with maxima of up to 1000mm of mean annual rainfall recorded for the Taurus range. Average temperatures are in the range of 0°C during winter and 22°C in the summer season. Extreme values of −25°C and over 35°C have also been reported. The average number of days with temperatures below 0°C is 103.3 for the area of Konya and 97.6 for the area of Çumra, occurring in autumn, winter and early spring (de Meester 1970: Table 1).

1.1.3 Subsistence activities

Dry and irrigated farming alongside animal husbandry are the predominant subsistence activities today in the Konya plain. The principal crops are winter wheat, barley, rye, oats, chickpeas, potatoes, sugar beet, onions, melons and grapes, whilst livestock includes cattle, sheep, goats and horses. The main irrigated areas are situated in the surroundings of Çumra, whereas dry arable fields and rangelands take over on the margins of the plain and the lower upland zone (de Meester 1970: 37-38, id.: Figure 19 & Table 2).

Besides arable farming and stock rearing, most village households today keep gardens where tomatoes, cucumbers, apples, figs, grapes, large radishes, melons and marrows are grown (Shankland 1996: 350). Overall, as elsewhere in Central Anatolia, agriculture and animal husbandry provide the essentials for household consumption, whilst secondary crops such as garden and vineyard products together
with surplus meat, cheese and butter end up as cash commodities in the local markets (ibid., Ertug-Yaras 1997: 50).

Apart from this very general information on the main subsistence activities practiced in this area, very little is known in detail about the ways through which people interact with the landscapes they inhabit and how these affect their daily routines. In her exhaustive study of subsistence and plant gathering in the Melendiz plain of Central Anatolia, Ertug-Yaras (1997) was able to isolate two crucial elements that define the relationship of the local societies with the environment: a. An extensive knowledge of the resources significant for the well-being of the community, and b. The existence of locally devised strategies to cope with seasonal fluctuations in resource availability.

More specifically, she observed that the inhabitants of this area possess a very detailed knowledge of the local environments. This knowledge has been formed not so much as a response to the immediate needs of the community but rather inherited through the years, as the outcome of their practical engagement with the world:

'... the contemporary villagers have extensive knowledge of the local resources, even if these resources are no longer crucial to their economy as a result of the mechanization of farming, new varieties of crops, chemical fertilizers, and developing relationships with national institutions ... I have recorded 60 different localities that are named by local villagers, and referred to daily in this relatively small area. Every hill or rock, every source of water, or places where ice can be found even in summer, sources of water known to attract specific animals, all basic roads, and dangerous hilly parts of the roads, old cemeteries and site locations, sheltered rocks, specific areas for rare plants or areas where you find one species in large quantities, are known and named.' (Ertug-Yaras 1997: 70, 106; emphasis added)

That such a detailed knowledge is vital for securing the existence and continuity of local societies is further corroborated by the fact that people can respond to situations of scarcity by opting for the intensive utilisation of wild resources. The latter may be used for various purposes such as food, fodder, fuel and the production of medicinal
substances (Ertug-Yaras 1997: 70). Plant gathering in particular is still widely practised for adding variance to an otherwise monotonous diet consisting mainly of cereals and meat.

Further, seasonal fluctuations in resource availability may also lead to the adoption of specific strategies aiming at reducing the risks and constraints facing the community. These take place mostly at the household level and include labour arrangements (usually agreed through a complex network of social relations), the integration and scheduling of subsistence activities, storage, exchange and the participation at communal feasts and other ceremonies (Ertug-Yaras 1997: 84). Over time, such practices get to be incorporated into the daily and seasonal routines of the community life hence forming an indispensable part of local traditions and social interplay.

1.2 Late Quaternary landscapes of the Konya basin

1.2.1 The environmental setting

1.2.1.1 The geomorphological and geoarchaeological evidence

Evidence that the Konya basin was occupied by an extensive lake during the Pleistocene was first produced early in the 20th century through observations on sandy and gravely deposits rich in molluscan findings, terraces, erosion surfaces on the sides of the mountains fringing the basin, shorelines, sand ridges and deltaic formations at the mouth of stream valleys (cf. de Ridder 1965). The study of the molluscan material from these deposits indicated the existence of a large, non-stagnant brackish lake with the sporadic occurrence of freshwater species (cf. Roberts 1983).
The first attempts to obtain a chronological framework for the Konya palaeolake were effected through the correlation of shoreline formations with archaeological deposits. Hence, the Neolithic settlement of Çatalhöyük dated at c. 8,400-7,500 B.P. served as a definite *terminus ante quem* for the last major lacustrine phase, whereas the discovery of a lithic assemblage in a spit associated with the 1010-1006m shoreline levels, led to their dating at c. 11,000 B.P. (Cohen 1970: 131).

In addition to this, Erol (1978) attempted to establish a relative chronology for the Konya palaeolake based on the study of terraces and relict shorelines. Accordingly, the highest shoreline traces (1017 and 1010m a.s.l.) were taken to represent the "Würm Pluvial", thus conforming to Karl Butzer's earlier postulations with reference to the Anatolian plateau (Butzer 1958: 87-91), whilst the 1006m, 1002m and 1000m levels were attributed to the early Holocene lake recession, interrupted by minor re-advances.

In his detailed study of the late Quaternary formations of the Konya basin, Roberts (1980) challenged the validity of the above chronological scheme and the assumptions it set forth concerning the palaeoecology of the area. By considering the altitude of terrace deposits, and their molluscan content and radiocarbon dates, he managed to distinguish three main depositional units: the Upper Terrace (broadly above 1017m and older than 30,000 B.P.), the Main Terrace (falling within 1004 and 1017m and dated between 23,000-17,000 B.P.), and the Lower Terrace (below 1004m, encompassing the secondary depressions of the basin).

The environmental conditions associated with the formation of the oldest shoreline are still poorly understood. The molluscan fauna obtained from its sandy and gravely sediments points to the co-existence of freshwater habitats with stretches
of drier marshland. The discovery of a jaw of a large cervid (Cervus sp.) was taken as indicative of a rich herbaceous ground cover (Roberts 1983).

The exact sequence of events during the lacustral episode represented by the Main Terrace unit is not entirely clear, but it seems that initially high lake levels (1012 m) from c. 23,000 to 19,500 B.P. were succeeded by a fall in water levels, as indicated by the existence of colluvial deposits and the formation of a palaeosol on top of them with signs of biological activity (c. 19,000 B.P.) (Roberts 1983). There followed a second lake transgression (1014 m) and afterwards a constant decrease in water level, below 1010 m. Based on a radiocarbon date from shoreline deposits corresponding to the last rise in lake levels (17,610±160 B.P.), it was concluded that the final lake regression should have taken place at around 17,000 B.P. (Roberts 1983, Roberts et al. 1999). Between 17,000 and 12,500 B.P. periglacial features, such as ice-wedges, were formed in the sediments of the Main Terrace.

The Lower Terrace comprises the secondary depressions of Hotamiş and Yarma at the western part of the basin and the Karapinar, Akgöl and Hamidiye depressions in the east. The molluscan assemblages of the former suggest that lakes were shallow, almost eutrophic and rich in vegetation. On the basis of stratigraphic features (i.e., dessication cracks and wormcasts) and radiometric dates, it has been suggested that both depressions dried up between c. 17,000 and 12,500 B.P., with a subsequent rise in water levels between 12,000 and 11,000 B.P. (Roberts 1983, Roberts et al. 1999). A similar situation has been observed for the eastern part of the basin, although here there are no signs of it being completely dry during the Lateglacial. Shallow freshwater conditions prevailed at the eastern part of Akgöl through most of the Holocene. By contrast, at Karapinar and the rest of the Akgöl depression the sedimentary sequence indicates their evolution from predominantly
lacustrine to seasonally flooded environments, receiving runoff from the volcanic uplands (Roberts 1983).

It seems therefore that during the late Pleistocene the basin was occupied by a shallow freshwater to brackish lake, whereas its margins were characterised by fan-shaped coarse gravels deposited at the mouth of strongly seasonal stream flows (Roberts 1991: 14). By c. 17,000 B.P. the western part of the basin had effectively dried up, with the possible exception of seasonal flooding, whilst a residual shallow brackish lake persisted in the Akgöl area until approximately 13,000 B.P. Shortly after this, another lake transgression took place, now giving rise to five small water bodies occupying the smaller depressions in the basin floor, most probably enhanced by glacial meltwater. Palaeoecological indicators such as ostracods, diatoms and molluscs, point towards freshwater, more or less eutrophic conditions for these lakes, lasting until c. 11,000 B.P. (Roberts 1991: 9). The lack of datable sediments corresponding to the Younger Dryas indicates a return to drier conditions marked by intense erosion. During this period a small, shallow lake persisted only in the Akgöl depression. Marshes and shallow lakes re-appeared in the basin from around 9,000 B.P. until the mid-Holocene and the establishment, once more, of arid conditions (Fontugne et al. 1999, Roberts et al. 1999, cf. Bottema and Woldring 1984).

This picture of the physical settings is enriched by information made available by on-site geoarchaeological investigations (cf. Roberts 1991, Roberts et al. 1996, Roberts and Boyer 1999, Roberts et al. 1999). The systematic examination of sediment cores and exposed sections on and around Çatalhöyük and Can Hasan III further elucidated the environmental conditions encountered by their Neolithic inhabitants. Hence, it emerged that both settlements were founded on alluvial deltas that had started to accumulate on the fans by perennial river flows at the beginning of
the Holocene. This situation is represented in the sedimentary record as a clear break with the conditions prevailing during earlier periods, when waterflows had a stronger seasonal character and the fans were subject to flash floods. For Çatalhöyük in particular, the occurrence of very fine, dark grey backswamp clays contemporary with the earliest traces of human activity down to the very end of the main period of the Neolithic occupation (c. 8,400-7,500 B.P.) shows that the settlement was founded on a wetland floodplain subject to periodic inundation. The presence of a distributary of the Çarsamba river running between the two mounds (Çatalhöyük East and West) is ascertained by the occurrence of anthropogenic debris mixed with sands and gravels of fluvial origin. Furthermore, the discovery of Chalcolithic potsherds in the lower channel fill indicates its continuous deposition throughout the period of human occupation. The available evidence points to the existence of a topographic mosaic around the site comprising both raised surfaces and low-lying depressions. Following the backswamp clays, there are indications of soil development (i.e., buried paleosols and land surfaces) which correlate with the latest Neolithic occupation and the beginning of the Chalcolithic and suggest a shift towards drier conditions (Roberts and Boyer 1999).

1.2.1.2 The evidence for past vegetation
The next step in reconstructing past landscapes entails an appreciation of the biotic resources, notably vegetation, which contributed to shaping the surroundings of the prehistoric settlement. In the Near East, the principal means for reconstructing palaeovegetation has been through palynological investigations. Pollen data are assembled from suitable coring sites, such as marshes and lake bodies, and interpreted as a reflection of vegetation and climate change in the past (Bottema
Yet, as practice has shown, this approach is fraught with problems concerning both the reconstruction of the biotic environment at a local scale and, more generally, the interpretation of long-term environmental change.

The published datasets available for the Konya basin are restricted to a pollen diagram from the Akgöl depression (cf. Bottema and Woldring 1984). However, the distance of Akgöl from both the major Neolithic settlements (c. 100 km from Çatalhöyük and 50 km from Can Hasan III) diminishes the usefulness of its pollen sequence for tracing the impact of human activities on prehistoric vegetation, a situation frequently encountered with Near Eastern coring sites (Behre 1990: 228).

The pollen diagram from Akgöl (Fig. 1.3) indicates a predominantly steppic vegetation for the Konya plain during the Lateglacial, whilst the uplands probably offered slightly more favourable conditions for the establishment and maintenance of scattered tree stands. A reversal of this trend is evident from c. 12,000 B.P. onwards. A slow but steady increase in tree cover is suggested by the higher values for deciduous oak and cedar, coupled with a rise in grass pollen and a concomitant decrease in dry-steppe indicators, such as wormwoods (*Artemisia*). This phase was somehow abruptly interrupted by the spread once more of steppe plants, especially *Artemisia*, at the expense of woodland and grasses, an episode that probably lasted for a few hundred years only. Its characteristics match descriptions of the Younger Dryas biozone, as it has been defined from other Near Eastern pollen sequences (cf. Baruch 1994). However, this interpretation finds little support in the radiocarbon date of 10,920±150 B.P. towards the end of the pollen zone. One might suspect here the possibility of a dating error, due to contamination of the material sampled for dating by redeposited old organic carbon detritus or diluted C-14 levels (the so-called "hard water" effect, cf. Lowe and Walker 1997: 246).
Soon after the end of this phase, trees started to expand again. The beginning of this expansion is marked by the rapid advance of birch (*Betula*) and sea-buckthorn (*Hippophaë*), hence pointing towards an abundance of birch, probably flourishing on the volcanic uplands, whereas on the plain buckthorns and grasses replaced at least in part the steppic vegetation of wormwoods and chenopods. There followed an increase in deciduous oak and possibly juniper (dated by interpolation at c. 9,000 B.P.) with other deciduous elements also appearing for the first time, such as hornbeams (*Carpinus/Ostrya*) and hazel. Grassland evidently prevailed on the Konya plain. Shortly afterwards (8,040±140 B.P.) coniferous forest started to expand, with the synchronous gradual retreat of oak woodland, thus indicating increasingly arid conditions. Later developments include the transformation of coniferous forest, with fir (*Abies*) gradually replacing pine, cedar and juniper, and the appearance of plantain (*Plantago lanceolata*) at c. 6,000 B.P. most probably as an indicator of pastoral activities taking place in the mountain zone.

Recent palynological investigations in the same area broadly confirm the general pattern of vegetation evolution summarised above, with the exception of the early expansion of birch at the beginning of Holocene, whilst pine appears as a significant component of the late Pleistocene vegetation as well (N. Roberts, personal communication). However, these data may serve at most as a means for estimating the rhythm and rate of woodland expansion on the upland areas, as well as the general evolution of poaceous vegetation on the plain itself. Several dryland arboreal taxa that (human impact notwithstanding) normally abound in similar settings throughout the Near East are either insect-pollinated (e.g., *Prunus, Amygdalus, Maloideae, Celtis, Acer*) or have poor pollen dispersal (e.g., *Pistacia*) and are

These difficulties can be overcome to a certain degree through the consideration of different lines of evidence, including the published pollen and archaeobotanical data and aspects of the modern ecology of the area (i.e., local topography and vegetation studies). For the timespan corresponding to the Neolithic (c. 9,000-7,500 B.P.), the existing archaeobotanical studies from Can Hasan III (Hillman in French et al. 1972, Willcox 1977, 1978, 1991a) and Çatalhöyük (Helbaek 1964, Çatalhöyük Archive Report 1997, 1998, 1999) have shown the presence of almonds (Amygdalus), wild plums (Prunus), hackberries (Celtis), hawthorns (Crataegus) and terebinths (Pistacia) all of which are characteristic of open woodland formations in Central Anatolia growing on better-drained localities with a minimum of 250-300 mm of annual precipitation (Zohary 1973, Hillman 2000, Woldring and Cappers 2001). Taxa usually not encountered today (unless planted) in the lower upland zone such as walnut (Juglans) are also present in the archaeobotanical record of Can Hasan III, thus suggesting the presence of relatively moist habitats in the uplands (Hillman in French et al. 1972). Characteristic hygrophilous taxa found in the charcoal assemblages of Can Hasan III (Willcox 1977, 1978, 1991a) such as tamarisks (Tamarix), willows and poplars (Salicaceae), and elms (Ulmus) are likely to have grown on the banks of the rivers discharging into the plain (see also the summary presented in Table 1.1)

1.2.13 Summary of the palaeoecological evidence

To summarise the information available on the palaeoenvironments of the Konya plain (see also Table 1.1) it seems that high lake levels occurred at c. 23,000-17,000
B.P. most probably as a result of low temperatures combined with low evaporation rates (Roberts 1983). For the period prior to 12,000 B.P., both lake level data and the pollen evidence suggest a climatic regime characterised by rather arid conditions. Dry-steppe vegetation probably prevailed not only on the plain but also on the surrounding upland zone. From 12,000 B.P. onwards, the published pollen evidence has indicated a slow but constant rise in temperature coupled with an increase in precipitation, as suggested by the very gradual re-advance of oak at higher altitudes. Bottema and Woldring (1984) have concluded that grassland must have prevailed on the plain as indicated by the low AP values (<10%) and the respective high values for Gramineae (see Fig. 1.3; Bottema and Woldring 1984). During the same period, a series of small freshwater lakes, presumably rich in aquatic resources, were formed in the secondary depressions of the basin enhanced by glacial meltwater (ibid.; Roberts et al. 1999) (see also Table 1.1).

Shortly after 11,000 B.P. drier conditions returned, although it is difficult to assess with any certainty the precise effects of the Younger Dryas oscillation on the regional landscape due to the dating uncertainties previously outlined. After this period, the pollen data suggest a slow but constant increase in tree cover (AP increases from c. 5-10% average values to 20%; see Fig. 1.3) that becomes even clearer around 9,000 B.P., with an AP peak of 30% at c. 8,000 B.P. which has been interpreted as indicative of the expansion of oak and juniper in the upland zone (Bottema and Woldring 1984). Climate patterns prevailing during this period may have further underlined the fragmentary character of local vegetation by controlling the total amount and timing of precipitation available to plant communities. Climatic studies have indicated that, during the early Holocene, the general trend in the region was towards increased seasonality, with maximum temperatures and hence intense
drought occurring during the summer season, whereas higher precipitation characterised the winter months (Byrne 1987, COHMAP Members 1988, Rossignol-Strick 1999). This was also the time of the major expansion of annual grasses, which could have thrived on alluvial floodplains and the surrounding hill slopes, since they are particularly adapted to taking advantage of seasonal variations in surface moisture availability (Blumler 1993, Hillman 2000).

That upland areas offered overall more favourable conditions for the establishment of arboreal vegetation is further suggested by the pollen data from the Neolithic site of Suberde (Aytug 1967) dated to c. 8,500-7,500 B.P. and the Beyşehir lake (cf. Bottema and Woldring 1984) located to the south-west of the Konya basin in the intermontane Beyşehir-Suğla depression. These have indicated the abundance of a wide range of arboreal taxa during the early Holocene, including conifers such as pine (*Pinus*), cedar (*Cedrus*), fir (*Abies*), juniper (*Juniperus*) and cypress (*Cupressus*). During the Neolithic, limiting conditions for the full development of montane coniferous forest prevailed until c. 8,000 B.P. as evidenced in the pollen diagrams mainly from southwestern Anatolia (van Zeist et al. 1975; Eastwood et al. 1999). Broadleaves like oak (*Quercus*), chestnut (*Castanea*), birch (*Betula*), walnut (*Juglans*) and lime (*Tilia*) are also present in the pollen record, probably forming stands in protected intramontane valleys and more humid localities (Eastwood et al. 1999).

It appears therefore that for the period corresponding to the Neolithic occupation of the Konya plain and the surrounding areas (roughly 9,000-7,500 B.P.) forest occurred on the mountain zone, grading into more open woodlands on the lower upland areas with reduced precipitation, whilst grasslands and saline meadows (the latter in dry and/or seasonally flooded depressions) probably extended over the
marl plain. Marl would in general fail to support tree vegetation due to poor root penetration, especially during the dry summer months when surfaces would become compact-hard as a result of increased evaporation (G. Hillman pers. comm.) Riverine woodlands could have extended next to river courses, standing water bodies and on parts of the alluvial plains (see also Table 1.1).

1.2.2 The human settlement

The review of archaeological sites that follows (see also Fig. 1.4, Table 1.2) attempts to outline the distribution of the Neolithic settlements in south-central Anatolia and, at the same time, to provide a concise description of the evidence currently available on subsistence activities and material culture. The main purpose is to trace patterns and/or relations between sites in what concerns the utilisation of landscape resources. Special focus will also be given to those sites that precede the ceramic Neolithic occupation (i.e., Epipalaeolithic and aceramic Neolithic settlements) in the Konya plain and the neighbouring areas. Through this comparison and the detailed presentation of the Neolithic cultural sequences, it is hoped that certain patterns will begin to emerge on the ways through which presumed past resource management strategies might have influenced the choices of the Neolithic groups.

The decision to restrict the choice of the excavated sites discussed here to the Anatolian plateau and the Konya Basin (hence leaving outside much earlier developments in southeastern Anatolia) reflects the recognition of the Neolithic of Central Anatolia as a distinct cultural entity, whose “roots” cannot be readily extrapolated from the history of Neolithic settlement in other parts of Anatolia or elsewhere. Although detailed evidence on the earliest phases of Neolithic habitation in the plateau is still lacking (e.g., the full analysis of the subsistence data from the
basal levels at Aşıklı, the largest aceramic Neolithic settlement in the area, is awaited) recent observations on the procurement strategies and the technological characteristics of the regional lithic sequences cast doubt on a hypothesis favouring the colonisation of Central Anatolia through demic diffusion from the south-east or the Levant (cf. Balkan-Atlı et al. 1999). Equally, postulations about a northern “Pontic” and/or “Balkan” origin for the first sedentary communities of the Anatolian plateau (Özdoğan 1999: 227) seem unsubstantiated in the light of the currently available evidence (ibid.).

Another reason for focusing on the regional archaeological record per se, rather than attempting a more ambitious general synthesis, is my deliberate choice to bypass questions of proposed biological and/or geographical origins for the Neolithic inhabitants of Central Anatolia and concentrate instead on the specific circumstances of agricultural introduction and establishment in this area. Such tendencies to seek a fixed “point of origin” have as their main cause the overall lack of evidence for substantial settlement in the Anatolian plateau prior to the appearance of sedentary agricultural communities. Linked with this is also a dominant perception of major qualitative differences between the “sophisticated”, “high” cultures attested in the early Neolithic of Central Anatolia and the ephemeral, almost archaeologically “invisible”, sites of the Upper Palaeolithic:

‘Considering the paucity of earlier sites and the rather sudden appearance of early Neolithic sites, we must surmise that there was a population movement into the Anatolian plateau from elsewhere. Another factor in support of this hypothesis is that all elements of the cultures of even the earliest sedentary sites ... are already in a fully developed stage, implying a long tradition ... The scattered and insignificant occurrences of the Upper Palaeolithic sites ... are simply not viable predecessors for the sophisticated cultures of the early Neolithic settlements’ (Özdoğan 1999: 226)

However, such a view of the pre-Neolithic groups as the inappropriate, “backward” prelude to the culturally more “complex” and “evolved” village societies finds little
support in the existing ethnographic and archaeological record from Europe and beyond, which points to several alternative causal factors for the low archaeological visibility of hunter-gatherer habitation sites. These may include (aside from research and preservation biases the latter being particularly relevant in south-central Anatolia) dispersal and/or low density of population, small group size, high mobility, diversification of resource use, planned and/or seasonal patterns of resource exploitation, ecological constraints, etc. (cf. Halstead 1996: 299-301, Whittle 1996: 34-35).

Whilst by no means denying this general “paucity of earlier sites”, I will attempt to demonstrate that its causes lie more with the specific ecological settings constraining the exploitation of landscape resources in the Anatolian plateau during pre-Neolithic times, rather than the absence of human groups from this area. In this context, potential incentives for the introduction/adoption of the new mode of production will be also outlined. To take the argument one step further, through the close examination of the Neolithic settlement record and subsistence strategies I will seek to elucidate the nature of this apparent disruption in habitation patterns, by concentrating on those aspects of the Neolithic that might show signs of continuity with presumed earlier traditions of resource management and social interplay.

1.2.2.1 The Epipalaeolithic assemblages

I have already hinted upon the general rarity in the Anatolian plateau of sites dating from the last stages of the Upper Palaeolithic (see also Todd 1980, Esin 1999, Özdoğan 1999). Amongst the little evidence reported in the older literature there is one scatter of lithic artefacts made of chert from Dervişhani in the Konya basin,
which Cohen considered on technological grounds to be no earlier than the eleventh millennium (Cohen 1970: 130-131).

The sole excavated site that has produced some indications of Epipalaeolithic occupation until now is the open-air settlement of Pınarbaşı (Site A), at the foothills of Karadağ. The earliest deposits from Site A have revealed a lithic assemblage the characteristics of which (distinctive microlithic forms and extensive use of flint) suggest an early derivation. However, the available radiocarbon dates place them around 9,200 B.P. (i.e., the early Neolithic). Trevor Watkins has interpreted these findings as an indication that

‘... small-scale, bladelet-based, microlithic industries continued beyond the Epipalaeolithic into the Neolithic period in Anatolia, following a different developmental history from the Levantine industrial sequence, which has been the only one known in detail’ (Watkins 1996: 57)

In the Konya plain an additional factor affecting the archaeological visibility of early sites (which appear to have been small in size and located nearby watercourses) is that they are buried by later settlement and alluvial deposits, in places reaching a depth of 4m or more (Baird 1999; see also Özdoğan 1997a). Yet, recent field surveys have revealed evidence of extensive Epipalaeolithic occupation in the plain (Baird 1997, 1999). Although none of these sites has been excavated yet, based on their location it is reasonable to infer that Epipalaeolithic settlements were preferentially established in the vicinity of watercourses and marshland/lakeside environments.

1.2.2.2 The Neolithic assemblages

In contrast to the paucity observed for early prehistoric sites, the Neolithic is well attested in south-central Anatolia and the Anatolian plateau. The sites included in this
account can be divided in two major groups: a. Aceramic Neolithic settlements (Aşık Höyük, Musular, Suberde, Can Hasan III, Pınarbaşı, Çatalhöyük East), and b. Ceramic Neolithic (Erbaba, Çatalhöyük East and Pınarbaşı) (Fig. 1.4, Table 1.2).


The site (dated between c. 8,900-8,500 B.P.) is located in the Melendiz valley of Central Anatolia, 25km southeast of the town of Aksaray on the east bank of Melendiz river. Recent excavations have revealed a substantial aceramic settlement, with closely spaced mud-brick buildings, separated by narrow passages and large courtyards which were used for the disposal of refuse and various non-domestic activities such as stone-knapping. There are also indications for an earlier settlement, situated right on the bank of the Melendiz river, which was abandoned after a flush flood and may constitute a predecessor to the main occupation of Aşık Höyük.

The entrance to the houses was probably through the rooftops, since there was no evidence for the existence of doorways at the ground level. The flat roofs were supported by wooden posts, as indicated by the occurrence of postholes on the floors of the excavated buildings. Internal features consist of hearths, fire-pits and ovens and, in a few instances, platforms as well. Floors and walls (the latter occasionally founded on a stone footing) were commonly plastered with thick layers of clay, sometimes painted in yellow, red and reddish colours. The largest structure excavated so far (building T) preserved polished yellow and red plastered floors, walls and platforms, and seems to likely to have fulfilled some ceremonial purpose. Its separation from the main residential complexes and its strategic location next to the main access route (a pebbled road that was in use throughout the occupation of
Aşıklı indicate its central role in the life of the settlement. The existence of a large portico, comprising a pavement of sizeable mud-brick blocks with stones for the support of the posts, further testifies to the special character of building T.

Burials were found in the interiors of houses, placed under the floors. However, the small number of burials discovered thus far (70 corresponding to >400 excavated structures) leaves open the question whether this was the normal practice within the community (Esin and Harmankaya 1999: 129). There is no evidence for the manufacture of pottery, although the excavators have reported half-baked clay objects comprising crude animal figurines and small cones. Bone and horn tools were also found alongside the ground-stone and chipped-stone industries. Ground-stone artefacts are made of volcanic rocks and include mainly grinding stones, mortars and pestles. Among the obsidian industry scrapers, retouched blades and microliths were the most common tool types (Esin and Harmankaya 1999: 127).

From the archaeobotanical remains it is clear that the inhabitants of Aşıklı cultivated cereals and legumes. Einkorn wheat (*Triticum monococcum*), emmer wheat (*T. dicoccum*), free-threshing wheat (*T. durum*), two-row barley (*Hordeum distichum*), naked barley (*Hordeum vulgare var. nudum*), bitter vetch (*Vicia ervilia*), lentil (*Lens culinaris*) and pea (*Pisum sativum*) are all present. There are also indications that at least some cereals were collected from the wild (e.g., one-seeded wild eincorn wheat-*T. boeoticum* ssp. *aegilopoides* and possibly two-row hulled barley-*Hordeum spontaneum*), alongside fruits such as hackberries (*Celtis*), terebinths (*Pistacia*) and almonds (*Amygdalus*). Other wild taxa included corn gromwell (*Buglossoides arvensis*), various wetland plants (*Scirpus*, *Eleocharis*, *Carex*), legumes (Fabaceae), etc. (see van Zeist and de Roller 1995: 181).
Even though the archaeobotanical findings from Aşıkli seem to suggest that plant gathering maintained a prominent role in subsistence activities (van Zeist and de Roller 1995: 183), this assumption is based on the numerical predominance of hackberry stones (*Celtis*). This however may reflect post-depositional preservation biases favouring the survival of the tough and hard hackberry fruit stones (which were preserved mostly in calcified form) as opposed to the more brittle cereal remains. Since this report does not explicitly address questions of taphonomy and preservation conditions, it is very difficult to translate the quantitative predominance of hackberry remains into qualitative statements about their relative contribution to human consumption. Further research and sampling are necessary, especially among the earliest excavated levels.

Although no anatomical changes indicating animal domestication are evident, based on the reconstructed age of cull and the sex profiles it seems likely that some sort of controlled herding existed, at least in what concerns sheep and goat. Sheep were clearly predominant, followed by goat, bovids and pigs (Vigne and Buitenhuis 1999). Wild species such as equids, red, fallow and roe deer, hare and birds were all present with low numbers in the bone assemblage, with a tendency to decrease towards the later phases of the settlement (Buitenhuis 1997).

**Musular (Özbaşaran 1999, 2000)**

Musular is one of the 13 sites recorded in the vicinity of Aşıkli during the 1993 field survey of the area by a team under the direction of Ufuk Esin. The settlement is located on the west bank of Melendiz river, set against a low slope above a tufa rock formation. Excavations have revealed the architectural remains of a small aceramic
Neolithic compound comprising mainly pits, hearths and the remains of mud-brick walls.

The aceramic strata had been severely truncated by later occupation (late Neolithic/Chalcolithic) in the same locale. Still, the remains of a large mud-brick structure (building A), bearing strong resemblance to building T of Aşıklı, were uncovered. Timber posts probably supported the roof of the building, as it could be deduced from the occurrence of a sizeable flat stone with a hole in its middle surrounded by a pile of small pebbles. The floor was covered entirely with burnished, red-painted mud-plaster, whilst its fill contained abundant animal bone and obsidian debris. In the same location was found a pit containing discarded animal bone. The next phase of the settlement (late Neolithic/Chalcolithic) consisted of a massive limestone-built structure, which was associated with external pits and activity areas.

Based on the technological characteristics of the knapped stone assemblage, it seems that the aceramic levels at Musular are contemporary with the later phases excavated in Aşıklı, an observation that lies in agreement with the available radiocarbon dates (c. 8,200-7,900 B.P.) Preliminary analysis of the lithics has indicated that the industry is dominated by scrapers with a significant component of projectiles (Özbaşaran 1999: 152). No published results have appeared yet on the botanical and faunal assemblages retrieved from the excavated areas. Initially reported finds from the aceramic levels include hackberry (Celtis), cereals (Hordeum vulgare, Triticum aestivum, T. dicoccum) and pulses (Vicia, Cicer, Lens) plus a series of weedy taxa (Özbaşaran 2000). Animal bone is dominated by sheep and goat whilst cattle and deer are also present. Overall the faunal assemblage displays strong similarities with that retrieved from Aşıklı (ibid.).
Can Hasan III (French et al. 1972: settlement record, plant remains; Payne 1972: animal bone)

The tell site of Can Hasan III (c. 8,500-7,600 B.P.) is located at the eastern half of the Konya basin, some 13 km north-east of the modern village of Karaman. In the deep sounding dug below the Chalcolithic levels (Can Hasan I) there were recovered the remains of mud-brick and pisé walls. Mud-plaster coating, occasionally re-painted, was used on floors and walls, whereas certain floors had been constructed with compact hard clay, reinforced with small pebbles. The published portable objects include obsidian tools (points, scrapers and several types of blades) and, in lesser quantities, flint sickle-blades together with some worked bone. Obsidian debitage was also abundant. There was no evidence for the manufacture and/or use of ceramics.

Charred plant remains include wild and cultivated einkorn (*Triticum boeoticum, T. monococcum*), emmer wheat (*T. dicoccum*), bread wheat (*Triticum cf. aestivum*), two-row hulled barley (*Hordeum distichum*), naked barley (*Hordeum nudum*), lentil (*Lens culinaris*), bitter vetch (*Vicia ervilia*) and possibly common vetch (*Vicia cf. sativa*). Fruits were also present, such as walnut (*Juglans regia*), hackberry (*Celtis cf. tournefortii*), wild grape (*Vitis sylvestris*), cherry (*Prunus*) and hawthorn (*Crataegus*). It is also worth noting the presence of small-seeded legumes and grasses (e.g., *Medicago* and/or *Trifolium*, Gramineae), rose (*Rosa*), rushes (*Scirpus cf. lacustris*) and sedges (*Carex*).

Faunal remains comprise cattle, sheep, possibly goat, red and roe deer, equids, pig, hare, canids, tortoise, snakes, eggshells, bird bone, rodents, fish and amphibians. Cattle (either wild or domesticated) constituted the main meat source for the inhabitants of Can Hasan III alongside sheep/goat, pig and possibly onager too.
The site is located in the Beyşehir-Suğla intermontane basin, at an elevation of 1,070m a.s.l in the Taurus mountains, south-west of the Konya plain (Fig. 1.2). It occupies the top of a flat limestone ridge on the Suğla lakeshore. At the north-west part of the ridge, the remains of an aceramic/early Neolithic settlement (c. 8,500-7,500 B.P.) were recovered, consisting of a series of successive white plaster floors, underlain by numerous undisturbed hearths and circular clay-lined fire-pits. The latter were associated with thick lenses of ash, charcoal and burnt loam. In the upper phase, plastered floors rested on pebble bedding whilst mud-brick walls had stone foundations. On the contrary, the lower phase comprised structures with unplastered walls, floors and benches.

The knapped stone assemblage contained mainly obsidian artefacts (90%) and some flint implements. Obsidian projectiles and scrapers were the predominant forms, whilst a microlithic element was also present with occasional finds of geometric artefacts too. Ground- and polished-stone items included grinding stones, bowls, mortars and pestles. The finds inventory was complete with worked bone, a few clay objects (crude animal/human figurines and cones), a piece of copper wire and what appeared to be the remains of copper ore.

Animal bone remains comprised mainly sheep, goat, cattle, boar and red deer, and to a lesser degree roe and fallow deer, dog, fox, bear, wildcat, marten, badger, hedgehog, hare, tortoise, a few freshwater-clam shells, birds and fish. Sheep and goats were probably under human control, as indicated by the predominance of young individuals, but the status of the other potential domesticates remains uncertain (Perkins and Daly 1968). It seems very likely that cattle and pigs were
hunted in the site environs. No charred plant remains have been identified, but clay impressions of fragmentary wheat, barley, terebinth, pea and vetchling suggest the existence locally of plant domesticates and agricultural practices (Bordaz 1977: 32).


Erbaba is a tell site situated on a natural hill at the eastern bank of Beyşehir lake (c. 7,800-7,500 B.P.) Its architecture consists of cellular structures separated by large open spaces. The lack of openings on the ground level suggests here too the existence of rooftop entrances. Walls were built with rough limestones secured by earth mortar, on foundations made out of irregular limestone blocks (c. 50 cm in height). Both the superstructure and the stone footings were covered with thick coatings of mud-plaster occasionally painted in red. The knapped stone assemblage (obsidian and flint) indicates that, in clear contrast to Suberde, projectiles were very much under-represented compared to sickle blades, notched and denticulate tools, backed bladelets and scrapers. Ground stone implements included querns, green stone celts, pestles, mortars and hammerstones. Worked bone was also regularly present (awls, needles, spatulae and spoons, with occasional finds of hooks and antler tools as well).

The study of the archaeobotanical remains has shown that the inhabitants of Erbaba cultivated eincorn and emmer wheat (*Triticum monococcum, T. dicoccum*), free-threshing wheat (*T. durum/aestivum*), spelt (*T. spelta*), barley (*Hordeum spp.*), peas (*Pisum sativum*), bitter vetch (*Vicia ervilia*), lentil (*Lens culinaris*), vetchling (*Lathyrus spp.*) and chickpeas (*Cicer sp.*) Most of the wild taxa present in the archaeobotanical samples have been interpreted as field weeds (*Silene, Saponaria,*
Alyssum, Ziziphora, Thymelaea, Adonis, Convolvulus, Galium, Lithospermum, Medicago, Anagallis). The low proportions of wetland taxa (Scirpus, Eleocharis) however, have been interpreted as indicating that cultivation did not occur on the lakeshores (van Zeist and Buitenhuis 1983).

The analysis of the zooarchaeological material has demonstrated that domestic sheep, goat and cattle were present at Erbaba (Perkins 1973). Based on the proportions recorded for all three species it appears that whilst cattle gradually rose to the status of the major meat producer, on the contrary sheep and goat declined towards the later phases of the settlement (Bordaz and Bordaz 1982: 87). The age profiles for sheep and goat have also indicated that during the later periods they survived to an older age, hence indicating their exploitation for products other than meat (i.e., wool and milk) (Bordaz and Bordaz 1982: 87). A much lower proportion of the bone assemblage comprised animals hunted in the wild such as boar, deer and wildfowl, possibly supplemented by fishing as well (ibid.). A few marine shells were also collected from the excavated deposits.

Pınarbaşı (Watkins 1996)

As mentioned before, Site A has given the sole secure evidence thus far for an early Neolithic occupation in Pınarbaşı. The bulk of the late Neolithic deposits came from the rock-shelter (Site B) next to the aceramic campsite, whilst both sites also preserved evidence of Chalcolithic occupation. The available radiocarbon dates suggest that the Neolithic strata uncovered in the rock-shelter are partly contemporary with the late phases of Çatalhōyük East (7,450±70-7,145±70 B.P.) Such a date is further supported by the occurrence of fragmentary obsidian points and a few potsherds. Notable absentees are the ground-stone implements. An earlier
component, which may actually extend back to the aceramic/early Neolithic or even earlier, is also attested in the characteristics of the lithic assemblage collected from both the stratified deposits and the surroundings of the rock-shelter.

The excavated deposits were deficient in plant food remains (aside from the occasional hackberry stones), in sharp contrast to the amount of animal bone recovered from both sites. Ovicaprids, equids, cattle, wild boar, tortoise, fox, hare, small birds and mammals, larger birds (some the size of goose), snake and a few fish bones are represented amongst the animal bone remains. Ovicaprids, particularly sheep, dominate the earliest assemblages. The age and sex profiles for sheep suggest the existence of incipient herding strategies. Some indications for the seasonal occupation of the area by mobile groups of hunters and/or herders have also emerged (D. Carruthers, personal communication).


**I. A summary of the archaeological evidence**

The double mound of Çatalhöyük is situated on the Çarşamba alluvial fan, deposited by the Çarşamba river as it flows from Beyşehir lake into the Konya plain. The site lies on the natural communication routes running on a north-west to south-east axis from western Anatolia to Cilicia and through central Anatolia.

The ceramic Neolithic deposits excavated so far broadly comprise twelve excavation levels (I-XII from top to bottom). James Mellaart had considered these levels as valid stratigraphic subdivisions based on architectural layout and its
modifications. Recent research and excavations however have painted a more complex history of building modification and abandonment (Matthews and Farid 1996, Farid in Çatalhöyük Archive Report 1998, 1999). Still, in general terms, the old system maintains much of its value, not the least because Mellaart's levels are accompanied by a continuous sequence of radiocarbon dates. Hence, for the purpose of this study, the term "level" is used to denote primarily excavation levels. A sharp temporal distinction is implied only when describing and discussing pre- and level XII/post-XII deposits (broadly corresponding to the aceramic and ceramic Neolithic phases of the settlement respectively).

The available radiocarbon dates place the total span of Neolithic habitation between c. 8,400 and 7,500 B.P. However, if one considers the limited extent of the main excavated area (South Area, 20m x 20m, located on the south-west side of the mound; for the location of all excavated areas see Fig. 1.5), it is impossible to know whether the Neolithic settlement extended over the entire surface of the mound at any given point in time. Indeed, surface investigations have suggested an uneven coverage of the mound, particularly towards the later phases of the settlement (Matthews 1996: 86).

The excavated structures consist of rectilinear buildings, usually with two rooms, one large and one small. Features inside the larger rooms include plastered floors, circular and rectangular hearths, pits, ovens (usually oval, flat-topped and partially set into the south wall) together with plastered benches and platforms, basins and modelled posts. The smaller roofed spaces attached to the main rooms were probably used for storage purposes and contained plastered bins. The principal material for the construction of walls was mud-brick. Timber was also frequently used, especially for the structural support of the roofs. Entrance into the buildings
was through the roofs, possibly by a wooden ladder as indicated by the occurrence of timber imprints on wall plasters. The material used for plastering walls and floors was white silty calcareous clay/marl, locally obtained (Matthews W. et al. 1996: 304). It seems that, as a general rule, hearths and ovens were placed on the southern end of each building, below the main entrance, presumably in order to facilitate ventilation.

Based on the evidence available from the better excavated areas (levels VIII-VII) it seems that buildings were constructed against each other en bloc, with open areas ("courtyards" and abandoned and/or levelled houses) used primarily for the disposal of refuse. There are no indications of co-ordinated planning for the settlement layout. Buildings were raised on the layout of old and by then demolished structures, and became subject to several modifications throughout their lifetimes. Overall, the plans published by James Mellaart for each excavation level indicate a progressive increase in the amount and size of the external areas towards the later phases of the settlement (i.e., after level VI).

Burials were apparently intramural, placed inside platforms or under the floors, and usually contained the remains of several individuals. The occurrence of both articulated and disarticulated skeletons suggests the co-existence of primary and, in very few cases, secondary burials. The portable objects include ceramics (pots and clay figurines are present throughout the excavated sequence, aside from the pre-level XII strata, but are arguably more abundant and technically improved towards the later levels), stone figurines, baked-clay seals (levels VIb-II), clay balls, wooden vessels (see Fig. 1.6a-b), baskets, knapped and ground stone tools, worked bone, obsidian mirrors, beads (copper, seashell, bone, lead, clay, ochre, stone, marble, coal, mica, turquoise, rock crystal, serpentine, etc.) and textiles. The range of
the raw materials in use suggests the existence of long-distance contacts and exchange but there is little evidence as yet for the operational mechanisms of the latter (e.g., direct procurement and/or organised "trade" networks; cf. Todd 1976: 89-97, 126). Obsidian was the principal raw material for stone knapping. The main forms encountered in the local industry comprise projectile points and bifacially worked pieces, large flake scrapers, various types of retouched blades and flakes, 

*pieces esquillés* alongside flint daggers and obsidian mirrors (Conolly 1999). It is also worth noting the enormous variability of forms displayed within the lithic industry, particularly in what concerns the projectile points, which is comparable with the evidence available from many of the Neolithic sites discussed so far (cf. Todd 1976: 82-85).

Archaeobotanical investigations have established the presence of emmer and bread wheat (*Triticum dicoccum*, *T. aestivum*), einkorn (*T. monococcum*), spelt (*T. spelta*), barley (*Hordeum vulgare*), chickpea (*Cicer*), vetchling (*Lathyrus*), lentil (*Lens culinaris*), pea (*Pisum sativum*), purple pea (*P. elatius*), vetch and bitter vetch (*Vicia*) Weedy taxa include chenopods (Chenopodiaceae), wormwoods (Asteraceae), crucifers (*Capsella bursa-pastoris*, *Erysimum sisymbrioides* both with oil-rich seeds), plus small-seeded grasses (*Taeniatherum*, *Eremopyrum*) and legumes (Fabaceae). A wide variety of hygrophilous taxa are present as well such as flax (*Linum*), club-rush (*Scirpus maritimus*), reeds (*Phragmites*), sedges (*Carex*), pondweeds (*Potamogeton*), alder (*Alnus*), water dropwort (*Oenanthe*) and canary grass (*Phalaris*) (see Fairbairn and Kennedy in Catalhoyuk Archive Report 1999).

Tree crops collected from the wild included hackberries (*Celtis*), terebinths (*Pistacia*), plums (*Prunus*), figs (*Ficus*), acorns (*Quercus*), almonds (*Amygdalus*) and juniper (*Juniperus*) fruits.
The bone assemblage recovered so far comprises mainly sheep and goat, alongside cattle, pig/boar, red, roe and fallow deer, wild ass, dog, wolf, fox, hare, bear, wildcat, badger and hedgehog, as well as some small mustelid species, frog and tortoise together with bird and fish bones. Of the potential domesticates on the basis of anatomical criteria some appear to be wild (e.g., boar) while the status of the rest, with the exception of sheep, is uncertain (cf. Martin et al. in Çatalhörük Archive Report 2000). Based on the available osteometric evidence it seems likely (at least for cattle) that both wild and domesticated forms were present, although such variations in body size could also reflect marked sexual dimorphism (cf. Frame et al. in Çatalhörük Archive Report 1999). A temporal pattern in taxon representation is also evident in that sheep/goat (particularly sheep) and to a lesser extent cattle clearly predominate, whereas amongst the earlier levels wild animal bone is taxonomically more diverse.

During the 1999 excavation season evidence was obtained for the first time of the earliest phases of the Neolithic settlement, from two areas: a deep sounding dug through Mellaart’s old trenches (also the focus of the 1990s excavations known as the South Area) and an off-site area (known as the KOPAL -Konya basin Palaeoenvironment research programme- trench), situated on the northern edge of the east mound (Fig. 1.5).

The material culture uncovered in the early strata of the deep sounding (collectively termed as pre-level XII deposits) displays considerable differences with the assemblages retrieved from later levels (see Farid in Çatalhörük Archive Report 1999, Carter in Çatalhörük Archive Report 2000). These are evident in the lack of pottery, the technological attributes of the knapped stone (an abundance of microliths and sickle elements bearing resemblance to the assemblages known from Pınarbaşı-
Site A, Can Hasan III and Aşıklı, alongside a wider variety in raw materials used), and in the fired clay objects (occurrence of conical and cuboid shapes). Variations are also evident in the composition of the faunal, botanical (increased presence of fruit stones, especially hackberry, plus indications for the extensive use of dung as fuel) and shell remains (an abundance of fresh-water shells) (see contributions in Çatalhöyük Archive Report 1999). The presence of red-painted hard lime plaster floors is also distinctive. These are again commonly found in other aceramic Neolithic settlements such as Can Hasan III, Suberde, Aşıklı and Musular.

Still, due to the very limited extent of the excavated area, it proved impossible to establish any association between these deposits (mostly middens, isolated burning events and basal alluvium) and building structures. It remains therefore unclear whether the variations observed in material culture and the bioarchaeological remains are temporal or they reflect instead a different range of activities taking place at some distance from the living quarters of the settlement. In the light of the similarities observed between these early levels, the findings of the KOPAL trench (see below) and other regional archaeological sequences, it seems probable that there is a strong temporal element. However, only further excavation will clarify its full manifestations in the way of life of the Neolithic community.

Excavations in the KOPAL trench produced evidence for substantial off-site activities that seem to correlate chronologically with those attested in the pre-level XII strata. Furthermore, later elements (late Neolithic/early Chalcolithic) were also unearthed, in association with buried soil horizons (Roberts and Boyer 1999). The Neolithic activities identified include the intensive quarrying of the backswamp areas for the extraction of marl to be used in lime plaster and mud-brick construction, the processing and preparation of cereal crops (as suggested by a large concentration of
cereal awns), and the dumping of animal bone, which seems to represent post-consumption refuse. Quarrying pits had been infilled with ash lenses, large brick fragments, chipped stone, fired clay objects, animal and occasionally human bone too. The fact that animal bone bore very little signs of weathering and post-depositional disturbance suggests that waste disposal took place mainly in flooded depressions. Although no waterlogged wood remains had been preserved, the occurrence of a large posthole with vertical sides and a flat base may indicate the use of quay-like structures in order to facilitate access to these flooded off-site areas (Roberts and Boyer 1999).

ii. The artistic representations

One of the most remarkable aspects of the Çatalhöyük buildings is their internal decoration. Paintings, reliefs, cutout figures and bone implements (especially the modelled bucrania) are more or less unmatched elsewhere in Neolithic Anatolia, hence offering a rare insight to the artistic traditions of the region. That the inhabitants of Çatalhöyük considered them important as well is suggested by the fact that sometimes they were retrieved from buildings prior to their final abandonment. It should also be noted that the paintings at least did not fulfil a purely decorative purpose, since they were frequently covered with plaster and the same surface repainted on another occasion. In fact, it is likely that for most of the time walls remained blank (Mellaart 1967: 132, Todd 1976: 34).

It is possible to follow the development of these features from the uppermost levels down to some of the earliest excavated structures. Level X has provided evidence for cross-like motifs and representations of large bovines cutout in plaster, whereas similar figures were found in level IX alongside red plastered floors (e.g.,
the "animal heads" in IX.8; Mellaart 1964: Fig. 24). Comparable are the representations in level VIII of a bovine and a large deer head also cutout in plaster. To these one should add the "kilim" patterns, probably imitating real textiles hanging from the walls, net-like drawings, relief representations of felines, vultures associated with human figures, red-painted plastered floors and benches, plus geometric and eye-like motifs (Mellaart 1964: 70, 1966: 178-182).

Red-painted plaster was also encountered in level VII. Other themes from this level include abstract motifs, human reliefs with outstretched arms and legs and a view of the village set against an active volcano (Mellaart 1964, 1966: 177). Here a more formalised use of the bovid theme is also observed, with horns and skulls appearing as implements on wooden posts set against the walls, a pattern that reached its fullest development in the buildings of level VI (Mellaart 1962: 51, 1963, 1964: 52).

From level V to the top of the excavated sequence it is possible to observe an overall decrease in the amount of paintings and reliefs, coupled with another thematic shift, this time expressed through the decoration of all four walls with the so-called "hunting scenes". This is best exemplified in the "hunting shrines" of levels III and II (Fig. 1.7, 1.8). In building F.V.2 these scenes depict various animals (a large bovid, equids, deer, lion, wild boar, possibly wolf, and dog). Three of the wall paintings appear to represent hunting episodes, with human figures trying to capture a stag and wild boars with nets, bows and axes, but the rest depict either animals in the absence of humans, or again large beasts (e.g., in the well-known "bull scene") surrounded by humans, but without being threatened by them. Overall, the impression is that of a joyful atmosphere with men, women and animals participating...
in some sort of ceremonial event, a symbolic reconstruction of which these paintings probably represent.

1.2.3 Synthesis: towards an integrated view of the Neolithic landscape

From the evidence outlined in the previous sections, it is possible to draw up some initial conclusions about the patterns observed in both the palaeoecological and the archaeological record. For the Epipalaeolithic, the little archaeological information currently available suggests that settlement was probably concentrated around wetland areas. As noted earlier on, burial by alluvium and later settlement has already been identified as one of the factors affecting the archaeological visibility of such early sites (Baird 1999). However, the low number of sites and their small size might also indicate that during this period a pattern of non-permanent habitation prevailed in Central Anatolia, possibly centred on those few localities (i.e., lakesides and alluvial deltas) that could attract wild game such as bovids, equids and wildfowl.

That some sort of contact existed at various points of time between both sides of the Taurus range is supported by the occurrence of "exotic" goods such as Mediterranean sea shells.

Differential resource availability might be held responsible to a considerable extent for the scarcity of pre-Neolithic sites in the Anatolian plateau. Whilst the Antalyan coast offered the settings that could sustain a dense network of sites (well-forested areas, rich in game and other resources, cf. Otte et al. 1995), the situation further inland was nothing comparable. Recessing lake levels and unstable aquatic environments after approximately 17,000 B.P., further accentuated during the dry and cold interval of the Younger Dryas (c. 11,000-10,000 B.P.), must have been one of the factors limiting settlement expansion. Foraging groups were probably small
and highly mobile to counter for such marked spatial and temporal fluctuations in the availability of wetland environments, which in turn could have influenced the movements of ungulate herds on a seasonal basis. Only particular locales (e.g., the springs of Pınarbaşı) could have maintained their attractiveness during this period and, as a result, became foci to which people returned recurrently in later times.

The evidence available for the distribution of obsidian identified with known sources from this area during the Epipalaeolithic and on to the Neolithic lends additional credence to an argument favouring a long tradition of high group mobility in this area. Obsidian from this region (the principal sources being those of Acigöl, Nenezi Dağ and Göllü Dağ-Çiftlik, each of them comprising several distinct localities and/or workshops; cf. Balkan-Atli 1994: 29-31, Chataigner 1998) has been traced as far as the middle Euphrates and the Levant. Moreover, recent investigations have shown the existence next to the source areas of obsidian “workshops” dating from the Palaeolithic onwards (Cauvin M.-C. 1996, Balkan-Atli and Der Aprahamian 1998, Balkan-Atli et al. 1999), whilst many of these early sites were subsequently obliterated by geological changes (Cauvin M.-C. 1996: 23).

Although there is no evidence for the existence of large-scale, specialised exchange networks during the Neolithic which were directly controlled by individual settlements such as Aşıklı or Çatalhöyük (cf. Cauvin M.-C. 1998), the available data suggest that Cappadocian obsidian (apparently in the form of “exotic” goods) had reached such distant sites as Mureybet and Abu Hureyra (middle Euphrates), Mallaha (Jordan valley) and El Kowm (Surian desert) already from the Epipaleolithic (ibid.). For the Neolithic, recent investigations have demonstrated the co-existence of different chaines opératoires in the same source areas denoting both “domestic”-oriented production (easily identified with known lithic assemblages from Central
Anatolia) and highly standardised production destined for export. The latter bears strong similarities to industries encountered in the Levant and southeastern Anatolia (Balkan-Ath et al. 1999). It is likely that early “networks” of exchange, apparently maintained by mobile foraging groups and centred on the circulation of obsidian as an “exotic” item, gradually gave way to more complex patterns of group interaction, although the precise nature of the latter remains to be established (cf. Balkan-Ath et al. 1999).

It is therefore possible that the sparse Epipalaeolithic occupation of Central Anatolia was due (at least in part) to the prevalence in this area of a pattern of highly mobile habitation. Its causes may be sought at both the limited potential of the regional environment to sustain a large population on a quasi-permanent basis (e.g., of the type suggested by the Natufian example), and the need to secure an active role in the manipulation of these highly esteemed sources of raw materials. However, it is only through proper excavation of the Epipalaeolithic sites recently identified in the Konya plain that such a hypothesis might be checked against solid archaeological evidence.

With the onset of the Neolithic, the spread of cultivated crops enabled the establishment of permanent settlements in the vicinity of the obsidian and/or metal sources (e.g., Suberde in the Taurus mountains, rich in copper and iron ores, and Aşıklı Höyük near the Cappadocian obsidian sources), or on important natural communication routes (Çatalhöyük). The introduction of the new mode of production had undoubtedly significant effects on the organisation of subsistence activities as well, with a shift towards the cultivation of cereals and legumes and the sustained exploitation of wetland resources.
At the same time, we see the first local attempts to achieve a greater control over potential animal domesticates such as sheep, goat, cattle and pigs, apparently a long-term process if one is to judge from the uncertainty characterising faunal reports. Further research in the basal levels of Aşıklı will undoubtedly offer a much sounder zooarchaeological confirmation for the indigenous derivation of animal husbandry in Central Anatolia, as it appears to be the case with the early Neolithic faunal assemblages from Pınarbaşı (D. Carruthers, personal communication), which have provided so far the earliest (c. 9,200 B.P.) indications of incipient herding strategies in this area. The fact that the Anatolian plateau lies well within the zone of the natural distribution of all major potential domesticates (sheep, goat and cattle) lends additional support to a pattern of indigenous herding strategies (Vigne and Buitenhuys 1999).

Nonetheless, it is possible to trace some elements in the evaluation of the resource base that appear to have persisted from earlier periods. Hence diverse game and, to a lesser extent, plant foods collected from the wild had contributed to the diet of the Neolithic groups, especially during the early stages of the settlement (e.g., Suberde, Aşıklı Höyük). This trend is best exemplified in the long archaeological sequence of Çatalhöyük, whereby wild animal bone is taxonomically more diversified in the earlier levels. It is also interesting to note the increased occurrence of prismatic blades in the lithic assemblages recovered from the later phases, which has been interpreted as likely to indicate a shift in subsistence strategies with a greater emphasis on cereal exploitation (Conolly 1999).

The zooarchaeological evidence from the earliest Neolithic settlements excavated thus far (Pınarbaşı, Suberde, Can Hasan III, Aşıklı, Musular) suggests that animal hunting and herding maintained a prominent position in the lifestyle of the
early Neolithic communities. Such an observation accords with the findings of lithic analyses that have indicated the significant presence of projectiles of various forms (cf. Todd 1976: 82). Although the cultivation of cereals and pulses must have imposed enormous restrictions on the mobility of social groups, hunting and herding (especially of those animals that appear to fit best in a “proto-elevage” status such as sheep, goat, cattle and pig) could have operated on the opposite direction, by providing opportunities for moving across the landscape and thus creating suitable settings for interaction with animals in their own natural habitats. Such indeed is the meaning ascribed by Ducos on the wall paintings depicting “hunting” scenes at Çatalhöyük, which are interpreted as representing primarily episodes from the daily experiences of its inhabitants relating to animal “proto-domestication” (Ducos 1988: 94-98).

However, the temporal dimension of such an intimate relationship with the animal world might have been no less significant. Both the field surveys and the excavations at Pınarbaşı have indicated that the springs and the surrounding marshlands were the focus of intensive (albeit in all likelihood seasonal) hunting and herding activities from a very early stage. Although “hard” evidence exists only from the early Neolithic onwards, the surface surveys have indicated that a pre-Neolithic component exists in the area (as evidenced in the lithic collections, cf. Watkins 1996: 55). To date, the archaeological prospections suggest that traces of human habitation are preserved in at least four more rock-shelters (Watkins 1996: 50). Given the remarkably long history of human occupation in this area in the form of hunting and herding campsites (i.e., early Neolithic-Bronze Age), it seems very likely that such patterns of group mobility related to animal movements and/or herd control could have been in place already from the Epipalaeolithic.
Again Çatalhöyük has offered some interesting insights, with an additional temporal dimension, in the community’s perceptions of the animal world. Whilst in the earlier aceramic strata (KOPAL trench and the deep sounding) wild taxa such as deer and boar are represented by all body parts, this is clearly not the case later on in the sequence whereby cervid remains in particular appear mainly in the form of cranial elements, notably antlers (Martin et al. in Çatalhöyük Archive Report 2000). Although this pattern might also reflect temporal changes in carcass processing strategies, it is very likely that these animals ‘[were] no longer hunted near the site and only selected parts [were] brought in from a distance for their symbolic and technological value’ (ibid.). Furthermore, the lithic evidence from the aceramic levels has indicated the abundance of projectiles bearing signs of use-wear (overall much more frequent than in later phases). That projectiles were retrieved after their use and brought back to the settlement could also imply their importance as prestige items, possibly associated with hunting achievements (Carter in Çatalhöyük Archive Report 2000).

It is perhaps here that a re-evaluation of the Çatalhöyük wall paintings and reliefs becomes relevant, in that they offer a better insight into the evolution of animal-human relations from a temporal perspective. In this respect, the apparent contrast between the imagery of Çatalhöyük (with the elaborate hunting and festivities scenes alongside the frequent use of the bull theme) and the evidence relating to subsistence activities (dependence on cultivated plant foods and the predominance of sheep/goat), may reflect a conscious attempt from the part of the local inhabitants to assert their descent from the mobile hunting groups postulated for earlier periods. Although it is difficult to separate in the thematic content of the wall paintings what represents the “synchronic” experiences of the inhabitants of
Çatalhöyük as opposed to a distant world of collective memories or even “myth” (cf. Ducos 1988: 97) their overall correlation with platforms containing burials and their transient character seem to support a purpose related to notions of ancestry (see also Hodder 1999).

A further argument favouring the existence of indigenous patterns of landscape perception and exploitation prior to the appearance of sedentary village communities is offered by the close examination of settlement distribution and site location. Intensive field surveys in the Konya plain (cf. Baird 1998, 1999, 2000 and pers. comm.) have suggested the existence of a network of smaller late Aceramic/early Neolithic sites, with possible Epipaleolitich habitation too, covering extensive parts of the plain prior to the appearance of Çatalhöyük.

The KOPAL team investigating sedimentary histories on and around Çatalhöyük has put forward the suggestion that the location of the site right in the middle of the seasonally flooded alluvial plain (see also Fig. 5.1) probably did not present major benefits in terms of optimal agricultural production (Roberts and Boyer 1999, Roberts et al. 1999, Roberts pers. comm.) Their results have indicated that the site was founded on a low-lying alluvial delta/floodplain, lacking substantial raised dry surfaces. From this they argue that the soils of the area immediately around the settlement (mostly heavy backswamp clays) were probably saturated for much of the year and the spring floods (either annual or at longer intervals) could have inundated large areas of the alluvial basin for prolonged periods, thus destroying any cereal crops that had not been planted on raised locations (Roberts et al. 1996, Roberts and Boyer 1999; Roberts, pers. comm.) The heavy alluvial soils could have posed an exceptional challenge for the skills of these early farmers practicing non-plough cultivation. The weed flora recovered for the archaeobotanical
assemblages contains both wetland and dryland species, but since many of them were probably incorporated in the archaeobotanical record via dung burning it is likely that they do not represent an accurate reflection of cropping practices *per se* (although the occurrence of many dryland weed seeds co-varies with that of cereal crops; Fairbairn et al. in press, Fairbairn pers. comm.) Recent phytolith studies have also provided some indications for the occurrence of dryland cereal crops (Arlene Rosen pers. comm.). On this basis it has been argued that the most optimal source for crops were probably the Neogene terraces and the low hills flanking the Konya plain, some 10-12 km to the south of Çatalhöyük (see also Fig. 5.1).

It may be possible to counter this interpretation, by pointing out that the site is in a similar situation to settlements occupying the Mesopotamian lowlands, where successful cropping seems to have occurred in association with the annual floods (cf. Charles 1988, Potts 1997). The environment at Çatalhöyük however is qualitatively different. The site lies in the middle of the Çarşamba fan, which is deposited in a non-outlet basin (the Pleistocene Konya palaeolake) and is characterised by permanent high water levels. Alluvial sediments accumulated gradually on the marl lake floor and there is an absence of evidence for the development of levées and extensive dry raised surfaces during the early Neolithic (with the exception of the sand ridges 5 km to the south of the site; see Fig. 5.1). Instead, fine-grained sediments gradually prograded towards the centre of the basin to the north, where they settled in the form of heavy clays (Roberts et al. 1996, Roberts pers. comm.) At the same time, the whole area slopes from SW to NE, resulting in a higher water table in the northern part of the plain. Overall, without considering modern drainage works, drainage in the south and west of the Çumra area (i.e., closer to the foothills) is much better than in the east and north (where Çatalhöyük is located) thus leading
to the formation of extensive marshes and backswamps. On the low-lying areas the effect of having a high permanent groundwater table could have been profound, not only on the potential for exploitation of the soils, but in terms of landform development too. Presently the Neogene terraces south of Çumra are classified as the best agricultural soils for rainfed cultivation in the plain (Driessen and de Meester 1969; Roberts et al. 1999).

Still, one cannot claim that the floodplain was not used at all for cropping. It is entirely possible that certain pulse crops were spring-sown on freshly exposed patches of alluvium after spring floods had retreated (A. Fairbairn pers. comm.) Otherwise, marl hummocks and the backswamp clays would be very difficult to cultivate and much less productive, at least by methods not involving deep ploughing and/or terracing (and for heavy clays drainage as well) to improve soil aeration and root penetration (G. Hillman pers. comm., Grove and Rackham 2001: 59, 323). Levées or sand ridges (e.g. the sand ridges situated 5 km to the south of the site; see Fig. 5.1) could have provided potential growth sites. It has to be stressed however that the geoarchaeological sampling coverage of the area (i.e., coring) has not been as extensive as to preclude in a definite manner the existence of levée formations. Research is ongoing and present hypotheses are open to refutation by future findings.

From an archaeobotanical point of view, only the analysis of the crop stores retrieved in large numbers by Hans Helbaek in the 1960s will furnish some positive indications on the issue of field location (through the examination of the associated weed floras; no comparable crop stores have been retrieved during the recent excavations). However (provided that the results of the geoarchaeological investigations stand as they are) if cereals were indeed grown in the immediate environs of Çatalhöyük, the method of cropping would seriously challenge currently
established assumptions about Neolithic cereal cultivation. It would imply one or all of the following:

1. Spring-sown cereal varieties had developed: this would have been much earlier than we know at the moment (cf. Oates and Oates 1977). Winter-sown cereals need more stable, drier conditions and (while they could have survived the occasional prolonged flood) they could not persist in soils that were wet through much of the autumn, winter and spring. Permanent high water levels prevent germination (Hook 1984, 268) and lead to cessation of growth and/or death through hypoxia or anoxia in non-adapted plants such as the cereal crops (Trought and Drew 1981; papers in Kozlowski 1984).

Furthermore, the existing evidence on the ecology of early cultivated cereals has indicated that they would have required a vernalisation period before producing seed.

2. Some form of flood control existed, at least locally (i.e., in the form of drainage ditches or embankments none of which has been evidenced so far in Çatalhöyük); this again would be much earlier than we have evidence from elsewhere in southwest Asia (cf. Oates and Oates 1977).

3. Cultivation was dispersed and very mobile; this would also be a high risk strategy and prone to low yields or even total crop failure in the event of particularly wet winters or pronounced spring floods. At the same time, the higher groundwater availability secured by the proximity of the alluvial delta would not offer any substantial advantage compared to the drier areas further south, since the latter could certainly support reliable rainfed cultivation (they do so even under the present climatic regime, cf. Driessen and de Meester
1969, therefore there is no reason why this should not have been the case during the climatic optimum).

There is therefore the possibility that settlement location did not adhere to strictly defined, utilitarian considerations (i.e., availability and accessibility of prime agricultural land in the immediate settlement environs). Furthermore, such subsistence arrangements are likely to have necessitated a pattern of high seasonal mobility (i.e., annual and/or interannual variation in the location of the cultivated areas) as well (pending on the extent of the inundation of the alluvialmarsh environs of the site), in any case substantially higher than what is expected from settled Neolithic agriculturalists. One can only speculate as to the rationale that dictated this choice of settlement location, especially since an alternative location c. 10-15 km to the south would not deprive the site inhabitants of water resources while at the same time guaranteeing the accessibility of prime agricultural land for rainfed cultivation. Seen in a broader regional context, there is the possibility that such a pattern of resource perception and movements across the landscape may have links to pre-existing traditions of resource utilisation. In other words, similar strategies are much more akin to strategies pursued by mobile groups relying on the opportunistic exploitation of seasonally available resources than those of settled agrarian communities whose daily routines are conditioned by strictly defined subsistence goals. In this case the non-optimal farming location could be explained further as being the traditional ancestral home, people being bound to it by familiarity, history and well-defined routines and territories of resource extraction. Pinarbaşt Site A for example shows beyond doubt that mobile hunting groups occupying seasonal campsites were present in the area inhabiting wetland environments long before
Çatalhöyük was established. Similar evidence on the early settlement of the Çarşamba area is forthcoming (D. Baird pers. comm.)

1.3 Discussion

The approach that has been pursued in this chapter has concentrated on certain aspects of the palaeoenvironmental as well as the archaeological record that may shed some light on the landscape settings and the ways through which they may be related to human decision-making. The picture emerging from this process is informative, in that it unravels the broad pattern of the environmental conditions under which the establishment of the first sedentary communities in the Anatolian plateau took place, as well as the potential incentives that might have led to the widespread adoption of crop cultivation.

Previously proposed interpretive frameworks dealing with the appearance of the first Neolithic communities in this area, focus on two discrete theoretical approaches. The most widely known of them is grounded in the exploitation of the potential offered by geoarchaeological investigations, in order to investigate the environmental settings of early agriculture. Initiated by Claudio Vita-Finzi’s original conception of “geological opportunism” (Vita-Finzi 1969), it sought to explain settlement location as directly related to geomorphological change, which eventually created the water-retentive alluvial soils favoured by early agricultural communities (e.g., Roberts 1991).

Within this framework, the burden of interpretation shifted from the research of essentially deterministic parameters, such as climate change, demographic pressures and biological factors (i.e., the distribution of wild progenitors) towards a
more rationalised perspective of the relationship between the early sedentary societies of south-central Anatolia and the landscapes they inhabited. However, this view of the beginnings of the Neolithic as fundamentally concerned with the colonisation of virtually uninhabited areas and the full establishment of a transplanted mixed farming economy (e.g., Payne 1972, McCorriston 1992: 130-132) tended more often than not to overlook the individual particularities of each site. A further implication was that, by focusing on subsistence strategies alone, other apparently important environmental parameters, such as the distribution of the sources of raw materials (e.g., obsidian), were effectively dismissed from any discussion about the evolution of the regional landscapes. This applies with particular force to the case of Çatalhöyük, where the archaeological evidence for an elaborate local culture already from the earliest excavated levels, has been deployed at its best as suggestive of a higher order central place settlement (cf. Todd 1976: 129-130).

The realisation of this vacuum in the archaeological discourse led many scholars to formulate alternative approaches. Within these, priority was awarded to the manifestations of material culture and architecture as indicative of important changes in social organisation and, ultimately, the symbolic realm. The transformations of the latter were taken to involve an essential opposition between the domestic, that is the familiar space of the household and the security it bestows, and the wild, untamed external world, an idea first tested in the contextual associations of Çatalhöyük (Hodder 1987, 1990).

The pre-eminence of an elaborate symbolic system, manifested through the internal organisation of the living space and the use in artistic representations of archetype figures, such as the female and the bull, is thought to transcend the
Neolithic of the Near East as the decisive factor for the establishment and spread of early sedentary societies (cf. Cauvin J. 1994, Hodder 1996, Özdoğan 1997b). However, the degree to which such an interpretive scheme can account for the entire spectrum of cultural innovation is debatable. By stripping the term "neolithic" of any practical notion and subordinating it to a set of abstract and, in the course of time, essentially unaltered ideas, it only manages to reproduce the same binary distinction between culture and nature. As Hodder himself concurs in a different context, "...a duality is created between the cultural ... and the natural ... between the ordered world of social representation and the physical violent world of the non-social." (Hodder 1990: 283).

Contrary to these views, what I have attempted to demonstrate in the preceding sections is that the necessity to adopt a new mode of production might have stemmed from factors that are essentially non-linear, in that they account for local contingencies shaping the relationship of human groups with the landscapes they dwelt in. Accordingly, it is argued that one of the parameters that might have necessitated a shift towards a more sedentary lifestyle was the realisation of the potential it offered for establishing greater control over the procurement and circulation of highly esteemed raw materials (e.g., obsidian). It was probably a change dictated by both the rising unpredictability of traditionally available resources (e.g., wild game) and the potentially adverse effects it entailed for the ability of local groups to participate in the manipulation of the raw material sources.

The process and ultimate effects of this increased sedentism through time are perhaps best documented in the subsistence strategies practised by the Neolithic community of Çatalhöyük, whereby early opportunistic schemes of resource exploitation gradually gave way to a greater focus on the management of plant and
animal resources. It is primarily within this framework that the exploitation of woodland resources will be investigated, in order to determine whether it conformed to a pattern solely dictated by natural availability or, instead, it evolved through time on the same trajectory envisaged for the rest of the subsistence activities.

Furthermore, the differences observed in modes of firewood procurement and consumption between the settlements of Çatalhöyük and Pınarbaşı will be explored, in order to evaluate the potential impact of their divergent subsistence economies on patterns of resource perception and exploitation.
Chapter Two – Methodology I: Charcoal taphonomy and the interpretation of archaeological wood charcoal assemblages

The aim of this chapter is twofold. First, to present a detailed account of the various parameters affecting the formation of an archaeological wood charcoal assemblage, including firewood collection and consumption, burning, depositional contexts, post-depositional processes, field procedures and laboratory techniques. Second, in the light of this analysis, to offer a critical re-assessment of current approaches to charcoal interpretation, with particular emphasis on the issue of quantification. A short account of the history of charcoal analysis offers the background setting, in an attempt to trace the roots of the current debates within the discipline.

2.1 A short history of the discipline

It was in 1864, that the idea was conceived for the first time to analyse prehistoric wood charcoal macro-remains by the Italian G. Passerini and, following him, the Swiss O. Heer, in the context of the then recent impressive discoveries of the Neolithic and Bronze Age “Lake Dwellings” in Switzerland (cf. Chabal et al. 1999: 44, Trigger 1989: 83-84). At the beginning of the 20th century, the French clergyman and prehistorian Henri Breuil was the first to take an active interest in the study of wood charcoals recovered from Palaeolithic sites in France (cf. Badal Garcia 1992). At these very early stages, only material deriving from prehistoric hearth structures was destined for analysis and the interpretations sought by the researchers were of limited palaeoecological interest. Instead, the focus was on the choice of combustibles by the prehistoric groups (ibid.).

The first explicitly ecological interpretations based on charcoal evidence appeared in Britain with the publication in 1940 by E.J. Salisbury and F.W. Jane of
their report on wood charcoals from the Maiden Castle excavations in Dorset. In this paper, Salisbury and Jane suggested that the observed frequencies of individual taxa might correspond to their actual proportions in prehistoric woodland vegetation. They also used tree-ring data in an attempt to reconstruct past climate patterns (Salisbury and Jane 1940). Their interpretations were questioned by H. Godwin and A.G. Tansley, who drew attention to the role of ecological variables (structure of plant communities and species physiology) and cultural parameters (wood selection) in determining species availability. They also stressed the potential effects of differential wood combustion on taxon representation (Godwin and Tansley 1941). Hence, the debate was launched for the first time, which continues to the present-day, concerning the appropriateness of archaeological wood charcoals for reconstructing prehistoric vegetation.

That such early developments should take place in Britain is not surprising given the long-standing tradition of prehistoric and ancient wood studies on the British Isles, from the 17th century onwards, dealing mainly with the remains of waterlogged artefacts and wood macrofossils (cf. Coles et al. 1978: 2). These were matched later on by extensive and detailed studies on wood anatomy, initially addressed to botanists, foresters and timber experts but later proven invaluable to archaeobotanists interested in wood charcoal identification, such as ‘The Anatomy of The Dicotelydons’ by C.R. Metcalfe and L. Chalk (1950) and F.W. Jane’s ‘The Structure of Wood’ (1956).

Comparable events followed shortly afterwards in France, stimulated by a stronger interest of botanists and wood anatomists on archaeological charred wood macro-remains and their palaeoecological interpretation. Momot (1955) explicitly used wood charcoal macro-remains derived from late Palaeolithic hearth structures
as a guide to reconstructing past climate patterns. In his treatise on the methodology of charcoal analysis, the French wood anatomist M. Couvert stressed the uniqueness of charcoal data in supplementing a picture of past vegetation essentially synchronous to prehistoric settlement, a quality not shared by pollen analytical investigations that usually offer a much more arbitrary sketch of woodland composition (Couvert 1968). His studies of charcoal specimens from the cave sites of Khanguet Si Mohamed Tahar and Tamar Hat in Algeria provided the first “hard” evidence for the existence of non-analogue vegetation types in this region during prehistoric times, which were interpreted as indicating different climate regimes in the past (Couvert 1969a, 1969b). Following a slightly different approach, in 1976 he published the results of his analysis of wood charcoals retrieved from the sixth millennium site of Relilaï in Algeria. In this paper, he attempted to reconstruct the spatial distribution of past vegetation based on modern rainfall values from wooded areas and topographic relief. His stated purpose was to reconstruct vegetation catchment areas, measure the distances people had to walk in order to collect wood and reconstitute their paths of movement (Couvert 1976).

A qualitative approach to vegetation reconstruction was proposed by another French botanist, S. Santa, in his synthesis of charcoal data from North Africa. Based on the axiom that “the same floristic stock will generate identical vegetation groups” (i.e., if vegetation communities are defined as essentially a group of species, then the same range of species will give rise to identical floristic associations, now or in the past), he used qualitative data (namely lists of taxa compared to their modern distributions in the area of study) in order to reconstruct past vegetation formations (Santa 1961). He was the first to introduce the concepts of the “probability” of preservation and the “possibility” of taxon recovery from the charcoal macro-
remains. His answer to this problem was to exclude from his vegetation surveys species that were least likely to be collected by prehistoric groups (e.g., those that have poor heat value) or those which, due to their natural characteristics (e.g., small-sized woods), did not have a high chance of preservation in the archaeological record (Santa 1961: 56). The remaining taxa were then classified into different vegetation types according to their ecological status in modern day formations (i.e., as pioneer, dominant, climax or secondary species) and the latter served as a comparative basis for the reconstruction of past vegetation.

After the Second World War, the widespread adoption of radiocarbon dating signalled a new focus on charred plant remains, particularly charcoal. However, the limitations of the existing laboratory techniques hampered exploiting the full potential of wood charcoals. The preparation of charcoal for microscopic identification involved the impregnation of charred specimens with paraffin or polyester, in order to stabilise individual fragments, and then with a synthetic resin so as to obtain small, transparent blocks enclosing each specimen. These were then sectioned with the aid of a microtome in the three anatomical planes (i.e., transverse, radial and tangential, see Fig. 2.1). The upper surface of the resultant pieces was subsequently abraded in order to produce thin sections that could be examined under a transmitted light microscope (cf. Momot 1955, Couvert 1968, Santa and Vernet 1968). Predictably, this extremely time-consuming method of laboratory preparation resulted in few and in some cases even problematic identifications, due to the distortion of anatomical characters. It also severely compromised the suitability of charcoal specimens for radiocarbon dating, due to the contamination caused by their chemical treatment.
At the end of the 1960s, the adoption of reflected light microscopy by charcoal analysts was bound to revolutionise the state of affairs within the discipline (Western 1969, 1971, Leney and Casteel 1975). In contrast to the impregnation methods, charcoal specimens are fractured either by hand or by using a razor blade in the three anatomical planes and examined directly under the microscope. Simplifying preparation techniques and microscopy procedures meant that it was now possible to identify a high number of specimens in a relatively short time. Hence, it became realistic to undertake systematic studies of large wood charcoal assemblages, which could furthermore produce statistically meaningful results. These advances in laboratory procedures were in line with the widespread implementation in the field of various flotation techniques (cf. Pearsall 2000: 14-27), which enhanced dramatically the recovery and retrieval of charred plant macro-remains.

At the same time, the first major syntheses and systematic studies were produced in the Western Mediterranean, particularly in France, under the influence of Jean-Louis Vernet who was the founder of a strong research tradition centred on the University of Montpellier. During the 1980s, another generation of researchers laid the foundations for the systematic application of charcoal analysis on archaeological sites, with a renewed emphasis on appropriate sampling strategies and the need for charcoal analysts to have an active role in excavating and sampling archaeological sites. Further, new avenues were explored for the interpretation of charcoal data in relation to wood combustion experiments, ethnographic research and wood anatomical studies. Parallel to these developments was the expansion of the methodology in other Mediterranean countries as well, such as Portugal, Spain and Italy, in the rest of Europe, in Africa, the Near East, North and South America, etc.

2.2 Factors affecting the formation of a wood charcoal assemblage

In the following sections, the parameters affecting the formation of an archaeological wood assemblage are examined. Three major stages are identified in this process involving the whole spectrum of influences and transformations, from the source area itself (past vegetation) to the laboratory space (charcoal identification and interpretation): a. Environmental and cultural parameters (species availability, firewood selection and fuel consumption), b. Physical parameters (burning, depositional environments and post-depositional transformations) and c. Field and laboratory techniques (recovery, sampling and identification).

2.2.1 The impact of environmental and cultural parameters: species availability, firewood selection and the socio-economic context of firewood consumption

2.2.1.1 Species availability and firewood selection

One of the most important factors impinging on the ease of collection of woody plants is their availability in the settlement environs. As such, availability attracted considerable attention on the part of charcoal analysts, since it offered the potential to develop functionalist interpretations of archaeological wood charcoal assemblages. The latter envisaged a direct causal relationship between wood selection by prehistoric groups and the floristic composition of woodland catchments, which was summarised in the "Principle of Least Effort" (cf. Prior and Price-Williams 1985). According to this paradigm, firewood collection in the past took place in those
woodland catchments situated closest to the settlement and all species were collected in direct proportion to their occurrence in the site surroundings. Thus, the frequencies of individual taxa in any given assemblage, allowing for potential biases introduced by differential preservation, rates of charcoal deposition and sampling strategies, can be considered as an accurate reflection of their abundance in the natural environment at the time of human habitation.

The overtly deterministic premises of this approach were challenged by other researchers, who pointed that availability is not a function of species abundance alone (Shackleton and Prins 1992). On the contrary, it represents the synthesis of a multitude of ecological parameters and processes that may operate simultaneously and at many different levels. It has been ethnographically observed that factors such as the abundance of dry deadwood, which poses almost minimal requirements in what concerns its ease of collection and transport back to the settlement, have an important influence in fuel selection (Heizer 1963, Openshaw 1974, Ford 1979). This has an obvious effect on the range of species selected, since some trees are more likely than others to shed their lateral branches (cf. Millington and Chaney 1973). Furthermore, the speed by which certain species of trees and shrubs regenerate and colonise new habitats as a response to woodcutting, land clearance and browsing may signal a focus on their exploitation as easily renewable firewood resources (Minnis and Ford 1977). Important factors affecting taxon availability are also the age and structure of the tree stands and their seasonal transformations.

Furthermore, species availability is integrally linked to cultural perceptions of preference or avoidance, which may actively encourage or discourage the distribution of particular species across the landscape (Unruth 1994). Trees and shrubs may be preferentially selected for their burning qualities, the physical
properties and size of wood, and the cultural beliefs attached to them. Smart and Hoffman (1988) cite many cases from the ethnographic record whereby certain types of wood are seasonally collected on such a basis. An example is the choice of spruce by the Ingalik (an Atapaskan group living in Alaska) as their main winter fuel, and willow and poplar during the spring months when heat requirements were not as high. At the same time, they never used alder in their domestic fires because they regarded its red sapwood as offensive. Other woods such as birch, elder and elm give off a lot of smoke when burned and therefore tend to be avoided for indoor consumption. On the other hand, many conifers are used as kindling since they are rich in resinous substances and thus burn faster and with a fiercer flame than hardwoods. The same authors recount the preference of Australian Aborigines for different sizes and types of wood to fuel fires lit for specific purposes, such as the heating of stones for baking ovens, the removal of scales, fur and feathers from game animals, and the grilling of small game.

Perceptions about the real or imagined qualities of individual taxa may sometimes override practical considerations, as in the case of certain western Eskimo groups who refused to cook with heather and instead preferred to use willow, which was scarce and time-consuming to obtain during the winter, because they considered burning heather as "degrading". Similar attitudes were observed amongst the Bear Lake Indians who were not accustomed to use heather as fuel and thus, on their annual hunting expeditions to the Barren Lands, brought with them firewood supplies collected for this purpose from their native forests. When these were exhausted they retreated to the forests, as Heizer notes "... either in ignorance of the locally available heather or because they will not demean themselves to use it" (Heizer 1963: 191).
Such discrepancies between “natural” availability and group preferences may also operate at the level of collective identity. A characteristic example of the divergent firewood acquisition strategies adopted by the Pueblo prehistoric cultures of New Mexico and the historic Navajo groups that settled virtually the same territories. Whilst the Pueblo groups gathered fuel from the saltbrush and sagebrush communities flourishing around their habitation sites, Navajos exploited primarily the far less common juniper stands, although both groups had access to the same vegetation catchments (Ford 1979). Differences in patterns of fuel use have also been interpreted as indicators of social status. In ancient Mesoamerica, the “upper class” used almost exclusively charcoal fuel prepared by villagers in the mountains, whereas lower status groups relied on the collection of wood that was available in the environs of their residence areas (ibid.).

Human perceptions of woodlands and woody plants, occasionally manifested in the form of local folk traditions, may also influence attitudes of avoidance and preference. European folklore in particular is rife of such examples to cite but a few: burning elder, especially indoors, was to be avoided due to its associations with death and the underworld. On the contrary, trees like oak, ash and rowan, have been some of the most important magical plants in European myths and local customs, and as such formed an indispensable part of fire-related rituals and, more generally, symbolic and moral representation (cf. Fraser 1922, Fernandez 1998).

2.2.1.ii The socio-economic context of firewood consumption

Firewood has been, and to some extent still is, the single most important source of energy for human societies of the pre-industrial era, from prehistoric times to the present day. Yet, with some exceptions, for anthropologists and ethnographers alike
firewood consumption has been an object of peripheral interest only and, more or less, cursory observations. Instead of a systematic treatise, what we find in the literature rests mainly at the level of anecdotal information. More detailed studies have been undertaken by environmental or economic policy-planning agencies and other international organisations, although these can be of limited use to other fields of research due to their disproportionate preoccupation with the economics of fuel consumption in agrarian communities.

However, it is still possible to organise the available information into some general categories. The latter follow the elementary distinction between mobile hunter-gatherer groups, nomadic pastoralists and sedentary agrarian/food gathering societies. Such a categorisation, albeit somewhat arbitrary, is both theoretically and methodologically valid, since it allows for an evaluation of the impact of the social context on patterns of resource exploitation (cf. Ingold 1984). By the term “social context” I identify here the relations pertaining to the control, access to and use of woodland resources by human communities. From a strictly archaeological viewpoint, we must be aware of the possibility that any temporal changes observed in the modes of firewood procurement and consumption may actually reflect fundamental shifts in patterns of resource exploitation and, by extension, social organisation.

In addition to this, ethnobotanical studies have shown that whilst human needs and patterns of plant use take shape in response to present-day subsistence activities, at the same time they carry the signs of historical strategies of resource perception and exploitation out of which they evolved (Alcorn 1981). Parameters such as these, which relate to the social environment of firewood consumption, have
a direct effect on resource perception and utilisation and are therefore of key explanatory value for archaeological interpretation.

Mobile or semi-mobile hunter-gatherer and foraging groups are expected to rely for the most part on what is available in the campsite territory and to use these resources on a quasi-opportunistic basis, by simply extracting what they need from the local vegetation. However, it is precisely these conditions of relative resource "affluence" that may induce groups and individuals (pending on their knowledge of the territory and its habitats, and the range of tasks they are expected to fulfil) to apply very selective criteria in their choice of firewood species. We have already seen how versatile "availability" may be in terms of fuel selection, especially in what concerns the form of wood collected as fuel (e.g., dead, dry, fallen branches, etc.) and ephemeral habitation sites constitute indeed a prime candidate for behavioural patterns of this sort. Furthermore, within this particular social context, the cooperative exploitation of woodland resources would ensure that all members of the community would maintain access to broadly the same range of plant species, either directly or through firewood sharing and reciprocal exchange.

Nomadic pastoralists, on the other hand, rely on firewood not only for satisfying daily heating and cooking requirements but also for the preparation and processing of milk-products (Martin 1980). Converting milk into various products that can be stored for later consumption and exchange requires large amounts of firewood, which is usually gathered from areas within easy walking distance from the campsite (Cribb 1991). It has been estimated that the maintenance of 250 milking animals calls for the collection of some 21 tons of firewood per summer season (from May to August, when the highland pastures are freshest and milk yields highest), most of it for the processing of milk into storable and marketable products
In this respect, what matters most from the pastoralist’s viewpoint is not the form or species of wood to be gathered but the actual quantity of biomass available for consumption. Martin (1980) in her discussion of milk-processing activities at the summer pastures of Turan in northwestern Iran, specifies that firewood is collected indiscriminately and comprises live and dead vegetation alike.

At the level of sedentary food gathering groups (those practicing in Testart’s terminology “intensive food storage”, cf. Testart 1982) and farming communities, the picture emerging from the available evidence is that of an altogether more complex arrangement. By their very nature, permanent settlements exert a significant and sometimes irreversible impact on their catchment areas, which is further conditioned by the range of demands placed upon the resource base. Such demands are in turn determined by a complex set of economic activities and social relations taking place within the community. All these factors may have a direct effect on the availability and accessibility of woodland resources, and the modes of firewood collection and consumption.

For the so-called “storing societies”, the base of their economic organisation rests more in the ability of individuals and/or kin groups to accumulate food resources rather than it being vested on animal and land ownership. There follows that, at the community level, one could identify similar provisions to those of agrarian settlements concerning the sustainability of firewood and/or timber resources. Yet, at the same time, access to and use of woodlands and forests, although presumably much more structured than amongst mobile hunter-gatherers, does not have to accommodate patterns of land rights, clearance for cultivation, browse and fodder availability, etc. It should be stressed however that there is no
ethnographic research on firewood storage and consumption amongst sedentary
hunter-gatherer groups.

For agrarian societies, on the other hand, the existing evidence shows that
access to tree crops and woodlands is primarily a function of ownership (either
individual or communal). Systems of individual tenure may incorporate such diverse
ecological entities as gardens, patches of woodland surrounding cultivated plots or,
in other instances, entire woodlands that are privately owned (Devres Inc. 1980: 13-
15). There exist several kinds of individual ownership, including household or
lineage property, which can determine the right to own, inherit, plant or dispose of
trees. Horne (1982) in her description of firewood use in the Turan plain of
northwestern Iran, notes that villagers in this area collect firewood only where their
kin group or village community maintain grazing rights. Peluso (1996) in examining
the historical development of rural landscapes in Indonesia, discusses how tree crop
gathering and hunting rights within forested areas are almost always defined in
relation to tenure arrangements, most prominent amongst them being inheritance
(kinship) and the investment of labour in resource production and management. The
biological characteristics of trees may play a role in these arrangements as well.
Attributes such as the longevity, age of bearing fruits or nuts and the reproductive
strategies of individual species affect the productive lifespan of each tree and
therefore people's ability to manage it. Date palms for example can be "inherited"
indefinitely, since new sprouts emerge continuously from the parent trunks (ibid.).

In other instances, felling of a tree or even gathering of branches from a felled
stump automatically establishes ownership of the wood, as it happens amongst the
Tiv people of Nigeria. A similar situation is encountered in the Tzotzil region of
Mexico, where once a tree is felled it becomes the property of the wood collector
(usually a woman) who can return at her leisure, pack its lopped branches and split the trunk into bundles to be carried back to her homestead (Devres Inc. 1980: 14). From Nigeria again, in the area of Ibadan, it is reported that anybody can claim wood from a neighbour's farm, with the obvious exception of logs already stored to be used as firewood (ibid.).

The most common form of woodland ownership in traditional rural communities is by far communal tenure. In fact, the transition from communal to individual ownership has been largely a modern development, resulting from the substitution of customary land law by statutory provisions and the rise of barter and, later on, market economies based on tree cash crops (Scherr 1997). Prior to that, especially in areas practicing shifting cultivation as in large parts of Africa, southeast Asia and the Middle East, tracts of scrub unsuitable for farming were set aside as communal firewood reserves and/or grazing areas. Moreover forests, woodlands or scrub growing on such common lands, were and to a large extent still are valuable to small-scale farmers worldwide as sources of timber, wild plant foods, leafy fodder and medicines (Michael Arnold 1997).

Village communities rely on the implementation of various mechanisms for regulating access to wooded areas, usually manifested through the exertion of authoritative, religious or hereditary rights, with the aim to ensure the continuity of resources critical for the community's existence and reproduction. Such strategies frequently involve restrictions on woodcutting or the protection and promotion of preferred species by cutting away competing nearby plants. More importantly perhaps, they aim at preventing the over-exploitation of particular tree species by members of the community and/or their destruction by wildlife and livestock (Unruth 1994). These goals are realized through the recognition of the social, aesthetic and
economic values of forests and the concomitant emphasis placed upon these resources as common property by local traditions, folklore, fables and mythology (cf. Dei 1992). Smith et al. (1996) describe how in the village communities of the Ngorongoro District in north-central Tanzania, where irrigation agriculture is practised, a whole set of rules have been developed regulating access to and use of trees growing close to rivers and streams, and around springs. The widespread belief that the quality and quantity of the water available for irrigation depends on leaving intact trees growing along watercourses, has lead to the enforcement of restrictions on tree cutting from river banks and the complete banning of lumbering on the edges of irrigation channels. Only members of the Wenamije ruling class, who maintain hereditary entitlement to the control of the channels, have the right to remove trees or give permission for others to do so. Elders of the same group are the sole individuals who have physical access to the woods growing around springs and then only in order to perform their ritual duties.

Woodlands may be endowed with spiritual dimensions as well, usually reflecting group attitudes towards resources that represent an essential part of their life routines. The perceptions of the savannah bush amongst the Dogon settled communities of the Gondo plain in the Sudan-Sahel zone of north-west Africa, have been described in detail by van Beek and Banga (1992). In the Dogon ecocosmology, the bush represents a live force, the source of not only wisdom and knowledge but also of life and death. As such, it is the object of respect, which is expressed in various ways within Dogon attitudes towards bush plants, trees in particular:

'Using trees for medicinal purposes implies a ritual conversation with the tree; cutting wood for construction or utensils should be done with care and restraint, using the proper axe in the proper fashion. Felling a whole tree is a difficult decision, never taken by a single individual, sometimes requiring a small offering. In return, the wooden utensils, like mortars, pestles, bowls, etc., are never burned, but left to decay slowly ... Women have to be careful when,
where and how to cut firewood. They may not cut major branches, have to avoid trees near the village (unless owned by their husband) and should select trees in the au (non-cultivated bush) ... Wood can be conserved (a notion in perfect harmony with respect). It should not be burned indiscriminately, nor felled without good reason and ample discussion. Cooking should be -and is- done with a minimal loss of heat (as with beer-brewing) and wood from old, discarded buildings can be reused.' (van Beek and Banga 1992: 70-72)

In parts of rural Ghana, virtually all land including arable fields and uncultivated woodland was until recently communally owned, with the village chief acting as the principal custodian (Dei 1992). His consent was necessary for land use rights to be transferred to matrilineal groups. Farmers with rights over lineage land were subject not only to the control of their family elders but also, in a symbolic manner, to that of the lineage ancestor by virtue of their spiritual affinity to the dead. Forest trees and the land on which they stood were thus considered as communal and ancestral property and no individuals had the moral authority to alienate such group rights.

Despite such provisions, intercommunal conflicts were all but common and although usually focused on the definition of harvesting, hunting and grazing rights on the disputed areas, they nevertheless contributed in restricting access to woodlands. The village communities of Central Anatolia offer a characteristic example. Up until 30 years ago, there existed a situation sometimes akin to civil war between different villages over harvesting rights of communally owned fruit trees. Although as a general rule use rights were awarded on the basis of proximity, this was never really observed by local villagers, whereas in some instances (as for example around the settled communities of Karadağ) guarded areas were defined, usually encompassing the trees “belonging” to a certain village. Long-standing disputes were resolved through the mediation of the council of the village elders and the muhtar (A. Erkal, personal communication). In another case, this time amongst the Ifugao of the Philippines, firewood trips undertaken into enemy territory
necessitated wood collectors to set out in large groups, with some of the men
chopping down the most valuable tree species whilst others stood on their guard
(Devres Inc. 1980: 16).

Burning qualities, ease of collection and the incentive to conserve woodland
resources that can be exploited in various other ways, may drive farmers in choosing
which parts of the tree will be harvested as firewood. Wood collectors and users
often justify their choice of species by drawing from the very extensive and detailed
knowledge they possess on the burning properties of all woody plants indigenous to
the region. Although there appears to be some universal scheme concerning the
qualities of the "ideal" firewood (dense, burning with a strong and hot flame, and
drying rapidly) there may exist several variations with regard to the ease of collection
of particular types of wood. Dead wood (branches and trunks) is always highly
ranked, followed by twigs and live branches and, only when communities are faced
with severe fuel shortages, cutting of young saplings and trees proper. Sometimes,
dead wood will be "manufactured" by girding or ring-barking trees when there are
insufficient quantities of it naturally available, or local groups face official
restrictions as it happens in large parts of India (Devres Inc. 1980: 28).

Practical considerations also dictate the size of the wood finally gathered,
such as the type of tools used (especially in relation to pole diameter) and the
distance of the collection point from the settlement. The Kwemzitu women of
northeastern Tanzania select as many long, straight branches and large pieces of
wood as possible so that their loads balance properly, whilst at the same time trying
to avoid smaller pieces that may drop and be lost (Fleuret and Fleuret 1978). When
tree cutting is deemed necessary, preferred species are usually cut at the pole stage,
which may in turn enhance the regeneration process and stimulate biomass
production (Shankar et al. 1998). Recycling of old timber is also widely practised. In rural Colombia, old houses are regarded as communal property and their defunct timber can be used as fuel by all members of the community (Devres Inc. 1980: 28). In the Kurdish villages of northern Iraq, where deciduous oak trunks are extensively used for pillars and/or rafters in village houses, the tendency of over-mature oaks to be readily attacked by heart rot meant that much of this timber would eventually find its way into the fireplace, when it had exhausted its structural lifetime (Chapman 1948).

Within traditional farming communities, the bulk of firewood collection takes place on a seasonal basis. The dry season, particularly after harvest, is in most cases the preferred period, since wooded areas are easier to access, days are longer and dry wood is more abundant (Devres Inc. 1980: 32). At this time, wood may be gathered in excess of demand and the surplus will be stored and seasoned for consumption during the rest of the year. Storage of fuel usually takes place at the household level. In the villages of the Turan plain, brushwood is kept in roofed spaces or unused stables, where it lies protected from rain, browsing animals and the eyes of inquisitive officials and neighbours (Horne 1982). Small amounts of firewood (twigs, branches and bark) can be collected throughout the year and brought back to the settlement when returning from the fields (Fleuret and Fleuret 1978).

The task of collection may be gender specific. In general, it has been observed that where wood is the basic cooking fuel, women are the principal collectors and transporters, whereas men will undertake most of the work necessary to maintain tree crops by cutting and trimming (Devres Inc. 1980: 20-22). However there are exceptions to this pattern: in large parts of Asia, there seems to be little differentiation in gender roles, whereas amongst the Maya communities of
Mesoamerica, men are responsible for firewood gathering whilst women are allowed to amass only fallen deadwood ("moloch") that is considered "polluting" for men to collect. In the highlands of Peru, men may organise special firewood trips lasting for several days; however, wood gathering actually forms part of anybody's excursion outside the village and therefore can be viewed as the responsibility of men, women and children alike (ibid.). In the Turan plain, men do the collection of brushwood far away from the main settlement areas, whereas women prefer to stay closer to the village (Horne 1982).

Firewood gathering rarely takes place in isolation from other tasks usually performed on a seasonal basis, such as land clearance and fodder provisioning (Ben Salem & van Nao 1981). Amongst the Twi-speaking groups of southeastern Ghana, clearance of the bush involves cutting of the smaller trees and shrubs before burning the vegetation, and the piling of wood into heaps where it is left to dry. Apart from fuelwood provisioning, this procedure allows for better control of the fire so as it does not spread to neighbouring farms and the uncultivated bush (Dei 1992). In certain parts of the Middle East, shrubs may be harvested as winter fodder for stalled animals and fuel (Horne 1982, Ertug-Yaras 1997: 183-184). The use of leafy branches of willow, poplar, elm, oak and oleaster as fodder is also reported ethnographically from the same region, whereas in times of fodder shortage acorns could be used for the same purpose (Townsend and Guest 1980: 28, 32, 44, 66, 426). Chapman (1948) mentions the regular pollarding of oak trees in a three-year rotation at the villages of northern Iraq, for the acquisition of edible leaves to be fed to cattle during the winter when snow covers the ground vegetation for prolonged periods. At some Nepalese villages the organisation and scheduling of fodder and firewood
collection follows various rotation systems, a practice that also allows for adequate vegetation regeneration in the communal forested areas (Gilmour 1997).

Research on patterns of firewood consumption has demonstrated that for the most part it is done for cooking purposes, with heating seldom as the sole function of a fire lit within the household. A significant proportion of firewood is also used for food processing and manufacturing activities, such as pottery, brick making and other small-scale industries (Devres Inc. 1980: 43-46). Particularly in dryland areas, with the exception of grain, the preservation of almost all other foodstuffs through the winter requires some kind of drying and/or cooking (Horne 1994: 48). Hearth fires also give off smoke, which protects stored grain and house timber from insects and pests (Devres Inc. 1980: 52).

Finally, substantial quantities of wood may be required for ceremonial or ritual purposes, as for example in the Hindu cremation rites or the ceremonial fires of the Tarascans in Mexico, whereby the preferred sacrifice during sun-worship rituals was the burning of wood in the temples (Devres Inc. 1980: 52-53). In a like manner, large amounts of firewood were brought from long distances in the form of carved and decorated logs to burn in the Inca sun-worship ceremonial fires (Johannessen and Hastorf 1990: 77).

2.2.2 The impact of physical and cultural parameters: burning, depositional environments and post-depositional transformations

Throughout the preceding paragraphs, the exploitation of wood as fuel is overtly emphasised with little consideration of its various other uses, for example construction wood, unless they form part of a complex use cycle (e.g., through the re-use of defunct timber and the by-products of leafy fodder as fuel). This was a
conscious choice in an attempt to present an overview of the existing ethnographic information on firewood selection and hence cover a substantial gap in the current literature of archaeological wood studies, especially charcoal analysis.

The same emphasis is retained in the following sections dealing with the effects of physical parameters (i.e., burning, depositional environments and post-depositional alterations) on archaeological wood charcoal assemblages. The underlying idea is to trace in their entirety the transformations, both environmentally and culturally induced, firewood undergoes from the moment of its collection to its final deposition in the form of charcoal remains in the archaeological layers, and to show the various ways through which these transformations are interrelated.

2.2.2.1 Burning

Charcoal forms as a result of the thermal decomposition of wood when burned in an inadequate supply of oxygen. It is possible to distinguish four successive stages in the combustion process, corresponding to different temperature environments (Beall 1972): dehydration (up to 200° C), char formation (200°-280° C), pyrolysis or carbonisation (280°-500° C) and ignition (above 500° C). The first two phases can be described as endothermic. At this stage, wood loses some 35% of its total weight in the form of vapour, non-combustible gases and organic compounds. During the stage of pyrolysis, the chemical degradation of cellulose and lignines produces flammable gases and aromatic compounds (generally classed as tars). Thermal decomposition that up to this point was dependent on a heating medium (e.g., kindling) becomes exothermic: temperature rises spontaneously and wood is set into flames. The transition from carbonisation to ignition can be very quick. At this stage, charcoal
gloows and may turn into ash (the inorganic by-products of charcoal combustion) if enough oxygen is available.

Carbonisation of wood causes a number of changes in its physical properties of which mass reduction, discolouration and shrinkage are the most apparent (Beall et al. 1974). Generally, it has been observed that two-thirds of the mass loss will occur between the temperatures of 200° to 400° C, whereas the total reduction has been estimated to represent approximately 80% of the original mass (ibid.). Shrinkage occurs in all three surfaces (tangential, longitudinal and radial) with longitudinal contraction being the most severe. Carbonisation results in volumetric shrinkage too that increases in proportion to the length of the log’s exposure to fire (McGinnes et al. 1971). Release of volatiles may also generate cracks (e.g., radial and longitudinal fissures) due to mechanical stresses caused by the uncontrolled drying of wood when heated (Zicherman and Williamson 1981). Despite these deformations, the gross anatomical structure of wood, as well as most of its microstructural elements, remain largely unaffected (ibid.).

Such differences as they may arise in burning conditions (temperature, intensity of fire, length of exposure, heating environment) and wood properties (size, moisture content, taxon anatomical structure) have a direct effect on taxonomic representation within a wood charcoal assemblage. Small-sized woods such as shrubs, which may also be used as kindling, are more likely to be consumed entirely in lower temperatures, whereas pieces of wood lying at the centre of the fire heat faster and thus can burn completely (Smart and Hoffman 1988). On the other hand, charcoal that is buried in the ash at the bottom of the hearth has a greater chance of preservation due to lack of oxygen (ibid.).
It has also been observed that, as a general rule, soft woods such as willow and poplar, tend to conflagrate faster and reduce to ashes easier than dense ones such as oak, elm and chestnut (Rossen and Olsson 1985; for a corresponding classification of woods according to their value as fuels, cf. Boulton and Jay 1946: 112). However, density alone is not a secure indicator of the potential effects of carbonisation in terms of mass reduction and volume loss. Parameters such as the size of wood, its chemical composition and its moisture content, have themselves a critical impact on the rate of burning, and thus on the amount of mass decomposition different types of wood will undergo when subject to combustion (Lopinot 1984: 130-131, Rossen and Olsson 1985, Minnis 1987).

2.2.2.2 Depositional environments
Wood charcoal macro-remains found in archaeological deposits are likely to represent either the remains of firewood or the burned vestiges of structural timber resulting from catastrophic conflagrations (the remains of charcoal used as fuel are not dealt with in this chapter; for further references, see Chabal et al. 1999). In the case of firewood, the type of fire installation and the associated discarding practices may influence in various ways the preservation of charred remains. For example, it has been observed through ethnoarchaeological studies that open-air hearths are rarely contained. Cooking of plant and animal foods may cause intermixing of deposits and considerable displacement of cinders, ash and fire-cracked stones, due to the constant searching in the ashes for roasted foods. Over time, as fires are re-kindled and the same processes repeated, the centre of the hearth tends to drift (Binford 1983: 157). On the other hand, hearths located inside habitation structures
are usually lined with stones so as not to allow the spread of fire to flooring materials (id.: 156).

Further, cooking habits may have a variable effect on the preservation potential of wood charcoal macro-remains. Covered hearths used for the preparation of meat or plant foods without direct exposure to fire, are more likely to retain wood charcoals in a good state of preservation than open ones (March 1992). Another ethnographic example, drawn from observations on the use of roasting pits by the Alyawara Australian Aborigines, serves to illustrate the point:

'The burning wood is flamed up to a fast burn. Singeing the game as well as occasionally beating the burning wood results in the accumulation of a substantial bed of charcoal. Once it is judged that enough charcoal has been scaled off the burning wood, the remaining burning sticks are pulled out and tossed to the side, leaving only the charcoal in the pit and on the platform ... The kangaroo is nested in the charcoal within the pit, followed by the birds wrapped in leaves to hold in the juices formed during cooking. Once the hot sand and charcoal from the platform are shovelled into the pit to cover the meat, the cooking begins.' (Binford 1983: 167)

In all cases, ash and hot charcoals may be regularly cleaned from the base of the fire installations and scattered around them or beyond the limits of the main activity area. Amongst the Hazda of northern Tanzania, ashes from domestic and open hearths alike were dumped along the edges of the campsite, a process that resulted in the formation of various types of secondary refuse deposits, from simple concentrations to distinct ash dumps (O'Connell et al. 1991). Similar patterns of refuse disposal are reported for the Efe Pygmy campsites in the Ituri forest of northeastern Zaire. The only time when hearth maintenance does not take place is in the event of camp abandonment, when 'hot fires are left to burn out and nobody will be around later to sweep up and discard the ashes' (Fisher and Strickland 1991). Bartram et al. (1991) in their description of the camps of the Kua San hunter-gatherer groups in east-central Kalahari, observe that fireplaces used for cooking were cleaned of their
contents more frequently than small fires lit for other purposes (e.g., lighting tobacco pipes, straightening of bows, arrows and digging sticks, skin pegging, etc.) In most cases, ashes and hot coals would be swept away from the opening of the adjacent hut or windbreak structure. This resulted in the formation of ash scatters around one side of the hearths. Less often, the entire contents of the fireplace would be scooped onto dumps located at the edges of the camp area.

Maintenance of domestic spaces on permanent sites also entails the regular clearing of ashes from fire installations and their disposal in a spatially removed location, such as a midden, fill or abandoned structure. Only the smallest items will escape the sweeping of floors and hearths or those left as vestiges of the last phase of use. In fact, any sort of waste that is likely to obstruct indoors activities such as obsolete bulky items or those representing potential hazards to the house occupants (e.g., stone knapping debris) is rapidly disposed off as secondary refuse (LaMotta and Schiffer 1999). An ethnographic example comes from the waste disposal routines at Hasanabad, a village in western Iran, whereby fireplaces are cleaned out on a daily basis and their contents are thrown into dump areas lying at the borders of the village or, more rarely, at a corner of the house courtyard (Watson 1979: 37). The same areas receive rubbish generated by floor sweepings, human and animal excrement, plus discarded household items and food processing waste (pieces of cloth, sticks, paper, bits of wool, broken utensils, bone fragments, goat and wild sheep horns and horn cores, etc.)

Such refuse deposits may display very complex depositional histories. Apart from the disturbance caused by dogs and chicken scavenging on their contents, they are frequently dug up by villagers for the extraction of earth (locally called “chineh”) to be used in the construction of walls for houses, stables and other buildings. Some
of the organic debris may actually re-enter the household fireplace: in Hasanabad, “chineh” earth mixed with animal dung is used for the manufacture of dung cakes to fuel domestic fires (Watson 1979: 39).

2.2.2.3 Post-depositional transformations

Either as primary or as secondary refuse, all classes of archaeological remains are subject to further distortion under the impact of various post-depositional processes that will transform their original patterning, in both qualitative (spatial distribution and contextual associations) and quantitative terms (Schiffer 1983). Trampling, variations in surface exposure and sediment moisture, reheating and freeze-thaw may result in further breakdown of wood charcoals (Ford 1979, Lopinot 1984: 98).

Moreover, vertical and horizontal displacement of charred remains may occur as a result of bioturbation (burrowing, earthworm activity, root penetration) and later erosion of archaeological deposits due to eolian and fluvial action (Gifford 1978, 1980; Keepax 1988: 54).

Another factor influencing charcoal preservation in archaeological strata are the chemical conditions of the sediment matrix. Due to their large porous surfaces, wood charcoals are susceptible to the accumulation of mineral inclusions and precipitates, which can in turn decrease fragment porosity and increase density (Greenlee 1992). Therefore, and despite the lack of a universally agreed scheme for assessing wood charcoal taphonomy (as it happens for example in animal bone studies), an overall appraisal of the nature of post-depositional conditions is essential for understanding their impact on the preservation of wood charcoal macro-remains.
2.2.3 The impact of field and laboratory techniques: recovery of wood charcoal macro-remains, sampling, subsampling and identification

2.2.3.1 Recovery of wood charcoal macro-remains

Nowadays, most of the charred plant remains are retrieved from archaeological deposits by using some system of flotation. Indeed, with the exception of fine-grained sandy or ashy sediments, other methods of retrieval such as dry screening will cause excessive damage of charcoal fragments. Furthermore, the mesh sizes usually employed for both dry and wet sieving (in the range of 5mm) let too much material pass through, hence introducing a further source of bias in taxon representation (Wagner 1988).

A biased picture of sample composition also arises when charcoal fragments are manually collected from the archaeological strata. The only instance when handpicking should take priority is in the case of burned structural timber, whereby it is important to maintain the integrity of individual specimens for studying technological aspects of wood use or for dating purposes (i.e., dendrochronology and radiocarbon dating). Otherwise, manual retrieval invariably results in the selective choice of larger fragments thus leading to samples of small size and the subsequent recovery of only the most commonly present taxa (Keepax 1988: 43, Chabal et al. 1999: 65).

Returning to flotation, experimental work on its potential effects on the rates of recovery and preservation of wood charcoals (Keepax 1988: 70-79, Brady 1989, Greenlee 1992) has demonstrated that charcoal fragments incur a variety of destructive mechanical stresses that may lead to re-fragmentation and subsequent loss of charred plant material. These are of two types: a. Impact stresses, that potentially affect charcoal fragments during the flotation process, and b. Internal
static stresses that may cause further breakage as charcoal dries out and moisture gradients develop from the outer layers towards the wet inner core, leading to differential compression and tension stresses. The obvious result of these processes is the accumulation of greater numbers of fragments in smaller size fractions (Keepax 1988: 76, Brady 1989: 210).

Aside from fragmentation, there have also been noted significant disparities and variation between pre- and post-flotation total charcoal weights. These appear to correlate with differences in anatomical properties and, even more so, sedimentary conditions which ultimately control the amount of soil chemical compounds precipitated as residues in the pores of charcoal fragments (Greenlee 1992: 279-280). It follows that the use of total charcoal weights as a means to evaluate relative taxon abundance, occupation intensity and preservation conditions between deposits (e.g., Pearsall 1983, Miller 1985, Johannessen 1988, Johannessen and Hastorf 1990) runs the risk of failing to account for similar influences on charcoal recovery and loss rates.

2.2.3.2 Sampling

When choosing samples in the field, the archaeobotanist needs to understand in advance the function and provenance of the wood from which the charcoal remains retrieved on site originated. In other words, he or she should be able to tell whether wood charcoals represent the remains of fuel (domestic or otherwise) or structural wood, by exploring their contextual associations. Do they derive from domestic fire installations, open hearths, cremation fires and *in situ* burnt structural features or they were found scattered in external spaces? Not all deposits have the same interpretive potential for addressing questions relating to the uses of wood, the site environment
and the modes of woodland exploitation (Chabal et al. 1999: 61). In practice, this objective can be achieved through the detailed consideration of the excavation records and the finds inventory for each sampled location (e.g., animal bone, seeds, etc.)

Once function and provenance have been established, attention must be paid to the duration of the activities represented in the archaeological record. In their effort to isolate those botanical assemblages that are most likely to represent the product of intentional human action (e.g., fuel consumption) instead of random events associated with post-depositional disturbances, archaeobotanists have to prioritise samples that are judged, on archaeological grounds, to stand for a certain duration of activities. Chabal et al. (1999: 62-63) distinguish two main types of deposits for which such predictions are feasible:

a. Short-term deposits: Typical examples offer contexts holding primary in situ refuse, such as hearths and fire installations. Wood charcoals found scattered in them are likely to represent the remains of their last use prior to abandonment, possibly heavily transformed by divers post-depositional factors and, furthermore, containing a limited number of taxa. Even if substantial quantities of charcoal are retrieved from fire installations and a high degree of taxonomic diversity is established, the probability that these are related to the specific circumstances of the last firing event and do not represent a long-term trend cannot be eliminated. However, such assemblages may furnish important information on the structure and function of particular hearth types. Equally, destruction levels can provide evidence on aspects of wood use (e.g., choice of building materials and woodworking), but little nonetheless on the duration of the activities represented in the archaeological record.
b. **Long-term deposits**: Into this group fall archaeobotanical assemblages that represent mainly discarded refuse, such as those deriving from external, non-domestic areas (middens, fills, etc.). Pending on the predicted frequency of the disposal events (e.g., day-to-day or at longer intervals) they are better suited to characterize lasting patterns of firewood selection and consumption. Such deposits are also most likely to produce a high diversity of woody taxa and thus maximise the potential of the analysis for palaeoenvironmental reconstruction. Finally, charcoal assemblages retrieved from such areas can be expected to have been subject to broadly the same range of post-depositional alterations, thus allowing for a more precise evaluation of the effect sedimentary conditions have imparted upon taxon representation.

### 2.2.3.3 Subsampling

Another major consideration when sampling for charred plant remains concerns the size and number of samples that are likely to provide meaningful (i.e., statistically coherent) results. Optimal sample size (the quantity of fragments per sample that should ideally be examined by the charcoal analyst) varies following sample properties and the degree of accuracy required (van der Veen and Fieller 1982). The total number of charcoal fragments to be examined from each sample is also more difficult to establish following some independent criterion (as it happens for example with seeds or animal bone, whereby the analyst knows *a priori* the population of identifiable items based on the occurrence of specific surface features; wood charcoals obviously do not conform to this principle).

Several authors have observed that taxonomic recovery follows an exponential curve: the number of the taxa present in a sample rises sharply as the
first few charcoal specimens are examined and then settles down as more fragments have been identified (Keepax 1988: 44, Smart and Hoffman 1988, Chabal et al. 1999: 67). Keepax (1988: 120-124) has suggested that a minimum number of 100 fragments per sample should be examined, which may actually extend up to 300-400 fragments pending on the diversity observed within the charcoal assemblage. Chabal et al. (1999: 66) raise this lower limit to 250 fragments, with 400-500 fragments considered as the optimal subsample size per excavated level.

Provided that results are for their most part replicated across a certain number of samples from each excavated stratum, the size of the subsample can be more realistically set to 150-250 fragments per sample. It has been observed that the point when recovery curves tend to level off is not solely a function of the number of examined fragments but also depends on the spatial extent of the sample population across the excavated level (Badal Garcia 1992). Indeed, by maximising the spatial coverage of sampling it may be possible to compensate for temporary, and for that reason mostly unpredictable, “levelling-off” sometimes observed in individual recovery curves (Figueiral 1992). Keepax makes a similar point when she states that,

‘Over-identification of individual samples does not compensate for insufficient sample number ... A certain number of samples must always be identified to account for between-sample variation’ (Keepax 1988: 45)

As to the number of samples to be analysed (depending on the research objectives and the available resources) recovery from twenty-five to fifty samples on average is considered as a reasonable minimum, whereas for more complex archaeological sites, with a greater variety of depositional contexts, one hundred or more samples may be required. For multi-period settlements, intra-site comparisons between contexts and/or excavated levels necessitate similar provisions (Keepax 1988: 45-47).
Equally important in terms of subsample selection is the size range of the fragments chosen for analysis. Opting for the larger fragments alone runs the risk of overlooking naturally small-sized taxa (e.g., shrubs) or those procured mainly in the form of twigs and small branches, all of which are likely to be better represented in smaller size ranges. Such a selection can be achieved through splitting the sample and randomly choosing a portion of it (Willcox 1974), “grab-sampling” fragments of different size and shapes (Miller 1985) or passing the dry flot through a stack of sieves of graded mesh sizes and subsampling each size fraction (Zalucha 1982: 79). Of all three methods, dry sieving is by far the most efficient for this purpose. “Grab-sampling” suffers from a lack of standardization thus being inherently subjective, whereas splitting the sample with a riffle-box will invariably result in further re-fragmentations. Finally, the use of grid systems can prove very time-consuming without also being altogether “free” of similar subjective elements (cf. van der Veen and Fieller 1982).

2.2.3.4 Identification

Several factors may inhibit the precise identification of wood charcoal macro-remains. In many cases, it may prove very difficult to identify individual specimens to species level, due to the similarities in anatomical structure exhibited amongst members of the same family and/or genus (Hather 2000: 11-12). In addition to this, variation in anatomical characters can occur even amongst specimens belonging to the same taxon, due to differences in genetic stock, habitats, growing conditions, age and part (bark, stem, twig, branch, root) of individual plants and the exposure to occasional hazards such as fire, frost and pest outbreaks (Dimbleby 1967: 107-108, Wilson and White 1986: 198-199).
One remedy to this situation is the use of wood anatomical descriptions and extensive comparative collections covering particular geographical regions. However, such collections and/or descriptions usually comprise only trunk wood specimens and are mostly assembled from thin sections of fresh wood. For the purpose of charcoal identification, this can be problematic. Characters such as the size and dimensions of pores, vessel elements and rays that may be of diagnostic value in fresh specimens (e.g., Fahn et al. 1985) in charred specimens are either seriously deformed, due to shrinkage and cracking, or missing altogether as is the case with certain types of parenchyma and also septate fibres and crystals. Other features as well (e.g., spiral thickenings, intervacular pits) can be difficult to locate and describe with any precision, due to variations of lighting on charcoal surfaces during microscopic examination, or if fragments are not studied under sufficiently high magnifications (Western 1969: 112-113, 115).

Difficulties may also arise due to the small size of individual fragments. The required size will vary between taxa, pending on the relative frequency of the diagnostic features preserved within the charred specimen and the uniqueness of these features amongst the woody plants of the region (Smart and Hoffman 1988). Some anatomical characters that occur infrequently may be absent from specimens smaller than 4mm, whereas others can be quite distinctive even in small fragments if not shared between many taxa (e.g., the size and structure of multiseriate rays in oak).

All these problems can be partly surmounted by using modern charred specimens as reference material, by examining in detail all three anatomical surfaces (transverse, radial and tangential) at least for the more "problematic" taxa, and through the appropriate adjustment of identification criteria. However, as it so often
happens, specific identifications apart from ascribing a family or genus label are in most cases unattainable.

2.3 Interpreting taxon abundance: qualitative versus quantitative approaches

In what concerns the quantification of wood charcoal macro-remains there are two schools of thought. One claiming that mainly qualitative statements (i.e., establishing taxon presence) are feasible from describing sample composition and thus the relative proportions of charcoal taxa bear little or no relation at all to their ecological and economic significance in the past (e.g., Wilcox 1974, Zalucha 1982, Smart and Hoffman 1988). This approach dominates research undertaken within British and, largely, North American-based archaeobotany. The other school of thought advocates a rigorous quantitative approach, based on the recording of taxon frequency values (expressed as percentage fragment counts) and their interpretation as a reflection of woodland composition in the past. This is routine practice in research establishments in continental Europe, particularly France, and took shape primarily under the influence of Jean-Louis Vernet and the Montpellier school (cf. Chabal 1988, 1992, Chabal et al. 1999). The different premises of both approaches are outlined and critically assessed in the following paragraphs.

2.3.1 Qualitative approaches - Ubiquity analysis

The reasons why a great many archaeobotanists feel uneasy with quantifying wood charcoals have to do with two issues: a. The uncertainty surrounding the correlation between the abundance values of charcoal taxa retrieved from an archaeological site and the amount of wood put into fire in the past, and b. The suitability of such
frequency measurements for reconstructing the actual proportions of individual woody taxa in the site environment. These questions are aptly summarised by Smart and Hoffman (1988):

'The relative amount of a taxon present in a charcoal assemblage is difficult to estimate for two reasons. First, it is difficult to relate the amount of charcoal to the amount of wood that burned. One log can produce many fragments of charcoal, and both the number and mass of these fragments can be distorted by differential fragmentation and mass reduction. Second, because the archaeological charcoal assemblage is a biased sample of the woody vegetation, it is difficult to relate relative amounts of identified taxa to actual vegetation ... For these reasons, some analysts prefer not to use the relative amounts of charcoal taxa for environmental interpretation' (Smart and Hoffman 1988: 190)

Similar concerns (albeit from a more ecological viewpoint) about the value of quantifying wood charcoal macro-remains for the purpose of palaeoenvironmental reconstruction are expressed by Godwin and Tansley (1941) in their critical review of the evidence from the Maiden Castle excavations published one year earlier by Salisbury and Jane (1940):

'Can we assume that prehistoric man did not select or reject certain species for firewood as he certainly selected woods for other purposes? Does the dead wood of different species lying on the woodland floor represent, in approximately correct proportion, the woody species growing on the site, especially in view of the different tendencies of different species to shed twigs, or small branches, either spontaneously or under stress of competition for light, and in view also of differing rates of decay?' (Godwin and Tansley 1941: 118)

From an analytical perspective, Hubbard and Clapham (1992) concentrate on the issue of the accuracy of taxon representation in abundance measurements, by pinpointing the inability of the charcoal analyst to determine at least the minimum number of individuals present within a given assemblage:

'A seed is a seed: if there are two half-seeds of one species, they could be treated as two half seeds or a whole one. Leaf and pinna fragments may be equally identifiable, but there quantification is more problematic: and the counting of pieces of charcoal (which almost invariably shatters somewhat during recovery and transport) is (almost) blatantly ridiculous' (Hubbard and Clapham 1992: 119)
On these grounds, many analysts opt to use ubiquity analysis in order to evaluate taxon presence and, through this, assess how representative a wood charcoal assemblage is of past vegetation. The method amounts to calculating the frequency of occurrence of individual taxa by plotting the percentage of samples into which each taxon is present (Willcox 1974, Hubbard 1980). In doing so, it disregards abundance data (absolute and percentage counts) since they are considered as most susceptible to biases introduced by taphonomic factors such as preservation conditions and cultural selection (Smart and Hoffman 1988). One crucial characteristic of ubiquity analysis is that presence scores of different taxa can be evaluated independently, since the score of one taxon does not affect the score of another (Hubbard 1980).

However, the claim that by using presence/absence analysis instead of other quantification methods the effect of differences in preservation conditions is minimized rests unfounded (cf. Kadane 1988). Indeed, many analysts caution against the use of ubiquity analysis without due consideration of context-related variation (Hubbard 1980, see also Pearsall 1988: 61). In other words, if we accept that some types of wood are unlikely to be adequately represented in a charcoal assemblage due to various preservation and/or sampling biases, these types will simply be absent or under-represented in the final list of ubiquity scores as well. This also applies to the possibility of preferential selection of particular species.

Still, despite the occasional cautionary note, many analysts implicitly or explicitly assume that the proportions of charcoal taxa recovered from an archaeological site represent an approximation of their relative abundance in the local vegetation. Furthermore, fragment counts and/or weights are used for estimating the quantities of individual taxa present within an archaeobotanical sample, since it would be rather spurious to infer that a taxon present in a sample with one fragment is
equally "important" with another tallying 100 fragments in the same sample. Yet, the use of abundance values for this purpose is not always explicitly acknowledged or, for that matter, justified (e.g., Smart and Hoffman 1988: 190, see also Hubbard 1980: 53).

This last point gives rise to another significant corollary regarding the inherent limitations of presence/absence data, especially when applied at the site level. It has been observed that ubiquity analysis can obscure patterns relating to the intensity of plant exploitation, especially when the frequency of use remains broadly the same but abundance changes (Popper 1988: 64). In other words, what the analyst ends up with is a more or less even distribution of woody taxa across the site, with little if any information as to their relative input to sample composition.

To summarise the argument, it seems that ubiquity analysis offers little in reducing the effects of differential preservation, particularly in view of the drastic reduction in information it entails concerning sample composition (Kadane 1988). The utility of presence/absence data lies perhaps more in describing general trends, which is certainly productive when dealing with large databases or if the analyst knows little about the sources of patterning affecting his or her particular dataset (Popper 1988: 64, Pearsall 2000: 214). For the same reasons it is well suited for inter-site assessments, especially in those cases where differences in excavation and sampling strategies may have compromised the comparability of the archaeobotanical datasets (e.g., Hubbard 1980).

In order to justify the appropriateness of presence/absence analysis for studying archaeological wood charcoal assemblages, particularly in view of the effects of burning on taxon representation, the work of L. Anthony Zalucha (a North
American archaeobotanist) is often quoted in the relevant literature (cf. Smart and Hoffman 1988).

One of Zalucha's principal research objectives was to investigate charcoal fragmentation based on archaeobotanical material deriving from the 12th century Native American settlements of Mill Creek in northwestern Iowa (Zalucha 1982). Wood charcoals recovered from four of the excavated sites by means of water sieving, were size-graded in the laboratory into four different fractions: >6.3mm, >3.3mm, >1mm and <1mm. His "null hypothesis" (tested by means of logistic regression analysis, see Zalucha 1982: Tables 2, 3, 4, 5 & Figs. 1, 2) was that the frequency of each taxon is the same in all fractions. Subsamples of 25 fragments from each fraction (when available) were included in the analysis. In practice, this involved splitting each fraction into four portions and subsampling one of them through repeated quartering. However, in most cases the number of examined charcoal specimens did not exceed 50-75 fragments per sample.

Zalucha concluded from his analysis that there was significant and non-predictable variation '... both in the species identified and in their relative proportions' (Zalucha 1982: 39). He interpreted this variation as the result of the tendency of wood charcoals to '... break down differentially depending upon the structure of the wood from which they derived' (Zalucha 1982: 28). Further, he suggested that due to varying fire environments (temperature, length of burning, etc.) '... there is no way in which one could predict in which size-grade the charcoal of any given wood might cluster. A wood might fall in the >6.3mm size-grade after one burning episode and in the <1mm grade after another' (Zalucha 1982: 29).
Concerning the suitability of charcoal data for reconstructing past vegetation and wood use, Zalucha finally reached the conclusion that no quantitative measurements can achieve either purpose:

'It should be re-emphasized that [vegetation] associations are reconstructed on a presence-absence basis, not by proportions of identifications from any one or group of sampled units. Large numbers of units are sampled by size-grade not to recognize "trends" of wood use and species availability through time but to increase the likelihood of encountering rare or rarely used species or those species by chance over-represented in a size-grade which would not be examined by traditional means of investigation. Because of differential breakdown and cultural selection such "trends" would probably be spurious ... If appropriate [indicator] species ... are present in appropriate contexts, the [vegetation] associations should be reconstructable ... As a tool for determining wood use, however, charcoal studies may run into difficulty ... It is always possible that some utilized woods are being overlooked' (Zalucha 1982: 52-53)

Leaving aside for the moment (see below, Discussion section) the wider implications of this approach for vegetation reconstruction, there are several problems with Zalucha's analytical methodology. He adopts, for example, a system of arbitrary selection of fragments, whereby he equates the number of examined specimens from each fraction irrespective of their relative proportions in different size ranges. Even if this variation could be accounted for by the examination of large numbers of fragments, there are still substantial problems with the overall design of the analysis. Sampled features included a wide array of contexts such as domestic and external fire pits, "trash pits" (although at least in one case there was evidence for the use of plant material for pit lining which casts doubt upon the validity of the context label) and undifferentiated feature infill layers. Moreover, the volume of matrix retrieved from each of the excavated features very rarely exceeded 10 l, being mostly in the range of 5 l (for details, see Zalucha 1982: 80-126). In sum, there is little consideration of context-related variation and hence of the different depositional and post-depositional processes that might have affected fragment size distribution, with all emphasis placed unduly on the generalised effects of the burning process. In view of the small
sample size as well, Zalucha's results should be regarded as unrepresentative of the fragmentation status of the charcoal deposited in the sampled archaeological layers.

2.3.2 Quantitative approaches - The Montpellier school

The same two questions, pertaining to the feasibility of quantitative analysis for wood charcoal macro-remains and the relationship between the abundance values of charcoal taxa and their actual proportions in past vegetation, have been examined from a different methodological perspective by the Montpellier school. The account that follows critically reiterates some of the principal ideas appearing in the published work of one particular analyst, Lucie Chabal (Chabal 1988, 1992, Chabal et. al. 1999) who more than anyone else coming from this research tradition has concentrated on both the theoretical and the analytical aspects of charcoal analysis.

Her starting point in discussing the methodology of charcoal analysis is to define the constituent elements of the relationship between wood charcoal macro-remains (the object of measurement) and past vegetation (the object of study). Integral in this complex relationship are a series of parameters for which the analyst may know little or nothing at all: the age, structure and spatial extent of past vegetation units, the amount of wood collected, hearth structure and properties, the effect of combustion in fragmentation and mass reduction, the post-depositional alterations, etc. Chabal quite correctly points out that the sole possibility the analyst has at his/her disposal is to study directly the results of these processes. This comes in sharp contrast to practices prevailing in other disciplines, as for example pollen analysis whereby it is possible to observe the relationship between present-day vegetation and pollen representation in surface soil samples. Charcoal analysis characteristically lacks this “middle range theory” and the limited amount of
experimental work undertaken shows why: the range of variables to be accounted for (wood variability, moisture content, hearth structure and properties, etc.) is vast enough to guarantee that no single type of experiment will ever produce finite or even provisional results.

Chabal proposes three successive steps through which this loss of information can be compensated for from the part of the analyst: a. Reaching an understanding of past human practices in relation to woodland exploitation and the use of wood within the domestic space, b. Analysing through a statistical approach, assisted by the available experimental data, the process of fragmentation and the effects of mass reduction during carbonisation, and c. Adopting a rigorous sampling strategy (with due attention to context-related variation) that will provide a statistically sound basis for exploring questions of palaeoenvironmental interpretation.

The first variable -human practices- is by far the most difficult to assess. For historical periods, the charcoal analyst has the obvious benefit of textual records to complement the archaeobotanical evidence. Ethnographic parallels may be used for earlier periods in an attempt to reconstruct patterns of wood collection and consumption. However, Chabal cautions against the uncritical use of ethnographic analogues, by stressing the need to ground any assumptions of this genre on the charcoal evidence itself. If sufficient material is available to work with, cross-checking of all the available information (ethnographic, archaeological and palaeoecological record) as well as any inter- and/or intra-site discrepancies observed in sample composition, could be used in a productive manner to clarify practices relating to wood use and firewood selection.

Chabal chooses nonetheless to single out burning qualities as the determinant par excellence of human choices, in order to demonstrate that ecological imperatives
(i.e., availability) eventually overtake any concept of "preferred species". Thus she stresses that the calorific content of each type of wood depends more on parameters like pole size and diameter, its status as fresh or deadwood, moisture content, fire temperature, etc. rather than the individual properties of the species from which it derives. However, as it has been argued already, there is ample ethnographic evidence to suggest that firewood selection relies as much on existing knowledge and traditions, as it does on wood properties (real or perceived) and species availability. Moreover, at the settlement level, economic and social constraints will largely determine the dominant pattern of resource perception and exploitation. Yet, despite its reductionist undertones, Chabal's approach is at least from a theoretical point of view one step ahead from merely conceding to the possibility (much reiterated in the literature) that human choice is somehow reflected in the archaeobotanical record.

This brings us to the second point of her suggestions, dealing with the quantification of wood charcoal macro-remains. The paradigm of pollen analysis serves to illustrate her point. Palynologists count pollen grains that have been botanically identified with the purpose of reconstructing past vegetation. However, as Chabal stresses, a pollen grain stands for a unit of biological reproduction. By no means can it be considered as a unit of biomass or vegetation cover. Moreover, if one accepts that pollen production and dispersal may vary between species (particularly with regard to pollination methods) and also for individual/s of the same species (age, interannual variations, etc.) then any two pollen grains, although equivalent as units of reproduction, are very unlikely to represent equal values as elements of past vegetation. What is it then that makes their counting justifiable?

The answer lies in that, allowing for some variability, the mean annual pollen production is a biological trait of each species, observable by virtue of the survival of
pollen grains. Chabal rephrases this statement in order to draw attention to the fact that pollen counts define a measurement unit of vegetation different for each species but at, the same time, statistically accurate to the species. The distribution of the frequency of occurrence for all species (complex variable) is always expressed in the same unit of measurement (single variable: pollen counts). It is at this point that she proposes a potential analogy with wood charcoal macro-remains. If the observed fragmentation (size distribution of the recovered fragments) is a function of species (or, to take the opposite view, the same for all species) then we would find ourselves in a situation akin to that of pollen analysis. One fragment would be a unit of measurement statistically accurate to the species and the comparisons of fragment counts would be pertinent between species.

However, the analogy between charcoal analysis and palynology is not immediately evident. As mentioned earlier, pollen analysts can always retort to observing the correlation between modern pollen rain and the amount of pollen present in surface soil samples, whilst pollen grains themselves remain relatively unaffected from the vagaries of recovery and preservation. On the other end, charcoal analysts are able to evaluate only in approximation the effects of the taphonomic process in action. What they can measure though are its ultimate manifestations within the archaeological charcoal assemblage. The essence of Chabal’s argument is that by focusing on the observable (i.e., the state of fragmentation of charcoals as retrieved from the archaeological strata), it may be possible to make some inferences about the non-observable (i.e., the effects of combustion and post-depositional processes -all inducing fragmentation- on taxon representation).
For this purpose, she undertook a statistical analysis of the state of fragmentation of wood charcoals retrieved from the proto-historic site of Le Marduel in southern France (for details on the analytical procedures see Chabal 1988, Chabal et al. 1999: 77-79). Fragmentation was assessed by weighting individually all specimens ≥1mm (representing twenty different taxa) recovered from two stratigraphic levels (Level A: 670 fragments and Level B: 851 fragments), and plotting the distribution of the number of fragments per mass class of 0.03g for each taxon and sampled level (Fig. 2.2a-c).

The results of this exercise show that there is a uniform size distribution of charcoal fragments (for each taxon and between stratigraphic levels), according to which the larger the fragments the lower their numbers are and vice versa. In other words, it appears that wood charcoals (irrespective of taxon) break up in such a way as to produce a small number of large fragments and a high number of small ones. Chabal stresses the fact that for inter-level comparisons it is irrelevant to point out that one archaeological layer may be characterised by twice as much fragmentation (for each taxon) than another, since this would not affect inter-level comparisons (assuming of course that each level is characterised by the same pattern of post-depositional processes, i.e., that there is no significant intra-level variation). This happens because the proportions of all taxa are calculated separately for each level.

However, within the same level there may arise aberrations from this pattern, expressed in the form of over-representation of particular taxa in certain mass classes. Two types of biases can exist: an excessive presence of large fragments (affecting weight measurements) or of a high number of small ones (affecting frequency values). Such biases could emerge due to haphazard “grab-sampling” that fail to maintain the proportions between small and large fragments. As is evident in
the histograms of Figs. 2.2a-c, the state of fragmentation of a particular taxon is statistically correlated to its relative frequency in a given sample. What this means is that the most frequent taxa are those best represented amongst the larger fragments, whereas rare taxa tend to show up in smaller size ranges.

Alternatively, such biases may reflect random differences in fragmentation patterns. Chabal's statistical analysis suggests that variation in the state of fragmentation is not species-dependent. It may influence the fragment size distribution of a certain species in one assemblage whilst leaving it unaffected in another. She proposes that these discrepancies can be eliminated, when necessary, by counting and weighting individually all charcoal fragments recovered from a given volume of sediment (using a standard mesh size). The "aberrant" value of the taxon in a particular mass class can thus be substituted by its "expected" one, calculated from the ensemble of the fragmentation curves of the charcoal taxa present in the same level. Thus, counts and weights are finally correlated (Chabal 1990: 202-203). In practice however, this procedure is extremely time-consuming. Therefore, she recommends adopting fragment counts instead of weights in order to plot taxonomic frequencies. Given that charcoal analysts usually define their subsamples as a certain number of fragments per sample, the risk of identifying a very big fragment (which would inflate weight percentages) appears to be greater than that of identifying and recording a high number of small fragments.

There is however still a question left unresolved, which is pertinent to reconstructing both the palaeoenvironment and modes of woodland exploitation: is it feasible to estimate the amount of wood collected and burned in the past based on the frequency values recorded for each taxon?
The available evidence from wood combustion experiments shows that there is no clear-cut correlation between the mass of wood put into fire and the amount of charcoal left as a residue (cf. Lopinot 1984: 130-131, Rossen and Olsson 1985). In Chabal's view, mass reduction and volumetric shrinkage appear to be a function of the fire properties and the moisture content of wood rather than wood density per se. However, when investigating the state of fragmentation of an archaeological charcoal assemblage in its entirety, she has observed that the total mass of charcoal and the number of fragments are correlated. What Chabal deduces from this discrepancy is that fragmentation and mass reduction, although taking place simultaneously during burning, are a priori independent in their final manifestations (i.e., the fragment size distributions registered in the archaeological charcoal assemblage). Furthermore, she cites recent experimental research whereby it has been demonstrated that post-depositional processes in archaeological sites may even out disparities between the proportions of dense and light woods, originally deformed by combustion (Chabal et al. 1999: 92). Consequently, she concludes that the quantity of charcoal recovered from an archaeological layer for each taxon reflects (proportionally speaking) the different degrees to which individual taxa were used as firewood in the past.

Based on this reasoning, Chabal argues that for domestic firewood at least, the spectrum of taxonomic frequencies observed in the archaeological record represents a compound picture of the vegetation catchments from which the wood was collected. It is equally possible, at least in theory, that a taxon which accounts for 80% of the wood charcoal remains has derived from a very large catchment area and an open canopy or again from a very narrow catchment and a dense vegetation cover. In this sense, the abundance value of any individual taxon can only be interpreted in relation to those of other taxa, that is within a strict ecological
framework. Chabal concludes that it is not methodologically valid to suppose that a list of taxa and their respective frequency values (presented in the form of a “charcoal diagram”) can be directly translated into particular ecological units. Such values stand for only one dimension of an essentially three-dimensional entity, past vegetation, which must be approached (this time in direct analogy to pollen analysis) through the application of the appropriate ecological theory.

Whilst this line of argument may appear, at a theoretical level at least, to underplay substantially human agency, it is nonetheless useful for its innovative analytical approach. It is proposed that through the combination of appropriate sampling strategies, archaeological judgement and the methodical evaluation of sample composition, it is feasible to build archaeobotanical datasets that may enable the assessment of both palaeoenvironments and fuel use in the past. Wood charcoals represent perhaps the sole class of archaeobotanical remains to offer this twofold potential. By virtue of their origin in past vegetation, they can offer clues to palaeoenvironmental interpretation. At the same time, as fuel remains, they represent the genuine product of purposeful human action, in contrast to charred plant foods (e.g., seeds) the preservation of which is mostly accidental (cf. Western 1971, Dennell 1976, Pearsall 1983). In this sense, the quantification of wood charcoal macro-remains (after controlling for differences in post-depositional conditions and context-related variation) and, from that, the evaluation of the relative importance of each taxon as a component of both cultural practices and, to a lesser extent, past vegetation seems reasonably justifiable.
2.4 Discussion: charcoal taphonomy and interpretation

This is the point where we can examine anew the two questions posed repeatedly within the discipline of charcoal analysis in the course of the last fifty years: a. Is it feasible to estimate the relative amount of a taxon present in a charcoal assemblage, and b. Could such an estimation relate to its actual proportions in past vegetation?

The answer to the first question relies, perhaps disproportionately, on the methodological convictions of the analyst. Through the preceding paragraphs it has become evident the deep rift existing between the two principal research traditions, the French and the British-American. Here it would be useful to try and rephrase the question: Is it feasible to establish a correlation between the relative proportions of individual woody taxa burnt in the past and their frequencies in the archaeological wood charcoal assemblage? On purely analytical grounds, an affirmative answer to this question is possible, if the requisites of systematic sampling and subsampling, identification of provenance/function and accurate assessment of post-depositional conditions are met.

It is the evaluation of these parameters (i.e., the impact of context and post-depositional conditions on taxon representation) that strikes with its absence from the vast majority of the works published on charcoal analysis. Instead, it is usually taken for granted (particularly amongst English-speaking audiences) that any differences observed in taxon abundance may mirror in varying degrees the direct effects of the burning process. In this respect, charcoal analysis has lagged behind long-established analytical approaches in other sub-disciplines of environmental archaeology (e.g., zooarchaeology and seed archaeobotany).

This is one aspect where the present work strives to make a difference. As it will be further elaborated on in Chapter 3, the detailed analysis of the contextual
attributes and taphonomic characteristics of the charcoal assemblages (including size of wood, burning environments, post-depositional transformations, etc.) is an essential precondition for dealing with issues relating to the intensity of fuel use. It is only when the effects of these parameters on sample composition have been addressed and fully understood, that a quantitative approach can provide meaningful answers to questions about patterns of firewood collection and consumption.

In what concerns environmental reconstruction, it seems reasonable to conclude that the quantity of wood put into fire, irrespective of the method chosen to quantify it, does not necessarily mirror the actual proportions of individual taxa in past vegetation. Instead, what it may reflect much more closely is their intensity of use. Whether or not intensity of use relates to “actual” taxon representation (meaning the relative proportions of individual taxa in past vegetation) is a matter to be judged primarily on ecological (nature of woodland catchments) and archaeological (economic and social parameters) grounds. Ultimately, any relevant hypotheses should always be tested against independent palaeoecological data (e.g., pollen analysis).

At a theoretical level, choosing between qualitative and quantitative methods for the purpose of environmental reconstruction will always be dependent on the predicted structure, form and variability of the woodland catchments. For example, long-term changes in the taxonomic composition of assemblages retrieved from sites which had access to divers and patchy vegetation catchments, are likely to be better understood by means of taxon presence (a more detailed discussion of these issues in the context of this research project is presented in Chapter 5). On the other hand, however, we saw that ubiquity analysis might mask important disparities in taxon frequencies, particularly when taxon presence stays approximately the same but
abundance has changed. Such distorting effects would be most pronounced in the case of potential indicator species, hence leading to a biased picture of temporal fluctuations in woodland composition. Therefore, ubiquity analysis and frequency measurements should be used in a complementary way and their final results evaluated in the light of the evidence provided by the off-site palaeovegetation record.

Still, even when the assumption that the relative frequencies of charcoal taxa constitute a reasonable estimate of their actual proportions in past vegetation seems warranted by the available evidence, the scope of the analysis should extend beyond the mere reconstruction of vegetation catchments and climate patterns, and address core issues relating to the “rationale for the exploitation” of woodland resources:

‘From an anthropological perspective, the rationale for the exploitation of environmental resources is embodied in the social relations that govern their appropriation ... therefore an understanding of these relations must constitute a starting point for the analysis of economic behaviour. Prehistorians, on the other hand, are inclined to reduce the economy to the ecological dimension of population - resource balances, treating the constituents of the social domain as mere ephemera, super-imposed on a more fundamental and enduring set of biological imperatives’ (Ingold 1984: 3)

The ethnographic record reviewed in the preceding pages seems to substantiate this claim in what concerns the “economy of wood”. It has been demonstrated that the analytical tools are also in place to tackle the complex issues arising.
Chapter Three – Methodology II: Sampling in the field, laboratory procedures and data analysis

This chapter begins with a discussion of the sampling strategies adopted in the field at Çatalhöyük and Pınarbaşı, seen in the context of the research aims and objectives promoted by the excavators of each site. The purpose of this description is to provide a full account of the complex ways through which these policies ultimately affected sample selection and the designing of research questions appropriate to the particular circumstances of each site. Recovery, laboratory and analytical techniques (flotation, dry-sieving of the flots, microscopy procedures, identification, and methods of subsampling and quantification) are also presented in detail.

3.1 Sampling strategies and recovery techniques

3.1.1 Sampling strategies at Çatalhöyük

Proper excavation work at Çatalhöyük resumed in 1995 by a number of research teams, including British (director Ian Hodder), North American (directors Ruth Tringham and Mirjana Stevanovic) and Greek (director Kostas Kotsakis) teams. Complementary to these is the research undertaken by the KOPAL team (director Neil Roberts) exploring landscape features, geoarchaeology and off-site activities. British excavations concentrated on three different locations, namely the North and South areas (the latter coincides with the old Mellaart trenches and was formerly known as the Mellaart area) and the West, which comprises the Chalcolithic settlement on the west mound excavated by a team under the direction of Jonathan Last (for the location of all excavation areas see Fig. 1.5). The wood charcoal material examined in this thesis derives from the Neolithic deposits investigated by the British team (North and South areas), therefore all further discussion will deal
with the sampling methodologies adopted for this part of the Çatalhöyük excavations.

One of the stated aims of the renewed excavations at Çatalhöyük has been to develop a "reflexive method" (Hodder 2000: 5). The main goal of "reflexivity" is to foster at the level of the excavation and laboratory practice as well, the need for accountability towards the multiple interested parties laying their own claims on the archaeological site. These actually include very diverse groups, from the state authorities, the local community and non-governmental organisations (e.g., the Turkish Friends of Çatalhöyük) which maintain a close interest in heritage management, education and local development, down to individual local and state functionaries with their own political agendas to pursue, various western New Age and Goddess groups and, last but not least, the all-important sponsors of the Çatalhöyük Research Project itself. Ian Hodder has made very clear his vision about the duty of the research team to respond to these "external" challenges:

'We cannot just hand over objective data to interested groups. At least some of those groups recognise that interpretation is involved in the very collection of evidence, in the laboratory itself, and at the trowel's edge ... We need different methods to handle this new situation and it is this we are calling a 'reflexive method' ... In archaeology a critical reflexivity has to deal not just with writing but with those aspects of method which involve scientific observation and natural science techniques – that is with the laboratory and the excavation trench' (Hodder 2000: 5)

What this stance entailed in terms of the sampling strategies finally adopted, was a radical re-structuring of the relationship between the excavation team and the laboratory staff, with special emphasis on the notion of interactivity. In practice, this takes the form of regular visits (2-3 per week) to the excavated areas by members of the laboratory staff (comprising several specialists working in the field such as archaeobotany, zooarchaeology, lithics, human remains, soil micromorphology, etc.), whereby information is exchanged on the features and layers under excavation and
the results of the ongoing laboratory analyses. The aim of this process is to enhance
the on-site interpretation of the excavated deposits and thus facilitate decision-
making about sampling methodologies. The main purpose, however, remains to
avoid imposing preconceived categorisations on the contexts and features
encountered during excavation and instead to accept, in principle at least, the
provisional nature of all interpretations:

'Sampling strategies are [often] adopted 'off the shelf', using pre-set formulae.
In practice, archaeologists have a duty to be responsible to what they find. As a
result sampling strategies are often changed as a survey or excavation
progresses. But even the most codified of sampling strategies involves making
interpretive decisions. For example, it may have been decided to excavate 10
per cent of all pits on a site, but 20 per cent of the hearths. It becomes necessary
to interpret a feature as a pit or hearth before excavation ... In order to avoid
these difficulties at Çatalhöyük, we have replaced decisions about sampling
with negotiations about priorities.' (Hodder 2000: 6)

Such negotiations take place between excavators and laboratory specialists and have
as their outcome the assigning of the label of "priority unit" to particular deposits and
features unearthed during excavation. In principle, all excavated units (i.e., the
layers, features and contexts unearthed during excavation) are sampled for flotation
and are also dry-sieved for the recovery of animal bone and lithic debris. However,
these are but a fraction of the samples taken for further analysis in the laboratory (see
Farid 2000, Matthews and Hastorf 2000). Prioritising certain units means that these
will have, when applicable, the maximum sampling coverage and all the specialist
information extracted from them will be communicated between team members
during the trench tours. This process has important ramifications for the range and
number of samples examined in the field and, perhaps more decisively, within
specialised laboratories in Turkey and abroad:

'Different members of the team argue for this or that layer or feature to be
sampled more intensively (wet-sieving as opposed to dry-sieving for example).
The percentages of deposits of a particular type which have been prioritized can
be monitored. The priority contexts are retained in all further laboratory
analysis. In this way, the sampling (prioritizing) can be related to the changing
interpretation of the site and its features. It can be moulded to the particular site and adapted to the particular interpretation. But also this process ensures that all specialists look at the same samples so that for those samples studied there is the maximum contextual information available.' (Hodder 2000: 6)

This emphasis on the continuous debating and reconsideration of conclusions and interpretations is further promoted through the maintenance of an on-site electronic database to be used by field staff and laboratory specialists, in order to enquire into each other's data and evaluate working interpretations produced by their colleagues. Furthermore, the details of the exchanges taking place during the trench tours are video recorded, and the same happens with the summary presentations given by field and laboratory staff, where they have to explain the nature of their work and their assumptions in front of the camera (Hodder 2000: 7-8). Finally, there is provision to put the entire database of the Çatalhöyük excavations on the web (see entries in http://catal.arch.cam.ac.uk) so as to ensure unrestricted access for all interested parties (researchers working from a distance, academics from other research institutions not immediately related to the project and everybody who has an interest in the site) to the primary data produced through excavation and laboratory analyses.

The implications of these sampling and recording policies for the scope and the overall design of the wood charcoal project were multiple. The material available for this study includes wood charcoal macroremains retrieved through flotation from samples processed during five successive excavation seasons (1995-1999, but mostly from 1997-1999). Of these, although the original plan was to undertake fieldwork for at least two consecutive field seasons ('98-'99), a permit was granted for me to undertake research related to this project only during the 1999 season, for a period of two months. During this time I had the unique opportunity to familiarise myself with the excavation and laboratory procedures, to gain first hand experience of the recording and prioritising system in action and thus to exercise my own initiative in
what concerns the selection of samples in the field. It is obvious therefore that, for material retrieved in previous seasons, I had to rely on other project members, particularly the archaeobotany team, in order to get hold of those charcoal assemblages suitable for analysis.

At the time, it seemed that my absence from the on-site specialist team had some very serious practical consequences, in that it impaired significantly my ability to participate actively in the “negotiations about priorities” and thus have a substantial input in designing a sampling policy relevant to my research aims. This was so due to the fact that priority samples, as defined during excavation, were also those that were given precedence in basic archaeobotanical sorting both at the on-site laboratory and within those of the associated research institutions abroad (University of California at Berkeley).

On the other hand, however, the very existence of a web version of the excavation database accompanied by the archive reports compiled at the end of each season by field supervisors and laboratory staff, meant that at I had at my disposal a very powerful tool to guide me through the process of making sense of the available data and thus reach rational decisions concerning sample selection. Each excavated unit is entered in the database in full detail, including volume of excavated soil, matrix and finds descriptions, contextual associations, stratigraphic relations, its location in the trench, and a complete list of the samples taken from it. Repeated searches in the database and cross-referencing of the unit entries with the excavator and specialist reports, as well as going through the available published material and talking to other team members, helped me enormously to gain an in-depth understanding of the site’s archaeology and, more specifically, of the complex nature of the different excavated contexts and deposits.
Still, and despite the influx of information from many sources, the problem of choosing from the available archaeobotanical samples those suitable for charcoal analysis largely remained. As a class of bioarchaeological material, wood charcoal macro-remains have their own idiosyncratic attributes (see also Chapter 2). For example, certain of the prioritised units, such as burial fills (especially when there is no indication of fire-related ritual practices, e.g., cremation), general infill layers, levelling/foundation deposits and mud-bricks, run a higher risk of incorporating charcoal from a mixture of context types and thus of completely unknown provenance. Samples deriving from floors and fire installations, for instance ovens and hearths are potentially equally problematic, since they mostly represent just a snapshot in the use of wood as fuel. On top of all these, both sets of deposits are likely to be characterised by very complex depositional and post-depositional histories. Hence, the impact of the various taphonomic processes on taxon representation becomes extremely difficult, if not impossible, to assess.

Although within the current “orthodoxy” of the discipline, such constraints might have dictated a more conservative approach concerning sampling strategies (that is to “prioritise” both in the field and in the laboratory exclusively those refuse deposits representing long-term fuel use, which furthermore can be controlled more effectively for differences in preservation conditions), I decided to follow a more flexible course. Apart from the need to adjust my choice of samples to the circumstances described above, I took up the opportunity that a complex site like Çatalhöyük offers to investigate various aspects of the methodology of wood charcoal analysis. The aim was to explore, from a methodological viewpoint, the possibility of developing specific analytical tools through which the intricate issues concerning charcoal taphonomy could be addressed within a more objective
framework. In other words, to assess the potential of evaluating in a measurable way the impact of source, context, burning environments and post-depositional processes on the observed patterns of taxon abundance.

In fact, the effects of such “natural” and “cultural” parameters are not easily separated, in that they cannot be evaluated in isolation from each other. Cultural patterns of use, consumption and discard affect taphonomic processes; indeed, they form an integral part of the taphonomic process itself. The prevailing attitude towards plant remains, charcoal in particular, has been to treat them as an unreliable indicator of past populations (be they fields, cultivated plants and vegetation units, or collected firewood) mainly because of the difficulties inherent in moving from observed abundances to death assemblages and from the latter to living populations. However, I wish to argue that by untangling the complex relationships between behavioural patterns and preservation conditions, vital information can be obtained concerning cultural attitudes and the use of plant resources.

Furthermore, the meticulous excavation and recording of the various contexts and features, and the level of sampling coverage for different specialist analyses (both routine practices in Çatalhöyük) offer the additional advantage of an extremely rich archaeological record comprising multiple lines of evidence, against which the results and thus the reliability of the proposed methodology can be appraised.

In sum, two major concerns dictated the choice of archaeobotanical samples for charcoal analysis: i. To obtain a reliable picture of long-term patterns of fuel selection and consumption, and, ii. To investigate context-related variation in taxon representation and try to identify potential sources for the charcoal macro-remains retrieved from particular context types.
The archaeobotanical samples chosen for analysis fall thus into two groups respectively (for a detailed account see Chapter 4, Description of sampled contexts):

a. External refuse deposits (48 flotation samples) deriving from various excavation levels in the South Area (separated from the base to the top of the sequence into an early group comprising units from pre-level XII phases D-A, and a late one including units from levels IX-VII; see also Table 4.1). Another concern here has been to maintain the stratigraphic integrity of the examined assemblages.

b. A group of units derived from building 1 (North Area, generally corresponding to excavation levels VIb/VII: 27 flotation samples; see Table 4.10), plus a set of contexts other than midden/dump deposits (51 flotation samples) from the South Area (see Table 4.1). The latter include building infills (buildings 17, 18: levels IX, X), accumulation layers associated with penning activities (levels XI, XII), secondary fills of pits and various domestic features (levels VII, VIII, IX, X, XI, pre-level XII), charcoal spreads and occupation debris from floors (levels VII, IX and X), lime burning areas and other external surfaces associated with burning activities (pre-level XII), plus a set of open fires located within an external refuse area (space 115: level VIII). The overriding principle here has not been so much to follow up a temporal sequence of events but rather, as outlined earlier, to investigate context-related variation and attempt to identify particular processes through which charcoal remains were deposited in the archaeological layers.

3.1.2 Recovery techniques at Çatalhöyük: flotation, dry-sieving and sorting of the archaeobotanical material

With the onset of the excavations in 1995, a modified Ankara-type flotation machine (with a 55 gallon oil drum and a diameter of 56 cm) was built and operated by Ann
Butler (University College London, Institute of Archaeology), at the time overseeing archaeobotanical research at Çatalhöyük. During this first season, the target was to collect bulk samples amounting to 60 litres (when available) of soil from every excavated unit. A number of 200 samples were collected at that stage, of which approximately 70 were processed in the field. Most of these samples were later shipped to the Archaeobotany Laboratory of the University of California at Berkeley.

In 1996, under the supervision of Christine Hastorf and Julie Near (University of California-Berkeley) a second, larger SMAP-type machine (with a 75 cm diameter flotation tank) was built in order to process larger samples. The Ankara-type machine was from then on used to process only those samples that contained less than the standard volume of sediment. A mesh of 0.17mm was employed to retain the light fraction instead of the 0.25mm used during the previous season, whilst heavy residues were recovered with a mesh of 0.5mm. Both machines used recycled water from their individual two-tank settling systems. Some 700 samples were collected and processed during this season (20-40/l). For midden/dump units in particular, a second "average" soil sample was collected in addition to the standard bulk sample.

In the 1997 and 1998 seasons, with the enlargement of the on-site archaeobotany team, and the employment on a full time basis of four Turkish workers, the scope of sampling was once more expanded. Again, all excavated units were bulk sampled (~30/l), while a further scatter sample (equivalent to the "average" samples described above) was collected from midden/dump contexts. Floors in particular were sampled for flotation at one-metre intervals across each excavation unit. When less than one litre of sediment was available for flotation, a manual bucket-flotation system was applied. A chiffon mesh was put on top of a
bucket filled with water and then the soil was gently poured onto it. In this way, both the light and heavy fractions were retained after particles smaller than 0.34mm had been rinsed through gentle water agitation. Charred plant remains were also collected from the dry screening with a 4mm mesh of sediments, normally reserved for the retrieval of artefacts and animal bone.

In all, 525 samples were processed during the 1997 season whilst in 1998 this number was raised to 1006. As part of the normal practice, all flots were dry-sieved (4mm, 2mm, 1mm, 0.5mm and receiver) and each fraction was stored separately inside the sample bag. A major innovation introduced in 1997 was the prioritising of certain excavated units. Accordingly, the archaeobotanical samples deriving from the field “priority” units were sorted (full sorting of the 4mm and 2mm fractions, with a quick scanning of the rest of the botanical material) at the on-site laboratory. Charred items were separated into general groups (i.e., wood charcoal, cereal grains, pulses, fruit, non cultivars, parenchyma, nut husks, herbaceous material, various fruit stones, hackberry, endocarps, acorns) and their total weights and counts were recorded for each sample. Separate procedures were also established for the sorting of the heavy residues.

No major changes in field and laboratory procedures were implemented during the 1999 six-month season (overseen for the most part by Andrew Fairbairn and Amanda Kennedy, the archaeobotanists in charge of the material deriving from the South Area), aside from some modification of the field sorting routines through the introduction of a ranking system aiming at reducing sorting time. There was also provision for the wet-sieving of deposits likely to contain waterlogged remains, which however did not produce at that stage any significant results. A total of 1604 flotation samples were collected and processed from 1042 excavated units. For most
of these samples, charred plant remains were recovered from both the light and the heavy fractions. The archaeobotanical samples from the South Area were shipped to the UK laboratories (University of Cambridge and Institute of Archaeology, University College London).

3.1.3 Sampling strategies at Pınarbaşı

Excavations at Pınarbaşı were undertaken by a team from the University of Edinburgh under the direction of Trevor Watkins and in collaboration with the Karaman Museum represented by its Assistant Director, Cengiz Topal. Excavation work was extended over two consecutive seasons (1994-1995) on two different locations, Site A (on the neck of a short peninsula extending into the reed marshes) and Site B (one of the rock-shelters set against the cliffs facing the marshes) (see Fig. 3.1).

The whole project was designed to meet the requirements of a rescue excavation due to extensive illicit pit digging that had been ascertained through earlier reconnaissance surveys (Watkins 1996: 47). Consequently, during the first season, excavation focused on clarifying the depth of the stratified deposits at both sites, assessing the state of preservation of the cultural material and establishing its broad chronological framework. In 1995, investigations concentrated on the rock-shelter, with the aim of extending the area of the original sounding to reach the earliest stratified deposits (Watkins 1996: 50-51).

During both seasons, all excavated deposits were sampled for the recovery of plant and animal remains. Initially (1994) one sample per excavated locus (i.e., layer and/or feature) was taken, whilst in 1995 provision was made for the retrieval of at least two sediment samples from each locus and, occasionally, from different squares.
In total, 38 flotation samples were selected for charcoal analysis from the 67 originally submitted by Mark Nesbitt, the archaeobotanist in charge of the material. No particular context type was singled out for analysis (e.g., general refuse layers as opposed to specific features), since the overall lack of clearly defined features meant that substantial intermixing of the deposits might have taken place in the first place. Therefore, I decided to follow, as much as possible, an all-inclusive blanket sampling strategy. Selection was applied only if there was too much uncertainty concerning the dating of the deposits, when a high number of samples were available from the same locus, or there were extremely low quantities of charcoal remains in the bags submitted for analysis. The latter was the case with most of the deposits originating from Site A (details in Chapter 4, Description of sampled contexts).

3.1.4 Recovery techniques at Pınarbaşı: flotation, dry-sieving and sorting of the archaeobotanical material

During the first season of the excavation, a minimum of 30 or 60 litres of sediment (depending on the size of the excavated locus) was retrieved for flotation. In the following year, the size of the soil samples was standardised to 40 litres per sample. In 1994, the British Institute in Ankara flotation machine built by Mark Nesbitt was used. During the next season, a new machine (modified Ankara-type) was set up locally by Mark Nesbitt, similar to the one used at that time in Çatalhöyük. Fine materials were caught in a 0.3mm mesh whilst for the separation of bulkier items a sieve of 1mm mesh size was used. In 1995, again following the practice at Çatalhöyük, a single fabric mesh of 0.3mm was finally employed. Heavy residues
were retained using a 1mm flexible mesh. These were later separated into different fractions (>1mm, >3mm, >5mm, >10mm) (Watkins 1996: 51).

Few of the samples submitted for charcoal analysis had been sorted to any extent. This was certainly true for all 1mm flot fractions processed during 1994, whilst most of the 1995 material was still lying intact in the bags. Each sample was weighted using a high precision scale in the laboratory. Following this, it was passed through a stack of geological standard mesh size sieves (4mm, 2mm, 1mm, 0.25mm) with a brass receiver at the bottom for the collection of the residue. The weights of each fraction were again recorded. With the aid of a low power microscope, the 4mm and 2mm fractions were sorted in their entirety for any archaeobotanical (i.e., other than wood charcoal) and faunal remains. No seeds or fruit stones apart from the occasional hackberry (*Celtis*) were found in these fractions. Small pieces of bone, microfaunal remains and land snails were sorted as well and the remaining charcoal was weighted and put into separate bags. 1mm fractions were also scanned for materials other than charcoal, but little was found with seeds being the most notable absentees. The rest of the fractions (0.25mm and residue) were put in separate bags without being examined.

### 3.2 Microscopy procedures and identification

#### 3.2.1 Preparation methods, reference material and keys used

Depending on their size, charcoal specimens were either hand- or pressure-fractured with a carbon steel razor blade in order to produce fresh, clean surfaces, whenever possible in all three anatomical planes (transverse, radial longitudinal and tangential). The resulting pieces were then examined under a high power, epi-illuminating
Olympus microscope at magnifications of x50, x100, x200 and x400. Specimens from each identified taxon were photographed using the Scanning Electron Microscope facilities at the Institute of Archaeology (see Plates section).

Identifications were made by comparison to fresh and charred specimens from the A. C. Western wood reference collection held at the Institute of Archaeology, University College London, plus specimens collected in the field and wood anatomical descriptions and microphotographs available in Western (1969), Fahn et al. (1986), Schweingruber (1990) and Greguss (1959). The slide reference collection held at the Jodrell Laboratory-Royal Botanic Gardens, Kew was also consulted.

3.2.2 List of taxa and their anatomical descriptions

In total, twenty-nine different taxa were identified in the charcoal assemblages from both sites, comprising twenty-five families and twenty-four genera. It did not become possible to identify any of the examined charcoal fragments to species level on the basis of purely anatomical criteria. The anatomical descriptions of all taxa identified in the wood charcoal assemblages are presented below. Individual genera have been grouped according to the family to which they belong. To facilitate queries, families and therein genera are listed in alphabetical order. For each genus and/or family the reference to the relevant plate is also given.

List of identified taxa

| Family: | Cupressaceae |
| Genus: | Juniperus |
| English name: | juniper |
| Turkish name: | ardic |
| Description: | Growth rings distinct. Resin canals absent or very infrequent. Gradual transition from earlywood to latewood. Rays composed only of parenchyma cells. Transversal walls thick, tangential walls thin with nodules. Indentures present at the junction of longitudinal and horizontal |
walls. 1-4 cypressoid and/or taxodioid pits in earlywood cross-fields. Rays in average 1-5 cells high

Plate(s): Pl. 34

Family: Pinaceae
Genus: *Pinus*
English name: pine
Turkish name: çam ağacı
Description: Growth rings distinct. Resin canals present. Abrupt transition from earlywood to latewood. Rays composed of parenchyma cells and ray tracheids. Ray tracheids distinctly dentate. Two to four pits per cross-field

Plate(s): Pl. 35

Family: Aceraceae
Genus: *Acer*
English name: maple
Turkish name: akçağaç
Description: Growth rings distinct. Diffuse porous. Pores solitary and in short radial multiples of 2 or more. Perforations simple. Distinct spiral thickenings. Rays homogeneous, commonly uni- to 4seriate (4-5seriate). Vessel-ray pits slightly enlarged. Libriform fibres present

Plate(s): Pl. 1

Family: Anacardiaceae
Genus: *Pistacia*
English name: terebinth, pistachio
Turkish name: melengic, çitlembik
Description: Growth rings distinct. Ring porous. Pores solitary in the early wood (one row). Arranged in radial multiples, clusters and occasionally following a dendritic pattern in the latewood. Sometimes conspicuous tyloses occur in earlywood vessels. Perforations simple. Rays mostly bi- to 3seriate, heterogeneous, with one row of square and/or upright marginal cells. Latewood vessels and tracheids with distinct spiral thickenings. Vessel-ray pits large and simple. Resin canals present

Plate(s): Pl. 22

Family: Asteraceae
Genus: *Artemisia* & indet.
English name: (sagebrush, wormwood)
Turkish name: kısa bir çali (biikisi), pelin
Description: Growth rings indistinct. Diffuse porous. Pores in radial multiples of 3 or more, frequently arranged in long strings, occasionally in clusters as well. Perforations simple. Rays uni- to 5seriate (most commonly 3-5seriate), heterogeneous, composed of few rows of procumbent cells and numerous rows of square and/or upright sheath cells. Cell shape irregular. Libriform fibres present

Note: Fragments classified as Asteraceae indet. were either too small to be positively identified as *Artemisia* or had very narrow rays (uni- to biseriate). One of the genera described as having distinctively narrow rays by Schweingruber (1990: 298-299) is *Cirsium*. Seeds classified as *Cirsium*-type were found in the archaeobotanical remains (A. Fairbairn, pers. comm.). However, due to the lack of reference material for this taxon these fragments were classified as Asteraceae

Plate(s): Pl. 6, 7, 8
Family: Betulaceae
Genus: *Alnus*
English name: alder
Turkish name: kizilağaç
Description: Growth rings distinct. Diffuse to semi-ring porous. Pores densely packed in radial multiples and clusters. Rays homogeneous, of two distinct sizes, uniseriate and aggregate rays composed of numerous bi- to 3-seriate rays. Growth boundaries undulating at the proximity of aggregate rays. Perforations scalariform often with more than 20 bars. Libriform fibres present
Plate(s): Pl. 2

Family: Capparidaceae
Genus: *Capparis*
English name: caper
Turkish name: kebere
Description: Growth rings indistinct to fairly distinct. Diffuse to semi-ring porous. Pores of two size classes: large pores are mostly solitary whilst narrow vessels form radial multiples and/or clusters. Perforations simple. Rays 4–6-seriate, generally homogeneous, occasionally with square marginal cells. Vessels often with irregular axial orientation. Libriform fibres present
Plate(s): Pl. 9

Family: Caprifoliaceae
Genus: Indet.
English name: honeysuckle family
Turkish name: (hanimeli)
Description: Growth boundaries fairly distinct. Diffuse to semi-ring porous. Pores relatively small, solitary. Perforations simple. Rays uni- to bi-seriate, heterogeneous, with numerous rows of square and upright cells. Fibre tracheids present. Spiral thickenings were also occasionally observed. Specimens were too small very much fragmented to enable adequate observation. The characteristics cited here point towards *Lonicera* spp. The lack of reference material for this taxon from Central Anatolia however, did not allow a more precise identification
Plate(s): Pl. 10

Family: Chenopodiaceae
Genus: (Noaea-type, Suaeda/Salsola-type)
English name: goosefoot family
Turkish name: (kazayagi)
Description: Wood with included phloem of the foraminate to concentric type. Pores solitary and in irregular/radial groups. Perforations simple. Vessels, vascular tracheids and parenchyma storied. *Noaea*-type: rays absent. *Suaeda/Salsola*-type: rays indistinct, spiral thickenings present (it did not become possible to trace the latter feature in the specimens examined)
Plate(s): Pl. 12

Family: Cornaceae
Genus: *Cornus*
English name: cornelian cherry, dogwood
Turkish name: külcebik, kül cubuk
Description: Growth rings distinct. Diffuse porous. Pores almost exclusively solitary, of the same size across the growth ring. Perforations scalariform, with
more than 20 bars. Rays uni- and 3 to 5seriate. Uniseriate rays composed only of upright cells. Multiseriate rays heterogeneous, consisting of numerous rows of central procumbent and marginal square and upright cells. Fibre-tracheids present

**Plate(s):** Pl. 15, 16

**Family:** Fabaceae  
**Genus:** cf. *Colutea*?  
**English name:** (bladder senna)  
**Turkish name:** -  
**Description:** Growth rings distinct. Semi-ring to ring porous. Earlywood pores solitary and in oblique to tangential groups. Latewood pores in oblique to tangential groups and clusters. Perforations simple. Inter-vessel pits vestured. Rays 3-, 4- to 6seriate, homogeneous to heterogeneous (with one or two rows of square and/or upright marginal cells). Parenchyma storied together with vessel elements Libriform fibres and vascular tracheids present. Spiral thickenings on narrower vessel elements and tracheids

**Plate(s):** Pl. 14

**Family:** Fabaceae  
**Genus:** cf. *Genista*?  
**English name:** (broom)  
**Turkish name:** (şimşek)  
**Description:** Growth rings distinct. Ring porous. Earlywood pores arranged in oblique and tangential groups and clusters. Latewood pore clusters arranged in an oblique to dendritic pattern. Perforations simple. Inter-vessel pits vestured. Rays bi- to 3seriate, homogeneous to slightly heterogeneous (with one or two rows of square and/or upright marginal cells). Parenchyma storied together with vessel elements. Libriform fibres and vascular tracheids present. Conspicuous spiral thickenings

**Plate(s):** Pl. 13

**Family:** Fagaceae  
**Genus:** *Quercus* (deciduous)  
**English name:** oak  
**Turkish name:** mese ağacı  
**Description:** Growth rings distinct. Ring porous. Pores of two distinct sizes. Earlywood pores large, almost exclusively solitary. Latewood pores small, solitary and/or in groups, following a radial to dendritic arrangement. Perforations simple. Rays homogeneous, of two distinct sizes, uni- and multiseriate. Multiseriate rays more than 15 cells wide (often absent in immature wood and twigs). Libriform fibres and vasicentric tracheids present. Vessel-ray pits large, oval to slit-like

**Plate(s):** Pl. 27, 28

**Family:** Lamiaceae  
**Genus:** Indet.  
**English name:** mint family  
**Turkish name:** (ballibabagiller)  
**Description:** **Type 1:** Growth rings absent to indistinct. Diffuse porous. Pores small, in radial multiples of 2 or more. Perforations simple. Rays either uniseriate or uni- to 3seriate, heterogeneous composed of numerous rows of square and upright marginal cells and few rows of weakly procumbent central cells. Libriform fibres present
**Type 2:** Growth rings indistinct to faintly distinct. Diffuse to semi-ring porous. Pores arranged in clusters and/or tangential groups. Perforations simple. Rays uni-, bi- to 3seriate, heterogeneous composed of numerous rows of square and upright marginal cells and few rows of very weakly procumbent central cells. Inter-vessel and vessel-ray pits large, sometimes crossed and frequently scalariform. Spiral thickenings present.

*Note:* Based on these descriptions it is possible that type 1 represents wood anatomically similar to *Teucrium* spp, whilst type 2 could stand for *Phomis/Salvia* spp (cf. Schweingruber 1990: 444-445, 464-465; Fahn et al. 1985: 112). The lack of reference material from the area of study inhibited further precision with identification.

**Plate(s):** Pl. 20, 21

**Family:** Maloideae  
**Genus:** Indet.  
**English name:** (hawthorn, pear, apple)  
**Turkish name:** (çilç, armut ağacı, elma ağacı)  
**Description:** Growth rings distinct. Diffuse to semi-ring porous. Pores solitary. Perforations simple. Rays uni- to biserial, homogeneous to slightly heterogeneous with one row of square marginal cells. Fibre tracheids present. Very faint spiral thickenings occasionally present on vessel tails and tracheids.

**Plate(s):** Pl. 22

**Family:** Moraceae  
**Genus:** Ficus  
**English name:** fig  
**Turkish name:** incir ağacı  
**Description:** Growth boundaries absent to indistinct. Diffuse porous. Pores relatively large, infrequent, solitary and in short radial multiples of 2-4 (rarely in clusters), sometimes with fine tyloses. Perforations simple. Rays mostly bi- to 4seriate, heterogeneous, with one to two rows of square and upright marginal cells, and procumbent central cells. Vessel-ray pits elliptic in shape, with enlarged apertures, occasionally with irregular forms. Libriform fibres present.

**Plate(s):** Pl. 17

**Family:** Oleaceae  
**Genus:** Fraxinus  
**English name:** ash  
**Turkish name:** dişbudak ağacı  
**Description:** Growth boundaries distinct. Ring porous. Earlywood pores large, either solitary of in short radial multiples of 2-3, rarely in clusters. Latewood pores small, with similar arrangement. Perforations simple. Tyloses present. Rays generally bi- to 3seriate, homogeneous (composed of procumbent cells) or slightly heterogeneous, with one row of square marginal cells. Vessel-ray pits small and numerous. Libriform fibres present.

**Plate(s):** Pl. 18, 19

**Family:** Platanaceae  
**Genus:** Platanus  
**English name:** plane tree  
**Turkish name:** çınar ağacı
Description: Growth boundaries distinct, often festoon-shaped. Semi-ring to diffuse porous. Earlywood pores arranged in tangential groups and clusters, latewood pores mostly solitary. Perforations simple and scalariform (up to 20 bars). Rays often very wide, but generally 4-10-seriate (rarely uniseriate) homogeneous, composed of procumbent cells, occasionally with one row of square marginal cells. Inter-vessel pits arranged in horizontal, opposite rows. Fibre-tracheids present

Plate(s): Pl. 24

Family: Ranunculaceae
Genus: cf. Clematis
English name: (woody climbers)
Turkish name: (akasma, klemetis)

Description: Growth boundaries fairly distinct, generally festoon-shaped. Ring porous. Earlywood pores very large, mostly solitary. Latewood pores inconspicuous, in small clusters. Latewood part relatively narrow. Perforations simple. Rays very wide (5-10-seriate), heterogeneous, composed of few procumbent central cells and numerous rows of square and upright marginal cells. Inter-vessels pits of larger vessels mostly coalescent, slit-like. Spiral thickenings occur in narrow vessel elements. Libriform fibres and vascular tracheids present. Vessel elements, parenchyma cells and fibres mostly storied

Plate(s): Pl. 13

Family: Rhamnaceae
Genus: Rhamnus
English name: buckthorn
Turkish name: (dikenli küçük çalı, akdiken, topalak)

Description: Growth boundaries distinct. Diffuse to semi-ring porous. Pores solitary or in small groups, forming distinctive dendritic bands. Perforations simple. Rays uni- to biseriate (mostly biseriate), heterogeneous, with one or two rows of square and upright marginal cells. Inter-vessels pits with slit-like, often crossed apertures. Distinct spiral thickenings on vessels and vascular tracheids

Plate(s): Pl. 29

Family: Rosaceae
Genus: Amygdalus
English name: almond
Turkish name: acı badem ağacı

Description: Growth boundaries distinct. Ring porous. Earlywood vessels large, either solitary or in short radial multiples and clusters. Latewood pores mostly solitary. Tyloses abundant. Perforations simple. Rays either of two distinct sizes (uni-, biseriate and multiseriate) or 4- to 8-seriate, heterogeneous, composed of central procumbent cells with weakly square marginal cells. Spiral thickenings common in narrow vessels, infrequently present on large, earlywood vessels

Plate(s): Pl. 3, 4, 5

Family: Rosaceae
Genus: Prunus
English name: cherry, plum
Turkish name: kiraz ağacı, dag eriği

Description: Growth boundaries distinct. Diffuse to semi-ring porous. Pores numerous, arranged in short radial multiples and occasionally in small
clusters as well. Perforations simple. Rays mostly bi- to 3seriate, occasionally 4- to 5seriate as well, heterogeneous with central weakly procumbent cells and few rows of square marginal cells. Spiral thickenings are prominent on vessel elements and occasionally fibres as well.

Plate(s): Pl. 25, 26

Family: Rosaceae
Genus: Rosa
English name: rose bush
Turkish name: (gülpüntü/kusburnu)
Description: Growth boundaries distinct. Ring porous. Pores generally infrequent, solitary. Perforations simple. Rays uniseriate and multiseriate, markedly heterogeneous, composed of numerous rows of square and upright marginal sheath cells. Fibre tracheids present, spiral thickenings in general absent or very fine, visible on the tail ends of vessel elements.

Plate(s): Pl. 30

Family: Salicaceae
Genus: Indet.
English name: willows, poplars
Turkish name: söğüt, kavak
Description: Growth boundaries fairly distinct. Diffuse to semi-ring porous. Pores are numerous, sometimes solitary (especially in immature wood) but mostly in short radial multiples and clusters. Perforations simple. Rays are almost exclusively uniseriate and generally homogeneous to slightly heterogeneous. Vessel-ray pits large and simple. Libriform fibres present.

Plate(s): Pl. 31

Family: Tamaricaceae
Genus: Tamarix
English name: tamarisk
Turkish name: ilgm
Description: Growth boundaries distinct. Ring to semi-ring porous. Pores solitary and/or in small groups. Perforations simple. Rays very broad, 6-, 7- to 20seriate, heterogeneous with numerous procumbent cells and one or two rows of square and upright marginal cells. Vessels storied together with parenchyma cells. Inter-vessel and vessel-ray pits numerous and small. Libriform fibres present

Plate(s): Pl. 32a

Family: Ulmacaceae
Genus: Celtis
English name: hackberry
Turkish name: çitlenbik/çitlambik
Description: Growth rings distinct. Ring porous. Earlywood vessels solitary and in short radial multiples of two to three in association with narrow vessels. Latewood pores are arranged in large clusters forming an oblique to tangential pattern. Perforations simple. Rays generally uniseriate and multiseriate, although intermediate forms occur too, heterogeneous, with a few rows of procumbent cells and numerous square and upright marginal cells. Vascular tracheids and libriform fibres present. Distinct spiral thickenings on narrow vessels and tracheids.

Plate(s): 10a, 10c
Family: Ulmaceae  
Genus: *Ulmus*  
English name: elm  
Turkish name: karaağac  
Description: Growth rings distinct. Ring-porous. Earlywood occasionally with more than one rows of pores. Latewood pores are arranged in oblique to tangential bi- to 4seriate bands. Perforations simple. Rays mostly 4- to 5seriate, predominately homogeneous, occasionally with one row of square marginal cells. Vascular and fibre tracheids present. Conspicuous spiral thickenings  
Plate(s): Pl. 10b

Family: Verbenaceae  
Genus: *Vitex*  
English name: chaste tree  
Turkish name: -  
Description: Growth boundaries fairly distinct. Ring to semi-ring porous. Pores are relatively large, occasionally solitary but mostly in short radial multiples. Perforations simple. Rays bi- to 4seriate, heterogeneous with one or two rows of enlarged marginal cells. Inter-vessel pits numerous and small, with slit-like apertures  
Plate(s): Pl. 32b

Family: Vitaceae  
Genus: *Vitis*?  
English name: vine  
Turkish name: asma  
Description: Growth boundaries discontinuous. Ring porous. Pores of two distinct sizes. Earlywood pores large, solitary. Latewood pores arranged in radial files and small clusters. Rays large, homogeneous to slightly heterogeneous, composed mainly of procumbent cells with one row of square marginal cells. Narrow vessels occasionally with irregular spiral thickenings. The one specimen examined was too heavily degraded to allow more precise observations on vessel pitting and perforation plates  
Plate(s): Pl. 33

3.3 Methods of quantification and statistical analysis

3.3.1 Calculating taxon abundance: fragment counts and presence scores

From the Çatalhöyük wood charcoal assemblages a number of 150 fragments per sample were examined (each sample corresponding to one excavated unit; when more than one sample per unit were examined, the results were averaged before proceeding with further quantitative analysis). This number comprised 100 fragments
from the 4mm fraction of the dry-sieved flots and a further 50 fragments from the respective 2mm fraction, in order to trace small-sized woods (i.e., shrubs) and twiggy material not likely to be retained in the 4mm mesh. The decision to concentrate mainly on the 4mm fraction was dictated by the need to maximize the taxonomic information obtained from each sample, whilst at the same time preventing identification biases that might arise from the examination of charcoal fragments retrieved chiefly from smaller size ranges. Such a subsampling strategy did not pose any real problems with the external refuse deposits, the vast majority of which produced wood charcoal assemblages large enough to guarantee its applicability. In those few instances when this was not the case (i.e., flot charcoal from the 4 and 2mm fractions did not amount to the requisite number of 150 fragments) counting stopped when both fractions had been examined in their entirety (units 4846 s.2: 140 fragments, 4871 s.9: 104, 5286 s.7: 72, 5310 s.2: 93 and various units from the other context groups, see Chapter 4).

With the exception of units 4879 s.5, 5315 s.2, 5326 s.3, 5328 s.3 (external refuse deposits), 4711 s.2 (pit fill) and 4715 s.4, 4716 s.5 (accumulation/penning) of the South Area, and 1358 s.16, 1359 s.19, 1367 s.1, 1372 s.2, 1423 s.7 (building 1) of the North Area, no heavy fractions were examined. In all these cases, the decision to include (when available) the heavy residue fractions was mainly driven by the lack of adequate quantities of flot charcoal.

Concerning the external refuse deposits, all the aforementioned units belong to some of the earliest refuse areas excavated in Çatalhöyük, which also presented certain peculiarities regarding sample composition compared to the rest of the sequence (see Chapter 4). Examining heavy residues was therefore done in the course of investigating whether these discrepancies in taxon representation could be attributed
to variations in preservation conditions that might have affected the frequencies of individual taxa. This decision was based on the observation that many of these samples contained insufficient quantities of wood charcoal in their respective light fractions. In other words, it was predicted that most of the wood charcoal originally deposited in these contexts would be retrieved from the heavy residues. Therefore, their microscopic examination was imperative in order to obtain an adequate picture of sample composition.

However, the rather arbitrary selection of heavy residues for analysis and the ultimate decision not to treat them in any systematic way was essentially a compromise, made necessary for two reasons. Very few heavy residue fractions from strata later than level X were made available for analysis in the first place, thus raising the question of comparability of results between different settlement phases and context types. Secondly, it was empirically observed that whatever could be gained by this process in terms of monitoring taxon representation within individual samples, was in most cases counterbalanced by a disproportionate increase in the numbers of indeterminate fragments. For refuse deposits in particular, obtaining a fair picture of sample composition would have entailed a substantial increase in the number of fragments examined from both the flot and heavy residue fractions, and thus the microscopic examination of fewer assemblages. The choice therefore lay between examining few samples (300-400 fragments per sample), and expanding the number of the analysed samples, with the aim to offset potential biases in taxon representation through maximum sampling coverage of each excavated level. The solution finally adopted was to pursue the second alternative.

The same procedures with minor alterations were followed with the Pınarbaşı material as well. The focus of the subsampling strategy became the excavation locus,
much akin to the unit in that a locus may describe a well-defined context (e.g., a pit), or a distinct layer identified as such by the excavators. This also meant that, in general, I opted for examining at least one sample per excavated locus. However, certain very large loci had been repeatedly sampled by the excavators. During this process, sample numbers changed when a different excavation square was opened (e.g., locus BBE) or simply when the particular context under excavation was too large to be sampled comprehensively at one time (e.g., locus BBD). In both instances, one sample per excavated square or samples with different numbers (not split ones) were analysed. Given the very large quantities of wood charcoal retrieved from most of the Pinarbaşi samples it was decided to raise the number of the examined fragments to 200, comprising 100 fragments from the 4mm and 2mm fractions of the dry-sieved flot. The aim was to allow rare and/or under-represented taxa (e.g., small-sized woods such as shrubs) a better chance of registering their presence and abundance values in the wood charcoal assemblages. No charcoal deriving from the heavy residue fractions had been submitted for analysis.

The abundances of individual taxa within each sample and their presence across samples were plotted by means of fragment counts and presence scores. In order to draw comparisons between different settlement phases, it was necessary to convert both fragment counts and presence scores into percentage values. This was done after excluding from the sums of each sample the counts and presence scores relating to indeterminate fragments (representing, it has to be stressed, indeterminate fragments and not unidentified taxa). In this way, percentage fragment counts were calculated based on the numbers of total identified fragments for each sample.

Certain taxonomic categories were also excluded from further quantitative analysis (including calculations of diversity and multivariate analysis, see below).
These are the following: Gymnosperms (coniferous wood charcoal too small to identify), Ulmaceae/Pistacia (fragments again too small to allow more precise identification as either Ulmaceae or Pistacia), Anacardiaceae indet. (very small specimens that retained some of the anatomical characters of the family but otherwise could not be categorised even under the label cf. Pistacia) and Rosaceae indet. (comprising fragments too small to be ascribed positively to one of the genera already identified from this family, i.e., Prunus, Amygdalus and Rosa). Their numbers were so low in the assemblages that their omission could not have influenced in any way the plotting of taxon frequencies.

Wood charcoals of shrubs belonging to Asteraceae, Artemisia and Fabaceae, cf. Colutea?, cf. Genista? were combined for the purpose of quantitative analysis in their respective family groups (i.e., Asteraceae and Fabaceae). However, the same could not be done for Celtis, Ulmus and Ulmaceae. Celtis and Ulmus occupy very different ecological zones. Celtis was also regularly harvested by the inhabitants of Çatalhöyük for its fruit produce. It is evident therefore that any combination of the two under the label of Ulmaceae would seriously distort patterns of species representation relating to the reconstruction of past woodlands and their exploitation. So these taxonomic groups (Celtis, Ulmus, Ulmaceae) were retained separate for all further analysis.

A final comment must also be made here on Phragmites. Charred remains of reed stalks and seeds were sorted from the Çatalhöyük samples to be included with the rest of the archaeobotanical material examined by other specialists. This explains its absence from the respective list of taxa, although reed stalks and seeds are regularly recovered from the Çatalhöyük archaeobotanical assemblages (see entries in Çatalhöyük Archive Report 1999). On the other hand, I routinely recorded the
frequencies and presence of *Phragmites* charcoal fragments amongst the Pinarbaşı assemblages.

### 3.3.2 Recording of qualitative characters: decayed wood

In order to explore further patterns of taxon representation, an attempt was made to trace some of the qualitative characteristics of the charcoal fragments, particularly the potential for plotting the quantities of decayed/deadwood encountered in the charcoal samples. For this purpose, the presence of fungal hyphae (cf. Boyce 1948: 336-346; see also Pls. 37a-b) amongst the larger pieces of charcoal (≥ 4mm) was routinely recorded during microscopic examination.

Actually spotting fungal hyphae in charred wood specimens can be, to a large extent, a fortuitous affair. Due to its weakened internal structure, decayed wood has little chance of surviving the burning process, whereas decay cannot be assumed to have affected in a uniform way the pieces of wood eventually consumed in fire. At the same time, wood that is either in the early stages of decay or again very close to final decomposition very rarely maintains visible signs of fungal hyphae. In the first case, hyphae may be very small and difficult to trace, whilst in the latter their sole signs are frequently small boreholes, shrinkage cracks and cell walls in various stages of dissolution, all extremely improbable to identify under the microscope with any degree of certainty, particularly amongst archaeological specimens. There follows that any results produced by recording and quantifying signs of fungal decay should be interpreted with caution and always in relation to the taphonomic history of the assemblage in question.
Due to time limitations, it did not become possible to examine all samples in this detailed fashion (tracing fungal hyphae requires careful examination of both tangential and radial longitudinal planes in the largest surface available, since they are very rarely visible on a transverse section). A number of external refuse deposits from Çatalhöyük (levels VII-IX) were chosen as a control sample to test for the feasibility of this approach, while samples from other context types and excavation levels were examined in a more cursory way (see Chapter 4). The samples from Pınarbaşı were also not systematically scanned for decayed wood fragments, due to time restrictions.

The results of this process were plotted in two ways: as proportions of total decayed/non-decayed wood in each sample and then by groups of taxa (i.e., timber, riverine, fruit trees and shrubs). Grouping was necessary in order to obtain a clearer picture of decayed wood findings and their potential significance. This categorisation was based on the following assumptions: it was already known that oak and juniper were the two most important “timber” taxa in Çatalhöyük. Secondly, riverine species presented perhaps the sole coherent (in view of their strict ecological requirements and lack of overlap with other woodland types) ecological group. By contrast, certain dryland trees and shrubs (e.g., terebinth, almond, hackberry) could not be considered as representative of individual ecological units (e.g., woodland steppe as opposed to park-woodland), since they could have occurred in more than one woodland types. Hence, the label “fruit” was considered as a legitimate general descriptive term for dryland woody plants that grew further away from the alluvial flats and which were also present in the macrobotanical remains as seeds and/or fruit stones. Finally, under the label “shrubs” were categorised woody plants likely to occur in more arid and/or saline areas and woodland openings, and apparently were growing and/or gathered in
the form of small-sized wood (i.e., chenopods, legumes, wormwoods and mints). The overall rationale was to trace potential patterns in the proportions of decayed wood that might offer clues to taphonomic (survival biases) and/or behavioural (collection of certain taxa mainly as deadwood, firewood storage, etc.) interpretations (see also Chapter 4). The same grouping system, with the addition of Ulmaceae as a separate group, was also followed for certain applications of multivariate analysis (see below and Chapter 4).

3.3.3 Taphonomic analysis: Density, Preservation/Fragmentation and Diversity measurements

3.3.3.1 Density (STDW)

Density is widely acknowledged by archaeobotanists as one of the most basic ratios (expressed as either the number or the total weight of charred items per litre of floated sediment), for assessing assumptions of uniform deposition, preservation and recovery rates of charred plant remains (Miller 1988). In this context, wood charcoal macro-remains have been frequently used by archaeobotanists in combination with other indices, such as the total number/weight of seed items per litre and various preservation and fragmentation measurements (see below), in order to evaluate inter and intra-site differences relating to preservation conditions and depositional histories. For charcoal analysis in particular, density measurements are best not used alone for evaluating the intensity of fuel use and the effects of preservation conditions, since wood (being a porous material) is subject to processes such as the concentration of minerals and precipitates that may affect in various ways total charcoal weights (cf. Greenlee 1992).
For the purpose of this study, total wood charcoal weights have been standardized by using as denominator the volume of soil floated from each sampled context. What came out of this process was a unique for each context Standardised Weight value (STDW: g/l). In the case of Çatalhöyük reliable data on wood weights were available for the 4mm and 2mm fractions of the dry-sieved flots only, and these were used for calculating charcoal densities. For the Pinarbaşı samples, the weights of the 1mm fraction were used as well.

3.3.3.2 Fragmentation/Preservation (Fr/Pr index)
I devised this comparison ratio (Fr/Pr index) in an attempt to obtain a more objective measure of the effects of taphonomic processes on wood charcoal assemblages than simply relying on calculating the percentages of indeterminate fragments and plotting them against density values. In seed archaeobotany, such indices are constructed based on the ratio of fragments to whole seeds (fragmentation) and by assigning to individual seeds a numerical value (on a pre-defined scale) consistent with the survival of certain diagnostic features (preservation) (see Colledge 1994: 151-153). In the case of wood charcoal macro-remains, it is obviously beyond question to calculate “whole individuals” as opposed to fragments. Therefore, out of necessity any such index would have to be a compound one, in that it would describe in the same unit of measurement the effects of both fragmentation (i.e., occurrence of indeterminate fragments due to breakage and reduction of size) and preservation (deformation of diagnostic features caused by thermal degradation and/or the presence of mineral inclusions). This situation accords with the particularities of charcoal taphonomy since these factors are usually interrelated in the ways they may affect wood charcoal assemblages (i.e., aside from trampling and other mechanical
processes, the concentration of mineral inclusions and thermal degradation may also lead to charcoal fragmentation).

In the Fr/Pr index, the norming variable (denominator) is the total number of identified items per sampled context, whilst the numerator represents the total number of indeterminate fragments from the same context. Values of the Fr/Pr index equal to zero would mean that there were no indeterminate fragments in the assemblage. Values of <1 were taken to indicate low fragmentation and good preservation, 1-5 moderate to high proportions of indeterminate fragments and >5 very high proportions of indeterminate fragments.

3.3.3.3 Diversity (Shannon-Wiener index)

In order to obtain a numerical value summarizing information on sample diversity, the Shannon Wiener index was employed (cf. Popper 1988). The following formula was used to calculate diversity:

\[ H = - \sum \left( \frac{N_j}{N} \right) \log \left( \frac{N_j}{N} \right) \]

where \( N_j \) is the total number of identified fragments in a given assemblage and \( N \) the number of fragments recorded for each taxon in the assemblage. If samples contain many taxa that are evenly distributed, the index values show high diversity. If, on the contrary, taxa are few and unevenly distributed, the index values show low diversity. Measuring sample diversity in this way provides a concise numerical description of the broad trends within an assemblage, which may prove very useful for drawing comparisons between different phases/context types and thus distinguishing between specialised and generalised plant assemblages (Popper 1988: 68). The Shannon-Wiener index should however always be used in conjunction with abundance and presence data, since two otherwise equal values may represent a different range of
taxa but with the same evenness of distribution, or again low values may arise in one instance from a limited number of taxa and in another due to their uneven distribution.

3.3.4 Statistical analysis (correlation and multivariate statistics)

The values obtained from the density, diversity and Fr/Pr indices were compared against each other by means of correlation statistics (Spearman's Rank Correlation Coefficient, see Fletcher and Lock 1995: 103-114). The statistical package I used for this purpose and for drawing the correlation scatterplots was SPSS 10.0 for Windows.

In order to further investigate context-related variation and evaluate patterns in taxon representation that could be linked to the results of the taphonomic and general quantitative analysis, it was necessary to resort to multivariate statistics. To this end I used the CANOCO for Windows v.4 software in order to perform simple correspondence analysis (cf. ter Braak and Šmilauer 1998, Jongman et al. 1995), and hence summarise in an acceptable way the results produced from both sites. Taxa that individually scored less than 10% presence in any given group of samples were excluded from multivariate analysis. The limitations and ultimate applicability of all these methodologies are discussed further in the context of data analysis presented in Chapter 4.
Chapter Four – Presentation of the results

In the following sections, the results of charcoal analysis from the Neolithic sites of Çatalhöyük and Pınarbaşı are detailed. Presentation has been organised in three different levels, separately for each sampled location (Çatalhöyük-South Area, Çatalhöyük-Building 1, Pınarbaşı). First comes a description of the archaeological attributes of all sampled contexts as the necessary background for a contextual understanding of the wood charcoal evidence. Following that, the data assembled on sample composition and the taphonomic characteristics of the wood charcoal assemblages are treated in full detail. Finally, the results of this process are summarised and discussed for each area.

4.1 Çatalhöyük - South Area

4.1.1 Description of sampled contexts

The charcoal assemblages examined from the South Area derive from seven different excavation levels (following Mellaart’s system). From top to bottom these are VII, VIII-VIII/IX, IX, X, XI, XII and pre-XII (see Tables 4.1, 4.2). The summary context descriptions provided here follow for the sake of clarity the same subdivisions and have been based on the excavation reports available in the website of the Çatalhöyük Research Project (Farid in Çatalhöyük Archive Report 1995, 1996, 1997, 1998, 1999).
4.1.1.1 Level VII

The refuse deposits sampled from level VII include a series of fills (1072, 1073, 1091, 1506) in a shallow cut which had been dug as a foundation for wall 56, running from north to south on the western side of space 105 *(Fig. 4.1)*.

There were also examined an *in situ* bone cluster (1506) deriving from the same foundation cut and a midden unit (1627) associated with the early phases of space 107. The latter formed part of a complex of enclosed spaces, which had been excavated by James Mellaart as houses 12 (space 108), 2 (space 107) and 16 (space 106) and were associated with an open area (courtyard 15, equivalent to space 105). To the north, they ran parallel to another series of structures comprising spaces 109, 112 and 113. The foundation trench of wall 56 cut through midden deposits and had been gradually infilled with dumped waste including animal bone, clay balls and charred plant material. A substantial part of the carbonised material retrieved from these contexts could have been intrusive from the midden layers of level VIII, since wall foundations had truncated these midden layers. Therefore, charcoal finds were treated together with those of levels VIII and VIII/IX.

The non-midden units examined from level VII are 1888, 2022, 2704 and 2714 (space 112). Units 1888 and 2022 comprise scorched floor remnants mixed with ash and were overlying the collapsed vault of an “oven” (fire installation 96: Fig. 4.2). The latter was rectangular in shape and contained a fill of clay balls and stones burnt *in situ* (2704), plus a circular pit on each of its northwest and northeast corners. The fill of the pit on the northeast corner (2714) contained visible charcoal remains together with a quantity of obsidian flakes and a blade.

* The term “space” denotes any internal (i.e., room) or external excavated area which presents a unified character on the basis of the deposits unearthed in it, whether this is on the basis of structural features, similarity in the use of space or a temporal change in the use of space
4.1.1.2 Level VIII

Immediately below spaces 105, 106, 107 and 108 lay a large open area (space 115) bounded to the north by a row of structures (space 161 located below 109, space 162 below 112 and building 4 below space 113). To the south, it was limited by buildings 21, 7 and 6, while to the east it ran under courtyard 15 (space 105) (see Fig. 4.3). Its western end extended outside the excavated area. Space 115 comprised mostly midden deposits (1066, 1520, 1523, 1527, 1530, 1600, 1638, 1657) containing fine lenses of ash and charcoal debris interleaved with remnants of clay, plaster, coprolite, animal bone, obsidian, clay balls, figurine fragments, etc. These units have been interpreted as primary domestic refuse accumulated over long periods of time, apparently in rapid succession as can be deduced from the lack of wear and/or weathering signs.

Another set of midden/dump deposits included units 2840, 2846 and 2869. These had a higher content of clay, whilst 2840 and 2846 were associated with areas of obsidian micro-debitage. Larger debris, intermixed with fine lenses and yellow/orange layers (possibly the remains of dung), was retrieved from units 3314, 3366 and 3375, which sealed an in situ open fire (3365, 3600, 3601). Another in situ open hearth (3612) was spotted in the same area together with a layer of re-deposited ash (3611). Middens 3740 and 3773 were located below these open fires.

Refuse had also accumulated within building structures, either after their final abandonment or right before the construction of a new building on the same location. Unit 2890 represents part of the infill deposited inside space 162 after it fell out of use, as a sort of preparation for the construction of space 112. Although some reworking of the material destined to be used as infill had taken place, this particular unit maintained a substantial component of domestic refuse. Three more units can be
categorised in a somewhat similar way: 1563 (space 117) and 1649, 1803 (space 116). These, together with 1642, belong to the interface of levels VIII and IX and incorporate domestic refuse accumulated over an extended period of time in the abandoned structures of building 2 (see Fig. 4.4).

Two units representing non-midden contexts were examined from building 6. 4614 (space 163) comprised infill deposits derived from burial 513. The grave contained an adult skeleton in crouched position set against the eastern wall of the room. The rib cage bore traces of soot, whilst a thick layer of secondarily deposited owl pellets covered the torso. The same deposit gave a high concentration of carbonised cereal grains and tubers, a complete weasel skeleton and bones from a small dog. A matter for consideration has been to determine whether these items were placed deliberately in the grave or instead they were part of the building’s general backfill. Unit 4913 (space 173) was a small pit that contained fire-debris associated with the use of hearths 523 and 502. The latter were surrounded by compacted discontinuous surfaces of ash and rakeout deposits and had been subject to numerous modifications and repairs throughout their lifetime.

4.1.1.3 Level IX

The units examined from level IX include the infill (1889) of a clay bin (256) located inside building 2 (space 117), plus a series of infill layers (4605, 4625, 4626, 4632, 4634, 4636, 4644, 4648, 4654, 4921, 5220) and floor material (rakeouts 5021, 5034, 5059) from building 17 (spaces 170, 182) (see Fig. 4.5).

The material associated with bin 256 consisted mainly of food consumption waste, deliberately dumped on top of the collapsed bin vault. The matrix of this deposit was a mixture of clay and ash/charcoal debris containing a few bone
implements, some pieces of obsidian, broken grindstone and, most noticeably, a large assemblage of fire-cracked clay balls lined with animal bone. The bin had been truncated on its eastern side by a fire installation ("oven" 268), which may offer a possible candidate for the source of the clay balls. However, most of the bones bore no signs of burning.

Building 17 was the predecessor of building 6 and comprised a large room (space 170) on its eastern part and a narrower structure (space 182) to the west. The infill between the buildings measured approximately a metre in depth. Its initial layers included fragmented bricks, mortar and roof debris through which the timber posts supporting the roof had been retrieved. Units 4625, 4626, 4632, 4634, 4636, 4638, 4644, 4648, 4654 (space 170) and 5220 (space 182) represent part of these basal infill layers. Following this initial episode of deposition and the dismantlement of the roof, the whole area was infilled with a finely graded homogenous deposit (4921, space 182). Unit 4605 (space 170) contained similar material that had accumulated inside one the post retrieval pits.

The rakeout layers (5021, 5034) all come from space 170 and represent ash and charcoal spreads on floors associated with hearths 538 and 541 respectively. Unit 5059 was a basal layer rich in charcoal inside "oven" 548.

**4.1.1.4 Level X**

The contexts sampled from level X include three infill deposits from building 18 (4664, 4708, 4711) and two ash/charcoal spreads from building 23 (Fig. 4.6). Unit 4708 (space 171) was a general homogeneous infill layer that had been laid down as a foundation before the construction of the building commenced, very much akin to the upper fills already described from building 17. Similarly, 4711 (space 171)
comprised the fill of a small pit containing re-deposited building material. By contrast, unit 4664 was an infill layer carefully placed inside a plastered “bin” (466), as part of the backfilling process prior to the building’s final abandonment.

From building 21, units 4780 and 4783 (space 178) were two superimposed compound layers of floor surfaces associated with “ovens” 524 and 529 respectively, very rich in occupation debris (ash and charcoal spreads, bone, obsidian, etc.) Apparently, these surfaces received waste generated by food processing, the cleaning of fire installations and stone knapping. They had been separated from “clean” floors through a low partition, which contained them in the eastern half of space 178.

4.1.1.5 Levels XI-XII

The units examined from levels XI and XII form part of the upper strata (spaces 198, 199) uncovered in the deep sounding that was opened below the buildings of level X during the 1999 season (see Fig. 4.7, 4.12a). Level XI deposits consisted of a series of roughly horizontal, discontinuous light orange-brown and grey bands (4710, 4715, 4716, 4850) which contained accumulations of animal coprolites, dung pellets, spherulites, spreads of plant material that had left phytolith impressions, and thin bands of dumped clayey material. They have been interpreted as indicating animal penning areas. This hypothesis is further supported by the occurrence of polished bone surfaces (possibly caused by animal urine) and shed sheep/goat teeth. Apparently, straw or some similar material was being deliberately laid down in the stabling area prior to periods of use, whilst the lumps of decaying plant material and coprolites were covered from time to time with spreads of clay. The area was surrounded on three sides by walls. No similar boundary was found on its northern
part. That some type of roof structure must have existed is also suggested by the absence of any signs of wind and/or water erosion within the excavated deposits.

Similar, albeit less intensive, activities had taken place in space 199 (level XII). The "stabling" layers sampled from this area are 4821 and 4822. A boundary wall (551) was uncovered only on the western side of the excavation trench. The construction of this wall before the onset of the penning activities probably denotes an important transition in the use of space in this area, as evidenced by an extensive \textit{in situ} burning event (4826) which sealed the basket burial of a stillborn/newborn in the same location.

4.1.1.6 Pre-Level XII

The next large sequence of midden/dump units comes from the pre-level XII strata, uncovered in the 1999 deep sounding (space 181, see Fig. 4.7 and Harris matrix in Fig. 4.12a-d). The absence of architectural remains made it impossible to subdivide these early deposits according to excavation levels. Based on the material culture sequence and the observed contextual affinities and associations, they have been assigned by the field team to five different phases (A to E).

Phase A comprises a series of midden/dump deposits (4824, 4836, 4837, 4938, 4839, 4844, 4846) interspersed with pits (4842) and \textit{in situ} burning episodes (4845, 4848). The latter extended over the entire excavated area and appeared as heat affected, oxidized horizons underlying the material that was actually consumed in fire. These deposits also showed extensive signs of root and insect bioturbation, probably due to their long exposure to the elements before burning took place. The refuse layers, on the other hand, were very much akin to later midden deposits and probably represent similar routines of waste disposal, even though they lack the fine
lenses observed amongst the later midden/dumps. They were quite homogeneous, dense and contained abundant cultural material such as bone, obsidian, flint, fired clay objects and charcoal. It is likely that they have been under the influence of different depositional and/or post-depositional processes compared to the later middens.

Phase B strata contained a series of very distinctive, highly heat affected deposits which have been interpreted as the remains of lime burning (4872, 4881), intermingled with general refuse layers (4871, 4874, 4875, 4879, 5286, 5290) and in situ burning episodes (4873), similar to those described above. The lime burning layers were distinguished by their yellowish, white mottled colour and their sandy texture, and they overlaid very dark scorched areas containing charcoal, calcined dung spherulites and burnt bone (both calcined and carbonised). Within the same phase there were spotted some more specialised deposits: A thin band of heat affected clean clay sealed by scorched layers (5279) had probably been laid down deliberately as a surface on which lime burning could take place. Similar to this was unit 5291, consisting of a set of relatively clean clay bands interspersed with spreads of sand and highly fragmented animal bone. The latter bore signs of carnivore gnawing and digestion. These surfaces extended over the entire excavated area. Another deposit representing fire-related debris was 5292, the burnt fill of a shallow scoop. Unit 4883 was the fill of a small hollow that has been interpreted as a post pad. In the same area was located a shallow wide bottomed U-shaped cut (infilled by 4884), which appears to have been a gully feature (see Fig. 4.8). Both these features may represent a temporary structure relating to some kind of extra-settlement activity (e.g., drainage).
Phase C layers comprised exclusively midden/dump deposits (5299, 5310, 5313, 5315, 5317). These contained light to mid-brownish grey and olive silty clay, were relatively thin and retained low quantities of cultural material. No traces of features and/or layers associated with burning activities were spotted in this area, although unit 5317 bore signs of burning. However, since no scorched surfaces were associated with it, it may actually represent the dumping of burnt material that was still warm when discarded. The sloping of the refuse deposits in the trench did not follow the underlying topography of the mound. This probably indicates a deliberate dumping strategy aiming at raising the level of the area, in an effort to block incoming river waters and ultimately increase the space available for habitation.

Near the base of the mound, another set of distinct refuse deposits was revealed (phase D-units examined: 5326, 5328). Their matrix consisted of a thick homogenous band of very firm, dark grey clay (alluvial backswamp clay) and contained abundant cultural material including animal bone, fired clay objects and charcoal together with some stone, obsidian and flint, not unlike the domestic refuse layers described earlier on. Neither the animal bone nor the clay objects bore signs of extensive weathering, hence suggesting relatively rapid rates of deposition into what could have been a seasonally flooded area outside the limits of the main settlement.

At the bottom of the deep sounding (phase E), excavation reached layers of light grey clay occasionally interspersed with irregular patches of lake marl. No backswamp deposits containing cultural material were found at this level. It is possible that the whole area had been truncated by marl extraction activities. Hence, no charcoal material was examined from these layers.
4.1.2 Quantified results

4.1.2.1 Midden/Dump deposits

From the 48 midden/dump units examined in this study, 47 were finally assembled for further quantitative analysis. This was due to the need for averaging the results obtained from the split flotation sample of unit 4836 (s.2). The full lists of identifications are given in Table 4.3 (a-b).

i. Presence of taxa

Twenty-six different taxa were recovered from the midden/dump deposits belonging to excavation levels VII-IX, whilst the pre-level XII assemblages gave a number of twenty-two. Of these *Pinus*, *Alnus*, *Ficus*, *Acer* and Caprifoliaceae were present exclusively in the VII-XI samples.

The percentage presence scores for each set of deposits (Table 4.4, Fig. 4.9) show that broadly the same range of taxa dominate their assemblages. These are *Quercus*, *Juniperus*, *Salicaceae*, *Ulmus*, *Celtis*, Ulmaceae, *Pistacia* and Maloideae. *Amygdalus* is also represented in almost equal proportions in both assemblages. Certain taxa such as *Platanus*, *Alnus*, *Ficus*, *Vitex*, *Clematis*, *Capparis*, *Acer*, *Pinus* and *Cornus* register persistently low presence scores in either group of samples.

Disparities on the other hand are evident in the relative proportions of some of the aforementioned taxa, and the overall representation of *Fraxinus*, *Prunus*, *Rosa* and *Tamarix*. In the late assemblages, both *Quercus* and Salicaceae are present in all samples. By contrast, the presence of *Quercus* is reduced by 30% in the early ones. Similarly, within levels VII-IX *Juniperus*, *Fraxinus*, *Prunus*, *Rosa* and (to a lesser extent) *Tamarix* score very high presence values compared to the early strata.
The differences observed for *Ulmus* and *Celtis* are less easy to evaluate, due to the difficulties inherent in separating between the two genera belonging to the same family (Ulmaceae). It is therefore likely that the decline recorded for *Ulmus* in the early levels reflects an identification bias, resulting from the relatively higher occurrence of mineral inclusions in specimens examined from these samples, rather than a "real" difference in sample composition between the two assemblages.

A clear difference emerges however when considering the presence scores of shrubs such as Chenopodiaceae, Asteraceae, Lamiaceae and Fabaceae, which are much better represented in the late levels. The trend is constant for all four families and shows a difference in the range of 20% for Chenopodiaceae and Asteraceae, with the gap increasing substantially (roughly 50%) for Fabaceae and Asteraceae.

### ii. Fragment counts

Percentage fragment counts (calculated on the basis of the total number of identified specimens from each assemblage, see Table 4.4, Fig. 4.10) replicate to a certain extent the results of ubiquity analysis. Thus, the overall picture as to which taxa predominate in both assemblages remains broadly the same: *Quercus*, *Juniperus*, *Ulmus*, Ulmaceae, *Celtis*, *Pistacia* and Maloideae are much better represented compared to the rest of the taxa. *Amygdalus* values are once more almost equal between the two groups of samples, whilst similar trends to those described above are observed for *Vitex*, *Platanus*, *Clematis*, *Capparis* and *Cornus*.

Nevertheless, the comparison of percentage fragment counts with presence scores does reveal some interesting patterns, distinctive for each assemblage. In levels VII-IX, *Quercus* is clearly the dominant taxon with a difference of approximately 45% from the second most abundant (Salicaceae). Other co-dominant
taxa (Ulmus, Celtis, Ulmaceae, Pistacia, Maloideae) score individually values of less than 5% (Celtis: 5.44%). Even more depressed are the frequencies of Fraxinus, Prunus, Tamarix, Chenopodiaceae, Asteraceae and Lamiaceae (less than 1%, with Asteraceae scoring 1.06%). Only marginally better is the representation of Fabaceae (2.91%). What can be deduced from the evaluation of these low percentages against the respective presence scores is that the abundance values of these taxa are almost evenly distributed across the late midden/dump units.

On the other hand, amongst the pre-level XII deposits Quercus, Salicaceae and Ulmaceae display almost equal abundance values (~25%). Given the problems outlined before with separating between Ulmus and Celtis, it would be fair to infer that, as a whole, Celtis (9.81%) seems to be better represented than Ulmus (4.39%). Otherwise, apart from Pistacia, Maloideae and Asteraceae (~1%), all other taxa have abundances of less than 1%. It would seem therefore that Salicaceae, Quercus and Celtis/Ulmus are the dominant taxa, with Maloideae, Pistacia and Amygdalus being somewhat evenly distributed, whilst the remaining taxa appear more or less randomly across samples.

However, a closer look at the data (Tables 4.3, 4.4, Fig. 4.11) demonstrates how deceptive this first impression actually is. Following the abundance values of Quercus, I decided to split pre-level XII charcoal assemblages in two groups, hence distinguishing between those that gave high oak percentages and those that did not. This distinction appears also to tag along with the subdivisions of the stratigraphic sequence (see Harris matrix of space 181, Figs. 4.12a-d). From unit 4846 (the last unit examined from phase A) to the bottom of the sequence (unit 5328, phase D) oak charcoal fragments have registered very low frequencies (present in 8 samples out of 14 and never exceeding a maximum of 5 fragments per sample, see Table 4.3).
What this grouping demonstrated (Table 4.4, Fig. 4.11) was that phase A units (4824-4844) actually maintain a picture in many ways similar to that observed for the late midden/dump deposits. *Quercus* and Salicaceae are present in all samples, with the first being dominant in terms of abundance, whilst Ulmaceae and *Celtis* follow shortly behind (7/7 presence for Ulmaceae and 6/7 for *Celtis*; their percentages combined are almost equal to the values recorded for Salicaceae). However, this is where similarities end. *Ulmus* is practically non-existent (2/7 presence and a percentage fragment count of just 0.40%) whereas, at the same time, phase A assemblages are less taxonomically diverse compared to later middens.

On the other hand, samples categorised within the phases A (4846)-D group are dominated by Ulmaceae and Salicaceae. The high percentage of fragments identified as *Ulmus* in this group suggests that a significant proportion of Ulmaceae may actually stand for *Ulmus*, in clear contrast to elm's percentages in phase A. Another major difference between the two groups lies in the number of the taxa recovered: 13 from phase A and 20 from phases A (4846)-D. It is certainly significant to note that, besides the dominant ones, out of 20 taxa seen in phases A (4846)-D only *Amygdalus* (9/14), *Quercus* (7/14) and *Juniperus* (6/14) had some presence worth mentioning. The rest were present in very low proportions (1-2/14), hence indicating their very random distribution across samples.

To summarise, it seems that phase A samples have fewer and more evenly distributed taxa, with *Quercus*, Salicaceae, *Celtis* and Ulmaceae predominating. On the other hand, phase A (4846)-D samples are dominated by Salicaceae, Ulmaceae, *Ulmus* and *Celtis*. With the exception of *Pistacia*, Maloideae (co-dominants), *Amygdalus* and to a much lesser degree *Quercus* and *Juniperus*, the overall presence
and abundance values of the taxa recovered from this group show a distinctively random distribution across samples.

iii. Density, Fragmentation/Preservation and Diversity measurements

The values obtained for density (STDW), fragmentation/preservation (Fr/Pr index) and diversity (Shannon-Wiener index) measurements on all midden samples of the South Area are listed in Table 4.5. A graphic representation is also given in Figures 4.13, 4.14.

Of the 47 samples analysed, 16 gave density values well above the mean and the median and another 7 above the median (see Fig. 4.14). In their great majority, these samples belong to the late midden/dump deposits (excavation levels VII-IX), with 3 units also coming from phase A contexts (4824, 4836, 4838). On the other end, there are 6 units with very low charcoal densities. These include all units deriving from phase B (except 5286), plus 5328 (phase D). Higher values although still below the mean and median, were obtained from units 2890, 3366 (levels VII-IX) alongside some phase A (4839, 4844, 4846) and phases C-D (5313, 5315, 5317, 5326) contexts.

Generally, it appears that the late contexts (levels VII-IX) have denser assemblages compared to the early deposits, although some variation is evident, especially amongst middens associated with activity areas in spaces 105 (1073, 1506) and 115 (3366) and the dump layers in abandoned buildings (1642, 2890). Pre-level XII phase A units as a whole also display relatively high charcoal densities. On the opposite end lie the assemblages from phase B (the lime-burning areas), plus units 5299, 5310 (phase C). This negative trend is only partly reversed within the remaining samples from phases C and D.
Similar patterns are revealed when considering the values obtained for the Fr/Pr index (Table 4.5, Fig. 4.13, 4.14). In total, 13 units registered values above the mean and the median. Of these, following the scale from 0-5, only 7 units fall within the 1-5 class of the Fr/Pr index, indicating moderate to high proportions of indeterminate fragments: 4871, 4874, 4875, 4879, 5286 (phase B) and 5299, 5310 (phase C) (see also Fig. 4.13). The rest include 2840 (midden/dump associated with obsidian micro-debitage areas in space 115), 4846 (phase A) and all the remaining units from phases B-D, except 5315 and 5328. The latter recorded values equal and above the median respectively. A few contexts from levels VII-IX (1638, 3314, 3773, 1642) plus all units from phase A (except 4839, 4844) also gave Fr/Pr values above the median.

In terms of diversity (Shannon-Wiener index), there are only 2 units with very low values compared to the rest of the sequence: 5310 and 5299 (phase C) (see Table 4.5, Fig. 4.13, 4.14). These values are also well below the mean and the median for all samples and reflect very low taxonomic diversity. Much higher values (slightly below or equal to the mean and the median) came from the rest of the early units, with 4846-5328 having rather more taxonomically diverse assemblages compared to phase A contexts. The latter display instead a noticeably even distribution of their taxon frequencies across samples.

Values above the mean and the median were obtained on the contrary from over half of the late midden/dump deposits (levels VII-IX). From these, more taxonomically diverse appear to be 1066, 1600, 1627, 1649, 1657, 1803, 2846 and 3740, with the rest of the samples showing a trend towards even distribution. Comparable to those of the early contexts were the values of units 3773, 3375, 3366, 3314 (associated with activity areas in space 115), 2890 (room fill, space 162), 1072
These units gave assemblages overall less diverse in comparison to the rest of the contexts examined from levels VII-IX.

iv. Correlation between Density, Fragmentation/Preservation and Diversity measurements

Density (STDW), fragmentation/preservation (Fr/Pr index) and diversity (Shannon-Wiener index) values were compared using Spearman’s Rank Correlation Coefficient (STDW:Fr/Pr, STDW:S-W, Fr/Pr:S-W). The first run of the tests including all 47 samples, indicated a significant negative correlation between density-Fr/Pr ($r_s=-0.45$, $p \leq 0.001$) and a positive correlation between density and diversity values ($r_s=0.23$, $p = 0.06$). By contrast, there was a weak negative correlation between F/Pr-diversity ($r_s=-0.02$, $p = 0.45$) (see Fig. 4.15).

On closer inspection, it emerged that the apparent strength of the correlation between density-Fr/Pr index could be accounted for by the influence of a specific group of outliers. As such were identified units 4871, 4874, 4875, 4879, 5286 (phase B) and 5299, 5310 (phase C). These contexts gave the highest proportions of indeterminate fragments throughout the sequence whilst at the same time displaying overall low charcoal densities (see Table 4.5, Fig. 4.16, 4.17).

The detailed examination of their contextual attributes revealed that for the most part they were associated with external areas used for the production of lime plaster and, presumably, other outdoors activities also involving the use of fire. There follows that wood charcoal eventually deposited in these areas is more likely to have been subject to reheating, trampling and intermixing with other layers, all leading to further breakdown of charcoal particles (effects of post-depositional disturbances).
Apart from this, the very fact that the bulk of charcoal remains deposited in these middens most probably came from open fire installations (i.e., large shallow pits and/or roughly prepared clay surfaces) suggests another source of influence on charcoal densities. Their low values may also be the result of the burning of wood in strongly oxidizing environments (effects of burning environments and hearth structure). Herein lies an interesting contrast with the much higher charcoal densities recorded from the rest of the midden/dump contexts, which were receiving primarily domestic refuse. Given the lack of openings other than the customary rooftop entrance in the houses of Çatalhöyük, it is reasonable to think that the inadequately ventilated domestic spaces created those reductive environments that prevented wood charcoals from burning completely and thus enhanced substantially their preservation potential in the archaeological record.

Further evidence for the “special” status of these midden deposits has been made available through the study of animal bone. The latter indicated that these areas received mainly debris generated by bone processing activities (an abundance of long bone fragments showing signs of intensive processing for marrow and/or grease extraction) and thus very different from more “typical” domestic consumption refuse encountered in other midden contexts (Frame et al. in Çatalhöyük Archive Report 1999). Some of the bone was burnt and/or highly fragmented/digested, observations that also suggest a prolonged period of exposure and disturbance for the various materials (fuel and bone processing debris) disposed off in these areas. Exceptional in terms of preservation conditions was unit 5310. The animal bone recovered from this unit has indicated that it contained discreet pockets of material, each arriving there characterised by a particular preservation regime (burned, splintered, etc.). Still, the entire assemblage bore an even, light brown colour which is suggestive of
specific post-depositional environments that could have adversely affected the preservation status of wood charcoal remains (e.g., through the squashing of charcoal particles caused by the excessive accretion of minerals; the latter was also very evident under the microscope).

These observations offered the necessary archaeological justification for a re-run of the correlation tests after leaving out the aforementioned units. In other words, it was acknowledged that these contexts hold distinct plant assemblages, generated for the most part by a relatively narrow range of activities (i.e., lime plaster production, bone processing, etc.) that exerted their own impact on depositional and post-depositional conditions. They were thus deemed unrepresentative of long-term, widely observed routines of fuel consumption and discard.

From the re-run of the statistical tests (40 samples; Figs. 4.18, 4.19) there emerged a positive correlation between density and diversity (rs=0.34, p 0.01). In contrast to the earlier results, the negative correlations between density-Fr/Pr and Fr/Pr-diversity (rs=-0.27, p 0.09 and rs=0.07, p 0.33 respectively) were substantially downplayed.

Although these results might seem to substantiate an argument suggesting that the denser assemblages are also the most diverse ones, in real terms such a trend cannot be positively established. At the same time, density and diversity values do not seem to follow closely the fluctuations in the proportions of indeterminate fragments within the charcoal assemblages.

v. Multivariate analysis

Figures 4.20, 4.21, 4.22, 4.23 show the correspondence analysis scatterplots for all midden/dump samples of the South Area. The first principal axis separates the
samples of levels VII-IX/pre-XII phase A from those belonging to the phase A (4846)/phases B-D group. The tight clustering observed on the first principal axis is due to the higher presence of *Quercus, Juniperus, Fraxinus, Tamarix* and Chenopodiaceae amongst the samples of the first group, in sharp contrast to those of the second group, which are dominated by Salicaceae, *Ulmus* and Ulmaceae (see also Fig. 4.23). Very little variation is evident on the second axis, with the exception of a few samples which belong to the late middens and display relatively high frequencies of Maloideae and Fabaceae.

**vi. Discussion**

The picture emerging from the quantitative analysis of the charcoal assemblages shows clear differences in sample composition between units originating in levels VII-IX/pre-level XII (phase A) and those from pre-level XII phases A (4846) to D. This is mainly due to the fact that *Quercus* declines drastically from unit 4846 (the last examined from phase A) to the bottom of the sequence (phase D). A sharp increase through time in both the presence scores and the percentage fragment counts of *Juniperus* is also evident. Overall (apart from *Quercus* in the late deposits) Salicaceae, *Ulmus* and/or *Celtis* seem to dominate the charcoal assemblages.

Further to this, it has been possible to isolate within phases B and C a distinct set of depositional contexts, which appear to have received primarily waste generated by specific processing activities, some of them involving the use of fire (e.g., production of lime plaster). The taphonomic observations drawn from the charcoal assemblages of these deposits also seem to replicate results produced by other lines of evidence (animal bone, excavation records, etc.)
The assemblages originating in levels VII-IX appear to be denser and on average more taxonomically diverse than those derived from the earlier strata (see Table 4.5 and Figs. 4.14, 4.20). For the pre-level XII deposits in particular, it is important to note that although phase A units show on average higher density and diversity values than those from phases B-D, in reality these values reflect the remarkably even distribution of taxon proportions in their assemblages. By contrast, samples from the earlier phases (especially those deriving from the middens associated with the lime burning areas) are overall more taxonomically diverse compared to phase A assemblages.

These differences in sample density and (less conclusively) diversity may be interpreted in two ways: i. they may reflect variations in preservation conditions, between the early and the late midden samples; and ii. they may indicate that more wood and apparently from more varied sources too was used in the occupation phases represented by excavation levels VII-IX, than during the pre-level XII times.

At first glance, an answer favouring the first alternative would seem very plausible. Early deposits as a whole have provided enough evidence to suggest that preservation conditions may have influenced in various ways charcoal density and sample composition, especially in what concerns small-sized taxa (e.g., Fabaceae, Lamiaceae). However, it has not been possible to establish a strong negative correlation between density and Fr/Pr values. In other words, there is no good reason to believe that midden/dump units displaying overall lower charcoal densities have been affected by taphonomic parameters to the extent that they may stand for a biased picture of the intensity of fuel use. One could object here that the relatively raised density values recorded for the early levels (pre-level XII) may be due to the distorting effects of mineral inclusions on total charcoal weights. However, any such
effects do actually work both ways. Although mineral inclusions may have some impact on density values, they can also influence (in many cases more decisively than any other factor) the values obtained for the Fr/Pr index. In reality, most of the indeterminate fragments from these early units were so due to the presence, in varying degrees, of mineral inclusions.

Another point to be emphasized here is that, although differences in preservation conditions do exist between levels VII-IX and pre-level XII phase A deposits as a whole (the latter having a much higher clay content), both the presence scores and the percentage fragment counts of *Quercus* are virtually identical between these two groups. Taken together, these arguments appear to cast doubt upon a hypothesis that would hold preservation conditions as the main determinant for the differences (both inter- and intra-level) observed in sample density and diversity. The complex patterning observed in the charcoal assemblages cannot be adequately explained as the result of the likely influence of preservation conditions alone.

Finally, it should be stressed that there is a very weak correlation between Fr/Pr and diversity values. In other words, it has been possible to establish through quantitative measurements that these refuse deposits represent “generalised” plant assemblages (cf. Popper 1988) containing fuel debris accumulated in the long term, and have been subject to broadly the same range of post-depositional alterations. It was also demonstrated through the same methodology that “specialised” assemblages (e.g., those identified as such from phases B-C) bear the unmistakable signs of distinct taphonomic processes directly related to the types of activities and discarding routines that lead to the creation of these deposits in the first place.

In order to explore further some of the qualitative characteristics of the late midden/dump assemblages, an attempt was made to assess the potential for plotting
the quantities of decayed/deadwood encountered in the charred wood remains (see Chapter 3).

The results of this quantification experiment are shown in Figure 4.24. First, the percentages of fragments preserving signs of fungal decay were plotted for each sample (4mm fraction, major taxa i.e., *Quercus*, riverine and fruit taxa; shrubs were not considered since most of them were retrieved from the 2mm fraction). At a second stage, the proportions of “decayed” and “non-decayed” wood were plotted for each taxonomic group. These results indicate that the majority of charcoal fragments bearing signs of fungal decay belong to *Quercus*. Oak and riverine taxa comprise the bulk of deadwood specimens retrieved from these samples whilst fruit-producing trees and shrub taxa appear in relatively low frequencies.

**vii. Summary**

The main purpose of the analytical approach summarised in the preceding paragraphs was to determine how much of the differences observed in charcoal densities and sample composition between the early and the late refuse deposits can be attributed to taphonomic parameters or, instead, to shifts in fuel collection and consumption patterns. Despite the somewhat unbalanced nature of the dataset (early midden/dump contexts are somewhat under-represented compared to the late ones), when all the available evidence is brought together there seems to be a relatively strong case in favour of the second alternative. In short, it appears that overall “more” wood and from more varied sources was deposited in later excavation levels than during the early ones. An exception to this pattern seem to constitute the lime burning-related deposits of the early levels, which seem to hold a very broad array of woody taxa, despite their adverse taphonomic status.
Some insights were also gained concerning possible variations in fuel consumption, particularly within the later phases where data on the relative abundances of different types of deadwood were available. Thus it appears that most of the deadwood specimens belong to oak and riverine species. The taxonomic information available from the earliest levels seems to suggest that, generally speaking, at that time firewood collection concentrated on a relatively narrow range of species compared to the late levels. The implications of these observations for reconstructing patterns of firewood selection and past vegetation are dealt with in Chapter 5.

4.1.2.2 Non midden/dump deposits
A somewhat different approach was followed in the analysis of charcoal data from context types other than the external refuse deposits described in the previous sections. This was necessary for two reasons. First, in few cases were there samples available from a single context type covering particular buildings and/or excavation levels. Aside from sampling problems, time restrictions were also a major determinant, since initially the design of the analysis was geared more towards midden/dump assemblages. It was only at a later stage, and through my increased interest in exploring various analytical methodologies, that the potential for other types of deposits as well to provide meaningful results started to materialise.

Hence, the central idea around which my approach to the analysis of these datasets gradually unfolded was to explore their potential for evaluating in some objective way the impact of source and context on taxon representation. In this sense, I did not necessarily seek to tease out inter- and intra-level relationships in taxon representation within particular context types (e.g., fire installations). Such an
undertaking would require a very large sample size, covering all excavation levels, in order to be able to account for the enormous variation in preservation conditions normally expected from charcoal assemblages of this sort.

With this purpose in mind, the analysis focused on two main themes: a. A descriptive approach, aiming at identifying trends in taxon representation that could be characteristic of particular context types, and b. Inasmuch as trends like these could be established, to try and interpret them in relation to the broader temporal picture provided by the analysis of the midden/dump contexts, and the available archaeological evidence.

At a practical level, the fact that each context type should be treated on its own meant that certain methodologies espoused for the analysis of midden/dump deposits were no longer applicable (e.g., presence analysis and correlation statistics). This was so mainly due to the small sample size. Instead, other analytical tools such as fragment counts and multivariate statistics were better suited to describe sample composition and uncover any patterning of this kind in the datasets. Density, diversity and fragmentation/preservation measurements were similarly used in a descriptive manner, in order to see whether any broad trends would emerge which could be identified with particular context types.

I. Presence of taxa

The full lists of identifications from all non-midden/dump contexts are given in Tables 4.6a-c. In total, twenty-three different taxa were identified in their samples. Compared to midden/dump units, certain taxa were absent. These include Pinus, Alnus, Platanus and Ficus. One fragment closely resembling Vitis (a taxon not encountered in external refuse deposits) was also recovered from unit 4821 (s.3).
ii. Fragment counts

The first step was to plot in summary form the raw fragment counts obtained from each context type (the details for each sampled unit are listed in Table 4.7; see also Table 4.1). For the sake of clarity, individual contexts were grouped according to the type of depositional processes identified during excavation (this is what “Context categories” stand for). Thus, building infill layers have been separated from the secondary fills of features, but no similar distinction was drawn amongst the latter (e.g., “oven” as opposed to pit fills). Some categorisation was also necessary for describing general trends in taxon abundance. For this purpose individual taxa were grouped according to either their assumed primary uses (e.g., fruit trees based on the archaeobotanical evidence) or, as is the case with riverine taxa, by habitat preference. The rest (with the exception of Fabaceae, Lamiaceae, Capparis, Chenopodiaceae and Asteraceae, which were classified under the label of “shrubs”) were quantified individually.

The results of this procedure are shown in Figures 4.25, 4.26. Some interesting differentiations between context types are evident. Open fires (Context category 7, space 115; see Fig. 4.25) are clearly dominated by Quercus. A similar pattern, albeit somewhat downplayed by the increased frequency of riverine taxa (mainly Salicaceae), Ulmaceae and Celtis, is obvious amongst the samples deriving from the accumulation/penning layers of spaces 198, 199 (level XII; Context category 5). These are also for the most part directly comparable to the assemblages retrieved from the infill deposits (Context category 6) of spaces 170, 182 (building 17) and 171, 172 (building 18). Higher frequencies of fruit taxa were recorded for
units 4921 (the upper room fill layers in space 182) and 4664 (infill placed inside a plastered bin in building 18).

Contrasting patterns offer the external burning deposits (Context category 9) and the rakeout layers (Context category 8) (see Fig. 4.26). The latter, although still maintaining significant quantities of *Quercus* (except 5059 and 5021), display much higher frequencies for taxa previously recorded in relatively low numbers, such as *Juniperus* (1888, 2022), fruit trees (Maloideae: 1888, 2022, 5034, *Celtis*: 2022, 4780, 4783, *Pistacia*: 2022, 4780) and shrubs (1888, 2022). These units derive from excavation levels VII (1888, 2022), IX (5021, 5034, 5059) and X (4780, 4783).

On the other hand, with the exception of 4826 (the burning episode sealing the midden sequence of pre-level XII phase A), the burning events of phase A (4845, 4848) and phase B (4872, 4881: lime burning; 4873, 4883: burnt layers; 5279, 5291: clay surfaces) have given minimal quantities of *Quercus* (Context category 9). Of these, the burnt layers of phase B revealed assemblages which included all major fruit trees (*Celtis, Pistacia, Amygdalus* and Maloideae).

The feature fills (C.c. 10, 11) lie somewhere in between the context categories discussed so far. Units 2704, 2714 (fire installation 96, space 112), 4614 (burial fill, space 163), 4913 (pit fill, space 173) and 4711 (pit fill, space 171) are similar to the infill layers, penning areas and open fires in that they are dominated by *Quercus*. Unit 1889 stands out, due to the clear predominance of fruit (mainly Maloideae, followed by *Celtis* and *Pistacia*) and shrub taxa. With the exception of 4842 (pit fill in space 181/phase A) which contained a balanced mixture of *Quercus/riverine and fruit/shrub taxa* (*Salicaceae, Ulmus, Vitex, Celtis, Pistacia*, Maloideae, Chenopodiaceae, Fabaceae), the remaining units from pre-level XII gave almost no oak charcoal at all (4883, 4884, 5292: phase B). The retrieval of 4
fragments of *Cornus* from the fill (5292) of a shallow scoop associated with burning activities was interesting. *Cornus* is very rare throughout the sequence (midden deposits included) and this is its highest recorded frequency within the same sample.

Having identified these trends, the next step was to summarise all the available information in a single unit of measurement for every context type. To this end, the percentage fragment counts of all taxa were calculated for each context category. The groups of riverine taxa and shrubs were kept in place, since they are either dominated by a particular taxon (riverine-Salicaceae) or comprise different taxa which, taken individually, register very low abundance values (shrubs-Fabaceae, Lamiaceae, Asteraceae, Chenopodiaceae, *Capparis, Rosa, Caprifoliaceae*). Table 4.8 and Figure 4.27 present the outcome of this process.

As becomes evident from the inspection of the charts, the highest frequencies for *Quercus* occur by far within the open fires (space 115), the infill layers of buildings 17, 18 and the accumulation/penning deposits (spaces 198, 199). General building infills and penning layers also gave relatively high percentages for Salicaceae and low, albeit constant, values for fruit and shrub taxa. On the other hand, the open fires/burning layers belonging to earlier strata gave almost no oak fragments at all (with the exception of 4826). By contrast, rakeouts and floor deposits associated with the use of domestic fire installations had quite high frequencies of both *Quercus* and *Juniperus*. Fruit and shrub taxa are much better represented within the activity areas (domestic floors and external burning events) although *Celtis* is more dominant amongst the latter, with floor deposits containing assemblages that are more diverse. Feature fills closely resemble building infills in what concerns the frequency values of *Quercus*, even though they generally display higher abundances of fruit and shrub taxa. This apparently reflects the mixed nature of the deposits in
question (an assortment of “oven” fills and other feature layers more akin to building infills).

iii. Density, Diversity and Fragmentation/Preservation measurements

Table 4.9 and Figures 4.28, 4.29 present all the information available on the density, fragmentation status and diversity of the charcoal assemblages.

Building infills and accumulation/penning deposits show the most consistent pattern with low density and Fr/Pr values, which are almost evenly distributed around the median (see Fig. 4.30). Much higher charcoal densities are observed for the open fires of space 115 (4 out of 5 sampled contexts gave values well above the mean and the median) whereas rakeouts and external burning episodes show markedly fluctuating values, which is typical of short-term events (compare the very high densities obtained from 5059, 4826 with the rest of the sampled contexts). High charcoal densities (above the mean and the median) were also obtained from the feature fills associated with fire installations (1889, 2704, 2714).

As a rule, both rakeouts and external burnt deposits (especially the latter) display very high Fr/Pr values. Of the 7 units that have registered values in the range of 1-5 of the Fr/Pr index (moderate to high; see Fig. 4.29), 4 are identified with burning surfaces (including the lime burning areas) and pits containing fire debris (4872, 4881, 5279, 5292, 4883), whereas 2 correspond to burnt layers (4845, 4873). Note the contrast with the open fires of space 115 (unit 3600, for example, gave just one indeterminate fragment).

Although diversity measurements, due to the small sample size, should be viewed with some caution, they nonetheless indicate some interesting general trends, which are in line with the results produced by the analysis of fragment counts. Thus,
in contrast to some accumulation/penning layers (4710, 4715, 4822), the open fire deposits from space 115, two burnt layers (4845, 4826) and some fill layers (4711, 4708, 5220) that have registered values well below the mean and the median, the remaining units gave relatively high diversity values. By far the highest diversity show some general burning (4842) and upper infill (4644, 4654, 4921) layers, alongside the *in situ* clay ball dump in space 117 (1889) and 2 rakeout units (1888, 2022). High values were also registered for deposits associated with the lime burning areas (4872, 4873, 4881, 4883).

iv. Multivariate analysis

Figures 4.31, 4.32a-b show the correspondence analysis scatterplots for all non-midden/dump deposits of the South Area. The first principal axis separates between the assemblages dominated by *Quercus* (mainly open fires, building infills and accumulation/penning deposits followed by most of the rakeout units-all belonging to post-8,000 BP layers) and those displaying higher frequencies of riverine, shrub and fruit taxa (all the burning events from pre-level XII strata and a stabling layer [4850] particularly rich in riverine taxa). The second principal axis differentiates the samples deriving from open fires, accumulation/penning and infill deposits from the rakeout units, which were richer in *Juniperus*, shrubs and fruit taxa (aside from 5059 and 5021 that held high proportions of Ulmaceae). The high diversity of the upper infills (4921, 4664) compared to the rest of the infill layers in buildings 17 and 18 is also evident. Finally, as was expected, the feature fills (1889, 4842, 4913, 4614, 4884, 5292) do not demonstrate noticeable patterning.
v. Discussion and summary

Some interesting temporal patterns emerge from the comparison of non-midden contexts with the external refuse deposits discussed in the previous section (compare Figs. 4.20, 4.31). Hence, what the open fires in space 115, the accumulation/penning layers (spaces 198, 199) and the basal infills of buildings 17, 18 have in common with many midden/dump units deriving from the same stratigraphic layers (i.e., post-8,000 BP assemblages) is the clear predominance of *Quercus* in their charcoal samples. It is worth-noting here that certain late non-midden units (such as rakeouts, upper room fills containing a substantial component of domestic refuse and "oven" infills) although still dominated by oak, display overall higher frequencies of fruit and shrub taxa. By contrast, the external burning events, the majority of which derives from pre-XII strata, demonstrate very low frequencies of oak.

Very few of all the aforementioned units gave enough charcoal from the 4mm fraction (i.e., at least 100 fragments) for plotting with some degree of reliability the quantities and proportions of decayed wood. One such unit was 3600 (open fires, space 115), very rich in oak charcoal. Of the latter, 50 out of 86 fragments retrieved from the 4mm fraction bore very clear signs of fungal decay. This trend was also evident amongst the rest of the samples belonging to the same context category (3601: 3/5, 3365: 12/16, 3611: 9/11). The material from building infills and accumulation/penning layers was also not systematically quantified for the same reasons (lack of sufficient fragment numbers from the 4mm fraction in most cases). However, *Quercus* and Salicaceae fragments bearing signs of fungal decay were regularly found in their charcoal assemblages. Decayed oak wood was not as ubiquitous amongst samples recovered from other context types (e.g., rakeouts and
burning episodes, including 4826 that gave the highest oak frequencies from all burning layers).

Units that represent major external burning events and activities such as lime burning (pre-XII strata) are also clearly differentiated from the rest of the examined material in what concerns their overall high taxonomic diversity. No comparable domestic contexts (e.g., infill layers) were available from the pre-level XII strata in order to evaluate patterns of taxon representation (particularly in relation to fruit and shrub taxa). Still, a comparison of these lime-burning layers to the midden/dump contexts associated with them is instructive. Both sets of deposits display similarities in what concerns their taphonomic characteristics (e.g., density and Fr/Pr indices) and sample composition (a mixture of Salicaceae, Celtis, Pistacia, Amygdalus and various shrubs such as Lamiaceae and Asteraceae). It is evident therefore that "specialised" burning activities were consuming a very broad mixture of fuels including a wide variety of fruit/shrub and riverine taxa.

4.2 Çatalhöyük - North Area: Building 1

Building 1 and its predecessor, building 5, were the sole architectural structures excavated in the North Area over four consecutive field seasons (1995-1998; cf. Çatalhöyük Archive Report: Matthews 1995, 1996, Lucas 1997, Cessford 1998, 2000). The aim of this lengthy process was to unravel, in the maximum possible detail, the life histories of habitation spaces in Çatalhöyük. The excavation of building 1 demonstrated that the construction process followed at large a well-structured pattern. A series of infill layers were laid over the demolished walls of the pre-existing building (phase B1.1A). Then the walls were raised while the last phases
of the infilling were moulded to give shape to platforms, steps and ledges. At this stage, burials were carefully placed within the upper infill (phase B1.1B).

The sequence of construction works continued with finalising the internal arrangements: plastering of the walls, possibly with raw materials processed on the spot, building of the oven and the plastered posts, and placement of the ladder below the rooftop entrance (phase B1.2A-spaces 71, 186, 187; see Fig. 4.33). Throughout the main occupation phases (B1.2B-B1.2C) ovens, hearths, bins, pits, grinding installations, painted surfaces and reliefs were frequently remodelled and/or repositioned. The platforms located inside space 71 were also recurrently modified to receive burials.

During the next phase (B1.3-spaces 186, 187, 183, 188, 111, 110; Fig. 4.34) the layout of building 1 became subject to major alterations. Space 71 was subdivided into a northern (183) and a southern part (188) through the construction of wall 18. Afterwards, the southern section of the building was burned in a controlled way (there is no real evidence of a catastrophic conflagration) and then gradually infilled. The centre of activities shifted to the northern half of the building that saw through successive modifications and alterations of its general layout. Most conspicuous were the establishment of a new entrance (F.368) and the creation of additional spaces (111, 110). Several features existing from the previous phase (bins 215, 214 and oven 360) had been burnt and/or infilled separately from the rest of the disused area. The occupation of the northern half continued into the next phase ("secondary occupation" phase B1.4; see Fig. 4.34).

The final abandonment of building 1 was marked by the removal of wall plasters and the general infilling of its northern half as well. Following this, only oven F.11 remained in use, in association with scoop F.362 (B1.5; see Fig. 4.35). A
large pit (F.17) was dug through the infill to remove part of the surviving wall decoration. Later on, the oven was demolished, whilst a ditch (F.363) and few other cuts were the sole traces of construction activity below the modern surface.

A series of deposits external to building 1 have been excavated as well, which appear to be contemporary with its early phases (Fig. 4.36). One of the fire installations (F.39 B1.2A) had truncated much of this external material and there was also evidence for in situ scorching effects caused by both the fire installation and the burning episode of phase B1.3.

4.2.1 Description of sampled contexts

Eight units were examined from the main occupation phases B1.2B-C (Fig. 4.33; for a full listing of all the examined contexts see Table 4.10). Unit 1440 (space 71) represents part of a dark ashy layer that formed the packing below the plaster floors. Units 1437 and 1291 (space 187, phases B1.2B and C) are rakeout floor deposits associated with the use of hearth F.33 and “oven” F.360 respectively. A burial fill (1372-burial F.30) from the northern part of space 71, two layers of burnt material (1332, 1344) from the so-called “lentil bin” (bin 215, thus named after the discovery on its floor of a clean layer of charred lentils) and two floor surface layers (1367, 1423) were also examined from space 71.

The “burning” phase (B1.3, Fig. 4.34) is represented with a series of burnt fill deposits, four from space 188 (1222, 1223, 1318, 1319) and one from space 71 (1349). During this phase, separate burning events and infilling activities took place on many features, including bin 215. From the “secondary occupation” (B1.4, Fig. 4.34) there is one rakeout unit (1391), a posthole/stakehole (1390) and a hearth fill (1386-hearth F.14, space 183), plus a burial fill (1368) and a floor deposit (1358).
from space 110. Units 1264 and 1283 (space 183) are deposits belonging to the abandonment phase (B1.5, Fig. 4.35) and contain the very first layers of infill, directly above the floor surfaces.

From the external deposits of building 1, there were examined six units: 1310, 1315, 1347 (space 73) and 1351, 1396 (space 69) (Fig. 4.36).

4.2.2 Quantified results

The approach followed with the analysis of the charcoal data from building 1 is similar to that adopted for the study of the non-midden/dump contexts from the South Area. However, due to the small sample size, it did not become possible to classify charcoal assemblages according to context type. Instead, the categorisation by occupation phase as identified by the excavators was maintained. The aim was to investigate potential sources of patterning in the archaeobotanical record introduced by shifts in the general use of space throughout the life history of building 1. In addition, the external deposits served the purpose of tracing possible differences in the types of waste disposed in these areas compared to the midden/dump contexts of the South Area.

4.2.2.1 Presence of taxa

In total, twenty different taxa were recovered from the 26 charcoal samples of building 1 (see Tables 4.11a-b). These include all the major taxa encountered in the South Area (i.e., Quercus, Juniperus, Salicaceae, Ulmus, Celtis, Ulmaceae, Pistacia, Maloideae and Amygdalus) and broadly the same types of shrubs (Rosa, Capparis, Fabaceae, Lamiaceae, Asteraceae, Chenopodiaceae). In contrast, certain taxa associated with riverine habitats were absent (Alnus, Clematis, Vitis). Others, such as
Platanus, Fraxinus, Tamarix and Vitex, were present in very few samples (one each). Low presence was also observed for Chenopodiaceae, Ficus and Caprifoliaceae.

4.2.2.2 Fragment counts

Table 4.12 and Figures 4.37, 4.38a-b present in a summary form the absolute and percentage fragment counts for phases B1.2, B1.3, B1.4 and B1.5-A, plus the external deposits (B1.E). Quercus, Salicaceae and Juniperus are by far the commonest taxa. The highest percentages for Quercus are recorded amongst the destruction fills (phase B1.3) and the external deposits (B1.E). The latter together with phase B1.2 contexts (main occupation) have also given the most diverse assemblages. At the same time, Juniperus displays high frequencies within the main occupation phase (B1.2) being practically non-existent in the external areas.

Salicaceae (comprising the bulk of the riverine taxa) as well as fruit and shrub taxa show quite a random pattern in the distribution of their frequency values, which could be attributed to the uneven representation of individual context types. On closer inspection, it becomes evident that certain contexts contain very diverse assemblages. These are 1437 (rakeout-B1.2), 1372 (burial fill-B1.2) and 1310, 1347 (B1.E). In contrast, the least diverse samples seem to belong to the destruction horizon (B1.3). Occasionally, some rare taxa are also encountered amongst the “secondary occupation” contexts (e.g., Platanus in hearth 1386-B1.4).

4.2.2.3 Density, Fragmentation/Preservation and Diversity measurements

Table 4.13 and Figures 4.39, 4.40 list the details for all three measurements on the samples from building 1. Overall, charcoal densities are very low irrespective of the phase to which each sample belongs. A closer examination of the context details
reveals that some of the highest density values were obtained from assemblages likely to represent "primary" deposition episodes. These are 1291 (rakeout-B1.2), 1222, 1223 (the basal burnt fill layers-B1.3), 1349 (burnt fill-B1.3), 1391 (rakeout-B1.4) and 1386 (hearth-B1.4). High values have also been recorded for "specialised" contexts such as 1390 (posthole-B1.4) and 1332, 1344 ("lentil bin"-B1.2), plus one external layer (1310) and an infill deposit (1283).

The distribution of Fr/Pr values appears to follow similar patterns. Thus, comparatively low indices register the rakeouts (1291), the "lentil bin" deposits (1344), the burnt fill layers (1223, 1349; note the zero Fr/Pr value for 1318) and the external deposits (1351, 1396). By contrast, floor surfaces (1423-B1.2) have given, predictably, high Fr/Pr values. Some variation is however evident in that certain external areas (1315) and burnt fill layers (1222, 1319) display higher values compared to their counterparts in the same areas. High proportions of indeterminate fragments were also recorded for the posthole fill (1390).

Overall, the charcoal assemblages of building 1 have given very low diversity values (all but nine contexts registered indices of less than 0.50). The lowest are those of 1358 (floor-B1.4) and the burnt fills from the destruction level (B1.3). By contrast, rakeouts (1437) and infill layers (1244) have given relatively high diversity values. The high taxonomic diversity observed for the posthole assemblage (1390) might indicate its secondary origin (e.g., as re-deposited fill) given also its high proportion of indeterminate fragments.

4.2.2.4 Multivariate analysis

Figures 4.41, 4.42 show the correspondence analysis scatterplots of all charcoal assemblages from building 1. The first principal axis separates between samples
displaying higher frequencies of *Quercus, Juniperus, Pistacia* and shrub taxa
(Asteraceae, Lamiaceae, Fabaceae, *Rosa*) and those dominated by riverine taxa
(Salicaceae). The second principal axis pinpoints the clear differentiation of the
“lentil bin” (1344, dominated by *Celtis, Ulmus-Ulmaceae*) from the rest of the
charcoal assemblages.

What these scatterplots show is that there is a clear overlap in terms of
sample composition between contexts belonging to the occupation phases (B1.2,
B1.4) and the external deposits (B1.E). All three phases hold for the most part quite
diverse assemblages. The burnt fill layers on the other hand are less diverse, being
dominated by *Quercus* and Salicaceae. Exceptional concerning its sample
composition appears to be unit 1344 (“lentil bin”).

### 4.2.2.5 Discussion and summary

Overall, building 1 charcoal assemblages display very complex taphonomic patterns.
This may be a reflection, at least in part, of the small sample size. Variation is also
evident in what concerns sample composition and, more distinctively perhaps, the
density and Fr/Pr values of deposits belonging to the same context type (e.g.,
external layers, infills and burnt fills). The same is true for samples derived from the
occupation phases, although much of the variation in this case can be accounted for
by the expected differences in preservation conditions between floor surfaces (kept
overall very clean) and rakeout layers.

In terms of sample composition, there seems to be a clear differentiation
between assemblages deposited during the occupation phases and those belonging to
the phase of controlled burning (B1.3). Apparently, the latter preserved charcoal
deriving from the burning of timber structures in higher proportions (e.g., oak). The
more diverse nature of the external layers can be partly attributed to their association with the fire installation (F.39) which truncated their deposits, whilst they probably received material from the burning episode as well (this would explain the high frequencies of *Quercus* in their assemblages).

The “lentil bin” (215) assemblages are more unusual, especially 1344. Although in terms of sample composition unit 1332 resembles the infill layers, the same cannot be said for 1344 that contains almost exclusively *Quercus, Celtis* and *Ulmus*. When describing the excavated contexts from bin 215, the field team has reported that the fill layer (1332) layed on the eastern side of 1344 (see plans in Fig. 4.43). The latter consisted of a thick deposit of charred lentils (reaching a depth of 2cm) covered by a white/yellowish crust and patches of ash, all of which seem to suggest an *in situ* burning episode.

The charcoal material of 1344 contained some very well preserved fragments of oak, elm and hackberry. Oak specimens in particular were very sizeable, in some cases retaining up to 24 annual rings, whereas elm and hackberry fragments comprised mainly small round wood (3-5 annual rings, strongly curved; some larger fragments of elm were also found, a few of which preserved up to 7 annual rings and probably originated from timber-sized logs). Almost all pieces bore very clear signs of decay (mycelium and boreholes) thus indicating their burning as deadwood (see Fig. 4.44). The size and preservation status of the charcoal remains suggest an *in situ* burning episode rather than the secondary deposition of debris inside bin 215.

The overall characteristics of the charcoal assemblage paint a picture of a very controlled burning episode. It seems unlikely that the charcoal deposited inside bin 215 represents the remains of structural timber collapsing from above during the general burning of building 1 (phase B1.3). The excavation records indicate that bin
215 was burnt and infilled separately, prior to the general infilling of the southern half of building 1. The fact that this burning event was contained inside F215 certainly enhanced the preservation of sizeable fragments of charcoal, due to the protection afforded by the bin’s plaster walls. The peculiarities of its contextual associations (in situ burnt lentil layer, grinding installation set in front of the bin, its potential relation to the major burning episode that marked a transition in the life history of building 1) and possible interpretations are discussed in detail in the next chapter.

4.3 Pinarbaşı

The 38 archaeobotanical samples examined from Pinarbaşı correspond to 23 excavated loci. Of these, only 2 belong to the early Neolithic occupation uncovered in Site A (the open-air settlement on the peninsula). The rest derive from Site B (the rock-shelter) and comprise primarily late Neolithic and Chalcolithic deposits.

4.3.1 Description of sampled contexts

The early Neolithic assemblages examined from Site A include two loci (ABJ, ABU) which have been radiocarbon dated at 9050±80 and 9140±80 BP respectively. ABU was the earliest stratum uncovered and consisted of dark, humic loamy layers associated with the remains of three possible structures and a pit-cut (see Fig. 4.45; Watkins 1996: 53-54 & Fig. 4.6). ABJ was a thin stratum of fine, brown soil into which a small grave had been cut containing an infant inhumation. In between these strata lied ABR (not shown in the plan of Fig. 4.45), a thin lens of reddish-brown soil (9290±80 BP). All three loci were sealed by a sterile layer of dark brown sands,
which preceded the Chalcolithic, Roman and Byzantine deposits excavated in the
same area.

Although all these early layers gave substantial quantities of very well
preserved animal bone, the situation with charred plant remains was quite the
opposite. ABR did not produce any charcoal remains at all. From a total of 60 litres
processed from ABU and ABJ, only 0.47g of charcoal were eventually retrieved,
whilst samples from other locations gave even lower quantities of charred material
when sieved. The limestone sediment matrix and the proximity of the site to the
lakeshore may be responsible for the poor preservation of wood charcoal (e.g.,
through abrupt fluctuations in sediment moisture and the excessive accretion of
minerals). Bioturbation from roots and insects was also evident (very abundant
rootlets and modern beetle remains), particularly amongst the upper late prehistoric
strata. Hence, it was decided to limit laboratory analysis to those contexts that had
produced secure radiocarbon dates.

The deposits examined from Site B (the rock-shelter) can be broadly
separated into three different groups:

A substantial late Neolithic assemblage was recovered from the infill of a
curvilinear dry-stone structure (see Fig. 4.46, 4.47). The latter appears to have been
built as a revetment wall around a very large depression cut into pre-existing refuse
deposits, and was infilled with steeply sloping layers of clayey and ashy soil
interdigitating with thicker lenses of wood charcoal and animal bone. The overall
lack of wear and/or weathering signs suggests that infilling had been a rather speedy
process. No traces of floors or trampled surfaces were revealed at the base of this
structure (Watkins 1996: 52-53). The sampled loci from this area include (from top
to bottom) BAT (7145±70 BP), BAW, BAX, BBA (7450±70 BP) and BBH (amounting to a total of 9 samples).

Another series of deposits originated from areas external to the curvilinear wall (BAV, BAY, BBC, BBD, BBE, BBG, BBH, BBI, BBJ; 19 samples). These included ashy grey layers, rich in animal bone and charcoal, interspersed with grey silty ash lenses (see Fig. 4.47, 4.48). However, the lack of clearly demarcated features (hearths, walls, etc.) renders any attempt to attribute these layers to specific occupation phases highly doubtful. Based on the study of the lithic material, the suggestion has been put forward that an early Neolithic component is traceable in Site B (although of a seemingly different date from that of Site A) as well as late Neolithic and post-Neolithic elements (Watkins 1996: 55).

The latest deposits excavated so far in Pinarbaşı comprise two shallow, sub-circular pits with upper fills of medium-sized stones, some of which bore traces of burning (8 samples; Fig. 4.46, 4.47). The easternmost pit cut through the base of an earlier fire installation and was lined with a series of upright stones. Its fill layers (BAD, BAI, BAM) gave one radiocarbon date of 5725±65 BP (BAI). However, the precise dating of BAM remains uncertain, since it produced no artefactual evidence to suggest something definitive. Nearby this feature, on the western side of the trench, a shallow pit was unearthed (BAJ, BAK), which cut through an area rich in charcoal lenses (BBC, BBI, BBE). The excavators have interpreted both these features as cooking installations (hearths and/or fire pits). The latest locus to be sampled was BAC, a layer of stony friable soil sealing these deposits and the first archaeological stratum encountered after the removal of the topsoil. Like BAM, it could date to either the Chalcolithic or the Neolithic.
4.3.2 Quantified results

The full lists of identifications from the Pinarbaşı charcoal samples are given in Tables 4.14a-c. Due to their extreme paucity and their particular taphonomic circumstances, the results from the early Neolithic charcoal assemblages were not subjected to any systematic quantification (i.e., presence analysis and correlation statistics). However, various aspects of these assemblages (especially in terms of their taphonomy) are treated here alongside the discussion of the rest of the wood charcoal material.

4.3.2.1 Presence of taxa

In all, eighteen different taxa were positively identified amongst the Pinarbaşı wood charcoal macro-remains. The commonest are by far *Pistacia* and *Amygdalus* (100% presence in all areas, apart from locus ABU; see Tables 4.14a-c, 4.15 and Figure 4.49). *Celtis* follows in a short distance, with presence scores ranging from 75% (external late Neolithic and Chalcolithic deposits) to 88% (late Neolithic infill of the curvilinear structure).

On the other end, there are several taxa that are present only in particular phases and/or contexts. These are Chenopodiaceae (locus ABU: early Neolithic), *Acer* (BAV: late Neolithic) and Maloideae (BAC, BAJ: Chalcolithic). *Prunus* was also recorded once (ABU) in the early Neolithic deposits and then again in a Chalcolithic context (BAC). Similarly, *Quercus* and *Juniperus* occur only twice across the entire sequence (BAZ, BBG: late Neolithic; BBJ/BAD: late Neolithic-Chalcolithic, respectively).

Much better represented are *Rosa* and *Tamarix*. Interestingly, they both display the same trend in what concerns their progressive reduction towards the
Chalcolithic levels by some 30% to 40% when compared to the Neolithic deposits.
The uncertainties of the stratigraphy notwithstanding, it is certainly suggestive of a
general pattern that the same phenomenon applies to the presence scores of *Fraxinus*
as well.

Overall, apart from the above remarks, very little patterning can be discerned
in the Pınarbaşı wood charcoal assemblages. A wide array of taxa including
*Rhamnus*, Fabaceae, Asteraceae and *Capparis* appear to be very under-represented.
Of these, only Asteraceae occur in all three phases. At the same time, the presence
scores of the rest of the hygrophilous taxa (*Clematis, Phragmites*) are too low to
allow by themselves a positive evaluation of their potential significance.

### 4.3.2.2 Fragment counts

Absolute and percentage fragment counts from all phases are presented in Table 4.16
and Figures 4.50a-b.

As far as the dominant taxa (*Amygdalus, Pistacia, Rosa*) are concerned, all
four assemblages show remarkably stable proportions in their relative frequencies. In
addition to this, together they account for approximately 95% of the taxonomic
variation encountered within each assemblage. For the early Neolithic samples of
Site A in particular, the limitations imposed by the adverse preservation conditions
are evident in the high percentages of *Amygdalus/Rosa* (i.e., those specimens that
were too small and/or too crumbled to be positively ascribed to either taxon) and the
fact that out of 139 examined fragments, only 61 were eventually identified.

*Celtis*, Asteraceae, *Tamarix* and *Fraxinus* all display remarkably low
abundances compared to their respective presence scores. Whilst for *Celtis* (1-3%),
Tamarix and Fraxinus (overall less than 1%) these low frequencies seem to be more or less evenly distributed across samples, the same cannot be said for the rest of the taxa. This is particularly evident for Quercus, Juniperus, Acer, Prunus and Rhamnus. As a whole, with the exception of the dominant taxa, the assemblages deriving from the Chalcolithic fire installations and their associated external layers display a distinctively random distribution of taxon frequencies across samples compared to the earlier contexts.

4.3.2.3 Density, Fragmentation/Preservation and Diversity measurements
The data for density, Fr/Pr and diversity measurements on the Pınarbaşı material are presented in Table 4.17 and Figures 4.51, 4.52.

1. Density
From the 38 samples examined, 12 gave charcoal densities well above the mean and median for all samples. These include a single locus (BBH s.118.2) from the late Neolithic infill of the curvilinear structure and another (BAI) from the Chalcolithic covered fire-pits. The rest all come from the external lenses of charcoal mixed with animal bone (BAY, BBC, BBD s.106, 107, 108, BBE s.109.1, 112.2, BBG s.113.1, 126.2, BBJ) and identified by the excavators as general activity areas dating to the Neolithic. Similar is the distribution across contexts of samples with values above the median. Again, loci BBH (s.122.2; infill) and BAD (from the same fire installation as BAI) gave high charcoal densities, whereas comparable values were obtained from the external Neolithic layers (BBE s.111.2, BBG s.127.1 and BBI s.120.2). Density values above the median were also recorded for locus BAC (s.5).
On the other end, the early Neolithic contexts (ABJ, ABU) gave, predictably, extremely low densities. Low values were also obtained from locus BAV (comprising of the uppermost external lenses of charred material). Somewhat higher were the densities of the material derived from the other Chalcolithic fire installation (the shallow fire-pit containing BAJ, BAK, BAM).

Overall, it appears that the external activity areas (with the exception of locus BAV which represents deposits closer to the surface) hold the largest concentrations of wood charcoal, in contrast to the majority of the infill layers. Dense charcoal assemblages were also contained in at least one of the Chalcolithic fire installations and within the uppermost excavated layers (BAC).

ii. Fragmentation/Preservation

The sole loci that gave very high values of the Fr/Pr index (well above the mean and the median) were ABJ and ABU. Much lower values, albeit still above the mean and the median, were obtained for BAJ and BAM (s.21) (Chalcolithic fire-pit), BBK (one of the external lenses truncated by the Chalcolithic fire installations), BAV (s.27) and BAC (s.8). Above the median were also the Fr/Pr indices of BAT, BBH (s.116.2, 119.3) from the infill layers, and BBE (s.111.2), BBJ from the external activity areas.

In general, it appears that with the exception of the early Neolithic layers and some of the late prehistoric contexts, the charcoal assemblages from Pınarbaşı are remarkably well preserved, especially when considering the lack of well-defined structural features. It is perhaps significant to note that most of the indeterminate fragments displayed signs of extreme thermal degradation (see Pl. 38), whereas in very few cases (Site A) identification was not achieved due to the presence of mineral inclusions. Overall, 32 samples gave values below the mean whereas 17 of
these had values below the median as well. Most of the remaining samples (with the exception of those discussed above) had values slightly higher or equal to the median. Although a quick inspection of the relevant bar chart in Figure 4.51 would indicate that the assemblages from the curvilinear structure gave marginally higher proportions of indeterminate fragments than those of the external activity areas, in real terms no such trend can be positively established.

iii. Diversity

Only 7 samples produced diversity values well below the mean and the median. On the contrary, about half of the examined samples (19) had values above the mean and the median, whilst the rest gave values either equal or slightly below them. This almost even distribution of diversity values points to an overall lack of differences in taxonomic composition introduced by context-related variation.

Within those few samples showing low index values, the lack of taxonomic diversity seems to be the main reason. BBG (s.127.2), BAM (s.22) and BBE (s.109, 110.3) contained almost exclusively the dominant taxa (*Amygdalus, Pistacia*). Otherwise, low values indicate rather the uneven distribution of taxa within the assemblage (BBE 111.2, BAW, BAX). For those samples showing values above the mean and the median, the occurrence of more taxa seems to be the primary cause. BAV, BBD (s.108), BBG (s.113.1, 126.2), BBI (120), BBC (external activity areas), BBH (118.2, 119.3), BAZ (curvilinear structure) and BBK (covered fire installation) all demonstrate such a pattern.
iv. Correlation between Density, Fragmentation/Preservation and Diversity measurements

The first run included all 38 samples (see Figs. 4.53, 4.54). From the inspection of the frequency distribution bar charts and the corresponding box plot it becomes evident that the values of the early Neolithic assemblages (ABJ, ABU) are clear outliers (see also Table 4.17, Fig. 4.52). The correlation scatterplots also show that these samples are seriously affecting the strength and nature of the relationships, particularly when it comes to comparisons between Density-Fr/Pr and Fr/Pr-Diversity. Since these samples represent a special case in what concerns their taphonomic characteristics, it was decided to exclude them from further analysis.

The second run was performed with all 36 samples from the late Neolithic/Chalcolithic deposits (see Fig. 4.55, 4.56). The comparisons made by Spearman’s Rank Correlation Coefficient demonstrated that there was a significant negative correlation between density and Fr/Pr ($rs=-0.43$, $p=0.0096$), a weak positive correlation between density-diversity ($rs=0.03$, $p=0.8443$) and a weak negative correlation between Fr/Pr-diversity ($rs=-0.07$, $p=0.6957$).

The lack of correlation between density and diversity values suggests that the same range of species was in use throughout the occupation of the site, irrespective of potential taphonomic biases introduced by context-related variation and/or temporal differences in the intensity of fuel use. To this, additional support offers the lack of correlation between Fr/Pr and diversity. In other words, both the best and the least preserved deposits gave rise to almost identical assemblages in terms of diversity. Given the overall normal distribution of diversity values, it can be assumed that this weak negative correlation between Fr/Pr and diversity mainly reflects a stable range of activities associated with firewood collection and use. Not only do
samples contain in almost all cases the same range of taxa, but in approximately equal proportions as well, at least in what concerns the dominant taxa (*Amygdalus, Pistacia, Rosa* and to a lesser extent *Celtis, Tamarix* and *Fraxinus*).

In the context of these observations, it was more difficult to interpret this significant negative correlation between density and Fr/Pr. In order to check whether it could reflect to any extent patterning introduced by context-related variation, a third run of the same tests was performed, this time excluding the Chalcolithic contexts and their associated deposits (BAM, BAK, BAJ, BAI, BAD, BAC). The rationale was that they mainly represent short-term depositional contexts (fire installations) and for that reason very likely to have been affected by specific taphonomic parameters untypical of the assemblage as a whole. The decision to exclude, BAM and BAC (despite the dating uncertainties) was based on two observations. Their assemblages gave overall high Fr/Pr values, which suggest similar sources of influence in what concerns charcoal fragmentation (see Fig. 4.51, Table 4.17). Furthermore, BAM had been heavily disturbed by the overlying Chalcolithic fire installation.

The results of these tests (see Figs. 4.57, 4.58) demonstrate that, whilst almost identical patterns arise for the rest of the correlations, there is on the contrary no significant negative correlation between Density-Fr/Pr ($r_s=-0.35$, $p<0.0685$). In other words, they seem to verify the hypothesis that the Chalcolithic fire installations and their associated layers (BAC, BAM) hold more or less distinct assemblages in what concerns their taphonomic characteristics and specific depositional histories.
4.3.2.4 Multivariate analysis

Figures 4.59, 4.60 show the correspondence analysis scatterplots for the Pınarbaşı charcoal samples. Although all samples were included in the analysis, the early Neolithic assemblages were added as supplementary (i.e., non active) samples. The second principal axis separates the early Neolithic and some of the Chalcolithic samples from the bulk of the late Neolithic assemblages. Very little differentiation is evident amongst the latter on the first principal axis.

4.3.2.5 Discussion and summary

In the light of the preceding discussion and the description of the archaeological attributes of the sampled contexts (infill of curvilinear structure, external activity areas: late Neolithic; fire installations: Chalcolithic), it becomes evident that there are three distinct sets of deposits, each with its own characteristics and subject to different depositional and post-depositional histories.

The infill layers of the stone enclosure have given generally less dense assemblages than the external activity areas, which were in existence before its construction and continued to be frequented afterwards. The remarkable similarities noted between the two areas in what concerns sample diversity and the state of preservation of the charcoal assemblages, should be attributed to the rapid process of infilling, which prevented the severe weathering of charred plant remains. At the same time, the external activity areas saw much denser concentrations of wood charcoal, probably as a result of the intermittent use of the rock-shelter for carcass processing by hunting and/or herding groups paying little, if any, attention to the systematic disposal of fire-related debris.
On the other hand, the Chalcolithic fire installations and their associated deposits gave charcoal assemblages which represent short-term events and, for that reason, much less coherent in terms of their overall preservation and fragmentation status. The relatively high charcoal densities recorded for some of these contexts (e.g., BAI) can be explained as a result of their structure (covered fire-pits), which preserved in a selective manner lenses of fire-related debris.

The fact that, despite such differences, all three groups of contexts gave almost identical charcoal assemblages in terms of sample composition and the relative proportions of individual taxa (especially the dominant ones) suggests that broadly the same range of firewood species was exploited throughout the history of human habitation at the Pinarbaşı rock-shelter. Although much of this discussion on taxon representation and its potential significance in terms of fuel selection and past vegetation will be expanded on in the following chapter, a few points merit special reference here for they concern taphonomy issues. The overall very low abundance values of shrubs (Asteraceae, Chenopodiaceae, Fabaceae) and reeds (Phragmites) may relate to the small size of their stems/stalks and therefore the likelihood that they were consumed entirely in these open hearths. On the other hand, the survival within the Chalcolithic fire installations of taxa such as Rhamnus, Prunus, Maloideae and Quercus, which appear very infrequently throughout the sequence, can be partly attributed to the protection afforded to these deposits by the stone clusters covering the fire-pits.
Chapter Five - Woodland habitats and firewood consumption in the Konya plain during the Neolithic

This chapter discusses the interpretation of the analytical results presented in the previous chapter, in what concerns the reconstruction of woodland habitats and modes of woodland exploitation, with particular emphasis on fuel selection and consumption. Furthermore, vegetation reconstruction is used as a means for exploring the use of landscape resources and modelling their seasonal and temporal transformations. For this purpose, charcoal data are brought together with the off-site palaeoenvironmental evidence, and are also integrated with the ethnographic record, archaeobotanical investigations and data on the presence of animal species during the Neolithic. Finally, some comments are made on the occurrence of rare taxa and the potential symbolic significance of certain depositional contexts.

5.1 Reconstructing woodland vegetation

5.1.1 Theoretical and methodological issues

In order to reconstruct woodland vegetation based on the wood charcoal data, four different lines of evidence were brought together: a. Taxon presence in the archaeological charcoal assemblages, b. Currently available ecological analogues from the Konya plain and other areas, c. Field records of vegetation, and d. The palaeoenvironmental record (pollen analysis and geomorphological evidence).

The rationale for adhering to this four-stage process was based on the conceptualisation of the Neolithic vegetation essentially as a diverse mosaic. Several neoeccological studies have demonstrated that its vertical zonation is determined primarily by rainfall (hence in this region altitude), whilst its horizontal pattern by the distribution of soil types, which regulate the amount of precipitation made
available to plants as soil moisture. Geoarchaeological investigations have also indicated that both settlements occupied by and large ecotonal environments, lying at the intersection of riverine, marsh/lakeside, open woodland and arid steppe habitats (see Chapter 1).

It was therefore originally predicted that wood from all these different catchments could be represented in the archaeobotanical assemblages. Hence, abundance data (i.e., percentage fragment counts) were deemed a priori unsuitable for the task of delineating and reconstructing (both temporally and spatially) such diverse vegetation formations, since wood might have been collected from more than one vegetation type. Furthermore, with the exception of riverine plants, most of the taxa encountered in the charcoal assemblages could have occurred in more than one woodland catchment. In this respect, the combined use of taxon presence data, ecological analogues, field observations and the palaeoenvironmental record seemed to be a much more promising avenue. Instead, abundance data were employed mainly as a tool for reconstructing how intensively each of these vegetation catchments was exploited in the past.

However, appropriate ecological analogues (with some exceptions) were not always available, particularly in what concerns the more dynamic aspects of woodland ecology (e.g., data on the response of plants to biotic disturbance, seasonal transformations, competition between trees, shrubs and grassland, creation and maintenance of habitats preferred by different animal species, etc.), which are of critical importance in any attempt to reconstruct long and short-term interactions between human settlement and plant life. On the contrary, neoecological work undertaken in this region has been overtly dominated by the phytosociological approach (e.g., Zohary 1973, Akman and Ketenoğlu 1986, Atalay 1986, Quézel
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1986, Quézel et al. 1978). This paradigm identifies floristic associations (usually codified with long Latin names) as typified plant communities, which are tied to a specific soil type and rainfall regime. Under normal conditions (i.e., save human interference) they crystallise into "climax" formations, subject only to the vagaries of long-term environmental change.

The critique of the phytosociology model as applied to the interpretation of archaeobotanical assemblages by Küster (1991) and Hillman (1991) has laid bare some of its fundamental weaknesses in relation to vegetation reconstruction. Aside from its inappropriateness when considering parameters such as the taphonomy of charred plant remains (e.g., differential seed and pollen production) and identification biases (i.e., the habitual problems of identifying fossil specimens to species level), they also pointed out that strictly defined habitat affiliations tend to disregard potential discrepancies in the ecological preferences and tolerances of individual species now and in the past. Hillman (1991) has expanded further his criticism of the phytosociological approach, by stressing its inadequacy to account for differences in modes of resource exploitation and their long-term impact on the structure and composition of vegetation associations.

This last point brings out another aspect of the phytosociology paradigm, which may serve to explain its continuing attraction for archaeobotanists working in the Near East. Current approaches to vegetation reconstruction in this part of the world differ substantially from their counterparts in more temperate regions. Hence, amongst researchers working in Europe there is a long-standing tradition in studying woodland management and its implications for the creation and maintenance of cultural landscapes (e.g., Rackham 1976, Behre 1988, Rasmussen 1989, Kreuz 1992, Simmons and Innes 1996, Halstead et al. 1998). By contrast, for palaeoecologists and
archaeobotanists interested in southwest Asia, the principal objective for reconstructing early Holocene environments has been the investigation of past climate change as reflected in the pollen and plant macrofossil record (e.g., Bottema 1995, van Zeist and Bottema 1991, Miller 1998, Willcox 1992), and its role for the transition to the food production stage. Seen under this perspective, it becomes easier to understand the adherence of researchers to analytical concepts espoused by phytosociology with its emphasis on "climax" vegetation formations, typical of particular geographical regions and climatic regimes, and responsive only to climate change and/or sustained human "degradation".

One of my principal research aims has been to reconstruct ancient woodland vegetation and its utilisation by human communities residing in the Konya plain during the Neolithic, by integrating the charcoal evidence with data produced by the ongoing archaeological and palaeoecological investigations. An essential step in this direction is the reconstruction of past vegetation in terms of its structure, diversity and seasonal habit and its potential responses to natural and/or anthropogenic disturbance. In order, therefore, to redress the balance between aims and means and work out the theoretical concepts necessary for this purpose, I turned to the ecological literature available for the arid savannas of Africa and the wood pastures of south and southeast Europe (cf. Wiens 1985, Scholes and Archer 1997, Rackham 1998, Dean et al. 1999). The rationale was that such areas, which are characterised by strongly seasonal rainfall regimes and sharp boundaries in the distribution of soil types, are better suited to offer broad models of ecological processes that could then be applied to the area of study, after allowing for differences in floristic composition, plant physiology, soil types and general climate patterns.
Finally, the use of pollen and palaeoenvironmental evidence enabled the reconstruction of the broad configuration of past vegetation, palaeoclimate and, more importantly, landforms and pedological conditions that have been obliterated long ago in this area, due to environmental change and, perhaps more critically, recent human intervention. The latter is manifested in the continuously expanding irrigation works, the appropriation of land for the cultivation of cash crops (e.g., wheat) and the practicing of large-scale animal husbandry. A prime example constitute wetland environments, which are rapidly diminishing everywhere in the Konya plain as a result of the channelling of watercourses for irrigation purposes and the overgrazing and burning of reed vegetation in the few remaining marshlands (e.g., at Pınarbaşı where reed marshes have all but disappeared within the last five years). Likewise, formerly major lakes, such as Hotamış gölü to the west of Pınarbaşı, have been reduced lately to stretches of very shallow, saline reed marshes. Gone with them are also traditional activities, such as boat making and fishing, previously reported amongst the neighbouring villages. Such research on the palaeoenvironments and the vegetation formations of the Konya plain, apart from its obvious archaeological and palaeoecological interest, could also foster local and national awareness on issues of landscape conservation and, through environmental reconstruction, indicate potential avenues for future action.

5.1.2 Riverine and lakeside habitats

Recent on-site geomorphological and palaeoenvironmental investigations have indicated that both the major Neolithic settlements of Çatalhöyük East and Can Hasan III were founded on alluvial fans that had started to accumulate at the onset of the Holocene (Roberts 1991, Roberts et al. 1996; see also Fig. 1.1). Detailed studies
of the sedimentary sequences on and around the Neolithic mound of Catalhöyük point towards the existence of various local microenvironments, ranging from active and abandoned river channels to seasonally submerged stretches of marshland and backswamps.

Vegetation surveys of comparable wetland environments throughout the Near East (cf. Zohary 1962, 1973, Hillman 2000) have indicated that they may serve as a host for distinct hygrophilous plant communities (see also entries in Table 5.1). The structure and floristic composition of the latter are primarily controlled by the different flooding regimes characterising the various parts of the alluvial plain. The most conspicuous effect of the river action would be the creation of various landforms, such as levées, ridges, islands, oxbow lakes, ponds and backswamps, thus determining at large the pattern of tree communities. Generally, willows and poplars (Salicaceae), ash (Fraxinus) and tamarisk (Tamarix) together with woody climbers such as Clematis tend to form riparian gallery forests on alluvial flats, whilst plane trees (Platanus) and elms (Ulmus) can occur on better-drained localities towards the edges of the alluvial plain.

On more sandy and gravely exposures, such as levées and ephemeral streams, chast trees (Vitex) and capers (Capparis) may abound. Tamarisks and poplars in particular demonstrate an ability to withstand saline conditions (Le Houérou 1985). Tamarisks can occupy a variety of habitats such as sandy shores, abandoned channels and brackish ponds due to their deeply penetrating and laterally extensive rootstock, which allows them to take full advantage of the available moisture. On the other hand, shallow-rooted halophytes, as for example certain species of Chenopodiaceae and Asteraceae, can thrive on periodically exposed riverbeds and saline depressions (Zohary and Orshansky 1949). Minor lakes that form seasonally inside shallow
depressions may also favour plants that can tolerate a certain degree of salinity such as tamarisks, chenopods, wormwoods, capers and chaste trees. Similar hydrological conditions have been suggested for the marshlands bordering the Pinarbaşı rock-shelters (Reed et al. 1999, Roberts et al. 1999).

The periodically submerged backswamps and other inundated surfaces would have presented an altogether different picture. Being not high enough above water level to avoid prolonged flooding, the alluvial flats would be dominated by vegetation characteristic of a raised water table. Here, high concentrations of organic matter accompanied by slow decomposition rates due to waterlogging tend to favour the growth of extensive stands of monocotyledonous grasses, reeds and rushes such as *Phragmites, Scirpus, Cyperus, Typha,* etc. Anaerobic conditions are also advantageous to those few trees like alder (*Alnus*) that are able to fix nitrogen directly through their root system (Brown 1997: 112).

As mentioned before, floodplain environments are subject to periodic disturbance brought about mainly by the different river regimes alternating on a seasonal basis. A typical scenario in this part of the world would involve a relatively high frequency of flooding episodes during autumn and winter, coupled with a strong decrease in temperature and a concomitant rise in snow cover and frost. From early to mid-spring, snow meltwater together with sudden rainstorms could also result in extensive overbank flooding. Floods would have a direct effect on the vegetation structure and the regeneration process within riparian woodlands by depositing silt and nutrients, scouring floodplains and channel margins and washing out seeds and saplings (Peterken 1996: 109).

With the advent of the dry season (from late spring until early autumn), the lowering of the water table would follow the creation of new patches of riparian
woodland, through the re-seeding of the freshly exposed, nutrient-rich, alluvial flats. Increased animal activity around the progressively diminishing water bodies might also have multiple effects on the existing vegetation cover, through trampling, burrowing, deposition of excrement and browsing.

Likewise, woodcutting plays an important role in riverine woodland regeneration, since for most of the associated species biomass production increases as a result of coppicing and/or pollarding (cf. Rackham 1976: 20-22 & Table 1). In the long term, repeated gathering of firewood from riparian woodlands would lead to its dominance by shrubs, thus transforming riverine woods into impenetrable scrub (Zohary 1973).

Woodland regrowth could have been further enhanced by clearing patches of vegetation, and the removal of rotten stumps and vestiges of dead trees and shrubs. The archaeobotanical evidence and phytolith studies have suggested that cultivation is likely to have taken place mainly on better-drained localities although the low-lying areas could support crops as well, at least in what concerns possible pulse spring-sown crops (A. Fairbairn; A. Rosen, personal communication) (see also full discussion in Chapter 1). Therefore, the establishment of new fields must have required at least some small-scale clearance of vegetation.

Considering the possibility that other tree taxa (particularly oak) might also have grown in these alluvial settings instead of the typical steppe-forest formations attested for the Central Anatolian region (including oak, juniper, hackberry and the full array of rosaceous tree taxa; see especially Zohary 1973: 124) alternative interpretations depend to a large degree on the geoarchaeological reconstruction of the local setting. Current ecological analogues available from this region and similar environments from elsewhere in the Near East (see below) would suggest that a
combination of well-drained soils (colluvial, terra rossa, limestone terraces, volcanic slopes) and rainfall in the range of 400-300 mm per year constitute a suitable environment for the growth of open oak deciduous woodlands (for a comprehensive review see below; also Hillman 2000).

In relation to the ecological preferences and tolerances of non-hygrophilous trees in particular, Zohary has distinguished two types of wetland soil groups (Zohary 1973: 42, 50): hydromorphic and non-hydromorphic (alluvial, grumosolic) soils.

Hydromorphic soils (e.g., heavy backswamp clays and very fine floodplain soils) are characterised by high water table conditions that inhibit root penetration and soil aeration. Respective landforms comprise mostly swamps, riverbanks, drained ephemeral watercourses and irrigated fields. They are deep, fine-textured and (under arid conditions) prone to salinization. There are of course many other ecological factors besides soil aeration that could affect adversely tree growth, such as soil structure, temperature, seasonality of flooding, organic matter content and water table movements. Further, such soils are often with undifferentiated soil profiles (Zohary 1973: 50).

Non-hydromorphic alluvia are again fine textured, transported or formed in situ, filling up plains, valleys and depressions. Due to their steady rejuvenation and the constant influx of new material they often lack profile development too. In fact, most of the alluvial and colluvial soils in Middle Eastern countries support a kind of vegetation characteristic of the region as a whole or similar to that of nearby piedmont fans and hills (Zohary 1973: 42). Examples of such soils in the region where deciduous oaks may abound are also cited by Zohary: The intermontane valleys of the Zagros range, the Antalya and Adana plains, the plains and terraces of
western Elburz, the coastal plain of Palestine, and valleys in northwestern and southwestern Turkey (Zohary 1973: 42).

If one accepts that the first type of soils (alluvial, hydromorphic) was the dominant one in a radius of 10-12km around Çatalhöyük, then one also has to accept that oaks were procured from the same minimum distance (that is the limestone terrace soils to the south of Çatalhöyük, see also Fig. 5.1). Another possibility would be the sand ridges situated halfway to the hill zone (c. 5km) (see Fig. 5.1). However, there is no historical record of oaks growing in the sand ridges since, as Driessen and de Meester report, these have been some of the oldest dry-farmed soils in the area (Driessen and de Meester 1969). Both species for which such information is available (Quercus robur and Q. cerris) can withstand sandy, saline soils on condition that they comprise raised, well-drained surfaces. However, one has also to consider the possibility that even if oaks did grow there, the ridges (covering in total an area of 278 km² not all of which could have supported oak trees) could have been cleared for cultivation at a very early stage. It is thus difficult to imagine that they could have represented a viable timber and firewood supply throughout the one thousand years or so of the occupation of Çatalhöyük. The existence of levées of course could change everything, suggesting that a viable oak supply could have been available at a short distance from the settlement (with the same cautionary note in what concerns clearance for cultivation) (see Chapter 1). However, the geoarchaeological evidence as it stands at present does not offer conclusive support to such an interpretation.
5.1.3 Montane forest and oak woodland

Plant macrofossil evidence from sites closer to the montane zone and the hillslopes surrounding the Konya plain (Can Hasan III) has indicated the existence of a vegetation mosaic which included, besides riverine taxa (*Ulmus*, Salicaceae and *Fraxinus*) both dryland indicators (*Celtis, Amygdalus, Juniperus, Pistacia, Rosa* and Maloideae) and more moisture-dependent elements (*Quercus, Pinus*) (Wilcox 1977, 1978, 1991a). It is probable that such diverse and potentially highly localised microenvironments were also related to the increasingly seasonal climate patterns prevailing during the early Holocene in this part of the Near East (cf. Byrne 1987, COHMAP Members 1988, Rossignol-Strick 1999).

It is probable that such diverse and potentially highly localised vegetation microenvironments were also related to the increasingly seasonal climate patterns prevailing during the early Holocene in this part of the Near East (cf. Byrne 1987, COHMAP Members 1988, Rossignol-Strick 1999; Chapter 1). Spatial (i.e., from the hillslopes and the lower upland zone to the steppic plain) and seasonal variations in annual precipitation must have exerted a direct effect on the shape, structure and location of vegetation formations by controlling the amount of ground moisture available for plant growth (compare soil distribution in Fig. 5.1 with vegetation data in Table 5.1). Further modifications on the availability of ground moisture could have been induced by topography and soil properties (e.g., from marl to rocky and limestone outcrops), which control critical parameters for plant growth such as root penetration, thus giving rise to a discontinuous and highly fragmented vegetation cover (cf. Wiens 1985).

Some of the coniferous taxa present in the charcoal assemblages, as for example pine (*Pinus*), are presently found in this area only on the north-facing slopes
of the Taurus range. Here, black pine (*P. nigra*) forms dense stands in mid-elevation slopes together with oak (*Quercus macrolepis, Q. trojana*) and juniper (*Juniperus excelsa, J. oxycedrus*). Isolated black pine stands, much reduced due to woodcutting over the years, have also been reported from the volcanic uplands of Karadağ (Ocakverdi and Ünal 1991).

In the lower upland zone (i.e., the hillslopes surrounding the Konya plain), most of which today falls within the 400-300mm isohyet, pine and oak could have co-existed alongside taxa such as juniper (cf. Zohary 1973: 349, Davies 1965: 84), maple (*Acer*) (Hillman 2000, see also Davies 1965: 23), woody legumes (Fabaceae), wild plums (*Prunus*) (Hillman 2000, see also Davies 1965: 23) and other light-demanding undershrubs thriving in natural openings and cleared spaces (cf. Zohary 1973, Le Houérou 1985). Such open and semi-open woods might have developed on the Neogene terraces and the reddish-brown hillslopes (weathered limestone, in places deep and well drained, resembling the Mediterranean terra rossa) concentrated mainly south of Konya (de Meester 1971; see also Fig. 5.1, Table 5.1). In the long term, any radical alterations in the structure and composition of these plant communities would be critically dependent on anthropogenic disturbance. The prolonged use of these areas as pastures may lead to the expansion of conifers (especially of fast colonisers such as juniper; Zohary 1973) with detrimental effects on the more palatable broadleaved species. The shade intolerant pines and junipers compete successfully and often replace oaks and broadleaved undershrubs as the dominant elements, under conditions of intense browsing and/or selective logging, due to more successful seedling establishment (Zohary 1962, 1973).

Extensive oak forests could also have developed in protected localities on the volcanic upland zone. Ecological investigations on Karadağ (Ocakverdi and Ünal
1991) indicate that, until recently, deep volcanic soils in the bottom of valleys located on north-eastern slopes, could sustain very dense, damp deciduous oak forests (*Quercus vulcanica* in association with *Homalotheicum sericeum*, a lichen growing on the base of tree trunks and an indicator of very damp conditions). Due to the inability of light to penetrate the woodland canopy and the closely spaced tree trunks, oaks were reported to attain a thin straight shape and shed their lateral branches at regular intervals, leading to the accumulation on the forest floor of a very thick layer of deadwood. Intensive cutting for firewood during the last decade and frequent pest outbreaks have reduced these valley forests to scattered patches of sparse oak scrub.

On the southern exposures of volcanic slopes, at the foothills of the mountains surrounding the Konya plain and the low limestone ridges and hills rising from the plain itself (~300 mm of mean annual rainfall), oak forests would give way to open park-woodland. With this formation are identified a wide array of winter deciduous trees and shrubs which show a distinct preference for open habitats and are resistant to extreme dry and cold conditions (cf. Zohary 1973, Hillman 2000). These include various oaks, pears and hawthorns (Maloideae), cherries and plums (*Prunus*), almonds (*Amygdalus*), hackberries (*Celtis*), pistachios (*Pistacia*), shrubby junipers, and the occasional fig shrubs (*Ficus*) in rocky outcrops and ravines, near sources of fresh water (see also Table 5.1).

Nowadays such formations are encountered solely on the southern fringes of the Konya plain, especially in areas with well-developed soils where browsing, woodcutting and cultivation pressures have been recently eased. Extensive tracts of park-woodland were recorded at various locations on the sides of the main road from Konya to Seydişehir, during a one-day fieldtrip that took place in July of 1999.
Vegetation comprised abundant oak coppices, wild plums (Prunus) and pears (Pyrus), hawthorns (Crataegus), almonds (Amygdalus) and buckthorns (Rhamnus), alongside a ground flora rich in Tainiatherum. Signs of former intensive browsing were also evident in the stunted topiary forms and thickets. On the contrary, very little vegetation development occurred on the loose limestone soils of rocky outcrops.

More varied forms of park-woodland were encountered during another fieldtrip, this time on the foothills of eastern Karadağ (author with the assistance of Aylan Erkal and Meltem Ağcabay; Asouti fieldnotes August 1999). There, on the north-facing exposures of ravines, oak shrubs (Quercus trojana, Q. macrolepis) clearly predominated, alongside spiny almonds (Amygdalus orientalis). Conversely, on southern slopes, light-demanding pistachio shrubs abounded together with almonds, hawthorns (Crataegus orientalis) and buckthorns.

The predominantly stunted forms of trees and shrubs seemed to relate to the lack of sufficient ground moisture. Soils comprised mostly colluvium with boulders overlying two distinct layers of volcanic tephra deposits, as could be seen on sections along the main access road. At the same time, the spatial distribution of vegetation followed closely that of soils, with virtually no woodland growing further away from the volcanic layers and the colluvial slopes onto the marl expanses of the plain, apart from the occasional trees tended in village gardens and a few poplar/acacia plantations.

Towards the northeast, as we approached the village of Madenşehir (for a broad outline of the area see Fig. 5.2), the pattern of vegetation changed markedly. A clear difference was visible between house gardens and the surrounding semi-natural
woods. In the former, one could see cultivated varieties of trees otherwise not encountered in the area (e.g., apple trees; *Malus* spp.) It was also interesting to note that although twigs and branches of spiny almond were evidently very popular as fencing material, being stacked on top of the dry-stone walls, the surrounding slopes were nonetheless well wooded (mainly oak). This was probably due to the preference of the local villagers to use cultivated poplars instead of the forest timber as the principal raw material for the construction of roofs for their houses. Otherwise, the most commonly used fuels in the village today are oak, juniper and hackberry branches, supplemented by stalks of cultivated sunflowers (A. Erkal, personal communication).

Further to the east, as we drove over a narrow ridge past the village of Yassitepe, we came across an area with visible remains of derelict houses, dry-stone enclosures and field boundaries (Asouti fieldnotes August 1999). Some very large oak coppice stools, dwarf vines and overgrown hedges (oak, hawthorn, spiny almond) were also observed. The few and widely spaced oak trees alongside the abundance of traganthic *Acantholimon* and *Astragalus* shrubs in the ground flora and the occurrence of several stone basins around an abandoned dry well, seemed to suggest that this locality had served as a pasture/penning area in the relatively recent past. Oak timber had been used for the construction of roofs, wall frames and lintels in the abandoned buildings as could be deduced from the examination of timber vestiges in one of the best-preserved structures.

Immediately after this locality lied the forest reserve areas. These comprise large tracts of woodland, which have been fenced off by the authorities in the space of the last decade or so. Their use for animal browsing/grazing and firewood collection is generally prohibited to the villagers, although it is difficult to imagine a
completely enforceable ban in such a remote area. Vegetation was much denser and
diverse with trees reaching a height of 4-5m. Oaks, wild plums, pears, hackberries
and rosebushes, accompanied by a ground flora rich in annuals (especially wild rye)
were very abundant.

Repeated botanical observations in various parts of Anatolia, have established
a pattern of seasonal change for park-woodland communities. During spring and
early summer (from late March until June), oak park-woodland reaches its full
vegetative development, with most of the trees and bushes coming into flower and
lush stands of perennial and annual grasses forming a dense ground cover. The fruit
season then follows, from late spring until the end of summer and occasionally up to
mid-autumn, as is the case with wild plums, hawthorns and, less often, pistachio
trees. At this time of the year, the herbaceous cover dies off, hence leading to the
accumulation of large quantities of dry litter on the woodland floor. This eventually
turns into a ground layer of slowly decomposing dark herbaceous litter during the
wet season in autumn and the ensuing winter months. On the other hand, the resilient
nature of the park-woodland trees and shrubs generally inhibits the shedding of
lateral branches and shoots, unless the plants have already completed their life cycle
(G. Hillman, personal communication).

5.1.4 Woodland-steppe and treeless steppe
Towards the drier interiors of the plain, where mean annual rainfall rarely exceeds
200 mm and winter frosts are frequent, the dominant vegetation formations were
probably more akin to steppe, with perennial chenopods, wormwoods and various
aromatic shrublets of the mint family (Lamiaceae) alternating with stretches of
grassland. In places, as for example on limestone outcrops and chalky clays, nearby
alluvial plains and at the fringes of hill slopes abutting park-woodland, "islands" of xerophytic tree communities might have arisen (see Fig. 5.1, Table 5.1). They most likely comprised widely spaced, drought-resistant trees and dwarf shrubs.

In Central Anatolia, such associations of light-demanding trees and shrubs (including *Celtis tournefortii*) are encountered in Cappadocia almost exclusively on rocky outcrops (Woldring and Cappers 2001). Outside Anatolia, the closest present-day ecological parallels are represented by woodland-steppe in northeast Syria, in the areas of Jebel Abdul Aziz, Jebel Abu Rujmein and Jebel Bishri (Hillman 2000) and in southern Jordan (Kürschner 1986). Almonds (*Amygdalus orientalis, A. korschinskii*) and terebinths (*Pistacia atlantica*) are usually the dominant species occasionally associated with hawthorns (*Crataegus aronia*) and shrubby buckthorns (*Rhamnus*). Undershubs may include wormwoods (*Artemisia herba-alba*), capers (*Capparis*), rosebushes (*Rosa*) and various xerophytic hemicryptophytes of the Lamiaceae family such as *Phlomis* spp. The available terrestrial pollen records supplemented by deep-sea cores (cf. Hillman 1996, Rossignol-Strick 1999) offer additional support for the northwards extension of woodland-steppe during the Neolithic to encompass parts of Anatolia. So far, charcoal evidence indicating similar vegetation types had been produced only for northern Syria (Helmer et al. 1998, Roitel and Willcox 2000), Iraq (Watkins et al. 1991), the Zagros highlands (van Zeist et al. 1984, Willcox 1990) and Jordan (cf. Willcox 1992a).

These descriptions match very closely the taxonomic composition of the Pınarbaşı charcoal assemblages. The Syrian case studies suggest that woodland-steppe communities can also thrive in habitats where soil moisture is enhanced through the presence of ephemeral watercourses (wadis), seasonal water bodies and landform features such as breaks in slope which improve soil drainage (Hillman
2000). The location of Pınarbaşı right on the foothills of Karadağ and its very close proximity to seasonally flooded marshes and the spring-fed pool (which maintained freshwater conditions throughout its history, cf. Reed et al. 1999) all indicate a very diverse ecotonal zone. The latter probably comprised various different habitats such as steppe proper (grassland alternating with shrubs), lakeside and fresh-water vegetation (*Tamarix, Phragmites, Chenopodiaceae, Fraxinus, Clematis, Vitex*), woodland-steppe (*Amygdalus, Pistacia, Celtis, Artemisia, Capparis, Rosa*) and, closer to Karadağ, oak park-woodland as well (*Quercus, Acer, Prunus, Fabaceae, Rhamnus, Maloideae*).

Additional evidence provided by the study of animal bone, indicates that during the early Neolithic (8th millennium BC) forest habitats must have been much more extensive than in later periods. The bone assemblages retrieved from the open-air settlement on the peninsula revealed the remains of wild sheep (*Ovis orientalis*), auroch (*Bos primigenius*), red deer (*Cervus elaphus*), equids (*Equus spp.*), wild boar (*Sus scrofa*), wildfowl (*Aves*), whilst there was also at least one case of beaver (*Castor fiber*) (D. Carruthers, personal communication). Although the charcoal evidence from deposits corresponding to this period is very limited and subject to severe taphonomic biases, when seen in the context of the zooarchaeological findings it offers additional support for the existence of a very diverse ecological setting, comprising riparian and marsh vegetation, open woodland steppe, park-woodland formations and treeless steppe.

5.1.5 Dynamics of oak park-woodland and woodland-steppe

Both oak park-woodland and woodland-steppe are far from stable in what concerns their spatial extent at different times/seasons and the relative proportions of tree and
non-tree components such as annual and perennial grasses. Competition for water and soil conditions are the main factors responsible for this and have a direct effect on tree size and spacing, the development of lateral and/or vertical extensive root systems and woodland regeneration (Rackham 1998). In general, sharp distinctions between arboreal vegetation and grasses are not easily drawn. They are however particularly visible in areas where the better-drained colluvial slopes are alternating with deep, fine-grained soils, characterised by reduced water availability. As Hillman notes ‘this apparently reflects the greater availability of moisture in coarse-textured soils and around rocks and the failure of rainwater to penetrate fine-grained soils beyond the upper levels exploited by herbs’ (Hillman 2000: 54). Grasses are therefore much better represented on such soils, especially annuals that are well adapted in taking advantage of seasonal variations in the availability of surface ground moisture (Byrne 1987, Blumler 1993, Hillman 2000).

Furthermore fire regimes, livestock and wildlife grazing/browsing, and woodcutting can also affect vegetation types and the regeneration process. Hence, the continuous grazing of herbaceous plants during the growing season may lead in the long term to the encroachment of grasslands by less palatable xerophytic perennials from steppe areas, whereas woodcutting and fire usually reverse this trend to the benefit of perennial and annual grasses. On the other hand woodcutting, intensive browsing and the exploitation of tree stands for leaf-fodder in times of reduced herbaceous forage availability may result in the prevalence of stunted forms (Scholes and Archer 1997). The replacement of steppic grasslands (comprising mainly perennial feather grasses such as Aristida and Stipa) by less palatable shrub communities including wormwoods (Artemisia), spiny Zygophyllum and Noaea
mucronata due to overgrazing, has been well documented for the Bedouin pastoral areas of the Negev and Wadi Araba in Palestine (Boyko 1949).

In addition to these factors, individual trees and shrub thickets usually attract wildlife by providing food from their bark, seeds, fruits, twigs, leaves, flowers and buds, refuge from predators and adverse weather conditions, and a place to rear the young (Robinette 1972). In tropical savannas, it has been observed that isolated trees provide perches for birds bringing seeds of woody species into the savanna. Indeed, such trees may act as "regeneration nuclei" leading to the gradual development of small "islands" of woodlands, which can later coalesce into larger forest patches (Belsky and Amundson 1992).

Leaf litter, faeces, fallen nest material and carcass remains may enhance further nutrient availability and thus facilitate vegetation regeneration and the development of species-rich biomes (Dean et al. 1999). In central Asia, comparable conditions have been observed for the Pistacia vera woodland-steppe of Batghyz in Turkmenistan, near the borders of Afghanistan. There, in an otherwise bare landscape, dense stands of wild barley (Hordeum spontaneum) were able to grow around and in between pistachio trees, due to increased nutrient availability (G. Hillman, personal communication).

At the same time, in more arid localities, the shadow afforded by tree canopies usually creates microenvironments characterised by increased surface moisture, which are readily colonised by annual grasses. Similar patterns have been observed for oak park-woodland formations in southern Levant, whereby grasses grow under the shade of oak trees whilst with higher precipitation or deeper soils they would spread onto open spaces, thus displacing the surrounding xerophytic vegetation (Oppenheimer 1951/53). Overall, such highly specialised
microenvironments could eventually turn into focal points in the regional landscape and thus become a major source of attraction for humans and animals alike.

5.1.6 Discussion

The picture emerging from the botanical data warns against the uncritical adoption of present-day remnant vegetation types as the potential “natural” or even “climax” formations since, for the most part, modern analogues for past plant communities do not exist today in the region. An attempt was made to overcome this problem through the judicious use of the archaeobotanical record, pollen evidence, geomorphological data, field observations and ecological analogues, in order to reconstruct the Neolithic woodland vegetation and delineate its diverse ecological settings (cf. Table 5.1). An important element in this task has been the recognition (through modern case studies) of the essentially “historical” and fluid character of the various vegetation formations, shaped through their continuous interaction with human settlement, shifting habitation patterns and land use regimes, all adding up to the enormous diversity of landforms and environmental conditions encountered in this area now and in the past.

For the Neolithic in particular, the degree to which such a reconstruction may represent the “natural” environment as opposed to the anthropogenic landscape is debatable. From the earliest stages of settlement, human interference through woodcutting, herding and cultivating could have exerted a significant, impact on vegetation structure and its spatial and temporal transformations, albeit not always detectable by the standards of traditional palynological interpretations. Recent reviews of the pollen evidence from southeast Europe and Anatolia (cf. Willis 1995) have demonstrated that human-induced changes in woodland composition during the
Neolithic should not be ruled out on the grounds that clear "anthropogenic indicators" (sensu Behre 1990) are conspicuously absent.

On the basis of the archaeobotanical evidence, it can be argued that the gradual expansion of juniper (Çatalhöyük levels VII-IX) which, based on palaeoclimatic reconstructions alone, would be attributed to the increasingly drier conditions from ca. 8,000 B.P. (Roberts et al. 1999, cf. Bottema and Woldring 1984), might also represent the result of the intentional exploitation of oak woodlands for timber and/or browse. Similarly, the proportionally higher frequencies of woody legumes, labiates and rosaceous shrubs towards the later levels of the settlement need not imply a substantial change in climate patterns. They could equally signify the gradual opening of broadleaved woodlands and the establishment, within disturbed woodland patches, of shade intolerant taxa, or again the invasion of steppe grasslands by shrub communities due to their regular use as livestock grazing grounds. Such potentially complex patterns of interaction between the Neolithic groups residing in the Konya plain and woodland habitats are further explored in the following sections.

5.2 Patterns of woodland exploitation and fuel consumption

5.2.1 Pınarbaşı

The lack of permanent habitation structures in Pınarbaşı suggests that, throughout their history, both the open-air site on the limestone peninsula and the rock-shelters facing the reed marshes were used intermittently as hunting/butchering stations by mobile groups, operating either independently or in association with some of the major settlement centres of the area (e.g., Çatalhöyük). The charcoal assemblages retrieved from all excavated deposits are dominated by those elements that could be
attributed to a vegetation type very much akin to woodland-steppe. They also include a smaller hygrophilous component, which can be identified with submerged marshes and riparian forests growing around the spring-fed pool and the shallow saline lakes receiving seasonal runoff from the volcanic uplands of Karadağ.

Despite the lack of adequate numbers of samples covering all phases of the settlement, the general impression is that no major temporal changes register in sample composition. Based on this, it seems reasonable to infer that the seasonal occupation of at least the rock-shelter resulted in overall little pressure being exerted on the local vegetation. Woodlands had ample time to recover from woodcutting and, presumably, suffered very little from the effects of animal browsing. Wood charcoal from the dominant taxa (*Amygdalus, Pistacia*) comprised mostly small and medium-sized round wood with occasional finds of twigs as well. This would suggest that cutting of trees proper was probably considered as an unnecessary act (perhaps also impractical from the point of view of a transient campsite). Such an attitude could have eventually resulted in introducing an element of unintentional management and woodland conservation in firewood collection. In the long term such unstructured, albeit routinely practiced, "pruning" strategies would have favoured the regeneration of woodland patches, through the enhancement of fruit production.

Further to this, the uniformity of the charcoal assemblage suggests that the groups occupying the rock-shelter at regular intervals used the available firewood resources on a very opportunistic basis, by simply extracting what was available in the site environs. This interpretation is further corroborated by the negligible presence in the archaeobotanical samples of taxa associated with higher elevations such as oak and juniper, despite the close proximity of Pınarbaşı to the volcanic uplands of Karadağ. The rock-shelter apparently was located right at the heart of the
woodland-steppe niche. Yet, despite the differences in the preservation potential of small-sized woods (e.g., reeds and woody legumes), it is tempting to think that some selective criterion in the choice of fuel was applied, especially if we take into account the marked under-representation of hygrophilous taxa such as tamarisk and ash. Both almond and pistachio furnish excellent firewood (dense, drying easily and burning with a strong flame). Almond is also reputed to produce a particularly pleasant fragrance when burnt, whilst pistachio owes much of its properties to its resin content (cf. Miller 1984). It is entirely possible that such burning qualities also played a major role in their selection as firewood as well as their availability in the natural vegetation and the narrow range of fire-using activities performed on the site.

5.2.2 Çatalhöyük

As it has been already outlined in Chapter 1, all the available palaeoenvironmental data point to a much moister regime for the timespan corresponding to the early stages of settlement in Çatalhöyük (c. 8,400-8,000 B.P.), followed by increasingly drier conditions towards later periods (from c. 8,000 B.P. onwards; cf. Fontugne et al. 1999, Roberts et al. 1999, Roberts and Boyer 1999). This chronological divide appears to follow the cultural sequence as well, with the pre-level XII phases D-A deposits corresponding to the early “moist” period characterised by extensive backswamp and marsh development, whilst later deposits (somewhat overlapping with pre-level XII phase A strata) are dated after 8,000 B.P., when wetland environments had just started to retreat.

The pollen evidence from Akgöl (see Chapter 1, Fig. 1.3) also indicates a general progression of coniferous elements (pine and juniper) at the expense of oak, starting from c. 8,000 B.P. Although the increase in the values of pine may also
reflect long-distance transport, it is significant to note the simultaneous expansion of juniper. Such a succession, seen in the context of the pedological and limnic data, supports a pattern of drier conditions prevailing on the lowland areas after approximately 8,000 B.P.

The charcoal data conform only partially to this sequence of climatic and environmental events. As it becomes evident from the quantified results presented in Chapter 4, oak (*Quercus*), accompanied by willows and poplars (Salicaceae), juniper (*Juniperus*) elm (*Ulmus*) and hackberry (*Celtis*), is the dominant taxon amongst the late assemblages (i.e., those dating after 8,000 B.P.) (see Table 5.2). Although the proportionally higher frequency of juniper in the late levels could reflect large-scale climate change, the values obtained for oak clearly contradict this pattern. Other potential indicator taxa such as heliophilous trees and shrubs (*Prunus, Rosa, Chenopodiaceae, Fabaceae, Asteraceae, Lamiaceae*) are less secure in this respect, since they readily respond to conditions of vegetation disturbance (woodcutting, browsing and grazing) hence their utility for inferring past climate change is limited.

At the same time, the charcoal evidence from the early phases of the settlement is characterised by the almost complete absence of oak and juniper (see Figs. 4.10 [which includes all pre-XII levels] and 4.11 [which demonstrates the very low frequency of oak charcoal in pre-XII B-D deposits]; also Figs. 4.20, 4.23 and summary of data in Table 5.2). Instead, riverine taxa predominate. Shrubs (notably *Chenopodiaceae* and *Fabaceae*) are also very much under-represented. Another major difference between the early and the late levels is detected in the relatively higher density and diversity (both in terms of the number of taxa present and their distribution across samples) of the late charcoal assemblages. Given that biases arising from preservation conditions have already been discounted as the major
determinant for the differences observed between the early and the late assemblages (see Chapter 4, section 4.1.2.1: Discussion and Summary), the question arises as to how could one explain such discrepancies between the environmental record and the charcoal evidence. Was natural availability the primary determinant concerning the selection of firewood species and the quantity of fuel used by the inhabitants of Çatalhöyük?

5.2.2.1 The evidence for the use of timber

Oak and juniper constituted the principal construction timbers in use at Çatalhöyük, as evidenced from the excavations conducted by James Mellaart and recent dendrochronological research undertaken by Maryanne Newton (Mellaart 1967, Newton 1996). As these studies have demonstrated, oak and juniper posts were routinely used for the structural support of the heavy flat roofs consisting of layers of mud set on top of reed bundles and/or wooden poles. According to James Mellaart’s excavation reports, the use of vertical (mostly unworked apart from the stripping of their bark) posts was widespread in structures belonging to levels XII-XI (Mellaart 1966), although no walls had been preserved to a sufficient height to indicate whether some kind of “framing” was used for their internal support.

By contrast, the fire-destroyed buildings of level VI provided ample evidence for the existence of wooden frames, composed of vertical and horizontal squared timbers (mostly oak and juniper, with elm occasionally used for the engaged posts). Vertical engaged posts (either half-timbers or planks) divided the walls into several distinct units, which were further subdivided into horizontal panels (Mellaart 1967: 63-64; see also Fig. 5.3). Towards the latest phases of the settlement, the use of
structural timber gradually declined, with little evidence for its survival amongst level II buildings.

Recent research has further elaborated on these findings, particularly in what concerns the life histories of built spaces and the treatment of timber elements. The complex sequence of building abandonment and re-use, either for raising new structures on the old layout or as open areas receiving domestic refuse, has been documented in detail (cf. Çatalhöyük Archive Report: Farid 1998, 1999). The excavation of building 17 (level IX) painted a very vivid picture of the dismantling process:

'At the end of the life of the building, the access hole was blocked with fragmented bricks and solid material prior to dismantlement of the roof, resulting in an initial infill of fragmented brick and mortar. The archaeological record then shows that the upright roof posts from space 170 were removed before the deposition of the finer graded homogenous building infill. Of interest was a post retrieval pit, in the northwest corner of space 170, which had a secondary cut, interpreted as a hole resulting from a greater force required to drag or dig the post out. Within the backfill of it was a redeposited human skull. The question of whether this could be the head of the last individual buried in the underlying building ritually carried through to the next generation was much debated.' (Çatalhöyük Archive Report: Farid 1999)

Comparable evidence for the retrieval of vertical posts and their re-use, most likely in other construction works, has also been obtained by dendrochronological studies. The sampling in 1995 of charred timber fragments from the cleaning of sections in the old Mellaart trenches and their subsequent analysis together with material from the old excavations, suggested many cases of timber re-use. The latter was indicated by the occurrence of timbers with cutting dates earlier than the rest of the posts recovered from the same structure (Newton 1996: 52-57).

These data are in accordance with indirect evidence provided by the quantitative analysis of charcoal assemblages from non-midden contexts of the South Area. In them, it was observed that the deposits holding the largest concentrations of
oak wood charcoal were those associated with roofed structures, such as the general infill layers accumulated inside buildings 17, 18 and the stabling areas (spaces 198, 199) (see Chapter 4, section 4.1.2.2; Table 5.3). Although little archaeological evidence is available *per se* on the details of roof construction, it was hypothesized that much of this oak charcoal actually derives from roof beams and/or thatching material. One possible cause may have been fire-related accidents (e.g., matting and/or exposed beams catching fire from sparks generated in hearths and fire installations).

Besides that, the dismantlement and collapse of roofs during the demolition of disused buildings could have contributed to the accumulation of charcoal debris (due to the breaking up of blackened and partially charred roof elements), which was subsequently incorporated in the infill matrix. The presumably lighter structures covering the barn enclosures could have witnessed similar processes. It is possible that rotting away wooden elements were periodically burnt as part of general cleaning and/or repair routines. The seed assemblages recovered from the same contexts have indicated the *in situ* burning of dung (large concentrations of chaff, small-seeded legumes and grasses), which could also reflect cleaning activities (A. Fairbairn, personal communication).

The evidence from the open fires of space 115 seems to corroborate such a hypothesis. The charcoal assemblages comprised almost exclusively heavily degraded pieces of oak. Similar large concentrations of oak charcoal originated only amongst the burnt horizons of building 1 (North Area) (Table 5.3). It is therefore likely that these open fires represent the burning of defunct structural timber. The fact that it was burnt outdoors instead of being recycled in domestic fire installations may indicate an accidental event, probably involving internal wooden elements.
scorched by fire to the extent that they were unusable any longer as either structural timber or firewood suitable for domestic consumption. Hence, they were disposed off at this external midden area.

The task of procuring large quantities of timber was probably a communally organised activity, involving several households and a serious investment in effort and time from the part of the local inhabitants. The evidence from the reconstruction of woodland catchments suggests that timber had to be carried to the settlement from a distance. Given the lack of pack animals during this period, we may assume that most of the oaks and junipers used for this purpose probably originated in the upland areas south of Konya and were floated down Çarşamba river to the outskirts of Çatalhöyük. This might have been the object of special woodcutting trips, most probably occurring at the beginning of spring, when the river discharge would be particularly strong and construction/repair activities could be scheduled to take place during the oncoming dry season. Preliminary evidence from the dendrochronological examination of wooden posts from buildings of level VI has suggested that such a scenario is plausible, given the clustering of felling dates observed amongst the surviving timbers of certain buildings (Newton 1996: 53).

That wood had to be brought in from a considerable distance (c. 20km) instead of resorting to poplars and elms, readily available in the riverine forest, most likely reflects the recognition by the local residents of the superior qualities of oak and juniper as timbers. They both produce very sizeable and tough poles, suitable for withstanding mechanical pressures in the long term, and are much more resistant to fungal attacks (especially juniper) than the majority of riverine species.

Large branches and knots from felled oak and juniper trees would be trimmed and the resulting poles stripped of their bark, before they were used in construction
projects. Such a procedure would normally generate some quantities of storable firewood, especially during intensive building periods. Vestiges of defunct timber unsuitable for further use could also have entered the domestic fireplace. Certainly, the persistent occurrence across samples belonging to the late middens of oak (mostly in the form of decayed wood) and juniper, suggests that both taxa were regularly used as firewood too.

Such a reconstruction of timber-related activities lies also in agreement with the available corpus of ethnographic evidence (see Chapter 2). More region-specific studies of traditional architecture in Central Anatolia (Kafescioglu 1949: 44-55) have indicated the very complex nature of roof building, and the range of practical considerations that need to be accommodated, especially in areas where construction timber has to be fetched from distant areas. Amongst the villages of the Ankara District, locally available timber resources are extremely scarce and even small pieces have to be imported from elsewhere. Therefore, care is taken to use as many poles as possible (usually larger and thicker than necessary) in order to enhance the longevity of the whole structure and thus reduce the amount of future repairs and/or beam replacements. This is also the main reason why villagers prefer to use hard and durable woods, as for example pine. Ethnoarchaeological research in northeastern Anatolia has also indicated that timber elements retrieved from roofs, doors, lintels and windows are always removed upon the abandonment of buildings in order to be re-used either immediately or at some later date (Hopkins 1999).

As a rule, branches and big knots will be trimmed first, followed by the peeling of the bark. The resulting poles are used on the roof itself and as upright posts to prevent wall subsidence. Branches, small twigs and/or reed bundles will be piled on top of the horizontal poles to provide bedding for the earthen superstructure.
The latter may comprise a thick layer (approximately 20cm) of mud (toprak) sometimes overlain by çorak (a material much reminiscent of lake marl, rich in mineral salts and very waterproof). Roofs are also built with a slight curvature (achieved through the addition of extra mud layers in the central portion of the roof) in order to let rainwater roll over the top surface easier and thus prevent cracks and holes occurring in the dirt packs.

Despite such efforts to ensure the stability and longevity of roof structures, maintenance works have to take place regularly, particularly during the summer months. Soil must be added every year due to its constant removal by rainwater. In the village of Del Koh in western Iran, roof repairs are a constant preoccupation for the house residents. Uneven spots and cracks have to be filled in with dirt, whilst persistently leaky spots are dug up, refilled and pressed as soon as possible (Friedl and Löffler 1994). By far, the most important maintenance task is to keep the roof free of snow and to squeeze rainwater out by pulling a heavy oak- or stone-roller on a rope across it. The same authors report the preference of local villagers in the past for oak trees, instead of poplars, for roof construction. The latter became popular only recently, after the widespread introduction of poplar plantations on the banks of irrigation ditches. They also emphasize that conditions of scarcity (including that of fuel resources) have imposed on the local community an ethos of recycling, whereby all material items pass through different phases of use before reaching the ultimate stage of discard, which in the case of wood is represented by its eventual consumption in the household fireplace.
5.2.2.2 Seasonal and temporal variations in fuel consumption

Any attempt to reconstruct seasonal variations in the use of woodland resources requires, apart from a rigid dating framework, the existence of such “hard” evidence as terminal growth rings (cf. Rasmussen 1989, Halstead et al. 1998) or at least corroborative data from sensitive indicators of environmental conditions and habitat variation (e.g., land snails). It has not been possible (to date) to obtain such evidence from the current excavations and specialist research in Çatalhöyük. For wood charcoal macrofossils in particular, no identifiable terminal growth rings in either stem or round wood specimens had survived, whilst the 1999 investigations on the potential of waterlogged preservation proved, quite predictably given the increasingly arid conditions of the present day, extremely unproductive (Fairbairn and Kennedy in Çatalhöyük Archive Report 1999).

A way to overcome, at least provisionally, this lack of direct evidence can be provided by the comparison of predicted seasonal variations in the availability of woodland resources to patterns of wood collection and consumption as these can be reconstructed from the archaeological and ethnographic record. To this end, the charcoal evidence (sample composition, taphonomic observations, charcoal densities and reconstruction of woodland catchments) was used in conjunction with the existing ethnographic studies, data on the presence of animal species and the archaeobotanical evidence. The correlation of the latter with the charcoal datasets provided also a useful means for evaluating temporal differences in the use of plant resources. The results and interpretations discussed in the following sections are also presented in a summary form in Table 5.4
i. Modelling seasonal variations

It has to be stressed once more that no direct evidence (e.g., growth rings) has been available from the study of wood charcoal macro-remains, which could provide some insights concerning the season of firewood collection. Therefore any attempt to model such likely variations in firewood procurement is by definition speculative, particularly since evidence from other sources of evidence (e.g., animal bone) is not yet available. However, it is still possible to put forward some preliminary suggestions as working hypotheses open to testing as more data become available.

Given the distances that people may have had to walk in order to obtain wood from oak park-woodland (e.g., Prunus, Ficus, Maloideae, Rosa, Fabaceae) and woodland-steppe (Amygdalus, Pistacia, Celtis) and also from the treeless steppe towards the centre of the plain (Asteraceae, Lamiaceae) it might be reasonable to suggest that such trips might have taken place in combination with other seasonally performed tasks. The latter might have included the collection of fruit crops from the wild, possibly herding and hunting in the steppic grasslands and the wooded uplands, and timber provisioning. Woodcutting and herding to more distant pastures further away from the wetlands most probably occurred from spring to early summer (March-June), when steppe grasslands reached the peak of their biomass production, alluvium was probably inundated and/or very wet (thus reducing available graze) and timber was probably more easily accessible and transportable back to the settlement. Furthermore (given also the frequent occurrence of charcoal fragments bearing signs of fungal decay in the charcoal assemblages) the availability of dry, easily transportable deadwood to be collected as fuel would be probably higher during the dry season (see Chapter 2). However the bulk of firewood gathering probably took place in periods free of major labour-demanding tasks such as sowing and harvesting.
(in the case of cereal cultivation autumn and late summer respectively; see Chapter 2).

During the summer months and up to early autumn separate trips were probably organised for the collection of fruit crops. This would be the time for the harvesting at different occasions of hackberries, pistachios, almonds, wild plums and cherries. The gradual drying up of grasslands in the lowlands might have encouraged the keeping of some herds (e.g., sheep) closer to the marshlands to graze on reeds and the patches of annual grasses growing on the freshly exposed, fine-grained alluvial soils. On the other hand, goats could have been driven to the woodlands in search of leaf browse, or to the low-growing shrub stands persisting in the steppe throughout the dry season. The latter, especially wormwood pastures, can also be seasonally browsed by sheep when herbaceous forage availability decreases during the late summer months (Larin 1947).

It is more difficult to propose paths of movement relating to the hunting of wild animals, particularly since very little is known about the ecology of wild animal populations in Central Anatolia. However, it is reasonable to assume that hunting expeditions would have been more feasible during the spring, summer and early autumn months. Apart from the increased accessibility to hunters of habitats frequented by forest species (e.g., wild boar, red and roe deer, bear), the greater availability of green pasture on the grasslands probably attracted large herds of ungulate herbivores in search of graze on the steppe at spring and early autumn as well. In high summer, large depressions maintaining bodies of water and the alluvial exposures would also form gathering points for herbivore herds in search of water. At this point however it should be stressed that although some indications for seasonal animal-related activities are available (e.g., the evidence for deer antler on
site has indicated antler collection after rut in autumn) research is ongoing and full results are not yet available (L. Martin, pers. comm.)

Although research on the cultivation methods of cereal and pulse crops is still ongoing and full results are awaited, it is likely that the cultivation of some pulse crops took place on the alluvial flats as well, perhaps aided by flood/groundwater (see Chapter 1). Recent archaeobotanical investigations have suggested that, whilst cereal crops were winter-sown, some pulse catch crops could have been spring-sown (A. Fairbairn, personal communication). As noted earlier on, such an agricultural regime would have necessitated some small-scale clearance of the riverine forest and the removal of dead vegetation accumulated on the banks of the river during the preceding winter months. It follows that field preparation most probably took place around mid-spring, immediately after the recession of the river floods and could have generated some quantities of firewood collected at a short distance from the site.

Such a pattern of activities and seasonal movements across the landscape would suggest the existence of tightly scheduled routines of firewood collection. In this respect, it is strongly reminiscent of patterns observed amongst traditional agrarian societies of the present-day (see Chapter 2), especially those inhabiting environments characterised by marked annual fluctuations in the availability of exploitable resources. It is likely that the bulk of firewood collection occurred in the dry season (from late spring to early autumn) as attested by many ethnographic studies in arid environments (see Chapter 2). The ecological basis for this is that in dryland environments with high seasonal variations in rainfall and ground moisture the growing season for woody plants may be constrained by both winter dormancy and the extreme dryness of the summer. Similar palaeoclimatic conditions have been suggested for the region during the early-middle Holocene timespan (see Chapter 1).
During the dry season, a wide variety of firewood species could enter the domestic storeroom through small-scale land clearance, the harvesting of leafy fodder, the gathering of wild tree crops and timber preparation. As heating requirements were probably low and much of the necessary drying of foodstuffs could have been done by spreading them on the rooftops, most of the collected firewood was probably stored for use during the winter. It is likely that less wood was consumed in domestic fireplaces, possibly also incorporating degraded vestiges of oak and juniper timber generated by a renewed cycle of repair works, the abandonment and/or demolition of old buildings and intensive construction activities. Furthermore, considering the high diversity observed for refuse deposits associated with areas reserved for the production of lime plaster, it is likely that the latter took place primarily during the dry season (e.g., to coincide with building construction and repair works). However, more data from sources of evidence other than charcoal (e.g., bone) are necessary to explore further this hypothesis.

ii. Temporal variations

In contrast to the post-8,000 B.P. levels, the earliest excavated strata produced evidence suggesting a greater concentration of firewood collection in catchments much closer to the settlement, such as the riverine forest. This is further supported by the occurrence amongst the charred seed remains of a broad variety of wetland taxa, previously unreported, such as pondweed (*Potamogeton*), *Aeluropus* (Poaceae) water dropwort (*Oenanthe*) and *Phalaris*, indicating deep water environments and wetland margins (Fairbairn and Kennedy in Çatalhöyük Archive Report 1999). Although the data from the earliest examined midden/dump deposits (phases C-D), which are very likely to represent domestic refuse, seem to suggest some variability in sample
composition, this lacks the coherence encountered amongst the later assemblages.

Overall, with the exception of hackberry (*Celtis*) that follows very closely the pattern of the dominant riverine taxa, the majority of fruit and shrub taxa appear in very low frequencies in the archaeobotanical record.

Another major difference between the early and the late levels is detected in the charcoal densities recorded for both assemblages. The analysis of the taphonomic characteristics of the early midden/dump samples has indicated that the cause of their lower charcoal densities can be attributed to changes in the intensity of firewood use rather than post-depositional factors. Seen in the context of the rest of the archaeobotanical evidence, it seems likely that during the early phases the collection, processing and burning of animal dung had a much more prominent place in the fuel economy of the settlement that later on. In terms of charcoal density, aside from the deposits associated with refuse deriving from the lime burning activities and/or taphonomically exceptional circumstances, there appears to exist an overlap between phase A and phases C-D assemblages. This suggests that, apart from the sudden increase in the use of oak during phase A, the overall intensity of firewood use was very similar across the pre-level XII strata. Indeed, these observations correlate very closely with the rest of the archaeobotanical data that indicate an increasing occurrence of dung fuel remains amongst the pre-level XII assemblages. Throughout the early strata small-seeded legumes and grasses, particles of charred dung, cereal chaff and mineralised dung pellets were very abundant (*Çatalhöyük* Archive Report: Fairbairn and Kennedy 1999, Matthews W. 1999; A. Fairbairn, personal communication).

On the other hand, the archaeobotanical evidence currently available for the use of dung fuel in late levels is not conclusive as to whether dung *per se* was used as
fuel on a large scale. The picture emerging from the archaeobotanical data shows considerable variation in the types and the relative proportions of plant remains that could be considered as indicative of dung fuel consumption (A. Fairbairn, personal communication). Some evidence for the burning of dung has been provided by the micromorphological examination of layers from hearths, fire installations and other domestic contexts (cf. Çatalhöyük Archive Report: Matthews W. 1998, 1999, 2000). However, it is difficult to generalise from these observations, given also the taphonomic and quantification problems facing the micromorphological analysis of domestic contexts especially in what concerns the reconstruction of large-scale patterns of resource exploitation. It seems likely (in view also of the high charcoal densities) that during the later phases of the settlement dung fuel was used periodically (possibly on a seasonal basis), being integrated to a much more structured and complex pattern of fuel consumption, which was well-adjusted to seasonal variations in firewood availability and the strategies for its procurement.

5.2.2.3 The “lime burning” deposits

The charcoal evidence from the lime burning layers excavated in space 181 suggests that little of the wood consumed in these open fires survived the high temperatures developed during the burning process. The discovery amongst the bone assemblages of calcined specimens actually indicates temperatures in the range of 600-650°C. It is extremely unlikely that charred wood particles could have withstood such burning environments without suffering substantial thermal degradation and breakage, even more so if old charcoal layers had been subject to reheating through repeated burning episodes on the same locations.
Data on the charcoal densities from both the lime burning layers and the midden/dump deposits associated with them indicate that such a taphonomic explanation is the most likely cause for the under-representation of wood charcoal macro-remains in these contexts. Another factor affecting the preservation potential of charcoal probably related to the structure of these open fires, set inside shallow pits and/or scoops without any surviving evidence for the existence of some kind of superstructure (e.g., earthen cover).

The study of animal bone, botanical macro-remains and micromorphological samples, has indicated that a wide assortment of materials were used to fuel these fires including bone, shell and animal dung (Çatalhöyük Archive Report: Fairbairn and Kennedy 1999, Frame et al. 1999, Matthews W. 1999). This picture is reproduced in the charcoal dataset. Despite the adverse taphonomic conditions described above, the systematic subsampling of the archaeobotanical assemblages made possible the retrieval of a wide range of taxa. It appears therefore that firewood was being used indiscriminately, with little if any consideration as to the burning properties of individual species.

5.2.2.4 Rare taxa

As noted in the previous chapter, a number of taxa appear very infrequently across the sampled sequence. These include pine (*Pinus*), plane trees (*Platanus*), alder (*Alnus*), fig (*Ficus*), dogwood/cornelian cherry (*Cornus*), chaste-tree (*Vitex*), maple (*Acer*), caper (*Capparis*), clematis (*Clematis*), and vine (*Vitis*).

Some of these taxa might represent chance inclusions in the archaeobotanical record. Pine seems to be a case in point: it occurs only once and with a single fragment. One possible scenario is its haphazard collection as driftwood from the
banks of the Çarşamba river (the possibility of a modern intrusion seems extremely unlikely since no such trees grow today anywhere near the site). Equally chance findings appears to be *Vitis*.

Capers and chaste trees probably were not appreciated much for their burning qualities and/or ease of collection (especially the spiny varieties of *Capparis*). Their increased (proportionally speaking) abundance towards the later levels might actually indicate the progressive impoverishment of the riverine forest and the more indiscriminate use of woody species. However, since both of them were probably growing as small shrubs, it is possible that their under-representation also reflects a preservation bias.

The same however cannot be said for *Alnus, Platanus* and *Cornus*. There are references in the ethnographic literature (cf. Smart and Hoffman 1988) describing the aversion felt by certain groups (e.g., the Ingalik of Alaska) for the strong red staining of alder sapwood. Apart from this, alder renders very poor firewood even when seasoned (Boulton and Jay 1946: 112).

The opposite is true for plane, which gives '... a good heat and lasts well, either green or seasoned. Excellent as kindling' (ibid.). Zohary (1973) stresses the age-old reverence expressed for plane trees throughout the Near East, in appreciation of the thick shade they provide during the heat of the summer and their association with running waters and springs. The persistent presence of *Platanus* wood charcoal across the sequence (early/late levels of South Area, building 1-North Area) suggests that some sort of avoidance taboo was practiced concerning the use of its wood as fuel, which probably aimed at the preservation of plane trees as a permanent feature of the riverine landscape.
The rare presence of charcoal from fig could be attributed to its low attraction as a firewood species for the inhabitants of Çatalhöyük. Although not encountered in the area today, it could have formed part of oak park-woodland and/or riverine native vegetation in the past. Hence, it cannot be considered as an introduced species. Fig wood has been recovered exclusively from the late levels (including building 1 contexts), whereas charred remains of fig fruits were encountered only amongst the pre-level XII assemblages, which seems to support a pattern of very random collection for this taxon.

*Cornus* presents a more complicated case. According to Davis (Flora of Turkey, vol. 4: 540-541) and Browicz (1986) both varieties of *Cornus* encountered in central Anatolia (*Cornus mas, C. sanguinea*) grow far away from the Konya plain, in the uplands of eastern Taurus and the Lake District. As the natural habitat of *Cornus mas* are described 'warm and sparse broadleaf forests, particularly of oak (*Quercus cerris* L., *Q. frainetto* Ten.), hornbeam, beech and even alder, more rarely coniferous ones, of fir and pine' (Browicz 1986: 14). On the contrary, *C. sanguinea* may occupy very diverse habitats. At the northern limit of its distribution (the Black Sea region) it frequents moist localities on riverbanks, lakesides and marshes and thrives in shady environments. Conversely, towards the southern end (Syria, Lebanon, Iraq) it may occur on sunny exposed slopes and limestone rocky outcrops (Browicz 1986: 15).

Given the absence from the botanical literature of references to *Cornus* from anywhere around or nearby the Konya plain and its overall lack of association with the vegetation formations reconstructed for this area, it would seem likely that it represents a case of imported wood. *Cornus mas* in particular is renowned for its wood properties: heavy, very hard, with narrow rings, elastic and splintery. The existing ethnographic records from north America describe its extensive use for the
making of arrow shafts (Browicz 1986: 14; G. Hillman, personal communication). One should however leave open the possibility that its distribution was very different during the Neolithic. To date, no archaeological wood charcoal assemblages from Central Anatolia and adjacent areas have been studied to the same detail as those of Çatalhöyük and Pınarbaşı. Until comparable datasets have been made available from more archaeological sites in this geographical region, it would be very unsafe to reach some definite conclusions.

5.2.2.5 “Specialised” contexts: feature 215 (building 1)

Building 1 has been the focus of much discussion concerning the symbolic aspects of life in the Neolithic settlement of Çatalhöyük (cf. Çatalhöyük Archive Report: Matthews 1996, Lucas 1997, Cessford 2000; Hodder 1999). The rigid demarcations observed in the living space between a south, “domestic”, presumably female area and a north, associated with death (most of the burial platforms occurred in the northern part of the building) “male” area, have dominated perceptions and interpretations of symbolism in Çatalhöyük. A succinct account of the archaeological evidence and its potential interpretation is given by Roger Matthews, the first who undertook the task of excavating building 1:

‘The S area is generally domestic, with an oven set into the S wall. There are also grinding and other food processing facilities here in later phases, which also must have existed in earlier phases. The S area is a completely undecorated part of the building, always lacking wall paintings or reliefs. The only possible exception is a brick and plaster protrusion on the S wall. The deposit of obsidian pieces occurs at a clear boundary between the domestic and the decorated regions of the house. This may also be the boundary between the female and male zones of the building, if like most commentators we see the domestic zone as being female.’ (Çatalhöyük Archive Report: Matthews 1996)

This rigid pattern, which lasted through the main occupation phase (B1.2A-C), was disrupted at the end of phase B1.2C. A firing episode destroyed in a controlled way
the southern half of building 1. Prior to the general infilling of this area and its separation through a new wall from the northern half of the building, some domestic features were burnt separately and infilled like bin 215. Others were demolished and obliterated altogether. Habitation continued thereof only in the northern half. A closer look to this sequence of events is provided again by the excavators:

'Turning to the significance of the burning which ends phase 2, this is tightly restricted to the S, female/domestic part of building 1. The burning may relate to the death of the main female of the house, leaving a widower alone in occupation. It is possible that the sole adult burial in the NW platform, which is the last burial here, is that of the last main female of the house. There is then a careful destruction by fire of the female/domestic zone. Occupation continues in the N, male, zone. In this new living space, the previously rigid separation of domestic and decorated breaks down. The new hearth is indeed in the S, domestic, zone of the new layout, but there is now significant decoration along the new S zone in the form of animal parts set into the faces of the new dividing walls both in space 70 and space 71. This suggests a sudden break down of the binary opposition in the demarcation of space ...' (Çatalhöyük Archive Report: Matthews 1996)

Bin 215 had stored in it a substantial quantity of lentils, which were not removed before it was burnt. Apparently, they were covered with some sort of organic material (they were overlain by a yellowish crust). On top of this material were lying the charcoal remains. Enough of them had survived the burning process and subsequent infilling to show that the wood burnt inside the “lentil bin” was different (large charred pieces of mostly decayed wood, very little fragmented and with few signs of post-depositional degradation) from the rest of the carbonised material retrieved elsewhere in building 1. Indeed, all the available evidence (including the excavation records) points to an in situ burning event. One question immediately arising is why was the storage bin burnt? Was this event somehow related to the controlled destruction of the southern half of building 1?

An interesting parallel is offered by ethnographic and anthropological studies amongst the indigenous people of Australia (cf. Warner 1969, Pyne 1991). These have demonstrated some common themes underlying the use of fire in mortuary
rituals practiced by different groups. Most eminent is the perception of fire as a means to segregate the living and the dead. For this purpose, bright and smoky fires are lit to repel the spirit of the deceased, to burn his or her possessions and prevent its return to the hearths of the living. Bunches of green leaves or reeds may also be burnt until they start smoking and then brushed over the bodies of relatives and friends to keep away the soul of the dead.

If the suggestion that the last burial placed inside the platform before the destruction of the southern half of building 1 was of a female adult is correct, then it would seem very plausible that the careful burning and subsequent infilling of bin 215 related to some kind of “purification” ritual, involving the death of a woman. The same practice had to be repeated at a large scale shortly afterwards, this time encompassing the entire southern part of building 1. The burning of deadwood inside bin 215 could have been related to a notion of smoke as a “cleansing” medium. The “possessions” of the deceased were also left on the spot: the lentils, the grinding installation, the bin itself. After the burning and infilling of this part of the house, it was never inhabited again. On the contrary, a wall was erected to isolate it from the northern half. Were then the elaborate wall decorations playing a similar role to that of fire in “keeping away” the lingering spirit of the dead? It is very difficult to provide an answer to this question. A more detailed examination of all its contextual associations would have to take place first, before such an answer becomes feasible.

The contextual associations of bin 215 however do seem to form a picture coherent enough to allow for this hypothesis. The discovery, careful excavation and recording of an almost undisturbed, primary context amongst the rubble and debris of the destruction horizon created the necessary preconditions for this analysis and the
discussion of possible interpretations on the specific nature of burning in building 1, otherwise very unlikely to have been supported by some kind of tangible evidence.

5.3 Discussion

The aim of this chapter has been to provide a full account of the complex relationships observed between woodland ecology, settlement patterns and the strategies adopted for the exploitation of landscape resources. In this context, old and new ecological concepts were brought together with the palaeoecological record, the archaeobotanical evidence, field observations, ethnographic accounts and excavation data, in order to obtain a picture of ecological interactions likely to have occurred on a human time scale. Part of the argument also involved an attempt to define notions of preference and avoidance relating to the selection of firewood species, and assess the potential for addressing issues of the ritual use of fire through the co-examination of the charcoal evidence and the archaeological record.

The charcoal evidence has indicated a temporal pattern in sample composition in the charcoal samples derived from Çatalhöyük. Early samples (pre-8,000 BP) are characterised by the very low presence and abundance of oak, the high presence and frequency of riverine species (particularly Salicaceae and elm) and also the low densities of wood alongside the marked presence of dung fuel indicators. By contrast, the late (post-8,000 BP) levels are characterised by the high presence and abundance of oak, the greater diversity of riverine taxa, and the higher presence and abundance of light-demanding taxa (such as shrubs, legumes and wild plums) and juniper. Also, the late (post-8,000 BP levels) are characterised by high densities of wood compared to the early levels. Furthermore, the picture obtained from the
Pinarbaşı assemblages has indicated the continuous use of the local vegetation (woodland steppe and lakeside vegetation) throughout its period of habitation without any evidence for substantial human impact and/or depletion of local woodland resources.

Through the detailed examination of these patterns observed in the charcoal record and their evaluation against the currently available ethnographic evidence, the archaeological record and models of possible seasonal variations in firewood availability, gathering and other likely associated activities, it has been demonstrated that (in all probability) even within apparently straightforward cases such as the transient campsites of Pinarbasi or the earliest levels at Çatalhöyük, fuel procurement practices were probably determined by the subsistence strategies prevailing among the local communities. Particularly for the early phases at Çatalhöyük, it is also likely that pre-existing perceptions of landscape resources could have played an important role in fuel choice and use. Hence, dung fuel was much more extensively used during this period (otherwise a time of woodland expansion; see Roberts et al. 2001) whilst it gradually declined later on (as can be inferred from the increasing densities of wood charcoal in middens of the late excavation levels when compared to the early ones; see Figs. 4.14, 4.17). Based on the criterion of natural availability and the available ethnographic and theoretical models suggesting substitution of firewood by dung fuel only in conditions of scarcity of the former (see Miller 1985) one would normally expect the opposite to be the case.

There is therefore the possibility that the data obtained through the systematic retrieval and analysis of the archaeological wood charcoal assemblages do not strictly match the palaeoenvironmental record. Furthermore, following the same line of argument, one could also discern a temporal change in the attitude of the
inhabitants of Çatalhöyük towards woodland resources, which appears to have evolved gradually from a distinctively opportunistic strategy of forest and fuel exploitation (based on the harvesting of locally available species from the riverine forest with a greater reliance on dung fuel) into a much more structured pattern involving resource extraction from more distant localities (see Fig. 4.20 for a clear demonstration of the differences observed in sample composition between the early and the late levels in Çatalhöyük). This process could further signify their increasing familiarity with landscape features and the distribution of resources in areas further away from the settlement. Hence, likely “old” and well-acquainted strategies of landscape management could gradually have given way to “new” routines, “new” paths of movement and ultimately “new” social forms and ecological relationships.

Within the later phases of the settlement, a broader range of demands placed upon the resource base had probably to be accommodated, such as the extraction of timber and the procurement of food, fodder and raw materials from longer distances. At the same time, the community probably had to deal as well with the consequences of riverine forest over-exploitation and its progressive transformation from a “natural” habitat into a clearly anthropogenic/cultural landscape. It is the complex imprint of these conscious human choices and habitat responses that appears to have registered in the archaeobotanical record rather than a passive and one-sided interaction between human groups and the palaeoenvironment.

The above interpretations are based primarily on the reading of charcoal data, alongside the consideration of other lines of evidence (i.e., the available archaeological and palaeoecological record and also the ethnographic evidence relevant to the subject of firewood collection and consumption).
Chapter Six: Conclusions

Three main issues emerge from the consideration of the archaeological, botanical and palaeoecological evidence discussed in this thesis. One of the most important is arguably the potential contribution of the present study towards a further refinement of the theory and methodology of charcoal analysis. Some reference has to be reserved also on the palaeoecological and archaeological significance of these results in relation to their broader regional context. Finally, in what concerns the questions initially posed on the emergence of sedentary agrarian societies in Central Anatolia, an attempt is made to bring out some concluding points which could serve as a basis for further research and discussion on the origins of agriculture in this area.

6.1 Methodological, analytical and interpretive issues

The first topic raised in this concluding account deals with the potential and therefore the utility of archaeological wood charcoal macro-remains to address matters of vegetation reconstruction and human behaviour. Understanding and assessing the taphonomic status of the wood charcoal assemblages is an absolute prerequisite in any attempt to interpret either past vegetation or wood use and exploitation. Burning per se is but one of the multiple parameters affecting the preservation of archaeological wood charcoals. Equally and sometimes even more influential are post-depositional conditions, hearth structure, and patterns of wood consumption and discard of fire-related debris.

Burning environments are integrally related to hearth structure and function. The detailed analysis of the material from both archaeological sites did demonstrate that charcoal debris deriving from domestic contexts retained overall much higher density and taxonomic diversity compared to assemblages from external fires. At the same time, however, the preservation status of charcoal remains retrieved from open
hearth was strongly conditioned by the use patterns of the latter. Hence, “production” spaces (i.e., the lime burning areas in Çatalhöyük) revealed very different assemblages compared to both domestic fireplaces and the external covered hearths (e.g., the Chalcolithic fire-pits in Pınarbaşı). There follows that, as a general rule, the impact of context on taxon representation should be evaluated separately in each case and the results interpreted in the light of the particularities of the site and the specific type of activities associated with firewood consumption.

Preservation conditions are by far the most difficult parameter to tackle. Especially in what concerns the influence of post-depositional parameters on total charcoal densities, the present study has shown that assemblages deposited in particular sedimentary environments (e.g., the lakeshore limestones of Pınarbaşı) or affected by specific post-depositional processes (e.g., the dumped material retrieved from unit 5310 in Çatalhöyük) may be subject to severe taphonomic biases. These in turn may render impossible the retrieval of any information other than a list of taxa, which will invariably be of limited value for either vegetation reconstruction or the evaluation of patterns of wood use.

Nevertheless, the correct identification of such biases is of critical importance, especially when it comes to formulating hypotheses about the intensity of firewood consumption and the overall types and proportions of fuel exploited in the past. One important implication is that measurements such as the seed:charcoal density ratios, frequently adopted by archaeobotanists as a means to assess shifts in fuel consumption (e.g., from firewood to dung fuel and vice versa; cf. Miller 1985, 1988, Miller and Smart 1984), may fail to address the potential influences of burning environments and post-depositional conditions on charcoal densities. It was also argued and proven through quantitative and statistical analysis that such a holistic
assessment of charcoal taphonomy is feasible, when charcoal densities are evaluated against preservation (Fr/Pr index) and diversity (Shannon-Wiener index) measurements. The correlation and overall agreement of the results produced by this approach with other, independent lines of evidence (e.g., animal bone, seed remains and excavation records) further testify to the reliability of the proposed analytical methodology.

In what concerns reconstructing past vegetation and the modes of woodland exploitation, it was demonstrated that the evaluation of sample composition (taxon presence and abundance) should be interconnected with the consideration of ecological analogues and the ethnographic record. The investigation of ecological processes and woodland exploitation strategies from suitable ecological and social contexts of the present-day led in assembling a substantial body of theory. The latter allowed the development of analytical approaches capable of tracing similar sources of patterning in the archaeobotanical record. Moreover, the detailed taphonomic analysis of the wood charcoal assemblages alongside the consideration of the off-site palaeoecological evidence provided the necessary background for testing the validity of the resulting interpretations.

6.2 Comparison with other sites: the evidence for woodland exploitation and environmental change

With the exception of Can Hasan III (cf. Wilcox 1977, 1978, 1991a), no other archaeological wood charcoal assemblages have been examined in detail from Neolithic settlements in Central Anatolia. Other sites from eastern Anatolia such as Cafer Höyük, Çayıönü (Neolithic), Hallan Çemi Tepesi (Epipalaeolithic/Neolithic) and Aşvan (Chalcolithic/Bronze Age to historic times) have provided evidence for
the exploitation of oak forests from the very beginning of the Neolithic (c. 9,000 B.P.) (van Zeist and de Roller 1991, Willcox 1974, 1991a, Rosenberg et al. 1995). In Aşvan, this pattern reached its peak in the early Bronze Age. During later periods, the progressive deforestation of the area is evident in the substitution of the preferred firewood species (i.e., Quercus, Ulmaceae) by spiny and riverine elements (Salicaceae, Crataegus, Eleagnus, Ficus, Paliurus, etc.), also supplemented by cultivated varieties (e.g., Juglans).

Although for most of these sites no details have been published on the relative abundances of the different taxa present in their assemblages, some local disparities in modes of woodland exploitation are still discernible. Hence, in Can Hasan III it is possible to trace a preference for juniper, almond and hackberry instead of oak and pine that certainly existed (especially the former) in the settlement environs, given also its location in the upland zone. On the other hand, in Cafer Höyük riverine taxa, particularly willows and poplars, were evidently selected over oak not only as fuel but also for construction purposes (Willcox 1991a). A similar pattern is revealed by the more detailed studies of wood charcoal assemblages derived from sites in the northern Euphrates (Mureybet, Abu Hureyra, Jerf el Ahmar, Dja’ade, Halula). These have also indicated that riverine forests, rather than oak and terebinth-almond woodlands, were preferentially exploited for firewood (cf. Helmer et al. 1998, Willcox 1992a, Roitel and Willcox 2000). This pattern is best exemplified in the long archaeological sequence of Abu Hureyra, where the available evidence points to the progressive impoverishment of the riparian forests from the Epipalaeolithic onwards (Roitel and Willcox 2000).

In terms of past vegetation, it appears that in their great majority Neolithic settlements had access to divers woodland catchments, comprising both riverine
gallery forests and open park-woodland and woodland-steppe formations. Although
the archaeobotanical signatures for the latter amongst Anatolian sites would seem
more ambiguous, the evidence from Pınarbaşı offers definitive support for the
northwards extension of woodland-steppe during the early/middle Holocene to
encompass Anatolia as well, besides northern Syria (Helmer et al. 1998, Roitel and
Willcox 2000), Iraq (Watkins et al. 1991), the Zagros highlands (van Zeist et al.

The evidence for long-term vegetation transformations and their relation to
climate change in the Konya basin is somewhat more difficult to evaluate. Although
further analytical work is necessary, spanning a wider array of archaeological sites
from different ecological settings and time periods, it is nonetheless possible to trace
some general patterns, which concur with the data made available through recent
palaeoecological investigations (cf. Eastwood et al. 1999, Fontugne et al. 1999, Reed

With reference to the early phases of the settlement, the currently available
palaeoecological evidence has indicated that, during the early Holocene, climate
conditions favourable to woodland expansion prevailed in south-central Anatolia
(Roberts et al. 1999, 2001). The off-site palaeoecological record (cf. Fontugne et al.
1999, Roberts et al. 1999) supplemented by pollen, diatom and ostracod evidence
(Roberts et al. 2001) has also indicated that climate conditions were substantially
moister at this time (c. 8,400 B.P.) thus favouring woodland expansion, with a shift
to drier conditions from around 8,000 BP (Roberts et al. 2001). Although the
charcoal assemblages retrieved from the aceramic levels in Çatalhöyük indicate a
concentration of firewood collection activities on the riverine forest, this does not
necessarily imply the absence of oak from drier localities in the uplands. Oak, despite its markedly low abundance, is still present in the charcoal samples.

The gradual rise in the presence and abundance values of juniper in the charcoal samples from Çatalhöyük levels VII-IX could be taken as indicative of progressively drier conditions that favoured the expansion of juniper stands from c. 8,000 B.P. onwards. However it could also indicate the invasion of oak woodlands by junipers due to human impact, since junipers are aggressive colonisers of broadleaved woodlands exploited for timber and/or firewood and compete successfully with oaks (Chapter 5; cf. Zohary 1973: 246). The charcoal sequence from Pınarbaşı has further provided some indications for an overall reduction in the presence of wetland taxa towards the Chalcolithic phases of the settlement. Preliminary observations on some of the Chalcolithic assemblages retrieved from the recent excavations in the West mound at Çatalhöyük have indicated as well the almost complete substitution of oak by juniper, accompanied by a substantial rise in the frequency of Pistacia and the sharp decline of riverine taxa. Although work on the Chalcolithic assemblages is still at its very early stages, it is likely that such changes reflect a major shift in species availability caused by climatic factors and the transformation of the hydrological regimes of the Çarşamba river, rather than a major re-orientation of wood gathering activities (see also Roberts et al. 1996, 1999, Roberts and Boyer 1999).

Such a pattern of environmental change would also be in agreement with the archaeobotanical evidence available from other regions including northern Syria, the Azraq basin, northern Levant and middle Euphrates. The occurrence of fruit stones and wood charcoal remains from Celtis, Pistacia, Ficus, Amygdalus, Rhamnus, Prunus and Crataegus has been interpreted as indicating the prevalence of moister

Hence one could argue that the charcoal data do seem to offer some evidence in support of a pattern of environmental change characterised by progressively drier conditions through time. However, the observed increase in oak charcoal values through time is at odds with a palaeoclimatic interpretation suggesting a decline in total precipitation from approximately 8,000 BP. A more convincing interpretation could be that it reflects a culturally derived shift in wood procurement strategies. One could not argue for the absence of oak from the area during the early stages of Çatalhöyük habitation, since oak fragments are present sporadically in the charcoal assemblages and the regional pollen data from both the Konya plain and Cappadocia suggest the presence of oak woodlands during this period in the lower upland zone (Roberts et al. 2001). On the basis of the presently available evidence it seems more likely that this change marks an expansion (in the spatial sense) of the range of activities performed in the settlement (including timber and firewood procurement) further away from the site and its immediate wet environs. Such a shift could have been further necessitated by the increasing human impact (likely to have resulted in over-exploitation) of the riverside vegetation.

The trends observed in the charcoal record have indicated a clear temporal difference in sample composition in the charcoal samples derived from Çatalhöyük. Thus, early deposits (pre-8,000 BP) are characterised by the following elements: very low presence and abundance of oak, high presence and frequency of riverine
species (particularly Salicaceae and elm) and low densities of wood alongside marked presence of dung fuel indicators. Late levels on the other hand are characterised by the high presence and abundance of oak, the greater diversity of riverine taxa, and the higher presence and abundance of light-demanding taxa (such as shrubs, legumes and wild plums) and juniper. Also, the late (post-8,000 BP levels) are characterised by high densities of wood compared to the early levels.

A series of possible interpretations for these patterns have been examined. Could they be explained as a result of natural availability? The palaeoenvironmental evidence reviewed in the previous sections suggests that this is rather unlikely given that during the early phases of habitation at Çatalhöyük the prevailing climate conditions rather favoured woodland expansion (see particularly Roberts et al. 2001). An alternative interpretation could be that we are faced with variation introduced by context-related variation which may not reflect "real" differences between the early and the late levels. However, this is also unlikely given that these differences were first established through observations performed on general refuse deposits (see relevant discussion in Chapter 2 and results presented in Chapter 4; also Fig. 4.20).

Another alternative which merits consideration is the possibility that these differences in sample composition may reflect changes through time in the areas and the environments exploited for firewood procurement. The available evidence supplemented by pollen and other palaeoenvironmental indicators and modern ecological analogues seems to support such an interpretation (although some caution is required in the interpretation of the geoarchaeological data). Such evidence, supplemented by the consideration of the ethnographic record and the existing archaeological evidence, seems to support a pattern of fuel collection and
consumption routines which evolved gradually from an early stage, distinctive for the intensive use of riverine resources supplemented by animal dung (aceramic levels), to a very different pattern characterising the later periods of the settlement. During this period, wood from a wider array of catchments (see Chapter 5; also Figs. 4.14, 4.17 for charcoal densities and 4.20 for sample composition) and likely to represent a broader range of activities (i.e., timber preparation, fodder and food harvesting, etc.) entered the domestic fireplace, possibly at different seasons, whilst wood storage (as suggested by the relatively high presence of deadwood in the charcoal assemblages) and recycling (see Chapter 5; direct evidence from excavation data and indirect evidence from charcoal analysis) could also have played a significant role in determining the local routines of fuel consumption.

The concentration of firewood gathering activities in the alluvial floodplain during the aceramic habitation of Catalhöyük probably necessitated a greater degree of reliance on dung fuel. This could have been the case because alluvial flats and depressions during this early phase were probably inundated for longer periods, hence preventing unrestricted access to dry patches of woodland, especially during the flood season (winter to early spring). This is indicated by the geoarchaeological evidence currently available (cf. Roberts and Boyer 1999).

In later periods, it is possible to discern a spatial expansion of wood gathering activities, accompanied by an increase in light-demanding taxa (*Prunus*, Fabaceae) and steppe shrubs (Chenopodiaceae, Asteraceae, Lamiaceae), which may represent the long-term results of the exploitation of oak woodlands and steppic grasslands for timber and pastures respectively. The existence of tightly scheduled routines of firewood collection and consumption (as suggested by the consideration of likely seasonal variations in activity patterns and the availability and accessibility of
woodland resources) points towards a rich local knowledge of the seasonal variations in species availability and also the close integration of wood procurement with the rest of the subsistence activities (animal herding, hunting and wild plant food gathering). In this respect, there is room to argue that the inhabitants of Çatalhöyük developed through time a more structured lifestyle, further inferred by their assumed increased reliance on storage and recycling practices. Earlier preferences (i.e., use of dung fuel) appear to have persisted into later periods, albeit substantially transformed to fit into the newly established routines of fuel consumption.

Indeed, what we may be dealing with in the case of Çatalhöyük is a pattern of cyclical shifts in the exploitation of woodland resources that were essentially asynchronous with changes in woodland composition introduced by climatic parameters (i.e., fluctuations in temperature and annual precipitation). Thus, this net increase in the abundance of oak charcoal in the late phases of the settlement appears to have been brought about by changes in wood acquisition strategies, which were probably further necessitated by the over-exploitation of the riverside vegetation.

There follows that interpretive models seeking to read in charcoal densities and taxon frequencies the direct results of differences in species availability and thus climate parameters, would be in this case totally misleading. As the detailed analysis of the wood charcoal material supplemented by the rest of the archaeobotanical data has demonstrated, during the early phases of the settlement animal dung constituted an important source of fuel, in clear contrast to the situation observed amongst later phases. Such a pattern of fuel consumption is clearly at odds with the premises of the "Principle of Least Effort" model, which envisages a direct causal link between species availability and shifts in the types and quantities of fuel exploited by prehistoric groups.
That similar patterns should emerge from this analysis is not surprising given the high spatial and temporal resolution of the charcoal record (cf. Shackleton and Prins 1992). These conditions, far from inhibiting the investigation of woodland composition and environmental change, enabled some unique insights into prehistoric firewood procurement and consumption strategies and thus a major advancement in both the theory and the archaeological applications of charcoal analysis.

6.3 Subsistence strategies in south-central Anatolia at the onset of the Neolithic: the implications of the present study

As it was demonstrated through the analysis of the wood charcoal assemblages, fuel collection and consumption routines in Çatalhöyük evolved gradually from an early stage, distinctive for the intensive use of riverine resources supplemented by animal dung (aceramic levels), to a very different pattern characterising the later periods of the settlement. During this time, wood from a wider array of catchments and representing a broader range of activities (i.e., timber preparation, fodder and food harvesting, etc.) entered the domestic fireplace at different seasons, whilst wood storage and recycling also played a significant role in shaping the local routines of fuel consumption.

On the other hand, in Pınarbaşı, the heat and energy requirements of the transient hunting and herding groups were met entirely through the collection and burning of wood available in the site environs. Some selective criterion was probably applied, reflecting the exceptional burning qualities of certain taxa (i.e., Amygdalus, Pistacia). However, it is difficult to estimate the precise contribution of individual species to total firewood consumption, due to the lack of clearly demarcated
structural features and thus the considerable intermixing of deposits representing seasonal periods of habitation and activity in these campsites.

The concentration of firewood gathering activities in the alluvial floodplain during the aceramic habitation of Çatalhöyük probably necessitated a greater degree of reliance on dung fuel. This could have been the case because alluvial flats and depressions during this early phase were apparently inundated for longer periods, hence preventing unrestricted access to dry patches of woodland, especially during the flood season (winter to early spring). This is indicated by the available geoarchaeological evidence (cf. Roberts and Boyer 1999).

In later periods, we can discern a spatial expansion of wood gathering activities, accompanied by a marked increase in light-demanding taxa (Prunus, Fabaceae) and steppe shrubs (Chenopodiaceae, Asteraceae, Lamiaceae), which may represent the long-term results of the exploitation of oak woodlands and steppic grasslands for timber and pastures respectively. The existence of tightly scheduled routines of firewood collection and consumption, as indicated by the detailed analysis of the charcoal data, points towards a rich local knowledge of the seasonal variations in species availability and also the close integration of wood procurement with the rest of the subsistence activities (animal herding, hunting and wild plant food gathering). In this respect, it can be argued that the inhabitants of Çatalhöyük developed through time a more sedentary lifestyle, further inferred by their increased reliance on storage and recycling practices. Earlier preferences (i.e., use of dung fuel) persisted into later periods, albeit substantially transformed to fit into the newly established routines of fuel consumption.

Although bioarchaeological data cannot pinpoint “origins” in the sense of defining the identity of different groups settled in particular areas (as it may be the
case, e.g., with the investigation of burial customs or the technological characteristics of lithic production), they can nonetheless trace long-term patterns in the evolution of subsistence strategies. The latter may prove an invaluable tool for composing a truly ecological history of the region to complement that of cultural developments and social innovations. Ultimately, such narratives should be brought together and constitute a holistic account of past cultures in their intertwined social, economic and environmental contexts.

This study aspired and to a large degree succeeded in gaining some advance towards this direction. Hence, it has been demonstrated that opportunistic strategies of resource utilisation gave way progressively to more structured patterns of landscape management and exploitation. In this respect, the aceramic settlements of Central Anatolia seem to have practised subsistence activities reminiscent of a "foraging mode of production" which could have originated, at least in part, from earlier hunter-gatherer traditions persisting in this region. The ideological connotations of such influences in subsistence strategies might have been no less significant. Thus, one could perhaps also argue for a possible link between the increased importance of animal herding and hunting (the latter being more likely to have served prestige and/or ritual purposes than solid subsistence objectives), and the higher value placed upon dung as a source of heat and energy during the aceramic Neolithic.

It seems therefore likely that the spread and full establishment of agriculture was a complex and long-term process, possibly instigated by contacts with other neighbouring territories. Such a view lies also in agreement with ethnographic and anthropological research into the symbiotic relationships between hunter-gatherer and agropastoral societies, which has indicated patterns of interaction and cultural
change based on the operation of extensive networks of exchange (cf. Headland and Reid 1989). However, the aceramic cultures of Central Anatolia were clearly past the stage of the incipient management of plant and animal domesticates. More excavation and analytical work is in demand, especially on the Epipalaeolithic sites recently discovered, in order to elucidate the initial stages of agricultural introduction in this area. Further research on settlement patterns in Central Anatolia at the onset of the Holocene will certainly enrich our present state of knowledge on early farming communities, their divers subsistence strategies, and the ways through which these might have shaped the dominant patterns of resource perception and exploitation.
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