
PEUPLEMENT RURAL ET AMÉNAGEMENTS HYDROAGRICOLLES DANS LA MOYENNE VALLÉE DE L'EUPHRATE FIN VIIe-XIXe SIÈCLE

Région de Deir ez Zor - Abu Kemâl (Syrie)

Sous la direction de
Sophie BERTHIER

Sophie BERTHIER, Louis CHAIX & Jacqueline STUDER, Olivier D'HONT, Rika GYSELEN, Delwen SAMUEL

Avec les contributions de
Jean-Yves MONCHAMBERT et Marie-Odile ROUSSET

Avec la collaboration de
Jean-Blaise GARDIOL et Cristina TONGHINI

Ouvrage publié avec le concours
de la direction de la Coopération scientifique, universitaire et de recherche du ministère des Affaires étrangères et de la Fondation Max van Berchem

DAMAS

2001
# SUMMARY

ARCHAEOBOTANICAL EVIDENCE AND ANALYSIS

**CHAPTER I: MEDIEVAL IRRIGATION AGRICULTURE IN THE SYRIAN MIDDLE EUPHRATES VALLEY: AN ARCHAEOBOTANICAL CASE STUDY** ......................................................... 347

**INTRODUCTION** ........................................................................................................... 347
- Aims of the archaeobotanical analysis ........................................................................ 347
- Sources of evidence ...................................................................................................... 348

**THE AGRICULTURAL SETTING: ITS PROBLEMS AND CHALLENGES** ...................... 350
- Climate .......................................................................................................................... 350
- Soils and irrigation ........................................................................................................ 352
- Euphrates river regime ............................................................................................... 354
- Irrigation and topography of the south-east Syrian Euphrates valley ..................... 354

**ARCHAEOBOTANICAL METHODS** .............................................................................. 355
- Sampling and flotation ............................................................................................... 355
- Choosing samples for analysis .................................................................................. 356
- Sorting and identification ........................................................................................... 357
- Limitations of the archaeobotanical material ............................................................. 359

**ARCHAEOBOTANICAL RESULTS** .............................................................................. 372
- Introduction ................................................................................................................. 372
- Winter field crops ....................................................................................................... 373
- Summer field crops ..................................................................................................... 375
- Fruits, nuts and condiments ....................................................................................... 377

**COTTON HUSBANDRY AND USES** ........................................................................... 379
- Description of the cotton plant .................................................................................. 379
- Agricultural requirements for cotton ......................................................................... 380
- Traditional cotton husbandry .................................................................................... 381
- Cotton husbandry according to Medieval Islamic sources ....................................... 382
- Medieval literary evidence for cotton distribution in the Syrian region .................. 382
- Uses of cotton ............................................................................................................. 383

**RICE HUSBANDRY AND USES** ................................................................................. 386
- Description of the rice plant ...................................................................................... 386
- Agricultural requirements for rice .............................................................................. 386
- Traditional rice husbandry and processing ............................................................... 386
- Rice husbandry according to Medieval Islamic sources ........................................... 390
- Medieval literary evidence for rice distribution in the Syrian region ...................... 392
- Uses of rice ................................................................................................................. 392
SESAME HUSBANDRY AND USES ........................................................................................................ 393
Description of the sesame plant ........................................................................................................ 393
Agricultural requirements for sesame ................................................................................................ 394
Traditional sesame husbandry ........................................................................................................... 395
Sesame husbandry according to Medieval Islamic sources ................................................................. 396
Traditional sesame processing ........................................................................................................... 397
Uses of sesame .................................................................................................................................. 397
TEMPEATE MILLET HUSBANDRY AND USES .................................................................................. 398
Description of the millet plant ........................................................................................................... 398
Agricultural requirements for millet and traditional husbandry .......................................................... 400
Traditional millet husbandry in Yemen ............................................................................................... 400
Millet husbandry according to Medieval Islamic sources ................................................................. 402
Uses of millet ...................................................................................................................................... 404
HUSBANDRY AND USES OF FRUITS, NUTS AND CONDIMENTS ........................................ 406
Introduction ....................................................................................................................................... 406
Grape .................................................................................................................................................. 406
Pomegranate ...................................................................................................................................... 408
Fig ...................................................................................................................................................... 409
Date, lemon and plum ........................................................................................................................... 410
Melon and cucumber ........................................................................................................................... 413
Cow pea .............................................................................................................................................. 414
The nuts: walnut and almond ................................................................................................................ 415
The condiments: coriander and caper .................................................................................................. 417
AN ISLAMIC AGRICULTURAL REVOLUTION? .............................................................................. 418
MEDIEVAL ISLAMIC AGRONOMY AND CROP USE IN THE MIDDLE EUPHRATES VALLEY ...... 423
The yearly agricultural cycle ................................................................................................................. 423
Comments on the winter field crops .................................................................................................... 423
Comments on the summer crops ......................................................................................................... 428
Possible imports .................................................................................................................................... 430
Unusual samples .................................................................................................................................... 431
Fuel resources ...................................................................................................................................... 432
Six hundred years of agriculture .......................................................................................................... 437
CHAPTER II: IDENTIFICATION CRITERIA FOR THE ECONOMIC PLANTS ................................ 439
INTRODUCTION ................................................................................................................................. 439
BARLEY GRAIN: Hordeum spp. .......................................................................................................... 439
Hulled and naked barley ....................................................................................................................... 439
Twisted and straight barley .................................................................................................................. 440
Estimating whole barley grain from fragments ................................................................................. 441
WHEAT GRAIN: Triticum spp. ........................................................................................................... 441
WHEAT CHAFF: Triticum spp ............................................................................................................. 441
Upper ear wheat rachis fragments ...................................................................................................... 442
Sub-basal and basal wheat rachis fragments ....................................................................................... 443
RYE GRAIN: Secale cereale subsp. cereale ....................................................................................... 443
RICE: Oryza sativa .............................................................................................................................. 443
Rice grain .............................................................................................................................................. 443
Rice chaff .............................................................................................................................................. 446
MILLET: Panicum miliaceum and Setaria italica ................................................................................. 447
ARCHAEOBOTANICAL EVIDENCE AND ANALYSIS

COTTON: *Gossypium herbaceum*/*arboreum* ................................................................. 449
SESAME: *Sesamum indicum* ......................................................................................... 451
LEGUMES .......................................................................................................................... 452
   Lentils: *Lens culinaris*; peas: *Pisum sativum*; chick peas: *Cicer arietinum* ............. 452
   Broad bean: *Vicia faba* ......................................................................................... 453
   Cow pea: *Vigna unguiculata* .................................................................................. 454
FIG: *Ficus carica* ........................................................................................................... 454
GRAPE: *Vitis vinifera* ................................................................................................. 455
   Grape pips ................................................................................................................. 455
   Grape pedicels .......................................................................................................... 456
POMEGRANATE: *Punica granatum* .............................................................................. 456
   Pomegranate seeds ................................................................................................... 456
   Pomegranate peel ..................................................................................................... 457
DIFFERENTIATING GRAPE AND POMEGRANATE SEED FRAGMENTS .................. 458
PLUM: *Prunus domestica* ............................................................................................ 459
   Modern subspecies of plum .................................................................................... 459
   Archaeological finds of plum ................................................................................ 462
   Ancient plum varieties .......................................................................................... 463
   Charred fruit ........................................................................................................... 463
PEACH: *Prunus persica* and ALMOND: *Amygdalus communis* .............................. 464
MELON: *Cucumis melo* and CUCUMBER: *C. sativus* .............................................. 465
   Identification problems .......................................................................................... 465
   Archaeological finds ............................................................................................... 465
OTHER OCCASIONAL FINDS ......................................................................................... 466
   Date: *Phoenix dactylifera* .................................................................................... 466
   Lemon: *Citrus limon* .............................................................................................. 466
   Walnut: *Juglans regia* ........................................................................................... 467
   Coriander: *Coriandrum sativum* ......................................................................... 467
   Caper: *Capparis* ................................................................................................... 468
ACKNOWLEDGEMENTS ................................................................................................. 468
REFERENCES .................................................................................................................... 469
CHAPTER I

MEDIEVAL IRRIGATION AGRICULTURE IN THE SYRIAN MIDDLE EUPHRATES VALLEY: AN ARCHAEOBOTANICAL CASE STUDY

INTRODUCTION

AIMS OF THE ARCHAEOBOTANICAL ANALYSIS

Much of the archaeological work which has been done to date on the Near Eastern Medieval Islamic period has focused on large urban centres. The overall aim for this archaeological investigation of Medieval sites in the Syrian middle Euphrates valley is to redress the balance by examining rural economy and development from Medieval times to the present day. A key aspect of rural life is the husbandry and processing of crops. Archaeobotany, the study of plant remains deposited as the result of ancient human activity, deals with the primary evidence for agronomic practices.

This chapter presents the record of crops retrieved from the Medieval Syrian Euphrates valley sites excavated by Dr. Sophie Berthier in the 1980s, and describes the traditional husbandry and uses of these plants. Based on the archaeobotanical record, the agrarian activities of the Medieval villagers are reconstructed. The region is harsh in climate and geography and is not hospitable to farmers (see page 350: The agricultural setting: its problems and challenges). This study aims to establish the nature of arable farming there in Medieval Islamic times and to investigate how the villagers coped with the challenges of their surroundings. Four main questions are addressed.

1) What crops were cultivated? Fundamental to any understanding of ancient agronomy, the components of the arable economy must be identified.

2) What was the nature of the farming system? Given the harsh conditions of the middle Euphrates valley, did the Medieval farmers cultivate a restricted set of crops in an agricultural system suited to marginal areas, or were they able to establish a sophisticated regime with intensive farming and specialised husbandry techniques?
3) What was the yearly rhythm of arable agriculture? Were the crops restricted to species raised during the cold, relatively moist winter, or was agriculture also practised during the hot and arid summer season? If summer was a productive agricultural period, was it on a small scale, or was it an important part of the agricultural calendar?

4) Was there any change in the agricultural regime over the period of Medieval settlement, from its establishment at the end of the 7th century or first half of the 8th century AD to abandonment in the 14th century? Many scenarios for change over time are conceivable, but since the soil in the region is highly prone to salinisation (see page 352: Soils and irrigation), and soil degradation is a serious problem today, it is reasonable to suggest that Medieval farmers faced the problem of progressive degradation of productive farmland over time.

SOURCES OF EVIDENCE

A number of scholars have studied Medieval Islamic agriculture, but virtually all their data comes from documentary sources (e.g. Watson, 1983; Ashtor, 1976a: 37ff; Aubaile-Sallenave, 1984; Canard, 1959; Miquel, 1980). Although a detailed understanding of the ancient Islamic agricultural economy has been gained from historical records, these records pose a number of serious problems, as Ashtor (1985) vividly describes. For example, different names for the same crops are used, clear descriptions of plants and farming practices are often lacking, there are many gaps in the record, and agriculture is rarely mentioned in any detail by most contemporary authors. Arab geographers generally mentioned plants insofar as they were of special economic interest, or curiosities, or to enhance regional descriptions (Miquel, 1980: 393).

The main documentary sources used in this chapter are those which are relevant to the region and which are accessible to a non-specialist. The area known as Al-Jazirah or Upper Mesopotamia in Medieval times (the northern lowlands of the Tigris and Euphrates rivers) seems to have been little visited by contemporary geographers or travellers, and accounts of its agriculture are very limited. In his comprehensive survey of documentary sources, Miquel rarely mentions Upper Mesopotamia when discussing plants (Miquel, 1980). There are more descriptions of the western part of Syria, but they are generally not as relevant to this study, for the climate, geography, trading patterns and political control were different. To the south, Iraq is useful for comparison and extrapolation to the middle Euphrates. Ibn Hawqal, a 10th century AD Arab geographer, was one of the few contemporary authors who travelled near the middle Euphrates valley region: He recorded some agricultural details in his *Arrangement of the world/Configuration de la terre (Kitāb sūrat al-ard)* (Ibn Hawqal, 1964). A survey of 9th c. AD Islamic agriculture in Iraq has been published by El-Samarraie, drawing primarily on Ibn Wahshiyya’s early 10th c. *Book of Nabatean agriculture (Kitāb al-fīlāha al-Nabatiyya)* (El-Samarraie, 1972); for a discussion of this author and the authenticity of his *Book of Nabatean agriculture*, see Fahd (1971). Ibn al-Awam, an Iberian author about whose life nothing is known, compiled an agronomic treatise, *Ibn al-Awam's book of agriculture/Le livre de l'agriculture d'Ibn-al-Awam (Kitāb al-Filāḥa)*, based on information culled from ancient and Medieval authors at the end of the 12th century or first half of the 13th century AD (Ibn al-Awam, 1977; Colin, 1965).

The plant remains from the Medieval middle Euphrates valley sites are the primary source of data for this chapter. Only the crop plants have been fully identified and tabulated. Remains
Figure 1 — Map of settlements in the Syrian middle Euphrates valley from which archaeobotanical data has been obtained.
of weed and wild plant species, as well as charcoal, have been recovered but have not been investigated. The archaeobotanical assemblage is entirely preserved by charring (burnt by exposure to fire) except for a few rare instances where seeds have been mineralised.

The interpretation of the ancient plant remains relies on a variety of sources. In addition to some contemporary accounts of geography and agronomy, I have referred to modern agronomic data for husbandry requirements of the crops grown in the Syrian Euphrates valley. Some ethnographic information, published by others as well as gathered by me, has also helped to develop the picture of ancient agronomic practices.

A variety of common and scientific names are often used for the same crops. For consistency, I have chosen to follow Zohary and Hopf (1993) for all common and scientific plant names, except for the cereals, for which I have used the names given by van Zeist (1984). For the crops which are not covered by these publications, I have used the names given by Zeven and de Wet (1982).

**THE AGRICULTURAL SETTING: ITS PROBLEMS AND CHALLENGES**

**CLIMATE**

The excavated sites are located in the Meyadin-Deir ez Zor area (Figure 1). This is part of the El-Hamad plateau which rises no higher than 500 metres (Beaumont et al., 1976: 348; Rafiq, 1976: 68). The plateau region is far inland, and is separated from the Mediterranean to the west by high mountain ranges. Like most of the Middle East, the climate of the Meyadin region is the basic Mediterranean rhythm of summer drought and winter rain. However, because of its land-locked location, this pattern tends towards a continental climate with extremes of temperature (Figure 2) and a minimum of rain during the relatively cold winter (Fisher, 1978: 64; Sanlaville, 1980: 18-9).

Two different weather systems affect the middle Euphrates valley according to the time of year. In summer, the dominant effect is exerted by the eastern monsoonal system. A large area of low pressure develops over north-west India and western Pakistan from June to September, drawing a strong wind over much of the Middle East. Warm air extending from the Atlantic Azore high pressure zone, together with warm dry air from Eurasia, is drawn through this corridor southwards (Fisher, 1978: 45-7). During this period there is no rainfall (Fisher, 1978: 374).
The lack of humidity means that skies are clear (Fisher, 1978: 59), and with nothing to alleviate the intense solar heat, temperatures are very high. In the Deir ez Zor area the average daily temperature is 41°C, with temperatures sometimes reaching 47°C (Rafiq, 1976: 72). The temperature of the ground surface in which plants grow, however, can reach 75°C (Fisher, 1978: 85). The absence of cloud also allows solar radiation to escape freely at night, and temperatures fall quite sharply, causing large temperature fluctuations over 24 hours.

Winter is dominated by the Mediterranean weather system. Rain is borne on the winter cyclones which move from north west to south east (Beaumont et al., 1976: 70). The first rain may come in early autumn; by the end of October, the area usually experiences heavier and more prolonged rainfall, and the wettest weather is normally in December or January (Fisher, 1978: 64). The total accumulation of rain is low, however. The westerly, moist winds pass first over the Lebanon mountains, or if from the north west, the Taurus and Amanus ranges, where most of the moisture precipitates. Data from the Deir ez Zor weather station indicates average annual rainfall is in the region of 116 mm and the total number of rainy days throughout the year is 29 (Fisher, 1978: 374). According to Fisher, the 375 mm isohyet marks the limit of rainfed agriculture, while Sanlaville states that the theoretical limit is marked by the 250 mm isohyet, which is highly variable from year to year (Fisher, 1978: 374; Sanlaville, 1980: 21). Beaumont et al. (1976: 71) state that the minimum requirement is an average of 240 mm, but in conjunction with a relative interannual variability of 37% (i.e. year to year fluctuations do not exceed 37%). Whatever the measure, the area around Meyadin must rely entirely on irrigation to sustain farming.

As with all continental climates, this region experiences marked interannual variability in rainfall (Beaumont et al., 1976: 70). Although some years can be very wet, others are very dry, and the pattern is unpredictable. A typical demonstration occurred during the two excavation seasons of 1988 and 1989. In 1988, rain was heavy and prolonged, continuing well into May. The popular saying was that it was the wettest winter in 40 years. It was a year in which the desert bloomed in spring, and barley was sown on the normally barren upper plateau. The following year, 1989, experienced drought, and the desert in spring looked as it would in summer, supporting only hardy perennials.

Winter temperatures are also essentially continental. According to Fisher temperatures are colder than might be expected in the low-lying plain, because of the influence of the snow-covered Taurus and Zagros mountains to the north and east (Fisher, 1978: 374). The average daily temperature in winter is 7°C (Beaumont et al., 1976: 58). The coldest weather occurs when the Siberian high pressure zone extends beyond south-west central Asia. This brings in cold dry air, and more heat radiates away from the ground and air. The minimum recorded temperature at Deir ez Zor as of 1978 was -9°C (Fisher, 1978: 374).

The Meyadin region has a climate of extremes. Daily temperatures vary widely, and the annual range of average temperatures is 26°C. This is within the area of greatest annual fluctuation in the Middle East (Beaumont et al., 1976: 61; Fisher, 1978: 61). The Mediterranean rainfall pattern is unpredictable; varying widely from year to year (Beaumont et al., 1976: 60, 61). This is a demanding regime for agriculture. Perennials and winter crops must be able to withstand frosts and occasional bitter winters. Perennials and summer crops must be highly heat tolerant. No crop will grow reliably in this area without irrigation.
SOILS AND IRRIGATION

In addition to the rigours of the climate, soils of the middle Euphrates valley are a challenge to farmers. The sites under discussion lie in two different zones. On the east bank, the 9th century settlements (n°93 Shheil 1, n°162 Diban 11, n°65 Safât ez Zerr and n°168 Shheil 5) lie on the upper valley terrace above the main flood plain of the Euphrates, whereas on the west bank, n°23 Tell Guftàn, n°30 Tell Hrim and n°36 Qaryat Medâd are built on alluvial soils (see Figure 1).

In south-east Syria the Euphrates river runs through a soil region of gypsic yermosols (Rafiq, 1976: 70). These are loamy or clayey, with a zone of gypsum accumulation of up to 20-50%, lying at a depth of about 20-80 cm. In some places, the gypsum layer lies on the soil surface. Gypsum in such concentrations is an impenetrable barrier to crop root growth, and soils which support plant growth are effectively shallow to moderately deep, depending on the local depth of the gypsum zone (Rafiq, 1976: 70). In order to grow irrigated crops, the gypsum layer must be at least 60 cm below the surface.

Overlying the gypsic sub-soils, layers of calcaric fluvisols have been deposited by the river in the Euphrates flood plain (Rafiq, 1976: 70). These are calcium-rich and may be loamy or clayey. In Iraq, the calcium carbonate content of the Tigris-Euphrates lowlands can reach 20-30% (Stevens, 1981: 74). Although these alluvial sediments have a higher organic content than the surrounding desert soils, much of the organic material is degraded by the intense summer heat (Fisher, 1978: 84). In loamy soils drainage of water is good, but it can be restricted in clay-rich sediments. Before dams were built along the Euphrates, floods brought renewed silts onto the land in winter and spring (Rafiq, 1976: 70).

The farmers of the Meyadin region report that the soil goes very hard whenever it dries out, because it is very rich in clay. The further from the river the less fertile the soil becomes, because it contains less river sediment. The east-bank settlements were therefore located on poor agricultural land. Today, the farmers mix the clayey sediments with organic-rich garden soil and pure sand to soften the soil.

Soil formation and structure is directly affected by the behaviour of moisture within it, which in turn is controlled by climate. In temperate or wet regions, water moves downwards before moving into the streams and rivers which drain the area. As it moves downward and drains out, the moisture dissolves and carries away the salts and minerals produced by soil weathering. In arid climates, such as south-east Syria, moisture at the soil surface is constantly evaporated by heat and low humidity. This causes moisture lower down to be drawn upwards by capillary action. Dissolved salts and minerals are carried upwards in the water, and deposited on the surface or upper layers as moisture is steadily evaporated (Beaumont et al., 1976: 45).

As a result, irrigation in arid areas must be carefully controlled to prevent salinisation. Fisher describes irrigation as more than just supplying water (Fisher, 1978: 35). The amount and type of water, the crops grown (each of which have different water requirements), soil type, soil porosity and slope of the land all affect drainage, which is the key to prevention of salinisation. Wherever drainage is poor, water — and the dissolved salts within it — will be pulled upward by capillary action, instead of moving out of the soil and into the waterways (Beaumont et al., 1976: 33). To avoid losing fertile land to salts, water should not remain in
or on the soil for long. It should be drained off as soon as the crop has absorbed what it requires. This leaches out any soil salts rather than concentrating them on the surface.

Uncontrolled application of water can cause waterlogging and breakdown of soil structure. Various ions contribute to this effect. Above certain concentrations they are toxic to plants, and make the soil impermeable (Fisher, 1978: 85). This is the case for all arid lands; the gypsum-rich soils of the Euphrates plain make the difficulties more acute, and the margin of error finer.

It is well known that the high gypsum content of land through which the Euphrates flows has always posed a serious threat to farming. Once fields become sterile, it is very difficult to remove the salts so that the land is again able to support the growth of crops. Beaumont et al. (1976: 342) describe how some agriculture may still be possible on saline fields. After harvest, the land is fallowed for a year, to allow the water table to recede and the earth to dry out. Before the following year's planting, the land is flooded to a depth of several centimetres, to flush out salts in the top soil layers. At first the newly-planted crop grows well because the roots do not reach beyond the salt-free zone. As growth and irrigation continue, the water table rises, salts reach the surface through capillary action, and growth is affected. The final crop yield is low.

In such situations, barley is grown rather than wheat. Barley has a greater salt tolerance (e.g. Farnworth, 1997: 296-7), although at such high concentrations barley grows poorly. Barley ripens earlier than wheat, which means the crop and its soil is exposed for a shorter time to high temperatures and salt deposition, and there is less time for the water table to rise. Because rice grows in water beds with a constant supply of fresh water running through them, this crop can also be used to reclaim salinised land (see also page 387: Agricultural requirements for rice).

There are two kinds of traditional irrigation. Basin, or flood, irrigation involves the diversion of water onto levelled fields surrounded by earth dykes. Water is applied rapidly and remains within the dykes until it is all absorbed into ground. This method is mainly used for cereal cultivation (Beaumont et al., 1976: 84). The second type is furrow or channel irrigation. Water is led through channels into prepared beds, along or down a slope between each crop row (Figure 3). The water is usually applied to beds in rotation (Fisher, 1978: 35; Beaumont et al., 1976: 84). This is a labour intensive technique, requiring maintenance of the beds and their raised borders and direct control of the water supply, especially when applying water to each bed. Because of the labour involved, furrow irrigation is generally used for higher value vegetable and fruit crops, as well as for rice (Fisher, 1978: 36; Beaumont et al., 1976: 84).
Today, farmers in the middle Euphrates valley irrigate their winter crops according to the amount of rain which falls. Even during very wet winters, they still irrigate because the water deposits enriching sediments. On average, each winter crop is irrigated four times. For the winter crops, the first irrigation is immediately after planting and the last irrigation is the first day of May. For summer crops, the frequency of irrigation varies depending on the temperature, but can be as much as every three days.

EUPHRATES RIVER REGIME

All irrigation water in south-east Syria comes from the Euphrates. The river flows southward from its Anatolian headwaters into the Syrian plateau, where it receives only two tributaries, both entering on the east bank. These are the Balikh to the north, and the Khābūr, which joins the Euphrates not far north of Meyādīn. Thereafter the river actually loses water as it continues south, because of evaporation (Fisher, 1978: 364).

Snow melt in the Anatolian highlands is the main source of river water, and it feeds the headwaters of the Euphrates, the Balikh and the Khābūr. These sources are located in porous rock, which causes the water to percolate through the ground before entering the river system. As a result, prior to the large damming projects in Turkey and Syria, the Euphrates flow was always relatively predictable, and unlike the Tigris not subject to unpredictable and extreme variations (Fisher, 1978: 365; Sanlaville, 1980: 19). Across Syria, the Euphrates flows swiftly. The rapid current erodes the riverbanks, and the water carries a heavy load of sediment throughout the year (Fisher, 1978: 365). Whenever irrigation is applied, the water deposits silts that enrich the soil.

Prior to damming, the volume of water in the river varied substantially throughout the year (Table 1). Because the source of river water was mainly from melting snow, the river was lowest in September and October, after the long, hot summer. The lower November temperatures caused a slight rise in water level because of decreased evaporation (Fisher, 1978: 366). The porous rock of the Euphrates headlands acts as a filter, delaying the entry of the first winter rains in October or November. Thus, a real rise further down the river did not begin until December. It reached its peak in April and May, when the flood level rose some 3.4 meters above low water (Fisher, 1978: 366; Sanlaville, 1980: 20).

<table>
<thead>
<tr>
<th>Month</th>
<th>May (m³/second)</th>
<th>September</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5000</td>
<td>250</td>
</tr>
</tbody>
</table>

Table 1 — The average water discharge of the Euphrates river at the Iraqi town of Hit (after Fisher 1978: 366).

IRRIGATION AND TOPOGRAPHY OF THE SOUTH-EAST SYRIAN EUPHRATES VALLEY

The location of the Medieval Islamic sites and their relationship to the Euphrates valley flood plain is described in detail by Berthier in this volume. The information is briefly recapitulated here (see Figure 1).

The short-lived Period Ia and Ib (8th to 9th c. AD) east-bank sites are located on the low terrace separating the flood plain from the upper plateau desert. During their occupation they
were served by the Nahr Dawrin, an irrigation canal which drew water directly from the Khabur River to the north, and which provided water by gravity-fed channels into the fields below the terrace. The application of water would thus have been difficult to control. The fields nearest to the settlements would have been at the more marginal edge of the flood plain where sediments would have been laid down in thinner deposits and with less frequency depending on the extent of the Euphrates spring floods.

The west-bank settlements (n°23 Tell Guftän, n°30 Tell Hrim and n°36 Qaryat Medäd), in contrast, are located within the Euphrates flood plain, and were served by the Nahr Sa'id. This irrigation canal was fed from the Euphrates river by raising the water with water wheels. The side channels were also operated on a raised water system, attested by the sherds of water wheel jars found in the canal banks adjacent to these sites (see Berthier this volume). The level and rate of water flow could thus be well-controlled, and the sites themselves were located on the fertile soil of the river edge and central flood plain.

ARCHAEOBOTANICAL METHODS

SAMPLING AND FLOTATION

During the 1988 and 1989 excavation seasons, the site excavators took samples of the archaeological matrix for charred plant remains. There was no archaeobotanist present during excavation to advise, and most samples were taken when charcoal and ash were visible in the deposits. A range of context types were sampled (see Tables 5-14), but they are dominated by features associated with fire, such as hearths, ovens, tannours, burnt areas, and middens which apparently contain the clearings from fire installations. In total, 85 soil samples were taken over two years, as well as two samples from earlier excavations at site n°30 Tell Hrim.

The soil was stockpiled for processing after each season's digging. Plant remains were recovered with a Siraf-type flotation machine (Nesbitt, 1995). The machine which processed the samples for this project is illustrated in Figure 4. As with all flotation systems, it uses the principle that charred plant remains float in water while inorganic materials sink. Each sample is poured into the central tank, a 40 gallon oil drum. Floating plant remains are carried over a weir and through a spout into sieves; this is the "flot". Fine sediment is flushed out through a large exit tap at the base of the tank. Inorganic contents which are larger than 1 mm are caught in plastic mesh placed mid-way in the barrel; the contents of the mesh are the "heavy

Figure 4 — The flotation machine in operation. Note the two sieves which catch the items carried off the surface of the water in the tank, and the plastic mesh which retains heavy items larger than 1 mm in diameter.
residue". The flow of water is regulated by a pump and a plumbing system attached to the barrel.

The plant remains from the Medieval Islamic middle Euphrates valley sites were recovered with a nested pair of 1 mm and 0.25 mm sieves. The system was highly efficient; very few plant remains (including charcoal) were present in the heavy residues. Most heavy residues were checked for plant remains and any plant items which were recovered were amalgamated with their respective flots.

**CHOOSING SAMPLES FOR ANALYSIS**

The 87 recovered samples varied widely in the quantities of plant material they contained, and it was not possible nor worthwhile to sort them all for plant remains. After assessment of the whole assemblage, 42 samples were selected for full sorting, identification and scoring of economic species, while six samples were subsequently sorted quickly and the presence of economic species was recorded. These 48 sorted samples cover 55% of the total number of samples recovered (see Table 2). Many samples which were not analysed were obviously sterile or extremely poor in plant remains; the samples analysed include the richest and most informative material.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample numbers:</td>
<td></td>
</tr>
<tr>
<td>Total number of samples floated:</td>
<td>87 samples</td>
</tr>
<tr>
<td>Number of samples given detailed analysis:</td>
<td>42 samples</td>
</tr>
<tr>
<td>Number of samples quickly scanned:</td>
<td>6 samples</td>
</tr>
<tr>
<td>Number of samples studied in total:</td>
<td>48 samples</td>
</tr>
<tr>
<td>Percentage of samples studied out of all samples:</td>
<td>55%</td>
</tr>
<tr>
<td>Sample volumes:</td>
<td></td>
</tr>
<tr>
<td>Total volume of soil floated:</td>
<td>1,331 litres</td>
</tr>
<tr>
<td>Soil volume of samples given detailed analysis:</td>
<td>628.8 litres</td>
</tr>
<tr>
<td>Soil volume of quickly scanned samples:</td>
<td>253.5 litres</td>
</tr>
<tr>
<td>Soil volume of all studied samples:</td>
<td>882.3 litres</td>
</tr>
<tr>
<td>Volume of smallest sample:</td>
<td>0.3 litres</td>
</tr>
<tr>
<td>Volume of largest sample:</td>
<td>137.5 litres</td>
</tr>
<tr>
<td>Percentage of soil from which all studied samples came:</td>
<td>66%</td>
</tr>
<tr>
<td>Total number of economic plant items from analysed samples:</td>
<td>18,827 items</td>
</tr>
</tbody>
</table>

Table 2 — Statistical summary of numbers and volumes of archaeobotanical samples, and total number of economic parts identified.

An important criterion for selecting samples for complete analysis was richness, but there were other considerations. To reduce biases in the assemblage due to different patterns of ancient activity and deposition, a variety of contexts needs to be studied. The two earliest periods (Ia and Ib) taken together had the greatest amount of soil processed, the greatest number of samples analysed, but amongst the fewest plant remains (Figure 5). Because of the paucity of plant remains, most early period samples were analysed in order to obtain enough data from these levels. Some samples of particular archaeological importance were examined, although they were extremely poor in plant remains.
In this report, each deposit from which plant remains was taken is identified by its site number (designated by "n°") and the context number assigned during excavation. For example, the sample taken from hearth 603 at site n°36 Qaryat Medād is identified as "n°36-603". There are several separate samples which have the same context number. These are listed in Table 3. For example, two samples from Tell Guftān (site n°23) come from a jar fill and from deposit around the jar, context 211. In this case, the deposit surrounding the jar is labelled n°23-211i, and the jar fill itself is n°23-211ii, for the purpose of identifying the plant samples.

### Sorting and Identification

The 42 samples selected for analysis were fully sorted for plant remains. The exceptions were two hearth samples from Qaryat Medād, n°36-603 and -605, which were exceptionally rich; only one quarter of each was sorted. For this study, weed seeds were picked out but most were not identified. Only economic plants are discussed in this report. The most important identification resource was the extensive reference collection housed at the British Institute.
### Summary of archaeological periods:

<table>
<thead>
<tr>
<th>Period number</th>
<th>Period name</th>
<th>Period date</th>
<th>Total # samples</th>
<th>Score tables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ia</td>
<td>Abbasid</td>
<td>mid 8th c.</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>Ib</td>
<td>Umayyad</td>
<td>end 7th - first half 8th c.</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>Ic</td>
<td>I-iamdanid</td>
<td>10th c.</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Id</td>
<td>Mirdasid</td>
<td>end 10th - 11th c.</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>Saldjukid-Zenguid</td>
<td>early 12th - 3rd qtr 12th c.</td>
<td>51</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>Ayyubid</td>
<td>end 12th - first half 13th c.</td>
<td>52</td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td>Mamluk</td>
<td>second half 13th - 14th c.</td>
<td>53</td>
<td></td>
</tr>
</tbody>
</table>

### Summary of presence of economic plants over time at the Medieval middle Euphrates valley sites.

#### Key:
- Winter cereals
- Summer field crops
- Winter legumes
- Summer legumes
- Fruits, nuts, and condiments
- Cultivated millet
- Wild cereals
- Wild legumes
- Trees
- Shrubs
- Aquatic plants
- Miscellaneous

#### Periods:
- Abbasid
- Umayyad
- I-iamdanid
- Mirdasid
- Saldjukid-Zenguid
- Ayyubid
- Mamluk

#### Samples:
- Total samples
- Whole samples
- Undamaged
- Damaged
- European grain
- European cereal
- European legume
- Asian grain
- Asian cereal
- Asian legume
- Mediterranean grain
- Mediterranean cereal
- Mediterranean legume
- American grain
- American cereal
- American legume
- Old World cereal
- Old World legume
- Cereal species
- Grape species
- Pomegranate
- Date palm
- Bread wheat
- Barley
- Free-threshing wheat
- Compact-threshing wheat

#### Number of quantified plant items for each period and period:
- Less than 20 items
- More than 20 items
- More than 400 items
- More than 4000 items

#### Figure 6:
- Summary of presence of economic plants over time at the Medieval middle Euphrates valley sites.

[Note: The image contains a table and diagram that are not fully transcribed here due to the limitations of the text-based representation.]
of Archaeology in Ankara. Tables 5-14 present the results of this detailed analysis. In these tables, the samples are grouped first by period and then by site and context number. They can be located quickly in the tables according to site and context number by referring to Table 4. After sorting was completed, I described the morphological criteria on which identification was based. These descriptions are presented in Chapter 2, Identification criteria for the economic plants.

Nearly all preserved plant items from these Medieval sites are charred, but a few unusual specimens are mineralised. In Tables 5-14 the two types of preservation are differentiated; numbers of charred items are indicated by normal font while desiccated items are indicated by bold font. Most of the results from samples n°36-603 and -605, for which only a quarter of the flot was examined, were multiplied by four, to make their numbers comparable to the rest of the assemblage.

A few categories of plant remains were recorded semi-quantitatively. Cereal awn fragments cannot easily be converted into the original number of whole awns, and relative quantities are indicated with plus (+) signs. A number of samples contained many fragments of grain, and their volume is recorded to give some idea of relative quantities. In two hearth samples from Tell Guftân, n°23-216d and n°23-216d/f, there are large quantities of poorly preserved but definite caper (Capparis) seeds. Both these samples also contain similar-looking seeds which are not from caper, but are perhaps from the Leguminosae (Fabaceae) family. Their poor preservation has made accurate quantification very difficult, and their relative abundance is indicated by plus (+) signs.

After most sorting and analysis was completed, a small number of samples were rapidly sorted to look for the presence of species. The samples which were quickly scanned in this way, and the species found in them, are listed in Table 14 without quantification. They were chosen to augment the data for the earliest and latest periods in particular, because there are very low numbers of economic plant remains from these periods (Figures 5 and 6). The results from these quickly scanned samples are included in the summary results shown in Figure 6 together with the data from Tables 5-14.

Most of the samples analysed for plant items had very low densities of economic remains: 32 out of 42 samples analysed have a density of less than 20 economic items per litre (see Tables 5-14 and Figure 5). Because of low densities and small sample volumes, many samples have very low numbers of identified economic plant parts. Although not sufficient for statistical analyses (Jones, 1991; van der Veen, 1985), the wide range of samples taken and the richness of a few samples have nevertheless provided nearly 19,000 identified crop items, and a further number of unquantified or semi-quantified remains, making a good, if uneven, plant record for these sites.

LIMITATIONS OF THE ARCHAEOBOTANICAL MATERIAL

There are two limitations associated with this assemblage: taphonomy and recovery technique. The taphonomic limitations of archaeobotany are well known and have been discussed by, for example, Hillman (1981), Pearsall (1989) and Hastorf and Popper (1988). In all but the most arid climates, exposure to moisture causes decay of organic material, and only those plant parts which have been exposed to fire, and have thus become charred, will
survive in the archaeological record. Plants which are unlikely to survive burning or to have been exposed to fire, such as leafy vegetables and flavourings, are unlikely to be represented. Although the assemblage of recovered plant remains from these medieval excavations is rich, there are undoubtedly other species which are missing from the record because they have not been preserved. Other plant parts may survive charring but may be numerically under-represented compared to their actual importance and abundance. For example, small, oil-rich sesame seeds are not common at these sites because they normally burn to ash.

The recovery method has also introduced bias. The contexts which were sampled were mainly obvious hearths, ovens, burnt areas or charcoal-rich fills (see Tables 5-14). As Helbaek has pointed out, such ash- and charcoal-rich deposits do not always contain the richest concentrations of seeds (Helbaek, 1969: 385). Previous archaeobotanical experience of Near Eastern sites indicates that an appropriate standard sample size is 40 litres of archaeological deposit for each feature, or the whole deposit if it is smaller than 40 litres (Nesbitt, 1995: 116). Over half the samples collected were less than 10 litres (see Figure 7). Three samples from Qaryat Medad, n°36-101, n°36-603 and n°36-605, are exceptionally rich in plant remains, with densities of well over 100 preserved items per litre (Tables 11 and 13). Most samples, however, have very low densities, of under 7.5 items per litre. The low seed densities and small soil volumes together mean that many of the samples have yielded very few plant remains.

The extent of sampling varied from site to site. On the west bank of the Euphrates, site n°23 Tell Guftân was extensively sampled with reasonably large soil volumes, while only a limited number of samples were taken from site n°36 Qaryat Medad. Site n°30 Tell Hrim was not part of the main archaeobotanical programme, and therefore only two samples were available for study. On the east bank, site n°93 Shheil 1 was quite extensively sampled and some relatively large volumes obtained. The remaining eastern sites which were sampled were excavated on a very small scale, and only one or two representative samples, sometimes of relatively large volume, were taken from section baulks.
Table 4 — Concordance of samples analysed, in site number and context number order, and the tables in which their plant remains are recorded.

<table>
<thead>
<tr>
<th>Site Number</th>
<th>Site Name</th>
<th>Context Number</th>
<th>Table Number</th>
<th>Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>n° 23</td>
<td>Tell Gufân</td>
<td>201i</td>
<td>14</td>
<td>IV</td>
</tr>
<tr>
<td>n° 23</td>
<td>Tell Gufân</td>
<td>201ii</td>
<td>14</td>
<td>IV</td>
</tr>
<tr>
<td>n° 23</td>
<td>Tell Gufân</td>
<td>203</td>
<td>12</td>
<td>V</td>
</tr>
<tr>
<td>n° 23</td>
<td>Tell Gufân</td>
<td>205b</td>
<td>12</td>
<td>V</td>
</tr>
<tr>
<td>n° 23</td>
<td>Tell Gufân</td>
<td>209</td>
<td>12</td>
<td>V</td>
</tr>
<tr>
<td>n° 23</td>
<td>Tell Gufân</td>
<td>210</td>
<td>11</td>
<td>IV</td>
</tr>
<tr>
<td>n° 23</td>
<td>Tell Gufân</td>
<td>211i</td>
<td>12</td>
<td>V</td>
</tr>
<tr>
<td>n° 23</td>
<td>Tell Gufân</td>
<td>211ii</td>
<td>12</td>
<td>V</td>
</tr>
<tr>
<td>n° 23</td>
<td>Tell Gufân</td>
<td>213</td>
<td>11</td>
<td>IV</td>
</tr>
<tr>
<td>n° 23</td>
<td>Tell Gufân</td>
<td>215 sud</td>
<td>9</td>
<td>III</td>
</tr>
<tr>
<td>n° 23</td>
<td>Tell Gufân</td>
<td>216d</td>
<td>9</td>
<td>III</td>
</tr>
<tr>
<td>n° 23</td>
<td>Tell Gufân</td>
<td>216df</td>
<td>9</td>
<td>III</td>
</tr>
<tr>
<td>n° 23</td>
<td>Tell Gufân</td>
<td>221</td>
<td>9</td>
<td>III</td>
</tr>
<tr>
<td>n° 23</td>
<td>Tell Gufân</td>
<td>223/1</td>
<td>9</td>
<td>III</td>
</tr>
<tr>
<td>n° 23</td>
<td>Tell Gufân</td>
<td>224</td>
<td>7</td>
<td>II</td>
</tr>
<tr>
<td>n° 23</td>
<td>Tell Gufân</td>
<td>403</td>
<td>13</td>
<td>VI</td>
</tr>
<tr>
<td>n° 23</td>
<td>Tell Gufân</td>
<td>408</td>
<td>10</td>
<td>III</td>
</tr>
<tr>
<td>n° 23</td>
<td>Tell Gufân</td>
<td>409</td>
<td>10</td>
<td>III</td>
</tr>
<tr>
<td>n° 23</td>
<td>Tell Gufân</td>
<td>411</td>
<td>8</td>
<td>II</td>
</tr>
<tr>
<td>n° 30</td>
<td>Tell Hrîm</td>
<td>400/1</td>
<td>14</td>
<td>V</td>
</tr>
<tr>
<td>n° 30</td>
<td>Tell Hrîm</td>
<td>400/2</td>
<td>14</td>
<td>V</td>
</tr>
<tr>
<td>n° 36</td>
<td>Qaryat Medâd</td>
<td>101</td>
<td>13</td>
<td>VI</td>
</tr>
<tr>
<td>n° 36</td>
<td>Qaryat Medâd</td>
<td>107</td>
<td>13</td>
<td>V</td>
</tr>
<tr>
<td>n° 36</td>
<td>Qaryat Medâd</td>
<td>120</td>
<td>7</td>
<td>lb</td>
</tr>
<tr>
<td>n° 36</td>
<td>Qaryat Medâd</td>
<td>603</td>
<td>13</td>
<td>V</td>
</tr>
<tr>
<td>n° 36</td>
<td>Qaryat Medâd</td>
<td>605</td>
<td>11</td>
<td>IV</td>
</tr>
<tr>
<td>n° 36</td>
<td>Qaryat Medâd</td>
<td>607</td>
<td>10</td>
<td>III</td>
</tr>
<tr>
<td>n° 36</td>
<td>Qaryat Medâd</td>
<td>607b</td>
<td>10</td>
<td>III</td>
</tr>
<tr>
<td>n° 36</td>
<td>Qaryat Medâd</td>
<td>Vd</td>
<td>10</td>
<td>III</td>
</tr>
<tr>
<td>n° 85</td>
<td>Dîbân 5</td>
<td>109</td>
<td>7</td>
<td>lb</td>
</tr>
<tr>
<td>n° 93</td>
<td>Shheîl 1</td>
<td>301</td>
<td>5</td>
<td>Ia</td>
</tr>
<tr>
<td>n° 93</td>
<td>Shheîl 1</td>
<td>301/2</td>
<td>14</td>
<td>Ia</td>
</tr>
<tr>
<td>n° 93</td>
<td>Shheîl 1</td>
<td>301/3</td>
<td>14</td>
<td>Ia</td>
</tr>
<tr>
<td>n° 93</td>
<td>Shheîl 1</td>
<td>603</td>
<td>5</td>
<td>lb</td>
</tr>
<tr>
<td>n° 93</td>
<td>Shheîl 1</td>
<td>605</td>
<td>5</td>
<td>lb</td>
</tr>
<tr>
<td>n° 93</td>
<td>Shheîl 1</td>
<td>606</td>
<td>5</td>
<td>lb</td>
</tr>
<tr>
<td>n° 93</td>
<td>Shheîl 1</td>
<td>610</td>
<td>5</td>
<td>lb</td>
</tr>
<tr>
<td>n° 93</td>
<td>Shheîl 1</td>
<td>611</td>
<td>6</td>
<td>lb</td>
</tr>
<tr>
<td>n° 93</td>
<td>Shheîl 1</td>
<td>612</td>
<td>6</td>
<td>lb</td>
</tr>
<tr>
<td>n° 93</td>
<td>Shheîl 1</td>
<td>614</td>
<td>6</td>
<td>lb</td>
</tr>
<tr>
<td>n° 93</td>
<td>Shheîl 1</td>
<td>615</td>
<td>6</td>
<td>lb</td>
</tr>
<tr>
<td>n° 93</td>
<td>Shheîl 1</td>
<td>617</td>
<td>6</td>
<td>lb</td>
</tr>
<tr>
<td>n° 93</td>
<td>Shheîl 1</td>
<td>621</td>
<td>7</td>
<td>lb</td>
</tr>
<tr>
<td>n° 93</td>
<td>Shheîl 1</td>
<td>624</td>
<td>7</td>
<td>lb</td>
</tr>
<tr>
<td>n° 162</td>
<td>Dîban 11</td>
<td>i</td>
<td>8</td>
<td>lb</td>
</tr>
<tr>
<td>n° 162</td>
<td>Dîban 11</td>
<td>ii</td>
<td>8</td>
<td>lb</td>
</tr>
<tr>
<td>n° 165</td>
<td>Safât ez Zerr</td>
<td>i</td>
<td>8</td>
<td>lb</td>
</tr>
<tr>
<td>n° 168</td>
<td>Shheîl 5</td>
<td>i</td>
<td>8</td>
<td>lb</td>
</tr>
</tbody>
</table>
Table 5 – Plant remains from the middle Euphrates Medieval Islamic excavations. Sample no.93-301 dates to the Umayyad period (first half of the 8th c.). The remaining samples in this table date to the Abbasid period (mid 8th c. - 9th c.). Scientific names follow Zohary and Hopf (1994) or Zeven and de Wet (1982) except for winter cereals which follow van Zeijl (1984).
<table>
<thead>
<tr>
<th>Archaeological period</th>
<th>Ib</th>
<th>Ic</th>
<th>Ia</th>
<th>Id</th>
<th>Ic</th>
<th>Ib</th>
<th>Ib</th>
<th>Archaeological period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site number</td>
<td>n93</td>
<td>n93</td>
<td>n93</td>
<td>n93</td>
<td>n93</td>
<td>n93</td>
<td>n93</td>
<td>Site number</td>
</tr>
<tr>
<td>Site name</td>
<td>Siheil 1</td>
<td>Siheil 1</td>
<td>Siheil 1</td>
<td>Siheil 1</td>
<td>Siheil 1</td>
<td>Site name</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Context number</td>
<td>611</td>
<td>612</td>
<td>614</td>
<td>615</td>
<td>617</td>
<td>Context number</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Context type</td>
<td>heath</td>
<td>heath</td>
<td>heath</td>
<td>tansour</td>
<td>tansour</td>
<td>Context type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soil volume (litres)</td>
<td>8</td>
<td>6</td>
<td>12</td>
<td>24</td>
<td>15.5</td>
<td>Soil volume (litres)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All identified economic parts</td>
<td>1</td>
<td>199</td>
<td>6</td>
<td>72</td>
<td>15</td>
<td>All identified economic parts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economic parts per litre (density)</td>
<td>0.13</td>
<td>33</td>
<td>0.5</td>
<td>3</td>
<td>0.97</td>
<td>Economic parts per litre (density)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**WINTER CEREALS**

| Hordeum grain, straight | 11 | Barley, straight grain |
| Hordeum grain, twisted | 14 | Barley, twisted grain |
| Hordeum grain, indeterminate | 1 | 25 | 2 | Barley, grain indeterminate |
| Hordeum/gramineae grain indet. | 1 | 1 | Barley/grass grain indeterminate |
| Hordeum distichon rachis | 3 | Two row barley rachis |
| Hordeum vulgare L. rachis | 10 | Six row barley rachis |
| Hordeum rachis: indeterminate | 6 | 4 | Free threshing wheat grain |
| Triticum durum: aestivum grain | 1 | 2 | Hard wheat rachis |
| Triticum durum: rachis | 1 | Bread wheat rachis |
| Triticum aestivum: rachis | 2 | 1 | Compact wheat rachis |
| Triticum free threshing rachis | 3 | Free threshing wheat rachis |
| Secale cereale grain | Rye grain |
| Winter cereal indet. grain | 0.5 ml | Winter cereal indet. grain |
| Winter cereal indet. rachis | 2 | Winter cereal indet. rachis |
| Winter cereal indet. awn | Winter cereal indet. awn |

**LEGUMES**

| Winter: Lens culinaris | 1 | Winter: lentil |
| Pisum sativum | Pea |
| Cicer arietinum | Chick pea |
| Vicia spp. | Vetch species |
| Vicia faba var. minor | Broad bean, small seeded form |
| Summer: Vigna unguiculata | Summer: cow pea |

**SUMMER FIELD CROPS**

| Gossypium herbaceum/arboresum seed | Old World cotton seed |
| G. herbaceum/arboresum boll base | Old World cotton boll base |
| Oryza sativa japonica grain | Temperate rice, grain |
| Oryza sativa japonica rachis | Temperate rice, rachis |
| Sesamum indicum | Sesame |
| Panicum miliaceum | Broomcorn millet |
| Setaria italica | Foxtail millet |
| Cultivated millet indeterminate | Cultivated millet indeterminate |

**FRUITS NUTS CONDIMENTS**

| Vitis vinifera seed | Grape seed |
| Vitis vinifera pedicel | Grape berry stem |
| Punica granatum | Pomegranate |
| Ficus carica | Fig |
| Persea vulgaris | Peach |
| Phoenix dactylifera | Date |
| Citrus limon | Lemon |
| Prunus domestica domestica | European plum |
| P domestica italic/sicula | Damson/greengage plum |
| P. domestica subspp. indet. | Plum; subspp. indeterminate |
| Prunus type | Plum-like seed |
| Cucumis melo/sativus | Melon/cucumber |
| Juglans regia | Walnut |
| Amygdalus communis | Almond |
| Coriandrum sativum | Coriander |
| Capparis spp. | Caper species |

Table 6 – Plant remains from the middle Euphrates Medieval Islamic excavations. All the samples in this table date to the Abbasid period (mid 8th - 9th c.). Scientific names follow Zohary and Hopf (1994) or Zeven and de Wet (1982) except for winter cereals which follow van Zeist (1984).
<table>
<thead>
<tr>
<th>Archaeological period</th>
<th>Ib</th>
<th>Jb</th>
<th>Jb</th>
<th>Jb</th>
<th>Jb</th>
<th>Archaeological period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site number</td>
<td>n°93</td>
<td>n°93</td>
<td>n°23</td>
<td>n°36</td>
<td>n°85</td>
<td>Site number</td>
</tr>
<tr>
<td>Site name</td>
<td>Shheil 1</td>
<td>Shheil 1</td>
<td>Guftân</td>
<td>Q. Medid</td>
<td>Dibân 5</td>
<td>Site name</td>
</tr>
<tr>
<td>Context number</td>
<td>621</td>
<td>624</td>
<td>224</td>
<td>120</td>
<td>109</td>
<td>Context number</td>
</tr>
<tr>
<td>Context type</td>
<td>floor</td>
<td>floor</td>
<td>around jar</td>
<td>floor</td>
<td>midden</td>
<td>Context type</td>
</tr>
<tr>
<td>Soil volume (litres)</td>
<td>18</td>
<td>1.5</td>
<td>3</td>
<td>12</td>
<td>42</td>
<td>Soil volume (litres)</td>
</tr>
<tr>
<td>All identified economic parts</td>
<td>2</td>
<td>1</td>
<td>14</td>
<td>15</td>
<td>14</td>
<td>All identified economic parts</td>
</tr>
<tr>
<td>Economic parts per litre (density)</td>
<td>0.11</td>
<td>0.7</td>
<td>4.7</td>
<td>1.3</td>
<td>0.33</td>
<td>Economic parts per litre (density)</td>
</tr>
</tbody>
</table>

### WINTER CEREALS

- **Hordeum grain, straight**
- **Hordeum grain, twisted**
- **Hordeum grain, indeterminate**
- **Hordeum/Brachytrium grain indet.**
- **Hordeum distichum L. rhabis**
- **Hordeum vulgare rhabis**
- **Hordeum rhabis: indeterminate**
- **Triticum durum/aestivum grain**
- **Triticum durum rhabis**
- **Triticum aestivum rhabis**
- **Triticum compactum rhabis**
- **Triticum free threshing rhabis**
- **Secale cereale grain**
- **Winter cereal indet. grain**
- **Winter cereal indet. rachis**
- **Winter cereal indet. awn**

### LEGUMES

- **Winter: Lens culinaris**
- **Pisum sativum**
- **Cicer arietinum**
- **Vicia spp.**
- **Vicia faba var. minor**
  - **Summer: Vigna unguiculata**
  - **Summer: cow pea**

### SUMMER FIELD CROPS

- **Gossypium herbaceum/t Borrem seed**
- **G. herbeceum/t Borrem bole base**
- **Oryza sativa japonica grain**
- **Oryza sativa japonica rachis**
- **Sesamum indicum**
- **Panicum miliaceum**
- **Setaria italica**
- **Cultivated millet indeterminate**

### FRUITS/NUTS/CONDIMENTS

- **Vitis vinifera seed**
- **Vitis vinifera pedicel**
- **Punica granatum**
- **Ficus carica**
- **Persica vulgaris**
- **Phoenix dactylifera**
- **Citrus limon**
- **Prunus domestica domestica**
- **P. domestica italic/insititia**
- **P. domestica subs. indet.**
- **Prunus type**
- **Cucumis melo/casinus**
- **Jasminum regia**
- **Amygdalus communis**
- **Cordiandrum sativum**
- **Capparis spp**

Table 7 — Plant remains from the middle Euphrates Medieval Islamic excavations. All the samples in this table date to the Abbasid period (mid 8th c. - 9th c.). Scientific names follow Zohary and Hopf (1994) or Zeven and de Wet (1982) except for winter cereals which follow van Zeist (1984).
<table>
<thead>
<tr>
<th>Site number</th>
<th>n°162</th>
<th>n°162</th>
<th>n°165</th>
<th>n°168</th>
<th>n°23</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site name</td>
<td>Dibān 11</td>
<td>Dibān 11</td>
<td>S. ez Zerr</td>
<td>Shheel5</td>
<td>Guftān</td>
</tr>
<tr>
<td>Context number</td>
<td>- i -</td>
<td>- ii</td>
<td>-</td>
<td>-</td>
<td>411</td>
</tr>
<tr>
<td>Context type</td>
<td>fill</td>
<td>fill</td>
<td>fill</td>
<td>fill</td>
<td>fill</td>
</tr>
<tr>
<td>Soil volume (litres)</td>
<td>14</td>
<td>11</td>
<td>42</td>
<td>10</td>
<td>20.5</td>
</tr>
<tr>
<td>All identified economic parts</td>
<td>52</td>
<td>20</td>
<td>310</td>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td>Economic parts per litre (density)</td>
<td>3.7</td>
<td>1.8</td>
<td>7.4</td>
<td>0.2</td>
<td>0.83</td>
</tr>
</tbody>
</table>

### WINTER CEREALS

| Hordeum grain, straight | 5 | 1 | Barley, straight grain |
| Hordeum grain, twisted | 1 | 9 | 2 | Barley, twisted grain |
| Hordeum grain, indeterminate | 1 | 11 | 1 | 6 | Barley, grain indeterminate |
| Hordeum/Grainaeae grain indet. |  |  |  |  | Barley/grain grain indeterminate |
| Hordeum distichum rachis | 3 |  |  |  | Two row barley rachis |
| Hordeum vulgare rachis | 1 | 5 | Barley rachis, indeterminate |
| Triticum durum/aestivum grain | 7 | 11 | 46 | 7 | Free threshing wheat grain |
| Triticum durum rachis | 13 | 61 | Hard wheat rachis |
| Triticum aestivum rachis | 61 |  |  |  | Bread wheat rachis |
| Triticum compactum rachis | 12 | 22 |  |  | Compact wheat rachis |
| Triticum free threshing rachis | 11 | 72 |  |  | Free threshing wheat rachis |
| Secale cereale grain |  |  |  |  | Rye grain |
| Winter cereal indet, grain | 0.7 ml |  |  |  | 0.1 ml | Winter cereal indet. grain |
| Winter cereal indet. rachis | 17 |  |  |  | Winter cereal indet. rachis |
| Winter cereal indet. awn |  |  |  |  | Winter cereal indet. awn |

### LEGUMES

| Lens culinaris | 1 | Winter: lentil |
| Pisum sativum |  | pea |
| Cicer arietinum |  | chick pea |
| Vicia spp |  | vetch species |
| Vicia faba var. minor |  | broad bean, small seeded form |
| Vigna unguiculata |  | Summer: cow pea |

### SUMMER FIELD CROPS

| Gossypium herbaceum/arboereum seed | 7 | Old World cotton seed |
| G. herbaceum/arboereum boll base |  | Old World cotton boll base |
| Oryza sativa japonica grain | 1 | Temperate rice, grain |
| Oryza sativa japonica rachis |  | Temperate rice, rachis |
| Sesamum indicum |  | Sesame |
| Panicum miliaceum | 1 | 2 | Broomcorn millet |
| Setaria italic |  | Foxtail millet |
| Cultivated millet indeterminate | 2 | 1 | 2 | Cultivated millet indeterminate |

### FRUITS/NUTS/CONDIMENTS

| Vitis vinifera seed | 1 | 8 | 1 | Grape seed |
| Vitis vinifera pedicel |  |  |  | Grape berry stem |
| Punica granatum |  |  |  | Pomegranate |
| Ficus carica |  |  |  | Fig |
| Persica vulgaris |  |  |  | Peach |
| Phoenix dactylifera |  |  |  | Date |
| Citrus limon |  |  |  | Lemon |
| Prunus domestica domestica |  |  |  | European plum |
| P. domestica italic/indet |  |  |  | Damson/greengage plum |
| P. domestica subsp. indet |  |  |  | Plum, subspecies indeterminate |
| Prunus type |  |  |  | Plum-like seed |
| Cucumis melo/latus | 1 |  |  | Melon/cucumber |
| Juglans regia |  |  |  | Walnut |
| Amygdalus communis |  |  |  | Almond |
| Coriandrum sativum |  |  |  | Coriander |
| Capparis spp |  |  |  | Caper species |

Table 8 – Plant remains from the middle Euphrates Medieval Islamic excavations. All samples except that from Tell Guftān date to the Abbasid period (mid 8th c. - 9th c.). Sample n° 23 Tell Guftān—411 dates to the Hamdanid period (first half 10th c.). Scientific names follow Zohary and Hopf (1994) or Zeven and de Wet (1982) except for winter cereals which follow van Zeist (1984).
<table>
<thead>
<tr>
<th>Archaeological period</th>
<th>Site number</th>
<th>Site name</th>
<th>Context number</th>
<th>Context type</th>
<th>Soil volume (litres)</th>
<th>All identified economic parts</th>
<th>Economic parts per litre (density)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>III</td>
<td>III</td>
<td>III</td>
<td>III</td>
<td>III</td>
<td>site number</td>
<td>context number</td>
</tr>
<tr>
<td></td>
<td>n°23</td>
<td>n°23</td>
<td>n°23</td>
<td>n°23</td>
<td>n°23</td>
<td>Guftin</td>
<td>215 sud</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>hearth</td>
<td>216d</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>midden</td>
<td>216d/f</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>oven</td>
<td>221</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>223/L</td>
</tr>
</tbody>
</table>

**WINTER CEREALS**

- Hordeum grain, straight: 2
- Hordeum grain, twisted: 4
- Hordeum grain, indeterminate: 7
- Hordeum/Graminaceae grain indet.: 1
- Hordeum distichicum rachis: 4
- Hordeum vulgare rachis: 10
- Hordeum rachis: indeterminate: 4
- Triticum durum/aestivum grain: 6
- Triticum durum rachis: 3
- Triticum aestivum rachis: 3
- Triticum compactum rachis: 3
- Triticum free threshing rachis: 3
- Secale cereale grain: 1
- Winter cereal indet. grain: 1
- Winter cereal indet. rachis: 1
- Winter cereal indet. awn: +

**LEGUMES**

- Pisum sativum: 1
- Cicer arietinum: 1
- Vicia spp: 1
- Vicia faba var. minor: 1

**SUMMER FIELD CROPS**

- Gossypium herbaceum/herbareum seed: 1
- G. herbaceum/herbareum boll base: 1
- Oryza sativa japonica grain: 1
- Oryza sativa japonica rachis: 1
- Sesamum indicum: 18
- Panicus miliaceum: 5
- Setaria italica: 48
- Cultivated millet indeterminate: 5

**FRUITS/NUTS/CONDIMENTS**

- Vitis vinifera seed: 3
- Vitis vinifera pedicel: 2
- Punica granatum: 2
- Ficus carica: 2
- Persica vulgaris: 2
- Phoenix dactylifera: 2
- Citrus limon: 2
- Prunus domestica domestica: 2
- P. domestica italica/italic: 2
- P. domestica subsap. indet.: 2
- Prunus type: 2
- Cucumis melo/sativus: 2
- Jujubas regia: 2
- Amygdalus communis: 2
- Coriandrum sativum: 2
- Capparis spp: +++

Table 9 — Plant remains from the middle Euphrates Medieval Islamic excavations. All samples date to the Mirdasid period (end of the 10th c. - third quarter 11th c.). Numbers in bold type indicate mineralised plant remains. Semi-quantitative scale: "+": 1-20 items; "++": 21-99 items; "+++": >99 items. Scientific names follow Zohary and Hopf (1994) or Zeven and de Wet (1982) except for winter cereals which follow van Zeist (1984).
Table 10 — Plant remains from the middle Euphrates Medieval Islamic excavations. All samples date to the Mirdasid period (end of the 10th c - third quarter 11th c.). Semi-quantitative scale: "+": 1-20 items. Scientific names follow Zohary and Hopf (1994) or Zeven and de Wet (1982) except for winter cereals which follow van Zeist (1984).
Table 11 — Plant remains from the middle Euphrates Medieval Islamic excavations. All samples date to the Saldjukid-Zenguid period (early 12th c. - third quarter 12th c.). Fig seeds in sample n°36-605 are not quantified because large numbers are embedded in charred matrix; there are hundreds of fig seeds in this sample. Scientific names follow Zohary and Hopf (1994) or Zeven and de Wet (1982) except for winter cereals which follow van Zeist (1984).
### Table 12 — Plant remains from the middle Euphrates Medieval Islamic excavations. All samples date to the Ayyubid period (end of 12th c. - first half 13th c.). Numbers in bold type indicate mineralised plant remains. Semi-quantitative scale: “+”: 1-20 items. Scientific names follow Zohary and Hopf (1994) or Zeven and de Wet (1982) except for winter cereals which follow van Zeist (1984).

<table>
<thead>
<tr>
<th>Archaeological period</th>
<th>V</th>
<th>V</th>
<th>V</th>
<th>V</th>
<th>V</th>
<th>Archaeological period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site number</td>
<td>n°23</td>
<td>n°23</td>
<td>n°23</td>
<td>n°23</td>
<td>n°23</td>
<td>Site number</td>
</tr>
<tr>
<td>Site name</td>
<td>Guf tán</td>
<td>Guf tán</td>
<td>Guf tán</td>
<td>Guf tán</td>
<td>Guf tán</td>
<td>Site name</td>
</tr>
<tr>
<td>Context number</td>
<td>203</td>
<td>205b</td>
<td>209</td>
<td>211i</td>
<td>211i</td>
<td>Context number</td>
</tr>
<tr>
<td>Context type</td>
<td>hearth</td>
<td>hearth</td>
<td>hearth</td>
<td>hearth</td>
<td>jar fill</td>
<td>Context type</td>
</tr>
<tr>
<td>Soil volume (litres)</td>
<td>37.5</td>
<td>7.5</td>
<td>2</td>
<td>4</td>
<td>3.5</td>
<td>Soil volume (litres)</td>
</tr>
<tr>
<td>All identified economic parts</td>
<td>527</td>
<td>332</td>
<td>17</td>
<td>90</td>
<td>18</td>
<td>All identified economic parts</td>
</tr>
<tr>
<td>Economic parts per litre (density)</td>
<td>14</td>
<td>44</td>
<td>8.5</td>
<td>23</td>
<td>5.1</td>
<td>Economic parts per litre (density)</td>
</tr>
</tbody>
</table>

#### WINTER CEREALS

| Hordeum grain, straight | 7 | Barley, straight grain |
| Hordeum grain, twisted  | 17 | Barley, twisted grain |
| Hordeum grain, indeterminate | 16 | Barley, grain indeterminate |
| Hordeum/Gramineae grain indet. | 1 | Hordeum/grain indeterminate |
| Hordeum distichum rachis | 24 | Two row barley rachis |
| Hordeum vulgare rachis | 14 | Six row barley rachis |
| Hordeum rachis: indeterminate | 94 | 2 | 2 | Barley rachis, indeterminate |
| Triticum durum/aeustium grain | 14 | 11 | Free threshing wheat grain |
| Triticum durum rachis | 60 | 1 | Hard wheat rachis |
| Triticum aestivum rachis | 54 | Bread wheat rachis |
| Triticum compactum rachis | 16 | Compact wheat rachis |
| Triticum free threshing rachis | 46 | 1 | Free threshing wheat rachis |
| Secale cereale grain | 1 | Eye grain |
| Winter cereal indet. grain | 0.1 ml | 1 | Winter cereal indet. grain |
| Winter cereal indet. rachis | 54 | Winter cereal indet. rachis |
| Winter cereal indet. awn | + | Winter cereal indet. awn |

#### SUMMER FIELD CROPS

| Gossypium herbaceum/arboreum seed | 4 | 273 | 70 | 2 | Old World cotton seed |
| G. herbaceum/arboreum boll base | 1 | Old World cotton boll base |
| Oryza sativa japonica grain | 1 | 2 | Temperate rice, grain |
| Oryza sativa japonica rachis | 2 | Temperate rice, rachis |
| Sesamum indicum | 17 | Sesame |
| Panicum milaceum | 12 | 2 | 3 | Broomcorn millet |
| Setaria italica | 3 | Foxtail millet |
| Cultivated millet indeterminate | 3 | Cultivated millet indeterminate |

#### FRUITS/NUTS/CONDIMENTS

<p>| Vitis vinifera seed | 27 | 2 | 1 | 6 | 1, 12 | Grape seed |
| Vitis vinifera pedicel | 2 | Grape berry stem |
| Punica granatum | 5 | 1 | 1 | Pomegranate |
| Ficus carica | 17, 4 | 1 | 6 | 2 | Fig |
| Persica vulgaris | | | | | Peach |
| Phoenix dactylifera | | | | | Date |
| Citrus limon | 1 | Lemon |
| Prunus domestica domestica | European plum |
| P. domestica italic/insititia | Damson/greenpage plum |
| P. domestica subsp. indet. | Plum, subspecies indeterminate |
| Prunus type | | | | | Plum-like seed |
| Cucumis melo/attivus | 2 | Melon/cucumber |
| Juglan regia | | | | | Walnut |
| Amygdalus communis | | | | | Almond |
| Coriandrum sativum | | | | | Coriander |
| Capparis spp. | | | | | Caper species |</p>
<table>
<thead>
<tr>
<th>Archaeological period</th>
<th>V</th>
<th>V</th>
<th>VI</th>
<th>VI</th>
<th>Archaeological period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site number</td>
<td>n°36</td>
<td>n°36</td>
<td>n°36</td>
<td>n°23</td>
<td>Site number</td>
</tr>
<tr>
<td>Site name</td>
<td>Q. Medad</td>
<td>Q. Medad</td>
<td>Q. Medad</td>
<td>Guffin</td>
<td>Site name</td>
</tr>
<tr>
<td>Context number</td>
<td>107</td>
<td>603</td>
<td>101</td>
<td>408</td>
<td>Context number</td>
</tr>
<tr>
<td>Context type</td>
<td>hearth</td>
<td>hearth</td>
<td>hearth</td>
<td></td>
<td>Context type</td>
</tr>
<tr>
<td>Soil volume (litres)</td>
<td>28</td>
<td>41</td>
<td>7.5</td>
<td>14</td>
<td>Soil volume (litres)</td>
</tr>
<tr>
<td>All identified economic parts</td>
<td>14</td>
<td>8706</td>
<td>1008</td>
<td>651</td>
<td>All identified economic parts</td>
</tr>
<tr>
<td>Economic parts per litre (density)</td>
<td>0.5</td>
<td>212</td>
<td>134</td>
<td>45</td>
<td>Economic parts per litre (density)</td>
</tr>
</tbody>
</table>

**WINTER CEREALS**

- **Hordeum**
  - **Hordeum sp.**
  - **Hordeum distichon**
  - **Hordeum vulgare**
  - **Hordeum tigrinum**
  - **Triticum durum**
  - **Triticum tauschii**
  - **Triticum aestivum**
  - **Secale cereale**

**LEGUMES**

- **Lens culinaris**
- **Pisum sativum**
- **Cicer arietinum**
- **Vicia faba**

**SUMMER FIELD CROPS**

- **Gossypium hirsutum**
- **Gossypium herbaceum**
- **Oryza sativa**
- **Sesamum indicum**
- **Panix tenuiflorus**
- **Sesbania sesban**

**FRUITS/NUTS/CONDIMENTS**

- **Vitis vinifera**
- **Vitis vinifera**
- **Punica granatum**
- **Ficus carica**
- **Persia vulgaris**
- **Phoenix dactylifera**
- **Ceris pinnata**
- **Prunus domestica**
- **P. domestica**
- **Prunus domestica**
- **Cucumis melo**
- **Iuglans regia**
- **Ammococcus**
- **Coriandrum sativum**
- **Capparis spp.**

Table 13 - Plant remains from the middle Euphrates Medieval Islamic excavations. Samples n°36-107 and n°36-603 date to the Ayyubid period (end of 12th c. - first half 13th c.); samples n°36-101 and n°23-403 date to the Mamluk period (second half of the 13th century - 16th century). Numbers in bold type indicate mineralised plant remains. Semi-quantitative scale: "c": 1-20 items; "++": 20-99 items; "+++": >99 items. Scientific names follow Zohary and Hopf (1994) or Zeven and de Wet (1982) except for winter cereals which follow van Zeist (1984).
Table 14 — Plant remains from the middle Euphrates Medieval Islamic excavations. These samples were “quick-scanned” to look for the presence of plant remains, and none of the species identified has been quantified. The samples date to various periods. The samples dating to period VI are from surface cleaning and may therefore be contaminated. They are not entirely reliable indicators of species present during that time. Scientific names follow Zohary and Hopf (1994) or Zeven and de Wet (1982) except for winter cereals which follow van Zeist (1984).
The quantity and diversity of plant remains differ markedly according to period. The earliest periods sampled were either from site n°93 Shheil 1, or from the deepest levels of site n°36 Qaryat Medād and n°23 Tell Guftān. At n°93 Shheil 1, the archaeology was close to the surface and plant preservation was very poor. Access was highly restricted in the lowest levels of n°36 Qaryat Medād and n°23 Tell Guftān, and therefore sampling was limited. Few samples were taken from the latest period of these sites. Of these, the two quickly scanned samples from Tell Guftān (n°23-201i and n°23-201ii) come from surface levels. Since the content and appearance of these samples closely match the rest of the ancient assemblage, I assume that these plant remains are ancient and are unlikely to be contaminated by modern plant material.

ARCHAEOBOTANICAL RESULTS

INTRODUCTION

This section summarises the economic plant species and their general pattern of occurrence. The economic plants have been divided into three main categories according to their agricultural ecology. The winter field crops are annuals planted in autumn in large plots, as individual species (for example bread wheat) or crop type (for example wheat). They ripen and are ready for harvest in spring. At these sites the winter field crops are the cereals barley and wheat, and the legumes lentil, pea, chick pea and broad bean. Their agronomy and uses are well known and useful summaries are provided in Zohary and Hopf (1993). They have not therefore been discussed in any detail in this report. The summer field crops are also annuals grown on an extensive scale. Fast growing, they are planted in spring or early summer and ripen in late summer or autumn. The summer field crops retrieved are cotton, rice, sesame and temperate millet. Although mostly well known for modern agronomy, they have so far been little found archaeobotanically. Their presence is also directly relevant to the aims of this report. Each of the four summer field crops have therefore been described in some detail. The fruits, nuts and condiments may be annuals or perennials. They may have been grown as single crops, such as grapes in vineyards, or they may have been planted together in orchards and garden plots. Their agronomy and uses are briefly discussed on pages 406-418, Husbandry and uses of fruits, nuts and condiments.

Interpretations of specific contexts and their associated plant remains, together with discussion and interpretation of the overall pattern of plant remains, are presented on pages 423-438, Medieval Islamic agronomy and crop use in the middle Euphrates valley. The plant identifications for each sample are laid out in detail in Tables 5-14, while Figure 6 summarises the archaeobotanical data by period.

Due to the low numbers of samples for most periods, the lack of diversity in context types sampled, and the general low density of economic plant remains from most samples (see Figures 5 and 6), analytical calculations such as percentages, ubiquity and diversity (e.g. Popper, 1988) are not applicable to this assemblage. This report relies primarily on simple presence of species over time. Ubiquity, that is, the number of samples in which the taxon appears within a group of samples (Popper, 1988: 61), can indicate a broad pattern of plant use. Because of the limitations of this assemblage, I have not attempted to make comprehensive
calculations of ubiquity, but I have distinguished between common (ubiquitous and/or abundant) and rare species.

The relative abundance of different remains is in general not a reliable indicator of past importance. Although species which are very abundant and very ubiquitous probably were important at these sites, the status of rare finds, especially those unlikely to have been in contact with fire, remains uncertain. The counts in Tables 5-13 are presented in detail for several reasons. The absolute counts reflect the quality of the data, and where counts per sample are low, indicate that many species may well be missing from the record of particular periods or sites. If, in future, archaeobotanical work is done at similar sites, samples from the assemblage discussed in this report may be compared and perhaps interpreted in more detail. In some individual contexts where samples are distinctive or very rich, it has been possible to comment on their composition and the ancient activities which may have led to their deposition.

Reasonable numbers of economic plant remains were recovered from most periods, but Period Ia and, especially, Period II are very poorly represented (see Figure 6). The scanned extra samples from Period Ia (Table 14) has added to the range of species known for this period, allowing a somewhat better understanding of the general agricultural regime at this time. Unfortunately Period II, represented by a single poor sample, remains an obscure period archaeobotanically.

The remains of the economic plants recovered from these sites were derived either from crops grown locally or from imports. Some species have been identified as imports on the basis of their ecological requirements (see page 430: Possible imports). Where by-products, for example cereal chaff, of crop processing are found, this is good evidence that these crops were grown, harvested and processed near the villages. If imported, only the more-or-less clean crop products would have been present at these sites. Crop by-products are frequent in this assemblage from wheat, barley and rice in the form of cereal chaff (rachises), and from cotton as seeds. The abundant presence of these by-products is good evidence that widespread agriculture was being practised by the inhabitants of these sites, and that the other recovered crops which were suited to conditions in the middle Euphrates valley were also being grown there.

**WINTER FIELD CROPS**

Winter cereals are very common throughout the archaeological sequence; they are present in nearly every analysed sample. They are barley, free threshing wheat and rye. Rye (Figure 8) occurs only as a few grains in Period V (n°23-205b, hearth, Table 12 and n°36-603, hearth, Table 13) and Period VI (n°23-403, hearth, Table 13). The legumes are fairly infrequent, and with the exception of lentil, occur in very low numbers.

Barley species differ according to the number of fertile spikelets on each rachis internode (Figure 9). Two row barley has one fertile spikelet per internode while six row barley has three (Zohary and Hopf, 1993: 55). As with many Near Eastern sites of all periods, both six row barley and two row barley have been recovered from the Medieval settlements, both as grain and as rachis fragments (pieces of the central stalk of the ear, to which the grains are attached). Barley grain is found in all periods, and rachises from all except Period II. The lack
of barley rachises in general in Period II, and of two row barley rachises in Period Ia and II, is most likely due to the overall low recovery of plant remains from these levels.

It is not possible to say whether two row or six row barley was more common. In this assemblage, barley rachises are always dominated by those which are relatively poorly preserved and thus cannot be precisely identified. Twisted barley grain, indicative of six row barley, is often more common than straight grain (produced by both six row and two row barley), but where barley grain occurs in any quantity, there is always a significant quantity of indeterminate grain. For typical examples of this pattern, see samples n°36-603 (Period V hearth, Table 13) and n°23-403 (Period VI hearth, Table 13).

Three wheat species were cultivated: hard wheat, bread wheat, and compact wheat. Hard and bread wheats have different culinary properties. Compact wheat is closely related to bread wheat, but has a very short ear (Figure 10). All these wheats are processed in the same way, requiring threshing to break up the ears, and then winnowing and sieving to separate the grain from the chaff (Hillman, 1985). As with barley grain, free threshing wheat grain occurs in all periods and apart from the poorly represented Periods Ia and II, wheat rachises are present at all periods. No compact wheat rachises were identified for Period III (Figure 6).

The low numbers of items for many samples and their mixed nature means that it is not possible to determine whether these wheat species were grown mixed together or as separate crops. The relative proportion of the different wheats is also hard to establish. It appears that the quantities of hard wheat and bread wheat are about the same, but there is much less compact wheat. However, there are large quantities of relatively poorly preserved wheat rachises which cannot be identified to species. Sample n°36-603 (Period V hearth, Table 13) is typical of this pattern.
Lentils, peas and chickpeas played a role in the agricultural system at these sites throughout their occupation. As a group, the winter legumes are poorly represented throughout the sequence but they were recovered from all levels except Period II. Where archaeobotanical preservation is better (i.e. after Period II), the winter legumes have been recovered more often.

Of the winter legumes, lentils are the most commonly encountered. Occasionally they are relatively concentrated, such as in sample n°23-210 (Period IV fill, Table 11) and n°36-603 (Period V hearth, Table 13). Both peas and especially chickpeas are rare. Peas appear occasionally throughout the sequence in low numbers, but only three samples contain chickpea (n°93-401/2, Period Ia, Table 14; n°23-221, Period III, Table 9; n°36-101, Period VI, Table 13). Perhaps they rarely came into contact with fire in their whole form and so are under-represented in the archaeobotanical record. Broad bean was recovered from two sites, sample n°36-605 (Period IV hearth, Table 11) and n°23-203 (Period V hearth, Table 12). The numbers recovered are unlikely to reflect the relative importance of these species.

SUMMER FIELD CROPS

The summer field crops recovered from these sites are cotton, rice, sesame and temperate millet.

Two parts of the cotton plant were identified, the seeds and the boll bases (the attachment and base of the bracts of the seed case). Boll bases were recovered only from Periods IV and V, the best represented periods in the archaeobotanical assemblage. Almost all the boll bases came from one of the richest samples, n°36-605 (Period IV hearth, Table 11). The one other
find was in sample N°23-203 (Period V hearth, Table 12). There are no cotton seeds in samples from Periods Ia or II, but cotton seeds are present throughout the rest of the sequence, sometimes in large numbers. Three samples are particularly rich in cotton seeds: N°36-605 (Period IV hearth, Table 11), N°23-205b (Period V hearth, Table 12), and N°23-211i (Period V jar pit, Table 12). As with the other remains from this sample, the cotton seeds from N°23-211i are mineralised.

Rice grains are uncommon at all periods but absent in Periods II and VI. Rice rachises are even more rare. They are almost all concentrated in two samples, N°23-408 (Period III midden, Table 10) and N°36-603 (Period V hearth, Table 13). A single example was found in another Period V hearth, N°23-209 (Table 12). The tiny size of the rice rachis means that it is likely to be burnt away to ash, and therefore may well be under-represented archaeobotanically.

Apart from Period II, sesame seeds appear in all levels except Period VI. They are generally uncommon, which is unsurprising, since their high oil content makes them highly flammable. The most concentrated find of sesame is from a Period Ib hearth at Tell Shheil 1, N°93-612 (Table 6); this sample contains nearly 200 seeds.

Two species of millet were cultivated, broomcorn millet and foxtail millet. Millet occurs throughout the sequence (apart from Period II) and is concentrated in Periods III, V and VI (see Table 15). Millet is one of the most abundant finds and is relatively ubiquitous, occurring in 22 out of 42 samples analysed in detail (52%). If the poorly preserved samples from Periods Ia, Ib and II are discounted, then millet occurs in 16 out of 22 samples analysed for Periods III-VI (73%). This suggests it was an important summer crop.

<table>
<thead>
<tr>
<th>Period</th>
<th>Total number of samples</th>
<th>Broomcorn (P. miliaceum)</th>
<th>Foxtail (S. italica)</th>
<th>Cultivated unidentified</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Number</td>
<td>Percent</td>
<td>Number</td>
</tr>
<tr>
<td>Ia</td>
<td>1</td>
<td>1</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>Ib</td>
<td>18</td>
<td>5</td>
<td>45.5</td>
<td>1</td>
</tr>
<tr>
<td>II</td>
<td>1</td>
<td></td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>10</td>
<td>227</td>
<td>72</td>
<td>69</td>
</tr>
<tr>
<td>IV</td>
<td>3</td>
<td>19</td>
<td>95</td>
<td>1</td>
</tr>
<tr>
<td>V</td>
<td>7</td>
<td>1356</td>
<td>99.5</td>
<td>4</td>
</tr>
<tr>
<td>VI</td>
<td>2</td>
<td>543</td>
<td>98.5</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 15 — Total numbers and percentages of cultivated millet seeds by period.

Since nearly all recovered millet seeds could be identified to species, it is possible to suggest the relative importance of the two species at these sites. In only one sample, N°23-216d (Period III hearth, Table 9), are the numbers of broomcorn and foxtail millet nearly equal. Otherwise, broomcorn millet is by far the most numerous species (Table 15). Wild millet and other probable weeds of millet (not recorded in the score sheets) always outnumber the finds of foxtail millet. In Period III, foxtail millet makes up 22% of the millet finds, but by Period V it makes up only 0.3% and in Period VI only 0.4% of all cultivated millet. In later periods, foxtail millet may well have been a tolerated contaminant or a weed of the broomcorn millet fields. It seems clear from these results that broomcorn millet was more extensively cultivated than foxtail millet.
FRUITS, NUTS AND CONDIMENTS

A wide range of fruits, nuts and condiments were obtained from deposits spanning the Medieval settlement, but most species appear rarely in the overall assemblage. Grape is the best represented fruit, while numerous pomegranate and fig seeds were recovered from later periods. The occasional fruits are peach, date, lemon, the plum group, and melon or cucumber. The remains of two nut species, almond and walnut, were recovered. Evidence for ancient condiments is rare but in this assemblage a few seeds of caper and coriander were found.

The only fruit which is definitely present throughout the whole settlement of these sites is the grape, and it is by far the most abundant fruit species recovered. It is represented mainly by seeds, but also by fruit pedicels, the woody stalks which attach each grape to the stem. The grape is one of the three crops present in the single sample from Period II (n°23-411, fill, Table 8). Grape seeds and pedicels are preserved in enormous numbers in sample n°36-605 (Period VI hearth, Table 11), and contribute by far the largest proportion of the plant remains in that sample, and to the period as a whole. Sample n°36-603 (Period V hearth, Table 13) also contains huge quantities of grape pips, but many fewer pedicels.

No pomegranate remains could be identified with certainty prior to Period III. Apart from the rich deposit of fruits in sample n°36-605 (Period IV hearth, Table 11), pomegranate seeds are present in low numbers, but from Period III onwards they are fairly ubiquitous, appearing in 16 out of 26 samples (62%). In general, whole or nearly complete pomegranate seeds are not common, and this fruit is mainly represented by seed fragments.

Fig seeds are well represented from Periods III, V and VI. They are present in 20 out of 26 later period samples (77%), including those which were quickly scanned (Table 14). No fig seeds were found in the samples from Periods Ia, Ib or II. The low sample numbers and soil volumes processed from Periods Ia and II mean no conclusions can be drawn about the presence of fig at these times. Figs produce tiny seeds, but the 17 samples and over 300 litres of soil processed from Period Ib levels, together with the use of 1 and 0.25 millimetre sieves throughout all flotation, means that archaeobotanical field processing is unlikely to be the reason for their absence in the early levels (Zohary and Hopf, 1993: 152). Even discounting the particularly rich samples from Qaryat Medâd (n°36-605, Table 11, and n°36-603, Table 13), there is good recovery of fig seeds from later levels, where fewer samples than for Period Ib were taken. Lack of evidence is not proof of absence, but the extensive sampling of Period Ib would lead one to expect that, if fig were grown at this date, it should have been found in at least one sample. Although it seems unlikely it is possible that, for some reason, fig trees were not grown at these settlements prior to Period III.

There are two finds of peach stone from these sites, widely separated in date. One comes from a Period Ib midden excavated at n°85 Dibân 5 (n°85-109, Table 7); the other from n°36-605 (Period IV hearth, Table 11). The peach stone and the grape finds are the only evidence for perennial crops in Period Ib.

As with finds of peach, the very few finds of date stones come from two well-separated periods. Date was recovered from a Period Ia quick-scanned sample, n°93-401/3 (around tannour, Table 14). Four date stones or date stone fragments were recovered from Period IV, all from sample n°36-605 (hearth, Table 11).
Four samples, from the middle occupation periods, contain lemon seeds. Some were found in sample n°36-605 (Period IV hearth, Table 11), which contains nearly all the different species of fruits and nuts found in this Medieval assemblage as a whole. Lemon is quite well represented in Period V. One mineralised seed was recovered from n°23-211i (around jar, Table 12), while both Period V quick-scanned samples (n°30-400/1 and n°30-400/2, jar fills, Table 14) contain lemon seeds.

Plums are certainly present in this assemblage (see Table 16) but can only be identified with certainty from the middle occupation levels, Periods III, IV and V. Several definite finds cannot be identified to sub-species, but 13 specimens from n°36-605 (Period IV hearth, Table 11) were sufficiently well-preserved that the type of plum can be determined. Both European plums and damson/greengage plums have been recovered. The latter tend to be relatively small trees with smaller, rounder fruits compared to the European plums, but plum varieties are highly variable in fruit form, shape and colour, as well as in form of the trees. There are a number of plum-like seeds in this assemblage, which strongly resemble the internal kernel of the plum fruit, but they may come from another member of the Rosaceae family.

<table>
<thead>
<tr>
<th>Period</th>
<th>Sample</th>
<th>Main Table</th>
<th>European plum</th>
<th>Damson/ greengage</th>
<th>Plum; species indeterminate</th>
<th>Plum-like seed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ib</td>
<td>n°85-109</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>III</td>
<td>n°23-221</td>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>III</td>
<td>n°23-409</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>IV</td>
<td>n°36-605</td>
<td>11</td>
<td>5</td>
<td>8</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>V</td>
<td>n°23-211i</td>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>V</td>
<td>n°36-107</td>
<td>13</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 16 — Finds of plum and plum-like seeds.

Seeds of melon or cucumber (or perhaps both) are rare. They appear only at the beginning and end of the archaeobotanical record. One melon/cucumber seed was recovered from the Period Ib fill sample n°168 (Table 8). Melon/cucumber does not occur again until Period V; some seeds were found in the hearth sample n°36-603 (Table 13) and two mineralised seeds were recovered from n°23-211i (around jar, Table 12). A concentration of 11 seeds are contained in the Period VI hearth sample n°36-101 (Table 13).

Cow pea, a summer-grown legume, is very rare. Although only three specimens have been recovered, they come from two different sites. Two cow pea seeds were identified in n°36-605 (Period IV hearth, Table 11) and one comes from n°23-221 (Period III midden, Table 9). Their rarity reflects the likelihood that this crop hardly ever comes into contact with fire, and the extent of its cultivation is uncertain. Since it has been found at two different settlements, it may not have been as uncommon as the archaeobotanical finds suggest.

The evidence for nuts is also rare. The only definite identification of walnut comes from sample n°36-605 (Period IV hearth, Table 11), from which a few distinctive shell fragments were retrieved. This sample also contains the only finds of almond shell, which comes from at least two separate almond fruits.
Condiments rarely come into contact with fire, and if remains of their preparation are discarded on the hearth, they are likely to be ground up or otherwise rendered unrecognisable. As a result, they are normally an unusual component of the archaeobotanical record. At these sites, caper seeds appear occasionally throughout the sequence. Very few seeds were found in the earliest levels (one in n°36-120, Period Ib floor, Table 7) and latest levels (six in n°36-107, Period V floor, Table 13, and one in n°36-101, Period VI hearth, Table 13). In Period III, however, there are large concentrations in two hearth samples, n°23-216d and n°23-216d/f (Table 9). Coriander is very rare; it is represented in Period Ia in sample n°93-401/3 (around tannour, Table 14) and there is a single coriander seed in the Period V sample n°36-603 (hearth, Table 13).

COTTON HUSBANDRY AND USES

DESCRIPTION OF THE COTTON PLANT

There are two cultivated species of Old World cotton: *Gossypium herbaceum* which can grow as an annual, a biennial, or more rarely, as a perennial plant; and the strictly perennial *Gossypium arboreum*. Genetically, the two are closely related and produce similar short fibres (Zohary and Hopf, 1993: 127). The height and degree of branching depends on the species and variety, but both are erect shrubs or sub-shrubs (Fryxell, 1979: 46) and can range from about 0.6 to 3 m high (Hutchinson and Ghose, 1937: 246, 249). Cotton is an attractive plant. The broad lobed leaves are dark green to reddish, and the showy, delicate flowers have the texture of crêpe paper (Figure 11). *G. arboreum* petals are red, yellow or white, and may or

![Figure 11 — Cotton (*Gossypium herbaceum*). From Balfour (1885: 230).]
may not have a red spot at the base (Hutchinson and Ghose, 1937: 246). Those of *G. herbaceum* are pale yellow, rarely white, and usually have a red spot at the base (Hutchinson and Ghose, 1937: 249). At the base of the cotton flower is a type of modified leaf called a bracteole. Bracteoles on both species have fringed edges, but their shape as well as the number and shape of the teeth are species-specific.

The fruits of cotton are called bolls (Figure 12). Those of *G. herbaceum* are 2.5 to 4.5 cm long (Hutchinson and Ghose, 1937: 249). Each boll consists of a capsule divided into three to five sections, called locules, each of which contains many seeds. The fibres, from which textiles are made, are an integral part of the seed, formed by elongations of cells on the seed coat. Both short hairs, called fuzz, and long hairs, called lint or staple, are produced (Robbins, 1931: 490), but it is only the latter which can be worked. Each fibre is hollow, and upon maturity, dries, collapses, and develops many twists along its length. These twists give strength to the fibres, allowing them to interlock and be spun (Watt, 1889: 32-33).

**Figure 12 — Cotton bolls (New World species) ready for harvest.**

**AGRICULTURAL REQUIREMENTS FOR COTTON**

Wild cotton is tropical in distribution and cotton must have been taken into cultivation somewhere in the tropics (Zohary and Hopf, 1993: 128). Although there are annual cultivated cotton varieties which are well adapted to the temperate zones, in particular the longer daylight hours, the husbandry requirements of cotton in temperate climates reflect the tropical origins of the crop.

Successful cultivation of cotton requires hot temperatures. The cotton crop is limited to those regions where the average summer temperature is at least 21-22°C during the growing season, and it cannot grow when the summer temperature falls below 15°C (Langer and Hill, 1982: 261). Some authors state the summer average temperature needs to be 25°C for proper development (Robbins, 1931: 497; Klages, 1942: 500). In practice, the boundary of cultivation is at a latitude of 40° (Langer and Hill, 1982: 261).

The date of first frost is also influential, for a light autumn frost may stop development, even if the plant is not killed. Cotton requires a growing season of at least 180 days (6 months), and up to 7 months (Whitney, 1896: 144; Robbins, 1931: 497). The interval between flower fertilisation and boll opening is 50-60 days (7-8.5 weeks). Thus it needs to be sown as early as possible to achieve a maximum growing season (Langer and Hill, 1982: 262). Buchanan notes that in regions of the American south west and China, where frost is early, cotton can be harvested before it is ripe and well dried before the fibres are removed (Buchanan, 1987: 20). However, she does not state how this may affect the quality.
Ample supplies of both sunshine and water are needed during growth. Sun is especially important during early growth and flowering. A minimum of the equivalent of 500 mm of water is necessary (Langer and Hill, 1982: 262), but heavy rain is especially harmful during flowering and ripening (Guthrie, 1798: 218). Growth under good irrigation is therefore most successful.

According to Langer and Hill (1982: 261) and Whitney (1896: 153), cotton does not have critical soil type requirements, but Whitney notes that the soil type may affect the yield. Klages (1942: 262) advocates a soil with good moisture holding capacity, good drainage and aeration, and a pH of 5.2-7. The soil should be thoroughly worked to create a good seed bed (Langer and Hill, 1982: 262). Cotton is sensitive to salinity during germination, but thereafter is highly tolerant (Farnworth, 1997: 301).

A report on optimum Syrian cotton cultivation techniques makes the following recommendations (International Bank for Reconstruction and Development, 1955: 306-8). Depending on the weather and region, seeding should take place in April to May. If ploughing is done manually, it should be done 2 or 3 times. Cotton should be planted at a density of not more than four seeds per hole; a spacing of 25x60 centimetres, or 120,000 to 150,000 plants per hectare, encourages early maturity. Wide spacing encourages more vegetative growth, late maturity, and thus greater vulnerability to pests. The first irrigation should be applied immediately after sowing and repeated every 10-15 days until about 80% of the bolls have formed. After harvest, the cotton stalks should be removed to eliminate a possible haven for pests, which could infect the next year’s crop. This report specifically states that rainfed areas are not suitable for cotton cultivation in Syria.

TRADITIONAL COTTON HUSBANDRY

Reports of traditional cotton husbandry on the borders of the Caspian Sea in northern Persia state that farmers worked the ground in spring and sowed between the end of March and end of April (Guthrie, 1798: 218). Dunn notes that cotton was sometimes sown broadcast, but usually was planted by hand in ridges (Dunn, 1952: 78). A hole was dug with a small hand tool, into which 5-7 seeds were dropped. These had been soaked overnight to soften the seed coat and encourage germination. Guthrie records that seeds were planted between 20-25 centimetres apart (Guthrie, 1798: 218). In northern Persia, the fields may have been manured with dung, but once the plants sprouted, manuring was not necessary (Guthrie, 1798: 218). The young plants were well weeded, using short handled hoes or knives (Dunn, 1952: 78; Guthrie, 1798: 218). Farmers aimed to provide as much water as possible during growth (Dunn, 1952: 78). Today, the main summer crop in the Syrian middle Euphrates valley is cotton.

Cotton is very vulnerable to insect damage because the developing fibres are rich in sugars (Buchanan, 1987: 19). The main pests of cotton in the Near East today are the spiny boll worm (Earias insulana Boisd.) and the locust (Dunn, 1952: 81). North Persian farmers sometimes applied a mixture of wood-ash and water to the young plants to protect against insects (Guthrie, 1798: 219). Harvesting was by hand picking (Dunn, 1952: 78), whereby the cotton lint, along with its attached seeds, is pulled out of the dried boll still attached to the plant in the field (Schlingloff, 1974: 83). This is still the most common method of harvesting in most parts of the world today.
COTTON HUSBANDRY ACCORDING TO MEDIEVAL ISLAMIC SOURCES

Ibn al-Awam quotes Ibn el-Fa‘el on the cultivation of cotton in Syria (Ibn al-Awam, 1977: 103-104). There, the ground was prepared up to a year in advance, fertilising it with manure and removing large stones. The fields were divided into squares and irrigated. When the soil was moist and soft, the cotton was planted. Two or three seeds were placed into a hole at a depth of about one finger's length, and the holes were about a third of a meter apart. No further watering was applied until the young plants had reached a height of about twenty centimetres. After this, weeding and irrigation took place at fifteen day intervals until the beginning of August. Then water was withheld to reduce vegetative growth and encourage flowering. The plants might also be pruned back at this stage. The harvest was in September - presumably towards the end of the month. The lint was gathered by hand in the morning; picking any of the capsule was carefully avoided. The harvested cotton was sun-dried and stored. Throughout Ibn al-Awam's account, he stresses the need for adequate moisture, thorough weeding, and extols the virtues of good manuring, which, he says, improves the quality and abundance of the lint (Ibn al-Awam, 1977: 105).

Ibn al-Awam also quotes the Book of Nabatean Agriculture (Ibn al-Awam, 1977: 105). This recommends avoiding soil which is saline or acidic. This book records that sowing was carried out in April, and surprisingly, the cotton was ready for harvest at the end of July and August. This seems too short a time for ripening. El-Sammaraie provides further details (El-Sammaraie, 1972: 61, 62, 66ff). Cotton was sometimes irrigated by means of furrows through the fields, but usually was planted in beds or basins which could be thoroughly flooded during irrigation periods. Irrigation intervals were recommended to be every ten days. The agricultural calendar for cotton given in the Book of Nabatean Agriculture is laid out in Table 17.

<table>
<thead>
<tr>
<th>MONTH</th>
<th>AGRICULTURAL ACTIVITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>January, February</td>
<td>Preparing and ploughing the land</td>
</tr>
<tr>
<td>March (2nd half of the month)</td>
<td>Early planting</td>
</tr>
<tr>
<td>April</td>
<td>Planting</td>
</tr>
<tr>
<td>May</td>
<td>Late planting</td>
</tr>
<tr>
<td>June</td>
<td>Weeding</td>
</tr>
<tr>
<td>July-November</td>
<td>Harvesting by picking</td>
</tr>
<tr>
<td>December</td>
<td>Late harvesting, uprooting plants, burning old roots for compost</td>
</tr>
</tbody>
</table>

Table 17 — The agricultural calendar for cotton according to the Book of Nabatean Agriculture (from El-Sammaraie, 1972).

MEDIEVAL LITERARY EVIDENCE FOR COTTON DISTRIBUTION IN THE SYRIAN REGION

Cotton was highly valued in the Medieval Islamic world, and each cotton-producing region made claims for the quality of its produce (Miquel, 1980: 432). According to Ashtor (1986: 555), several Arab geographers mention cotton cultivation around Ra‘s al-‘Ayn in the 10th c AD. For example, Ibn Hawqal described some of the crops raised in the province of Upper Mesopotamia (Ibn Hawqal, 1964: 207). He wrote a bitter description of the Hamdanid replacement of fruit trees by other crops, including cotton, in the region of Nisibe, to the east of the Syrian Euphrates, south of present-day Mosul. He also recorded that amongst the many
towns on the Khābūr was Araban, which produced abundant cotton, and exported cloth to Syria and other places. Ashtor (1986: 555) states that cotton played a minor role in the agricultural economy in the region at this time. Later, during the period of the crusades and especially after the collapse of the Crusader states, a decreased demand for cereals led to much greater emphasis on cotton and Upper Mesopotamia was an important area of production.

In the second half of the 10th century, cotton was also an important crop in Palestine. The contemporary geographer al-Muqaddasi (2nd half 10th c.) described cotton raised in the province of Aleppo, the Hula region in Northern Palestine, and the area of Jerusalem. His writings show that cotton cloth was manufactured in these areas (Ashtor, 1976b: 676). The eleventh century records of the Cairo geniza show that there was a widespread trade in raw and worked cotton, the greatest market being in Egypt (Ashtor, 1976b: 676-677). Contacts with southern Europe as a result of the Crusades encouraged further cotton production in Syria, and prices rose accordingly. European trade continued into the 13th century, and the second half of the 14th century saw a further great increase (Ashtor, 1976b: 677). During Medieval Islamic times cotton became an important crop in Syria and the Levant.

The mention of cotton cloth by Ibn Hawqal and Ashtor's early sources show that the technology for producing cloth from raw cotton was known in the Near East by the 10th century (Ashtor, 1976b: 676). Ashtor is confident that cotton cloth was not manufactured to any great extent in Syria before the later Middle Ages (Ashtor, 1976b: 682). It is difficult to know how much cotton textile was produced by the Medieval Euphrates farmers between the 9th to 13th centuries, nor whether it was taken to market as raw cotton, cleaned lint or cotton thread ready for weaving. Some may have been made into cloth for local needs or household use. The archaeobotanical assemblage from these sites does not give evidence for the relative importance of this crop, but it was certainly present throughout most of their occupation.

USES OF COTTON

The most important use of cotton is for thread and cloth. It was widely used for clothing in Medieval Islamic times (Miquel, 1980: 433). Most of the information presented here is based on Schlingloff's comprehensive account of cotton manufacture in ancient India, and is the source except where noted (Schlingloff, 1974). Ethnographic accounts of pre-industrial methods describe four stages in the processing of cotton. These are cleaning, ginning, batting, and twisting.

Cleaning consists of picking over the harvested cotton. Dirty and immature seeds are removed, as well as particles of earth and vegetation. The removal of the cotton fibre from the seed is called ginning. Traditionally, there were two methods for this: picking the lint off by hand, and using a simple roller.

Lint removal by hand is a slow and painstaking process; it can take several hours to obtain 30 grams of clean lint (Buchanan, 1987: 21). However, it has several advantages over the mechanical gin. The process is gentle to the fibres and if carefully done yields loose and fluffy fibres which can be spun immediately (Buchanan, 1987: 21). The thread which results is apparently much finer than that obtained from even a hand gin. In the hands of an expert, cotton spun from hand-picked lint has durability and exquisite softness. The fineness, strength, softness, and warmth is achieved because the spun fibres lie as parallel to each other as possible,
and have not been damaged or distorted, as happens with mechanical processes (Crowfoot, 1924: 84; Nicholson, 1960: 14). Hand-picking was the method of choice for local hand spinning in Sudan until the government required all cotton to be factory ginned (Crowfoot, 1924). Hand-picking was known up until a few decades ago in Afghanistan (Dunn, 1952: 56-57), and also practised in Ethiopia (Nicholson, 1960: 14). It is probable that in the past the finest quality, most expensive thread was spun from hand-picked lint.

The roller method is much quicker, and for that reason must have been the technique used for most textiles. The simplest method of rolling consists of placing a small quantity of seeds on a flat board and working a single roller backwards and forwards. This technique is still used in parts of Africa, including Ethiopia (Nicholson, 1960: 14). A simple machine based on the same principle is called a churka, or carkhi (illustrated by Schlingloff (1974: 83). It has two cylindrical rollers set close together horizontally, and supported at both ends by uprights. The upper roller is turned by a handle at one end, and the cotton is fed through one side. The two rollers turn in opposite directions, pulling the lint through to the far side. Because the rollers are set close together, the seeds cannot pass through, and they fall on the near side. This gin can be operated by hand or water power ((Buchanan, 1987: 20). It was used at least until recently in Afghanistan (Dunn, 1952: 56-57), and in India.

If a roller is used, the lint will contain a fair amount of dust, dirt, and seed particles. A further stage is required in order to clean the lint, and to fluff out the fibres. Short notes that the lint can be carded with a hand comb, but the traditional method in India was by battng with a bow, called dhanubi, or khunaki (Short, 1921: 21). This tool can be used for wool as well, and was widely known in medieval Europe. It was in recent use in Turkey, where its main purpose was to fluff up the fibre in mattresses, cushions and quilts. Here it is called "pamuk atag" (pamuk = cotton). Schlingloff shows several types from various countries (Schlingloff, 1974: 84). The string, mounted on a wooden frame, is held against the cotton fluff and plucked. The vibrations loosen the fibres, and beat out the dust. A simple wooden rod can also be used to toss and fluff the lint (Figure 13).

![Figure 13 — Turkish woman fluffing cleaned cotton lint with a stick.](image-url)
In India, once cleaned and fluffed, the pile of cotton is twisted into small rolls by hand and spun on the spinning wheel. Alternatively, cleaned lint is spun with a spinning whorl, often made of wood. The lint is attached and the thread is pulled while the whorl is dropped. As the whorl falls, it rotates, thus drawing and spinning the thread. Such whorls can also be used for wool (Figure 14). Since it is portable, a whorl can be used at home, or carried out and used at any appropriate opportunity.

Schlingloff has shown that ginning with a single roller and batting with a bow was known and used in medieval India and China (Schlingloff, 1974). Thus it may also have been known in Medieval Syria. So far there is no evidence to indicate when and where the double rollered churka was developed. In India, spinning has traditionally been a cottage industry, while weaving is done by specialist artisans. In Ethiopia, the process is assigned according to gender; women spin and men weave (Nicholson, 1960: 13).

Raw, unspun lint can be used for stuffing quilts, mattresses, and pillows (Watson, 1977: 362-363). The seeds are rich in oil, which can be used for culinary, industrial, and medical purposes (Watson, 1977: 362-3). Cotton seeds contain 16 to 19% oil, which is extracted in India by the same techniques applied to other oilseeds (Bailey, 1948: 67), described below for sesame. Cottonseed oil is highly stable and resistant to oxidisation, and is widely used as an
edible oil in, for example, China and Central Asia. Cold pressing can lead to the oil containing high levels of gossypol, a chemical in glands on the seed that can discolour oil and cause infertility (Hui, 1996). During hot pressing most of the gossypol binds to proteins rather than entering the oil. It is likely that traditional processing techniques may involve one of the traditional hot-pressing techniques described by Knowles (1967) for safflower. Nicholson (1960: 15) records that cotton leaves, flowers, seeds and roots are used medicinally in Ethiopia but does not mention their properties. Nicholson also mentions an association with ritual or magic, whereby a piece of cotton is tied around a tree, in order to bring good luck (Nicholson, 1960: 15-6).

RICE HUSBANDRY AND USES

DESCRIPTION OF THE RICE PLANT

Rice belongs to the grass family, and is an annual which grows up to 1 meter tall, with smooth dark green leaves. The grains are borne on an open panicle, which is erect except for the nodding tip (Figure 15). The spikelets may be awned or awnless, and the grain varies in

Figure 15 — Rice (*Oryza sativa*).
From Church (1886: 67).
colour according to variety (Bor, 1968: 47; Mill, 1985). There are two races of rice, classified as subspecies by Mill (1985). They are indica, or long-grained rice, which grows only in tropical regions, and japonica, or short-grained rice, which is well suited to temperate zones (Jennings, 1966: 396-397). Table 18 summarises the differences between races indica and japonica. The characteristics tend to overlap, and be influenced by geographical location, and thus are broad categories only. Race japonica was recovered from the middle Euphrates valley sites.

<table>
<thead>
<tr>
<th>Character</th>
<th>indica (long-grained)</th>
<th>japonica (short-grained)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drought resistance</td>
<td>high</td>
<td>low</td>
<td>Oka 1988: 152</td>
</tr>
<tr>
<td>Photoperiod</td>
<td>sensitive*</td>
<td>insensitive</td>
<td>Chang 1976: 432</td>
</tr>
<tr>
<td>Nitrogen need</td>
<td>high</td>
<td>low</td>
<td>Oka 1988: 152</td>
</tr>
<tr>
<td>Crowding</td>
<td>tolerant</td>
<td>intolerant</td>
<td>Oka 1988: 152</td>
</tr>
<tr>
<td>Effect of weeds</td>
<td>competitive</td>
<td>intolerant</td>
<td>Oka 1988: 152</td>
</tr>
<tr>
<td>Straw</td>
<td>long, flexible*</td>
<td>short, stiff §</td>
<td>Grist 1969: 17; Chang 1976: 432</td>
</tr>
<tr>
<td>Lodging</td>
<td>easily lodges</td>
<td>resistant</td>
<td>Oka 1988: 152</td>
</tr>
<tr>
<td>Ripening</td>
<td>earlier*</td>
<td>later §</td>
<td>Ho 1977: 441; Chang 1976: 432; Grist 1969: 17</td>
</tr>
<tr>
<td>Yield</td>
<td>lower*</td>
<td>higher §</td>
<td>Ho 1977: 446; Grist 1969: 17</td>
</tr>
<tr>
<td>Grain quality</td>
<td>higher</td>
<td>lower</td>
<td>Grist 1969: 17</td>
</tr>
<tr>
<td>Amylose content</td>
<td>high</td>
<td>low</td>
<td>Chang 1976: 432; Oka 1988: 152</td>
</tr>
<tr>
<td>Seed longevity</td>
<td>long*</td>
<td>short §</td>
<td>Oka 1988: 152</td>
</tr>
</tbody>
</table>

Table 18 - Comparison between the two races (or subspecies) of rice (Oryza sativa): indica and japonica. An asterisk (*) indicates Jennings (1966: 397) attributed the feature to tropical rice varieties, while a section sign ($) shows he attributed the feature to temperate forms.

AGRICULTURAL REQUIREMENTS FOR RICE

Some rice (called upland rice) is grown under dry conditions, but requires high natural humidity (Grist, 1975: 179). The hot, dry summer conditions along the Syrian Euphrates valley ensures that rice must be grown in irrigated fields. Abundant water supplied under the correct conditions is the most important factor for rice husbandry. Throughout the growing season, the plants are immersed in water to a depth of about 15 cm (Grist, 1969: 17), which creates high humidity. These unusual conditions prevent other crops being grown concurrently in the same area (Klages, 1942: 383). Rice consumes about four times the amount of water needed for raising cotton (Bor, 1968: 48).

The water provided to the rice fields must not be stagnant, and drainage is as important as supply. Without proper drainage, the water table will rise, and bring salts in solution to the soil surface. A soil salt concentration of 0.2% is the maximum rice can tolerate without loss of vigour (Grist, 1975: 25). Raising the water table will cause salts to crystallise out once the rice field is drained, making it infertile. Apart from the potential problem of salinisation,
good drainage is needed so that water can be drawn off promptly once the grain has ripened and is ready for harvest. Where a good irrigation system can be set up, hot desert regions produce the highest yields per unit area over the long term (Huke, 1976: 41).

The temperature of the water is important, the optimum being 27°C (Grist 1969: 17). Hot temperatures and plenty of sunshine are best for rice (Klages 1942: 382; Huke, 1976: 37; Ho, 1977: 447). According to Ho, the minimum average temperature for a normal rice crop in temperate east Asia is 20.5°C (Ho, 1977: 447). Soil type is not as important as water supply (Grist, 1975: 37), but Klages (1942: 383) recommends rich alluvial soils with impervious sub-soils.

From planting to seed maturity, rice takes anywhere between 90-260 days (3-8.5 months) to grow, according to Grist (1975: 83). Huke (1976: 37) states the range is between 120-175 days, or 4 to 6 months. These figures do not distinguish between temperate and tropical varieties. Anderson (1988: 115) says that the japonica race has a shorter growing season, although according to the sources used for Table 18, japonica is later-ripening. Rice in northern Iran, along the southern coast of the Caspian Sea, takes between 100 to 160 days (3.3-5.3 months) to mature, depending on variety (Mojtahedi, 1980: 3).

Rice cultivation requires careful control of water supply, but once in place, such a system may allow reclamation of land lost to salinisation. Although rice is salt-sensitive, as long as the irrigation water is supplied constantly and is rich in nutrients, it can be grown on land with initial high salinity (Grist, 1975: 87). Continual heavy but controlled irrigation washes out the salts, and other crops can then be grown on the drained fields (Grist, 1975: 25).

TRADITIONAL RICE HUSBANDRY AND PROCESSING

In ancient China, rice was first broadcast on natural marshy areas without ploughing. The ground was prepared by setting animals to tread it. Today, rice may still be broadcast or drilled directly on the field. More familiar is transplantation, where the young seedlings are raised in nurseries, and then planted out in the fields (Grist, 1975: 141). The technique of transplantation is believed to have developed in northern China about 200 AD (Oka, 1988: 133). For rice which takes 6-7 months to ripen, transplanting stimulates higher yields, but for rice which ripens in 3-4 months, it makes little difference as long as the water is strictly controlled (Grist, 1975: 149-150). Where water supply can be controlled, the fields can be cultivated as for other crops before planting, and then flooded. Subsequently, only weeding is necessary (Grist 1975: 151-152; 157).

Mojtahedi describes the traditional cultivation of rice in northern Iran (Mojtahedi, 1980). The fields are saturated with water in mid-March, and then ploughed three times, usually with wooden ploughs. The seeds are first germinated, then sown in nursery beds, and three days later, after the soil has been harrowed (smoothed out), transplanted into the fields. Water is maintained in the fields to a depth of 5-10 cm. This process of ploughing, harrowing and flooding creates an water-resistant soil zone, which holds irrigation water, preventing leakage and a rising water table. The height of water is controlled according to ambient temperature, so that water is higher during colder days and nights, in order to protect the young rice plants. Mojtahedi describes weeding every fortnight with a rotary hoe, but does not say whether fields are drained first (Mojtahedi, 1980: 3).
In northern Iran, rice fields are small, with constant circulation to avoid water loss. Water flows directly from one field into the next; the water is collected into a feeder canal, and directed into the next holding. Water may be redirected up to six times, and there seems to be no problem with salinisation.

Rice fields are drained before harvest (Klages, 1942: 383). In northern Iran this is done three weeks before, and clover is sown at the same time. The clover is later ploughed under to improve the soil and reduce salinity. Harvesting takes place by the end of August (Mojtahedi, 1980: 7). In Iraq, the grain ripens in September to October (Bor, 1968: 47). Ideal harvest weather is dry, warm and sunny, but this is not always the case (Huke, 1976: 37). Harvesting is done by sickle (Figure 16) once the fields are drained and have dried out somewhat (personal observation). The following description comes mainly from Grist (1975: 160-167), with added comments, some of which come from personal observation of rice farmers in Turkey. Reaping should be done before the grain is fully ripe, to prevent the grain cracking. Slow drying reduces this problem. Although rice plants can be stacked or hung to dry, as in northern Iran (Mojtahedi, 1980: 7), threshing is generally done immediately after harvest. Threshing is done by various means, but unlike wheat and barley, trampling tends to break the grain. Sheaves of rice can be beaten against a block of wood, an upturned threshing sledge (Figure 17), or a ladder in a tub. The grain shatters from the panicle and falls onto a cloth spread on the ground or into the tub.

Figure 16 — Turkish farmer harvesting rice near Kızılcahamam.

Figure 17 — Turkish farmers threshing rice near Kızılcahamam. The sheaves are beaten against the flints of an upturned threshing sledge. Note in the background the raised paths in the harvested rice fields and the livestock grazing on the stubble.
In northern Iran, rice fields are often left fallow for up to three years, and sometimes used for grazing. This practice varies, however, and rice cropping may be continuous from year to year. In general, the ratio of fallow to cultivated land is well under one third. The factors controlling land use are degree of land shortage, differences in soil fertility, water availability, and rents or need for higher income (Mojtahedi, 1980: 3).

The cultivation of rice was and is sometimes banned, especially near towns, because the flooded fields encourage malarial-bearing mosquitoes.

RICE HUSBANDRY ACCORDING TO MEDIEVAL ISLAMIC SOURCES

Ibn al-Awam, drawing on various agricultural sources, gives a very full account of the cultivation of rice (Ibn al-Awam, 1977: 54-60). El-Samarraie (1972: 66-71) has collated the agricultural calendar for rice cultivation from the Book of Nabatean Agriculture (Table 19). Rice was sown in February and March, according to Abou'l-Khair, while other authors instructed that rice should be sown in February and transplanted in March. Iambouschad is said to have sown rice in June on salty soil, apparently with good results. Ibn al-Awam does not say where this was done. Such a report hints that saline soil may sometimes have been reclaimed by rice cultivation, as described by Grist (1975: 87).

Canard quotes al-Maqrizi, who wrote that rice was planted in May and harvested at the end of September in Egypt (Canard, 1959: 119). According to Ibn Hawqal, rice was planted in June and July and harvested in November and December in the Fayyum (Canard, 1959: 120).

If two crops were to be grown, Ibn al-Awam recommends that the first should be planted in December to take advantage of the winter rains. However, summer planting produces a better crop, and the best time for sowing, he says, is at the beginning of July. This would, of course, depend on the local climate. According to El-Samarraie, in the Sawad district south of Baghdad, it was possible to produce two crops yearly; a winter one grown under rainfall, and a summer one entirely dependant on irrigation (El-Samarraie, 1972: 88). This summer crop was planted in the second half of July, and harvested in December, while the winter rice was planted at the beginning of January and harvested during May and June. Winter production of rice is not possible in the harsh conditions of the Syrian Euphrates valley.

<table>
<thead>
<tr>
<th>MONTH</th>
<th>AGRICULTURAL ACTIVITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>March</td>
<td>Planting rice</td>
</tr>
<tr>
<td>May</td>
<td>Preparation of land, planting rice</td>
</tr>
<tr>
<td>June</td>
<td>Preparation of land and planting late crop of rice</td>
</tr>
<tr>
<td>July</td>
<td>Planting rice</td>
</tr>
<tr>
<td>August</td>
<td>Hoeing</td>
</tr>
<tr>
<td>October</td>
<td>Harvesting and threshing rice</td>
</tr>
<tr>
<td>November</td>
<td>Final harvesting of late-planted rice</td>
</tr>
</tbody>
</table>

Table 19 — The agricultural calendar for rice, from the Book of Nabatean Agriculture (from el-Samarraie, 1972: 66-71). The activity for March does not seem to fit with the rest of the calendar.
Ibn al-Awam says that rice grows best on irrigated land, but can be raised on non-irrigated land providing it is moist and very well prepared before planting. Whether under irrigation or not, the land should be well ploughed and manured. Ibn al-Awam provides various compost recipes as recommended in Ibn Wahshiyya’s Book of Nabatean Agriculture.

A complicated procedure is described for preparation of the grain before sowing. It should be soaked in the husk for up to two days and nights, the water then drained off, the container covered and left in the sun for a day. That night, the grain should be buried in dung. If warm dung is not available, Ibn al-Awam recommends placing the container of rice in a kitchen or other warm place. These steps are to be repeated until the grain has swollen and is about to germinate. Ibn al-Awam reports that he was equally successful germinating both hulled and unhulled rice grains. When ready to germinate, Ibn al-Awam instructs that the rice should be planted in well manured small plots. Every day for eight days the plots should be watered in moderation and hoed, after which the young rice plants should be well established.

Ibn Wahshiyya describes two methods of planting rice, which Ibn al-Awam transcribes. First, the seed grain is mixed with an equal amount of earth and water to form small balls. These are placed in holes in the field and covered. After regular and extensive watering, several plants will grow from each hole. These are separated and transplanted, each plant being planted out individually. El-Samarraie states that this method was used chiefly in Lower Iraq, around the Great Swamp and the middle and south of Sawad (El-Samarraie, 1972: 72). The second method was to plough the field, divide it into basins, and fill it with water. The seeds were scattered on the surface and when they had absorbed the water, they were covered over in earth and after a few hours, irrigated continuously.

Between March and May, the rice is ready to be transplanted. Again, Ibn al-Awam gives detailed instructions. The young plants should be picked before sunrise, kept in a covered basket, and planted, leaving 23 cm between each plant, in the evening. The plots should be prepared and watered beforehand. Ibn al-Awam states that transplantation is preferable to direct sowing, but not absolutely necessary. Otherwise, the grain may be sown in the same spot where it will grow to maturity, and the plants later thinned.

The advice which Ibn al-Awam provides on watering differs sharply from modern recommended husbandry. He states that the fields should be watered two times a week until August. He also says that the Book of Nabatean Agriculture recommends rice must always have water, because rice prefers marshy conditions and stagnant water. He goes so far as to say that water should be held in the fields for seven days before replacing it, or even delaying replacement of water in the plots until there is an odour of decay!

According to Ibn al-Awam, the rice harvest is about the month of September, but this varies according to date of planting and geographical location. Rice is ready for harvest when the spikes are full and on the point of maturity. Ibn al-Awam describes how the harvested spikes are dried, put in a sack, and beaten vigorously with a stick until all the grain has separated from the straw. The contents of the sack are sieved and returned to the sack. The grain is beaten again to remove the husk. Ibn al-Awam recommends the addition of salt at this stage, to aid the dehusking process. The grain is sieved again and stored in ceramic containers. Some of the grain is kept back unhulled for the next crop.
MEDIEVAL LITERARY EVIDENCE FOR RICE DISTRIBUTION IN THE SYRIAN REGION

According to Canard, rice appears in the tax lists - and thus the records of Arab geographers - for certain districts of the Sawad area below Baghdad in about the ninth century (Canard, 1959: 115). Rice is also mentioned from the region of Kufa at about ca. 865 AD., and plantations in the region of Wasit, west of the Tigris in 943 AD (Canard, 1959: 116-117). In addition to these locations in Iraq, El-Samarraie mentions the low level fields of the Great Swamp area (Bata’ih) for the 9th c. AD (El-Samarraie, 1972: 87-88). Various contemporary authors record rice cultivation in Huzistan, parts of Persia, and south of the Caspian Sea (Canard, 1959: 117, 118). Ibn Hawqal makes only one specific reference to rice in Upper Mesopotamia. It is one of the crops introduced by the Harmandids in place of the mourned fruit trees of Nisibe (Ibn-Hawqal, 1964: 207).

Further afield in the Near East, rice was grown in Palestine around Baysan, and in Cilicia around Tarsus. Apparently it was grown in Egypt before the Islamic era, particularly in the Fayyum and Upper Egypt. It was also an important crop in the Fayyum afterwards, according to Ibn Hawqal and al-Muqaddasi. Other contemporary geographers mention rice in Egypt, including an early reference to it in the 8th century (Canard, 1959: 118-119).

USES OF RICE

Anderson says that japonica rice tends to have more protein and less starch than indica rice (Anderson, 1988: 115). The type of starch creates a more sticky and chewy texture when cooked. Oka states that japonica has a lower amylose content (16-20%), which affects the stickiness of the cooked rice (Oka, 1988: 153). McGee describes cooked japonica as moist, firm and sticky; this is due to a higher proportion than indica rice of waxy starch molecules called amylopectin (McGee, 1984: 238 - see also Table 18).

There seems to have been some disagreement amongst Medieval Islamic writers about the benefits of rice. Some delicious-sounding recipes have been preserved but others rate rice as food for the poor or famine food. At least one man considered it practically a poison. It seems to have changed its status over time and according to the economic conditions of specific regions and periods (Ashtor, 1976a: 43).

Ibn al-Awam, taking his source as the Book of Nabatean Agriculture, described the best way to eat rice: with butter, oil - especially from sesame - fat and milk (Ibn al-Awam, 1977: 60-61). Cooking rice in milk seems to have been a popular preparation method, as there are many variations on it. Ibn al-Awam says that ewe’s milk is best, but fresh, very rich cow’s milk will suffice. Soured milk (laban) was an alternative.

Ibn al-Awam describes a simple method of making rice bread: the rice is ground very fine and hot water is gradually worked into the flour, kneading constantly (Ibn al-Awam, 1977: 61). When the mixture becomes a dough, a small quantity of sesame oil is added, and the bread is baked in a moderate oven. According to Canard, such rice bread was the normal fare in several parts of the Near East, and was particularly associated with eating fish (Canard, 1959: 121). There are many references to rice and rice bread in Medieval Iraq (Canard, 1959: 131). Even so, the lower cost of rice, and its low fat and gluten content, gave rice bread and rice in general the status of poor people’s food or famine food (Canard, 1959: 131).
Rice seems to have been an ingredient in dishes which were definitely not prepared during times of hardship. Canard, for example, describes soup made of rice, chick peas, meat, or a variation which included leeks; a meat dish prepared with rice, soured or fresh milk, and the whole spiced with cinnamon; and another meat dish made with rice and chickpeas, as well as onions, macaroni, coriander and pepper (Canard, 1959: 127-8). A elaborate recipe called for meat or stuffed tripe, placed on a bed of rice and chickpeas, and seasoned with coriander, saffron, cumin, cinnamon and pepper, the whole to be cooked gently all night. More modestly, there were recipes made with rice and lentils, or harisa, usually made with cooked wheat and meat kneaded into a paste, but sometimes made with rice instead of wheat.

Nor was rice restricted to savoury dishes. One sweet dish used rice with boiled meat, saffron, and syrup or sugar. Mixing sweet ingredients and meat was not uncommon (Canard, 1959: 126). Other sweeteners included grape syrup, figs, dates or honey. Another dish was made with rice covered in browned flour, then sesame oil or butter, roasted almonds or pistachios, and honey or syrup (Canard, 1959: 129).

Ibn al-Awam said of rice vinegar that it is possible to make, but that it is strong enough to pierce rocks and ceramic vessels, and thus is not worth preparing (Ibn al-Awam, 1977: 61). Less desirable also, according to him, a fermented liquid can be prepared from rice, but the drink weakens the intellect and attacks the brain - an appropriate warning for alcohol-avoiding Muslims.

Canard mentions the medicinal properties attributed to rice (Canard, 1959: 129-30). Its use as a medicine was known through Greek texts. It was said to have mild astringent and constipating qualities, but its use as nourishment was in some dispute. It was held to have dry and hot qualities, and the cooking water of rice was reputed to strengthen the stomach. It was also said to bring good dreams. Some medical authors also held that it increased the production of sperm. Far from being medicinal, however, some authors regarded rice as poisonous. As such it was said to be bad for the mouth and tongue if eaten with the husk. It was also claimed to be more difficult to digest than wheaten bread, and that prolonged consumption provoked headaches.

I have not come across any evidence for uses of rice other than food in Medieval Islamic times. It can be used as a fodder for animals and probably was used in this way in the past. In China, the straw is used for thatch, sandal making, matting, and other woven goods (Anderson, 1988: 114). It may be more difficult to use straw from japonica varieties in such a way, however, because it is short and stiff (Chang, 1976: 435).

SESAME HUSBANDRY AND USES

DESCRIPTION OF THE SESAME PLANT

Sesame varies widely in size, form, flower colour, and seed type (Weiss, 1983: 285), in large part caused by human selection (Bedigian et al., 1986: 363). It is an erect branched annual, with fuzzy stems and leaves (Figure 18). It grows to between 30 and 90 cm in Iraq (Chalabi-Ka’bi, 1980: 641), and up to 150 cm in Turkey (Edmondson, 1978: 196). Weiss
(1983: 285) notes that sesame is occasionally perennial, and may grow up to 2 meters in height. Although not explicitly stated, these forms may be restricted to tropical and subtropical regions. The lower leaves are oblong and pointed at the tips, while the upper leaves are more slender. The attractive tubular flowers are borne individually at the junctions of stem and leaves (the axils), and range between 2 to 3.5 cm long (Chalabi-Ka’bi, 1980: 641; Edmondson, 1978: 196). As with the rest of the plant, they are somewhat furry, and are whitish or pinkish with markings which may vary from red, purplish or yellow (Chalabi-Ka’bi, 1980: 641). The capsule is divided into four chambers; at maturity it is rectangular in cross section, and approximately 7 cm long and 2 cm wide with a short beak at the tip (Chalabi-Ka’bi, 1980: 641; Weiss, 1983: 290). Capsule size varies widely according to growing conditions and individual development (Bedigian and Harlan, 1986: 138). The seeds are stacked within the capsule chambers with the narrow ends towards the centre. At maturity the capsules split down their length, releasing the seeds.

**AGRICULTURAL REQUIREMENTS FOR SESAME**

Sesame is naturally a crop of the warm tropics and sub-tropics but some varieties are grown in temperate regions (Weiss, 1971: 410). It is very adaptable, for it can be grown under a wide range of conditions (Weiss, 1983: 285) but does best in warm and hot climates.
Maximum yields are obtained under hot conditions; an average of 25-27°C stimulates rapid growth and flower formation, but temperatures above 40°C impair fertilisation (Weiss, 1971: 410). Low temperatures prevent proper growth (Joshi, 1961: 12). According to Weiss (1971: 412), sesame requires a frost-free season of at least 150 days, or 5 months. Bedigian and Harlan (1986: 138) note, however, that some varieties take as little as 70 days to ripen. A hard frost will kill the plants, and lower the quality of the seeds and oil (Weiss, 1971: 412). Weiss (1983: 292) states that the oil content is higher when sesame is grown in regions with longer days.

Water supply during early growth is critical. During the seedling stage, before the roots are well developed, moisture shortage is fatal, but once the extensive root network is established, the plants are relatively drought-resistant (Weiss, 1971: 411; 1983: 287). I have seen it growing unirrigated on a stony hillside in western Turkey where there is no summer rainfall. Too much water is detrimental (Joshi, 1961: 12) and even brief waterlogging will normally cause damage (Weiss, 1983: 287). Some varieties however can grow under conditions of high rainfall, but these are restricted to the Malabar Coast of India (Bedigian et al., 1986: 361).

According to Weiss, there is little information on optimum water regimes, because good drought tolerance means sesame is rarely grown today under irrigation on a large commercial scale (Weiss, 1983: 315). Observations at various agricultural research stations indicate that irrigation during flowering produces the highest yields (Weiss, 1971: 421). Presumably irrigation must be provided over a certain length of time, as all the flowers do not bloom at once. Weiss states that as long as careful husbandry is followed, sesame yields best when it is grown under irrigation in arid regions (Weiss, 1971: 473). The low rate of fungal disease under dry conditions may be one factor for this.

Sesame seed quickly loses its viability (Weiss, 1971: 390), so stocks intended for planting cannot be stored long. To encourage good germination, the soil should be well worked, and adequate moisture is needed (Joshi, 1961: 11). Because they are so small and light, the seeds are often mixed with sand or manure, and then sown broadcast or in rows to a depth of 2.5-3 cm. In Egypt, sesame has traditionally been sown from the beginning of June to mid-July (Bonaparte, 1903: 68), while in present-day Iraq, there are two planting times. The normal planting takes place from April to June, but there is also an early planting in mid-March (Stol, 1985: 119). Germination is rapid, occurring within 5-8 days (Joshi, 1961: 14). If sesame is planted in areas which experience ten hours of daylight, flowering will take place after 42-45 days (Weiss, 1983: 297).

Since the mature capsules tend to shatter easily, harvesting takes place while they are still quite green (Joshi, 1961: 14). According to van Rheenen (1967: 204) harvesting takes place
somewhat later. The plants are not gathered until after the leaves have yellowed and most have dropped off. Capsule ripening probably depends on local conditions. At this point, the lowermost capsules are about to split. Traditionally, harvesting in Egypt takes place from about the beginning of October to mid-November; that is, about four and a half months after planting (Bonaparte, 1903: 68). In Iraq, harvesting is done in mid-July for the early crop, and September and October for the regular crop (Stol, 1985: 119). After the sesame plants are cut, they are piled into bundles, either in shocks or racks in the field (van Rheenen, 1967: 204) or on threshing floors (Joshi, 1961: 14), where they dry for a week or two. Since the lower capsules mature before the upper ones, cutting and drying before full maturity reduces splitting while allowing the younger, upper capsules to ripen; this increases the yield (Weiss, 1983: 318). To obtain the seed, the dried plants are shaken or lightly beaten on the floor or onto a cloth (Joshi, 1961: 14). This method entails a high seed loss (van Rheenen, 1967: 204), especially if the plants are moved to a threshing floor away from the field, but this is difficult to avoid with pods ripening unevenly and splitting so readily.

SESAME HUSBANDRY ACCORDING TO MEDIEVAL ISLAMIC SOURCES

According to Ibn el-Façel, as described by Ibn al-Awam (1977: 72), a dark, moist soil is recommended for sesame, although rough sandy soil is acceptable. This is somewhat surprising advice, in view of sesame's drought tolerance. Ibn al-Awam also quotes Ibn Wahshiyya's Book of Nabatean Agriculture, which describes a similar type of soil considered suitable today: very low salt content, thin, and a low moisture content. Ibn Wahshiyya noted sesame's preference for complete lack of rain, and hot, dry conditions (Ibn al-Awam, 1977: 73).

Both Ibn Wahshiyya and Iambouschad mention that sesame should not be planted in the same fields in succeeding years, as it tends to deplete the soils (Ibn al-Awam, 1977: 73-4; El-Samarrae, 1972: 92). Redistributing the location of crops from year to year is a common agricultural practice, but modern references to sesame's tolerance to poor soils does not entirely correspond to the suggestion that it tends to deplete nutrients. Perhaps this warning was a result of sesame's ability to grow on soil which is already depleted, giving the impression that it is sesame which is nutrient-demanding. Iambouschad suggests a method of preventing exhaustion of the soil by the sesame crop: one soaked the seed for 2 weeks in water mixed with chicken blood. This procedure was also supposed to stimulate increased oil production, and guard against rancidity.

As is done in recent times, Ibn el-Façel recommends that the seed be mixed with a quantity of dung in order to sow it evenly, and not too thickly. Sowing was started in March on irrigated land and continued into April. On non-irrigated land sowing began about mid-March, after thorough soil preparation. However, the Book of Nabatean Agriculture states sesame should be sown at the beginning of May through to the 20th of June. Ibn el-Façel suggests the planted field should not be irrigated until germination, lest the seed rot. The crop was to be thinned and the unhealthy plants removed once they had grown about 10 centimetres. At this stage the field was hoed, and then irrigated about a day later. During the summer, the sesame crop was to be irrigated once a week until mid-August, when irrigation should cease.
According to Ibn al-Awam, Ibn Wahshiyya warns that sesame is susceptible to disease, causing the plants to become suddenly yellow or wilted. He advocates careful attention to the plants, and removal of wilted or drooping leaves (which would control disease). Further treatment was to apply a special mixture of compost and dung, spread through the field with the aid of irrigation water (Ibn al-Awam, 1977: 73).

The sesame harvest took place in September, when the seed was ripe and the capsule yellowed, but not too dried out. The plants were to be stacked to prevent the seed spilling out of the capsule. They were then left until they had dried to a "suitable state" - about eight days. Finally, the seeds were shaken out onto a square of cloth or similar material, and stored.

Ibn Wahshiyya's agricultural calendar for 11th c. Iraq includes some reference to sesame, although according to the information given in El-Samarraie, its husbandry is not described in detail (El-Samarraie, 1972: 66-9). Early sowing commenced in May, and continued into June. Sesame was harvested during September, and threshed in November. This description implies that the crop was left to dry for upwards of one month, but the harvesting and threshing times may have varied according to the time of sowing.

TRADITIONAL SESAME PROCESSING

If the whole seeds are eaten, sesame hulls are often removed first. This decortication is done by light pounding or rubbing on a stone or wooden block. The hulls are often fed to livestock. Once decorticated, the seeds may then be parched, roasted or ground. Parching is the application of indirect heat in a heavy pan, with constant stirring to prevent the seeds getting scorched. Roasting is the exposure of the seeds to direct heat in an oven (Weiss, 1983: 507, 508).

The most important product from sesame is its oil. The simplest traditional method of oil extraction is by pounding the seeds in a wooden mortar, and floating off the oil with hot water. In India and parts of East Africa, the oil is pressed out using a heavy pestle turned manually or by animal power (Joshi, 1961: 19; Knowles, 1967; Nayar and Mehra, 1970: 21). This method requires about two hours to extract oil from 20 kg of seed (Nayar and Mehra, 1970: 21). Bedigian and Harlan quote Law's Grocer's Manual (c. 1892), which gives a more detailed account: the seeds are soaked for 24 hours, then manually worked over with wooden hammers in a cement pot. This removes the hulls. The mixture is then floated in briny water, in which the hulls sink and the kernels float. After separation, the seeds are roasted and milled. The oil is expressed during the milling and is channelled off the millstone (Bedigian and Harlan, 1986: 138).

USES OF SESAME

Sesame seeds contain up to 51% oil, but the average content is 44-45%. This oil is highly valued because of its exceptional keeping qualities (Nayar and Mehra, 1970: 21; Weiss, 1971: 506; Weiss, 1983: 292). Oils and fats usually undergo chemical change at different rates depending on the oil and its storage conditions. This break down causes an unpleasant taste, and is known as rancidity. The unique stability of sesame oil is due to the presence of the antioxidants sesamolin and sesamin, which inhibit the break down process (Nayar and Mehra,

El-Samarraie states that sesame was the most important of the oil producing plants in 9th century Iraq (El-Samarraie, 1972: 92). He says that sesame oil practically replaced that of the olive, which can also be cultivated in the lower forest and moist steppe zones of Iraq (Critopoulos, 1980: 512).

The whole seeds are rich in other nutrients. Their protein content varies between 15-25%, but is normally between 19-23%. They are also a rich source of calcium, phosphorus and oxalic acid. When the hulls are removed the bitter taste which sesame seeds can have is lost, but the mineral and oxalic acid content is greatly reduced. The oil and protein levels in decorticated seeds remain essentially unchanged (Weiss, 1971: 507, 508; Weiss, 1983: 292). Sesame seeds are eaten raw, roasted, or parched (Weiss, 1971: 506), to garnish breads, cakes, and sweets (Chalabi-Ka’bi, 1980: 643; Ambasta, 1986: 568).

In Africa, after the oil has been extracted the meal is used in porridge, soup and confectionery, while in India, the meal is a famine food (Nayar and Mehra, 1970: 21; Chalabi-Ka’bi, 1980: 643). In less strenuous times, it is given to animals (Chalabi-Ka’bi, 1980: 643; Weiss, 1971: 506).

As sesame is so nutritious, in northern Africa the roasted seeds are often given to convalescents and to mothers after childbirth. This also stimulates the production of milk. The seeds help to soothe severe constipation, but are said to be abortive. The oil softens and soothes itching, cracked skin (Boulos, 1983: 142). It is also a mild laxative (Chalabi-Ka’bi, 1980: 643). Ambasta describes a paste from the seeds applied to scalds and burns, while mixed with butter, the paste can be used for piles (Ambasta, 1986: 568).

According to Chalabi-Ka’bi and Ambasta, the fresh leaves can be steeped in water to produce a mucilaginous decoction, said to help catarrhal infections, diarrhoea, dysentery, and kidney and bladder problems. In India, this preparation is also applied externally for complaints of the eyes and skin (Chalabi-Ka’bi, 1980: 643; Ambasta, 1986: 568).

Although the majority of sesame oil is used for cooking, it does have some other uses. It is sometimes an ingredient in soap and perfume (Nayar and Mehra, 1970: 21; Chalabi-Ka’bi, 1980: 641). In India it is widely used for illumination, and in ritual anointing (Chalabi-Ka’bi, 1980: 641). Nayar and Mehra (1970: 21) report that the soot obtained from burning the oil is said to be one of the ingredients of Chinese ink in India.

TEMPERATE MILLET HUSBANDRY AND USES

DESCRIPTION OF THE MILLET PLANT

The millets are a diverse group made up of several genera; the term “millet” is used to refer to the small-seeded cereals. Like all cereals, the millets are annual grasses. There are two categories, the tropical millets (such as *Eleusine coracana* - finger millet and *Pennisetum typhoides* - bulrush millet), and the temperate millets. The temperate millets which occur in
the Near East are *Setaria italica*, foxtail millet, and *Panicum miliaceum*, broomcorn millet. The most obvious difference between broomcorn and foxtail millet is in the shape of the inflorescence ("head" or "ear"): foxtail millet has a long and dense, cylindrical, bristly head (Figure 19) whereas the head of broomcorn millet is loose, branched and spreading (Figure 20).

Broomcorn millet grows from 50-80 centimetres high; foxtail millet can be up to 1 metre high. Broomcorn millet grains are about 2 millimetres long, while those of foxtail millet are smaller. Each grain is surrounded by a thick, tough, silica-rich husk, formed of a lemma and palea, and this must be removed by appropriate processing procedures before millet can be used as human food.

---

Figure 19 — Ears of two varieties of foxtail millet (*Setaria italica*). From Church (1886: 54).

Figure 20 — Broomcorn millet (*Panicum miliaceum*). From Church (1886: 41).
Agricultural Requirements for Millet and Traditional Husbandry

The tropical millets have been very well studied; their agronomy, traditional husbandry and nutritional properties are well known. In contrast, little information is available on traditional cultivation of the temperate millets in the Near East, partly because they are now minor crops in the region and their traditional agricultural role has been replaced by such crops as maize (*Zea mays*). The information given below is based on Mann's literature review, except where otherwise stated (Mann, 1946).

In the Near East, both species are sensitive to frost and must be sown on irrigated land in late spring, about April and May, when the ground is warm but still moist. Irrigated crops can be sown much later, so long as there is time for harvest before the rainy season which starts in October. In favourable conditions broomcorn millet ripens in 50-60 days after sowing, which is faster than any other cereal crop; foxtail millet ripens in 70-90 days. Broomcorn millet apparently has a low water requirement, but Mann's statement that it is not considered suitable for irrigation is incorrect, as both millets are irrigated in Afghanistan, Syria, and Turkey. Similarly, Watt records that in the north-western provinces of India, broomcorn millet is sown in March and harvested towards the end of May, receiving up to 14 irrigations during this period (Watt, 1892: 13).

The effect of irrigation increases millet yields as is the case for other summer crops. Purseglove quotes yield figures for broomcorn millet in India of 450-650 kg/ha if unirrigated, and 1000-2000 kg/ha when irrigated (Purseglove, 1972). According to Mann, both millet species can be grown on poor land, but even on poor, unmanured, unirrigated land a yield of 400-750 lb (181-340 kg) of seed/acre can be obtained from 22 lb (c. 10 kg) of broomcorn millet seed.

An example of irrigated millet in a mountainous area with a short growing season, the valley of the Greater Zab on the mountainous border of Turkey and Iraq (altitude about 900 m), is given by Maclean and Browne (Maclean and Browne, 1892: 34):

"...it is possible to build up artificially a small field by the side of the river...As these fields have a plentiful supply of water, which is ingeniously carried along the mountainsides from a higher level of the river by little streams often cut out of the face of the rock, the soil is very fertile. Two kinds of millet are grown, and rice; and the inner sides thus show a bright green which is very refreshing. Wheat is not grown..."

Ibn Hawqal mentions many crops in his discussion of Upper Mesopotamia but does not mention millet (Ibn Hawqal, 1964). El-Samarraie gives the impression that millet was considered a cereal for the poor or those of lower status. Millet may not have been considered by Ibn Hawqal to be worth including by name. He may have simply included it within his general category of "many cereals of all sorts", as he did for Rahba (Ibn Hawqal, 1964: 221-2).

Traditional Millet Husbandry in Yemen

Serjeant provides an account of millet cultivation in the Yemen, where the tropical millets are staple crops (Serjeant, 1974). Yemen, close to East Africa on the one side, India on the other, and Southern Mesopotamia not far to the north, is exposed to a wide variety of potential
crops. Unfortunately, Serjeant's account does not specify the precise type of millet being cultivated there today, nor which type is discussed in the Medieval agricultural text he translates.

Bornstein-Johanssen also provides a description of present-day millet and sorghum cultivation in Yemen (Bornstein-Johanssen, 1975: 288). She records that sorghum (Sorghum vulgare) and bulrush millet (Pennisetum typhoides) are the main crops of Yemen, and she lists several varieties of sorghum (p. 289). Bornstein-Johanssen's work suggests Serjeant also refers to Pennisetum and Sorghum. Bédoucha provides a detailed account of traditional highland Yemeni sorghum cultivation although this is less comparable to the temperate millets (Bédoucha, 1986). Neither foxtail millet nor broomcorn millet are grown today in Yemen (Marcel Gast, pers. comm.). Yemen has a highly varied topography, from the hot dry coastal plains to the cool mountainous plateaux (Bornstein-Johanssen, 1975: 287). This, together with the numerous different varieties of millet grown there make a comprehensive general statement about traditional Yemeni millet husbandry impossible. However, several relevant details help to clarify what cultivation of foxtail and broomcorn millets elsewhere in the Near East might have involved.

Before sowing at the beginning of summer, the ground is first prepared. This is done after a week with no rain, to avoid mud and soggy soil. The land is first harrowed, and then ploughed. Finally a wooden beam is dragged over the field to smooth the surface (Serjeant, 1974: 36). Millet is sown at the end of May or early June, although in parts of Yemen it can also be sown at the end of August, and the end of October/early November.

To sow the grain, a plough is taken down the field, and the millet is dropped by hand into the furrow by two people following behind. Serjeant describes a man dropping wheat and barley grain into furrows, and covering them by pushing earth over with his foot, and presumably millet was sown in the same manner (Serjeant, 1974). Sowing is not done between mid-day and late afternoon, because apparently if planted then, the seed does not do well. It may be that turning the soil at the hottest time of day dries it out enough to reduce the moisture around the newly planted seed.

Bornstein-Johanssen has also observed this sowing technique, as well as grain sown through a funnel and tube into the furrows. She notes that on soil with sufficient moisture, or on irrigated land, sorghum is frequently intercropped with cow peas (Vigna unguiculata) or field beans (Vicia faba) which are mixed with the seed and planted through the same funnel (Bornstein-Johanssen, 1975: 290).

Serjeant has observed that sheep are permitted to forage in the millet about two or three weeks after planting, when it is already about 30 cm high (Serjeant, 1974: 37). They appear to avoid the leaves which are apparently bitter and eat only the weeds. This may not be appropriate for all millet crops, however. Bor says that green broomcorn millet makes excellent fodder, but quotes Rozhevits and Shishkin (1934), who say that although animals will readily eat foxtail millet, the stems contain a glycoside and can be poisonous (Bor, 1968: 488, 503). Mann, however, reports that foxtail millet hay is said to be better than timothy grass (Phleum) hay (Mann, 1946). The concentration or production of any glycoside may depend on age of the plant, whether it is fresh or dried, and growing conditions.

Serjeant does not describe the traditional Yemeni harvesting and processing of millet (Serjeant, 1974). It appears that in the Jizan area, at least, millet takes three months to ripen,
but no more information about this is available. Bornstein-Johannsen describes the harvesting of sorghum, which is hand-picked, but as this is a much bigger plant, it cannot readily be compared with millet (Bornstein-Johannsen, 1975: 290). There is a record of hand-picking foxtail millet heads by farmers on Taiwan (Fogg, 1983: 103). The threshing of sorghum as recorded by Bornstein-Johannsen may be equivalent, however. The sorghum heads are dried on a threshing floor, which is stone-lined and generally communally owned by the village. Threshing is done by flailing with a wooden stick. More rarely, and generally used for threshing wheat and barley, oxen are driven over the threshing floor, dragging a large stone behind them. The threshed sorghum is winnowed and stored.

MILLET HUSBANDRY ACCORDING TO MEDIEVAL ISLAMIC SOURCES

When reading contemporary accounts of millet cultivation in Medieval times, it is not always clear whether foxtail or broomcorn millet is being discussed. The nomenclature is confusing and inconsistent (Miquel, 1980: 406; Dietrich, 1981: 249). Ibn al-Awam discusses two sorts of millet in separate articles, although the agricultural recommendations are much the same (Ibn al-Awam, 1977: 74ff). The first is called dochn, identified by the translator as the type of millet with compact heads, which he calls Panicum italicum, an outdated synonym for Setaria italicica, that is foxtail millet. Ibn al-Awam begins with a discussion on its identity, and whether it is the same as some other types of millet which he names. He mentions that it can be white, red, and black. Nicholson et al. (1985: 12) note the colour variability of foxtail millet, which can be white, yellow, red, brown or black. The second type of millet discussed by Ibn al-Awam is dourah, identified by the translator as Panicum miliaceum, broomcorn millet. (In many other reports dourah refers to the much larger sorghum). Ibn al-Awam says that there are two species, white and black. Nicholson et al. (1985: 12) describe the seed of broomcorn millet as whitish, straw-coloured or reddish-brown.

According to Ibn al-Awam, foxtail millet was sown at the beginning of March on ground which was first well prepared. In a brief comment on inter-cropping, Ibn al-Awam says that this crop can be sown with fennel, “without either harming the other” (Ibn al-Awam, 1977: 78). As quoted by Ibn al-Awam, Iambouschad gives a different opinion for the date of sowing foxtail millet; this is from mid-March to the end of April. The later date may refer to planting in a different geographical area. Broomcorn millet was sown in March on high ground, or in April and the beginning of May elsewhere. This later date corresponds with the ability of broomcorn millet to grow and mature quickly. Iambouschad is quoted as recommending it be sown towards the end of April and throughout the whole of May. Referring to the Nabatean Book of Agriculture, Ibn al-Awam records that broomcorn millet was sown towards the end of March and throughout most of April. The earlier planted crops were, however, said to be more successful (Ibn al-Awam, 1977: 78).

El-Samarraie (1972: 66-71) has only two entries for millet in his agricultural calendar of husbandry in 9th c. Iraq. May is the month both for preparation of the land for planting millet, and the sowing itself. The crop is harvested in September. May is normally the first month with reliable sustained high temperatures in this region. Therefore, it makes sense that millet, as a heat-loving crop, is planted then. However, given its rapid rate of maturity, harvesting in September seems rather late. If the crop were planted at the very end of May, and harvested at
the very beginning of September, this would be just over 90 days. It is more likely that planting would have gone on into June, and harvesting may have begun in August for crops planted somewhat earlier in May.

Ibn Wahshiyya's two sowing recommendations for millet are described by El-Samarraie (1972). One was to mix the seed with earth and water and plant small balls of this mixture into holes. When several plants sprouted from each location, they were to be separated and transplanted. The second method is clearly for land which can be irrigated. The fields could be divided into basins, and seed scattered over the surface. Water was then let in to flood the field and when absorbed into the ground, the seeds were covered in a thin layer of earth. This is the type of basin irrigation method which was commonly used for other cereal crops. Ibn al-Awam quotes similar methods described by Iambouschad (Ibn al-Awam, 1977: 78-9). Ibn 'Abbās, a medieval writer on Yemeni culture, describes a sowing method that seems unchanged in Yemen today; people followed the plough, dropping seed into the furrow, and covering it with their feet if the soil is heavy (Serjeant, 1974: 46).

Ibn 'Abbās describes a method of ploughing between the furrows when the millet is forty days old. This would result in channels running between the rows, so that the crop is growing on ridges instead of as formerly, in furrows. The implication is that this is used with irrigation, but the description of this process is not clear. While the crop is growing, any yellow leaves are removed from the plant.

According to Ibn al-Awam, millet could be grown on both irrigated and non-irrigated land. Unirrigated land which could support a crop of wheat would also be suitable for growing millet. Ibn al-Awam recommends that if irrigation were to be employed, the first irrigation was to be applied after sowing (Ibn al-Awam, 1977: 75).

In his section on foxtail millet, Ibn al-Awam is rather vague about the timing of the second irrigation. He says it was applied after hoeing to remove the weeds, which was done "after the plants reaches a certain height". In his discussion of foxtail millet he states that water should be provided only when the soil dries out, and the plants show the need for irrigation. According to him, this is indicated by a "well-known dark appearance". He says a third irrigation can be applied in the same way (Ibn al-Awam, 1977: 77). When describing broomcorn millet he quotes Ibn el-Faqel, who stated that an irrigation when either type of millet has just begun to grow is harmful. Equally, rainfall at this time can damage the crop.

Ibn al-Awam describes weeding for broomcorn millet. He directs that weeding should take place when the plants reach a height of one empan (0.23 m), and that they should have a distance of at least the same span between each plant, so that they can develop fully. When individual cereal plants are well spaced, they are able to produce many more shoots, called tillers, from the base than when they are crowded together. As each tiller generally forms a fertile spike, this permits a much higher yield.

Rice and millet are the two traditional summer cereals of the Near East. The calendar compiled by El-Samarraie shows that the land for both was prepared at the same time, and that both were planted at similar dates (El-Samarraie, 1972: 66). El-Samarraie (1972: 73) notes that millet cultivation was much the same as for rice, without the heavy irrigation. This comment is also made by Ibn al-Awam (1977: 78), quoting from the same source, the Nabatean Book of Agriculture.
Like their modern counterparts, neither El-Sammaraie's sources nor Ibn al-Awam provide information on harvesting methods. After harvesting, the grain was threshed by trampling animals, or by beating. Whether the latter refers to beating the stalks against a hard object to shake out the grain, or to beating a hard object against the stalks, is unclear (Ibn al-Awam, 1977: 75). The grain was left to air and dry, during which time it shrunk. Unusually, Ibn al-Awam gives no information on the optimum time of year for harvesting. Ibn ‘Abbās, writing about Yemen, is the only source to describe this. He describes how the crop stands until the seed is ripe and thoroughly dry. It is harvested with sickles, and then treated as for wheat. That is, it is taken to a threshing floor, “and then trodden out with cattle and the stone” (Serjeant, 1974: 47). The stone is not fully described, but is probably the same as in present-day Yemen, a heavy stone which helps to crush and separate the heads of cereal. Following the threshing, the grain is winnowed to remove the light chaff, and then stored in silos until required.

A passage from Ibn Abbas deals with the important subject of selecting and storing the seed grain (Serjeant, 1974: 47-8):

“If one wants to store seed-grain one should select the cleanest ears, those with the largest grain, the best quality of them, and lay them in the sun until the moisture in them dries out, beat them out with flails, clean them of the debris of the millet-heads, and take them, after drying them well, to a good well-ventilated place where neither the sun's heat nor damp can reach them, so they will not get wormed for the passage of a year - when one sows with them.”

USES OF MILLET

As temperate millet is scarcely grown now in the Middle East, and so little scholarly interest has been shown in it, there is next to no information indicating how it was prepared in recent times. Bornstein-Johanssen describes how, like most other cereals, sorghum and tropical millet are made into porridge or bread in Yemen (Bornstein-Johanssen, 1975: 292-4). The traditional method is to grind the grain on a rotary quern. In the region of Tiharna, the millet is soaked in water overnight and then rolled out. Bread can then be prepared by mixing a piece of dough from the previous batch, the starter, with flour, salt and water, and left to rise overnight. Sometimes ground lentils are added to the dough. The next day the dough is divided into portions, shaped into flat circular loaves, and baked in a tannour oven. Another way of baking is to put the thin layer of dough on a metal disc over the top of the tannour. A Ramadan dish is made by soaking bread baked this way in soured milk, thyme, and other green herbs. These tannour and disk baking methods can be seen throughout the Middle East for baking wheaten bread. Millet bread is more common in the lowlands of Yemen, and is often slightly fermented. Porridge is made by adding sorghum flour to boiling water, and stirred for about half an hour until the correct consistency is reached. It is thus time-consuming to prepare, both during the grinding and preparation stages. It is often eaten with melted butter and a gruel made from milk and wheat or barley flour.

Travellers' accounts often refer to the use of millet as bread. For example, Maclean and Browne (1892: 40) describe baking in northern Iraq.
“On the digdin (tripod), too, can be laid the thin slightly convex iron shield on which is spread sheets of dough when wheaten bread is to be provided for a guest of consequence or dignity. “Ordinarily, cakes of millet bread six or eight inches in diameter and about three-quarters of an inch thick, or in well-to-do houses, on some occasions, wheaten cakes of the same size, are baked in another contrivance [detailed description of tandoor oven follows]... “On the floor enclosed by this truncated hollow cone of solid clay a fire is made... Presently...the fire is swept away, and a broom dipped in water is used to clean the interior of the oven of all dust and smoke, then the dough cakes are forcibly slapped against the side of the oven... until they are baked”.

This account is interesting because it contains two references to the higher prestige of wheaten bread as compared to millet. In general, ethnographic and historical references to millet tend to refer to bread, gruel or porridge, and non-alcoholic fermented drinks such as bouza (cf. Sakamoto, 1987: 86).

The traditional methods of preparing sorghum or tropical millets in Yemen, and millet in Iraq, are very similar to Medieval sources which describe different ways of preparing foxtail and broomcorn millet. For example, Ibn al-Awam gives instructions for millet porridge (Ibn al-Awam, 1977). The hulls are removed from the grain, which is then cooked in plenty of water. He says that millet must be boiled for a long time. When the water has been absorbed, a measure of milk is added, making a very good dish. Ibn al-'Abbâs also mentions the preparation of millet with bread and milk, although he is writing about the tropical millet Pennisetum (Serjeant, 1974: 51). Milk is often mentioned in Medieval Arabic sources as an accompaniment to millet dishes (e.g. Dietrich, 1981: 249), and today a food called kochi is made in Afghanistan from the flour of foxtail and broomcorn millets mixed with milk or fat (Sakamoto et al., 1980: 1980).

Ibn al-Awam describes how bread was made from broomcorn millet, according to the Book of Nabatean Agriculture (Ibn al-Awam, 1977: 79-80). It is, he says, as nourishing as rice bread, but of more agreeable taste. The grain was ground with hot water; he says it must be soaked while working it, without interruption. The wet flour, presumably with more water added, was then boiled over a fire until all the water evaporated. It was kneaded along with an added quantity (unspecified) of wheat flour or even better, starch, which sticks the dough together. An alternative method was to mix small quantities of dry millet flour rapidly into hot water, completing the addition of flour before the water cooled. When all the water was absorbed by the flour, “a certain quantity” of wheat flour or starch was added. Yeast was also an ingredient. After vigorous mixing, the dough was left to ferment for an hour before baking. Quoting Dioscorides, Ibn al-Awam states that the bread made this way from foxtail millet is less nourishing that made from broomcorn millet. Ibn al-Awam himself ate a bread from foxtail millet which he found very tasty, made from dough which was left to rest overnight. This may have allowed a slight fermentation to take place, adding to the taste and food value. Ibn al-Awam recommended that millet bread be eaten with butter, oil or milk.

El-Samarraie’s sources for 9th c. Iraq mention that peasants mixed millet with barley for their staple bread (El-Samarraie, 1972: 87). The barley/millet bread was apparently endorsed by Ibn Wahshiyya for those involved in strenuous manual labour. Ibn ‘Abbâs describes a parched grain called “jahish”, which can be made from under-ripe millet grain. The cut ears
are roasted over hot embers. When cooked they are removed and the husks rubbed off to obtain the roasted grain. El-Samarraie briefly mentions drinks prepared from barley and millet “similar to strong wines in their effect” (El-Samarraie, 1972: 87). No details are given, but this may be a reference to bouza. Bouza is a fermented, thick, white, slightly alcoholic drink made from bread, which can be from a variety of cereals, and known in slightly different guises over a wide area, including sub-Saharan Africa. In the past, bouza was often made from millet in both Egypt and Turkey.

Ibn al-Awam states that the green leaves of millet are excellent fodder for cattle and goats (Ibn al-Awam, 1977: 79). Millet is recommended for fattening chickens also, although here one presumes it is the grain and not the leaves which are used. El-Samarraie implies that millet was an important fodder crop, along with oats and rye (El-Samarraie, 1972: 90). Dietrich refers to a few medicinal uses, for example as a compress to relieve gripe and cramps (Dietrich, 1981: 249).

HUSBANDRY AND USES OF FRUITS, NUTS AND CONDIMENTS

INTRODUCTION

Many of the plants in this section are cultivated in orchards or gardens. Garden plants can be annuals or perennials, while most orchard plants are perennials. Perennials grow over many years, and require an area permanently given over to them. They represent a long-term investment. They do not begin to bear fruit for several years but they need attention throughout their period of establishment. After maturity when they begin to produce, they often require regular maintenance such as pruning, fertilising and weeding. The perennials found at these sites yield their fruit in the late summer and autumn.

In this section, contemporary Arabic sources are used only for the three fruit crops which were most abundant in the assemblage: grape, pomegranate and fig. In addition to the perennial crops, three annual crops - melon/cucumber, cow pea and coriander - are discussed, as well as caper, a plant often gathered from the wild.

GRAPE

The grape (Figure 21) is a vigorous woody vine which climbs with the aid of tendrils. It is capable of growing as long as 15 to 20 metres or more, but under cultivation it is kept much smaller by intensive pruning. The leaves are large, lobed and coarsely toothed, while the fruit is borne in dense bunches. Grapes can vary from dark blue-purple, to red, green or yellow, and the fruit is juicy with a sweet or sour taste (Ketsa and Verheij, 1991).

The vine is dormant during winter; the longer days and warmer days of spring stimulate the main buds to grow. Grape can withstand temperatures down to -20°C, but sharp frosts will kill the young shoots in spring. Temperatures of 25-30°C are optimal for growth and fruit maturation. In addition, the grape needs high light levels, but the fruit is sensitive to scorching. Grape is able to produce a fair crop in semi-arid regions without irrigation due to its extensive root system. It yields best with a good water supply but cannot withstand flooding. An adequate water supply is most critical during flowering and fruit setting. Grape can grow in any type of
soil but the soil structure must support extensive root development. Better quality soils give higher yields. Vineyards need protection from strong winds, and do best in dry conditions, which discourage the proliferation of fungal diseases (Ketsa and Verheij, 1991).

Grape seedlings are not true to type, so vines are normally produced by vegetative propagation, either through rooting twigs or through grafting. The root stocks can be selected for their suitability to particular soils. The grafts or cuttings take about three years to produce fruit (Ketsa and Verheij, 1991: 306; Zohary and Hopf, 1993: 143). Training and pruning are very important. The training stage forms the permanent framework of the vine while pruning involves the removal of new growth to maintain the form of the vine and to regulate its fruiting. In lower latitudes where sunlight is intense, vines are trained on overhead trellises so that the leaves can shade the fruit below. The fruit quality can be improved by halting irrigation a few weeks before harvest and resuming irrigation when the vine is pruned again. The grapes are harvested by cutting the main cluster stem near the point of attachment to the branch. Before being placed in a basket or tray, the picker inspects the bunch and removes any damaged berries. In Syria grapes mature over a wide period, from July to October (Ketsa and Verheij, 1991; Thompson, 1986: 31).

The grape was very highly regarded in the Medieval Islamic world, and was almost as important as the date (Miquel, 1980: 452). The 10th century geographer Ibn Hawqal (1964) makes many references to vines in the Upper Euphrates region, such as in the valley of Hiyal near Sinjar (p. 214), at Ra’s al-‘Ayn (pp. 215-6), and at a number of villages along the Khābūr River (p. 215). The geographer al-Muqaddasi singled out Upper Mesopotamia as a region
which exported high quality grapes and mentioned the north-eastern town of Nisibe in particular (Miquel, 1980: 455). Ibn al-Awam has much to say about the best way to plant and establish vines (Ibn al-Awam, 1977: 329). He quotes Ibn Hedjadj, who recommends planting vine cuttings in autumn, especially in areas of low rainfall. The vine then has the chance to establish its root system, ready for rapid growth in the spring. However, others preferred to plant new vine cuttings in the spring. Ibn al-Awam continues in great detail, quoting many authorities, on methods of planting and raising vines under many different conditions (Ibn al-Awam, 1977: 329).

The agricultural calendar of Ibn Wahshiyya indicates the labour and continual maintenance which grape vines require (El-Samarraie, 1972: 66-71). A proponent of spring planting, he recommends grafting the vines in May. In June, the soil of the vineyards is hoed during the first half of June, and a second hoeing given in the latter half of June. Hand weeding around each vine might also be necessary. The first grapes can be harvested in July from established vines. Gathering continues throughout August, and the final bunches are brought in during September. In December Ibn Wahshiyya recommends manuring the vines; hoeing and manuring might continue throughout the winter months.

Grapes are eaten as fresh and dried fruit, and today their main importance is for wine-making (Ketsa and Verheij, 1991: 304). Dibs is a thick fruit syrup, and can be made with whichever fruits are abundant. Drying grapes and making syrup from them preserve the fruit for use out of season. In the Medieval period, grapes could be eaten as fresh fruit, dried as raisins or made into dibs. Grapes or raisins could be eaten alone, as ingredients in cooking, and as delicacies mixed with walnuts, pistachios and sesame. They were also made into vinegar and verjuice - an acidic liquid made from sour grapes and used for cooking or in medicinal preparations (Miquel, 1980: 459-60; Yusuf, 1985: 38). Ibn al-Awam describes some methods of preserving grapes (Ibn al-Awam, 1977: 619ff). Ibn Hawqal mentions that wine was taxed in Upper Mesopotamia, and there is other evidence that wine was produced at least to some extent in other Islamic areas (Ibn Hawqal, 1964: 208, 213; Miquel, 1980: 457; Unwin, 1991: 150-2, 155).

POMEGRANATE

The pomegranate is a hardy bush or small tree, growing up to 10 metres tall. It is an attractive plant with shiny leaves and bright red flowers which develop into large round fruit (Figure 22). The fruit can vary widely in colour from yellow-green to black-violet, but is normally orange-red (Rifai and Rifai, 1991: 270; Thompson, 1986: 31-2; Zohary and Hopf, 1993: 162). Pomegranate can survive temperatures as low as -10°C and tolerates poor soils, including Figure 22 — Pomegranate (Punica granatum). From Library of Entertaining Knowledge, 1830.
those which are calcareous and alkaline (Rifai and Rifai, 1991: 271). According to Purseglove, the best quality fruits are from areas with cool winters and hot dry summers (Purseglove, 1968: 641). In the non-mountainous areas of Iraq and Turkey, pomegranate blooms from May through to June or July and the fruits mature from August to September (Chamberlain, 1972: 173; Townsend, 1980: 403). After propagation by cuttings of 1-year old wood, the young bushes begin to flower in the fourth year of growth (Purseglove, 1968: 641).

The pomegranate fruit is either eaten fresh or made into drinks. Various parts of the pomegranate shrub are used medicinally. The bark, leaves and fruit rind are rich in tannins and the fruit rind also produces a dark dye. Its showy flowers make pomegranate an attractive ornamental tree (Townsend, 1980: 405; Rifai and Rifai, 1991: 270).

The only region in Upper Mesopotamia where Ibn Hawqal mentions pomegranate cultivation is Sinjar (Ibn Hawqal, 1964: 215). Pomegranate was grown in many parts of Iraq in the 10th century (El-Samarraie, 1972: 96). Ibn al-Awam lists many pomegranates, amongst them hairy, smooth, lenticular and acid types (Ibn al-Awam, 1977: 252-3), but the method of raising the trees is the same. He recommends that cuttings of pomegranate should be planted in February or March in Spain (Ibn al-Awam, 1977: 254). One can also plant pomegranate seeds. Ibn al-Awam quotes from the Book of Nabatean Agriculture which describes how seven to fourteen pips can be planted in small holes, watered, and later, when the young plants are established, fertilised. Apparently regular and frequent irrigation was applied. He also describes how the young plants can be transplanted after three years. According to Ibn Hagga, the pomegranate appreciates much water and regular cultivation. He recommends an application of water every five days, from the end of June to the beginning of September. He says that the fruit is harvested in mid-October. Ibn al-Awam says that certain snakes are repelled by the pomegranate tree, and that he himself had seen this phenomenon (Ibn al-Awam, 1977: 255-256).

FIG

Fig trees (Figure 23) are usually 5-7 metres tall, but can grow up to 10-12 metres if enough moisture is provided (Browicz, 1986: 22-23). The tree fruits every year and each tree produces ripe figs over an extended period (Goor, 1965: 130). The trees can grow in poor, stony ground and take 3-4 years to begin producing fruit (Zohary and Hopf, 1993: 150; Goor, 1965: 128-9). Ibn al-Awam discourages too much water or fertiliser for fig trees, for he says they make the fruit go soft and rotten (Ibn al-Awam, 1977: 227). Ibn Wahshiyya's agricultural calendar lists the gathering of figs over June and July (El-Samarraie, 1972: 67).

Because the sweet whole fruits are easily dried, transported and stored, figs are a useful and indeed valuable economic resource (Goor, 1965: 125; Browicz, 1986: 23). Goor describes three different methods of
drying figs, and the variety of ways they were eaten during the Classical period in Palestine (Goor, 1965: 131). Ibn al-Awam describes different ways of preparing figs and preserving them (Ibn-‘Awwâm, 1977: 279-280, 628-9). For preserving fresh figs he recommends making a type of jam or stewed fruit preparation; and he recounts how to dry figs properly, and prevent infestations of worms.

The only reference Ibn Hawqal (1964: 219) makes to figs in the upper Mesopotamian region is for a small village not far from Mosul. Based on its ubiquity elsewhere in the Middle East and its wide distribution (Browicz, 1986: 23, map 34, p. 69), fig was likely to have been more widespread in the region.

DATE, LEMON AND PLUM

The date palm (Figure 25) is tall and unbranched, crowned with large feather-like evergreen leaves. The date is dioecious; that is the male and female flowers are borne on different plants. The flower clusters of both sexes form within a large tough sheath called a spathe. Natural fertilisation is haphazard and dates have been pollinated artificially from very ancient times (Bircher, 1995). There is an ancient literature on artificial pollination (Goor and Nurock,
Apart from this important activity, date palms require little maintenance apart from thinning the foliage of male palms and removing suckers from the trunk. Planting these suckers is the most common propagation method, as date seeds are not true to type (Goor and Nurock, 1968: 151).

The date palm is suited to extremely hot climates and can flourish in saline conditions (Bircher, 1995; Goor and Nurock, 1968: 151). It is thus well suited to inhospitable regions where other crops do not grow well. Today the date is grown on a limited scale in central and south-eastern Syria (Thompson, 1986: 320), but it is much better suited to conditions further south in Iraq, where large date plantations flourish. According to Ibn Hawqal the date grew in the Upper Mesopotamian Euphrates valley in Medieval times, but its northern limit was not specified (Miquel, 1980: 466). In Iraq the northern limit of date cultivation on the Euphrates is between Abu Kemal in Syria and 'Ana in Iraq (Weulersse, 1946: 48, Figure 12, 51; Fisher, 1978: 379).

The most important product of the date palm is the fruits, which can be eaten fresh or dried. The sap of the date palm can be tapped and used as a drink on its own or fermented. Taking the sap kills the tree, however. The date provides the raw material for uses as diverse as basketry, rope, caulking and construction (Bircher, 1995; Goor and Nurock, 1968: 125-6). The date palm is especially valued in Muslim Arab culture (Goor and Nurock, 1968: 125).

The lemon plant (Figure 26) is a straggling bush or small tree; its branches are covered in short stiff thorns. The lemon is very sensitive to cold and frost. It needs long warm summers for the fruit to grow and mature. The mild Mediterranean climate is well suited to lemon-growing. Lemons can grow under irrigation and in areas where rain fall is adequate for agriculture (Chakravarty, 1976: 140-1; Spiegel-Roy and Goldschmidt, 1996: 15; Townsend, 1966: 466). Lemons, along with oranges and citron, seem to have been introduced into Syria in the 9th century (Yusuf, 1985: 40; Zohary and Hopf 1988: 160). The sensitivity of lemon to temperature change, and their poor resistance to cold or frost seems to make the continental climate of the middle Euphrates valley unsuitable for their cultivation. However, they are grown there today and Rafiq states lemons may even be quite well suited to the area (Rafiq, 1976: 70).

The juice of lemons are used for a variety of drinks, and the fruit itself is widely employed for garnishes, deserts and confectionery. Lemon peel is used for flavourings, condiments and medicinal preparations (Chakravarty, 1976: 141). According to numerous recipes recorded by Arabic writers of the Medieval period, the

Figure 26 — Lemon (Citrus limon).
From Library of Entertaining Knowledge (1830: 332).
flowers, fruits and leaves of the lemon were important in baking, confectionery, perfumery and the preparation of refreshing drinks (Viré, 1993: 962).

Plums (Figure 27) are highly variable in size, shape and colour of the fruits and in the form of the trees (Goor and Nurock, 1968: 214). Plums grow well in warm climates under irrigated conditions (Goor and Nurock, 1968: 219). There are two species of plum grown in Syria today; *Prunus domestica*, which is restricted to the west of the country, and *Prunus salicina* which grows in central Syria and the Euphrates region (Thompson, 1986: 32-3). The latter species was introduced from China (Thompson, 1986: 33) and was not known in Syria in the Medieval Islamic period.

Figure 27 — The greengage plum tree (*Prunus domestica insititia*), its branches, flowers and fruit. From Loudon (1854: 110).
MELON AND CUCUMBER

Melon (Figure 28) is an herbaceous annual creeper or climber with a thick hairy stem, simple hairy leaves and large hairy floral parts. Melon varieties look very similar apart from their fruits, which show great diversity in coloration and surface patterns, flesh colour, size and shape (Purseglove, 1968: 110, 112-114; Chakravarty, 1976: 168; Paje and Vossen, 1993).

Melon is suited to arid and warm sub-tropical and temperate climates. It requires warm dry weather, plenty of sunshine, and an optimum temperature of 18-28°C. It is killed instantly by frost. The best growth occurs on deep, well-drained and thoroughly cultivated fertile soils. In Iraq, ridge and furrow cultivation is most common. Two to three seeds are placed in each well spaced hole. Melon is often mulched and if not, needs to be well weeded until the plants are well established. In drier areas melon needs to be irrigated; in Iraq; irrigation is halted when the fruits are ripe. The fruits mature 3 to 4 months after sowing and are picked fully ripe (Chakravarty, 1976: 168; Paje and Vossen, 1993).

Melon is mainly eaten fresh for its juicy sweet flesh. The pulp can also be mixed with water, sugar and sometimes milk to make a refreshing drink. The immature fruits of some varieties are pickled or cooked, or eaten as fresh vegetables. The seeds are sometimes eaten after roasting (Purseglove, 1968: 110, 112-4; Chakravarty, 1976: 168; Paje and Vossen, 1993: 153).

The cucumber (Figure 29) looks similar to melon; it is an annual trailing or climbing creeper which grows up to 5 m long. It is covered in stiff bristly hairs, has a robust stem with
simple tendrils and more or less triangular leaves. The yellow flowers are large and the fruit is very variable in size, shape and colour, according to variety (Gildemacher and Jansen, 1993: 158; Chakravarty, 1976: 171).

The cucumber needs a warm frost free period of 3 1/2 to 4 1/2 months from sowing to harvest. The optimum temperatures for growth are 30°C during the day and 18-21°C at night. Cucumber does best in fertile, well drained soil and responds well to manuring or fertiliser. It is sensitive to waterlogging. It can grow well in sandy soils where other crops are difficult to grow, and is well suited to the sandy or pebbly banks of the Euphrates river. Normally, several cucumber seeds are planted in well spaced hills and later thinned to 2-3 plants per hill, or seeds are sown widely spaced in prepared ridges which are flanked by furrows. Cucumber plants destined for pickles are planted closer together than those for salad vegetables. The hills need to be weeded until the plants are well established. In arid areas irrigation is required at frequent intervals, especially when the plants are young. The beginning of harvest starts about one and a half to two months after sowing, when the first immature fruits are ready, and harvesting can continue over four to six weeks. The fruits are easily damaged and do not travel well. They are only grown to maturity for seed production (Gildemacher and Jansen, 1993: 158-60; Chakravarty, 1976: 171).

Cucumber is mainly used for its immature fruits in salads; the cool pulp is valued for its refreshing quality. The very young fruits are often pickled. The large yellow cucumber types are boiled and eaten in stews. Cucumber seed kernels are sometimes eaten as snacks, and the leaves have medicinal properties (Gildemacher and Jansen, 1993: 157; Chakravarty, 1976: 171).

COW PEA

The cow pea (Figure 30) is an annual vine which varies widely in habit, from short and erect, to twining up to 2 metres or more, and the pod can grow from 15 to 75 centimetres or even longer. The leaves are divided into three triangular parts and the flowers can be white, yellow or violet coloured. The highly elongated pod gives it one of its common English names: yard-long bean. The seeds are variable in colour and markings (Townsend, 1974: 582; Duke, 1981: 303).

The cow pea is sensitive to cold and is killed by frost but is highly tolerant of heat and drought. It grows equally well in a wide variety of soils, as long as conditions are well-drained. The exception is alkaline soils, in which the cow pea does less well. It can tolerate moderate shade but is sensitive to waterlogging. The cow pea is planted in rows or broadcast after the danger of frost is past. If the cow pea is to be used for seed or stored fodder it is

Figure 30 — Cow pea (Vigna unguiculata). From Church (1886: 157).
advantageous to plant early in the summer, but cow peas can be planted later on if they are intended for green fodder or green vegetables. The crop needs to be weeded at least twice. The plants can begin to produce pods in less than two months and seed in three months, but some varieties mature later. The pods and seeds ripen unevenly, and there are flowers, green pods and ripe seeds on a single vine at the same time. In Iraq, the cow pea flowers and fruits from June to October, and this pattern is probably the same in Syria (Cobley and Steele, 1976: 95; Duke, 1981: 304; Purseglove, 1968: 324; Townsend, 1974: 582).

The cow pea is often grown as a vegetable for its green immature pods, rather than as a seed legume. The young shoots and leaves can also be eaten like spinach, or the leaves can be cooked, dried and stored. Unusually for a legume, it will continue to put forth new leaves if it is cut back at an early stage. It is thus an on-going source of vegetables for people or fodder for animals throughout the growing season (Cobley and Steele, 1976: 95; Duke, 1981: 302; Purseglove, 1968: 322).

THE NUTS: WALNUT AND ALMOND

The walnut is a deciduous large tree which bears globular fruits (Figure 31). The fruit consists of a thin green rind surrounding a nut shell, which itself encloses an edible kernel. The walnut tree requires fertile, well drained soil which is at least 2 metres deep and free of alkali salts. It is best suited to sandy or loamy conditions. It is tolerant of great temperature extremes, from -11°C in winter when the tree is dormant, up to about 38°C, at which point fruit development begins to be affected. Walnut trees have a high water requirement, much higher than almond, for example, and are often planted along waterways. Walnut grows in Iraq only in the northern mountainous districts, and in Syria in the west. According to the Medieval Arabic geographers, the walnut was restricted to colder habitats such as the mountainous regions (Miquel, 1980: 446). Walnut trees begin to bear fruits after about eight years. The fruits ripen from September to October, when the fruit coat splits. The nuts are either allowed to fall to the ground or the branches are shaken or lightly beaten to loosen the fruits (Chakravarty, 1976: 309-11; Duke 1989: 195; Thompson, 1986: 32; Woodroof, 1979: 618).

There are many products derived from the walnut tree. The kernel is much esteemed and can be eaten green or ripe; it is tasty and rich in fat and vitamins. The ripe kernel is widely used in confectionery. Walnut milk can be made from the crushed kernels soaked in water. The ripe kernel also yields oil for cooking and lighting.

Figure 31 — Walnut (Juglans regia).
From Balfour (1885: 101).
A black dye is derived from the soft green outer fruit rind and the wood is highly valued for furniture and building construction. Different parts of the tree, including the leaves, bark and green shells have various medicinal uses (Chakravarty, 1976: 311; Duke, 1989: 1989 194-5; Goor and Nurock, 1968: 228-9, 234, 236; Rosengarten, 1984: 243-4).

The almond (Figure 32) is a deciduous tree which can range in habit from small and bushy to quite tall; it grows from 6.5 to 10 m high. The branches are spreading and the grey-green leaves are lance-shaped. The flowers appear before or with the foliage and are pink or white. The heavy, sticky pollen they produce are mainly spread by honey bees, which are an important part of almond production. The fruit has a finely hairy tough flesh, which splits when ripe to expose the pitted stone containing the almond kernel (Kester et al. 1991: 733; Rosengarten, 1984: 3, 11; Duke, 1989: 250).

The almond tree is highly variable in its flowering time, productivity and frost tolerance. The tree is best adapted to wet cool winters, mild springs, warm dry summers and mild autumns - the classic Mediterranean climate. In general, it is highly sensitive to spring frost, to which the almond is susceptible since it rapidly responds to short periods of warm weather in late winter and spring. It is one of the earliest temperate fruit or nut trees to flower. It does well in less fertile soils and is highly tolerant to heat and drought. In these conditions, however, and in calcareous conditions, the yield of nuts is low. If the trees are well irrigated and fertilised, the yield is much better. Almond can grow well in the drier areas of Syria and regions of less fertile soils. Traditionally, almond seedlings are grown in mixed cultures with other crops and given minimal management (Duke, 1989: 250; Kester et al., 1991: 718-9, 730; Thompson, 1986: 30). It grew throughout the Medieval Islamic territories either cultivated or wild (Miquel, 1980: 445).

The almond kernel is a rich source of fat, protein and fibre. It is eaten on its own and is also widely used in confectionery and baking. The kernel yields an esteemed culinary oil. The almond also has a wide range of medicinal uses (Duke, 1989: 249; Goor and Nurock, 1968: 253; Kester et al., 1991: 715).

Figure 32 — The almond tree (*Amygdalus communis*), its branches, flowers and fruit. From Loudon (1854: 105).
THE CONDIMENTS: CORIANDER AND CAPER

Coriander (Figure 33) is an erect annual herb which is much branched and grows from 30 cm to over 1 m high. The plant is smooth with fine, deeply lobed leaves and small white-pinkish flowers arranged in umbels (Chakravarty, 1976: 161; Diederichsen and Rugayah, 1999: 105-6).

In areas with a mild winter climate, such as in middle and lower Iraq and in tropical countries, coriander is a winter crop, but elsewhere it is planted later. Coriander prefers a sandy loam, but it can grow well on loam and clay with good drainage. Sowing can take place at any time because the seeds germinate over a wide temperature range. Coriander may be grown as a single crop or mixed with legumes and other crops. It needs two to three weedicings and occasional irrigation. If the crop is grown as a herb, it is uprooted about two months after sowing. The plant flowers 50-90 days after sowing and the flowering time lasts some weeks or up to a month depending on the weather. If the crops is grown for fruit production, the crop may be thinned when young, and fruit yield is much improved if the crop is fertilised. The plants are ready for harvest of the fruits between 3 to 4 1/2 months depending on the variety. Since flowering time is extended, the fruits ripen unevenly. When the first fruits are ripe the crop is uprooted or cut at the base, gathered into sheaves and left to dry in the field in order to ripen the remaining fruits. The fruits are then threshed from the dried plants (Chakravarty, 1976: 161; Diederichsen and Rugayah, 1999: 106-7).

Every part of the coriander plant has an aromatic odour and can be used as a flavouring. As a green herb, the leaves or entire plant is used. The dried fruits are extensively used as a condiment, and also have some medicinal uses (Chakravarty, 1976: 161; Diederichsen and Rugayah, 1999: 104).

The caper (Figure 34) is a shrub which grows up to 2 metres tall, with trailing prostrate branches. It bears more or less oval leaves and large white flowers, which turn red-purplish as they age. The fruits are olive-green berries, growing up to 5 cm long and 1.5 cm wide, and are fig-shaped. They have a thin leathery

Figure 33 — Coriander (Coriandrum sativum). From Balfour (1885: 140).

Figure 34 — Caper (Capparis spinosa). From Duchesne (1846: 191).
skin with distinct ribs and numerous seeds embedded in a yellowy-red pulp (Chakravarty, 1976: 97; Ong and Siemonsma, 1999).

The caper mainly grows wild in deserts, wastelands, dry fields and sloping rock crevices, but is sometimes cultivated. The root system is very extensive and the plant is well suited to arid conditions. The caper bush begins to produce flowers and fruit a year after germination of the seed and reaches full production after three to four years. Once the buds appear, they are harvested at regular intervals over 8-12 days (Ong and Siemonsma, 1999: 89-90).

The flower buds of the caper are gathered in spring or early summer and pickled for use as a seasoning. The pickled buds are used in salads and sauces. They keep their flavour when cooked and are especially good with fish. Less commonly, the ripe fruit is gathered in the autumn and eaten either fresh or pickled. The bark and leaves of the caper bush have medicinal properties (Blakelock and Townsend, 1980: 140; Chakravarty, 1976: 97; Helbaek, 1964: 46; Ong and Siemonsma, 1999: 88).

AN ISLAMIC AGRICULTURAL REVOLUTION?

In his book Agricultural innovation in the early Islamic period, Andrew Watson (1983) presents his controversial but influential thesis of radical change in agriculture during the early centuries of Islam. Watson argues that an agricultural revolution occurred, facilitated by a climate of receptivity to new ideas, within a vast region unified by religion and political control. During this time, he suggests, an entirely new season of agriculture was opened up through the introduction of summer crops. In Watson's view, pre-Islamic agriculture incorporated widespread fallowing and had no agrarian production during the summer, apart from a few crops grown on a restricted scale (Watson, 1983: 123ff).

Watson suggests that the rise of Islam led to more specialised and effective land use due to newly introduced crops, more intensive rotations, improvement and extension of irrigation, the spread of cultivation into new or abandoned areas, and more labour-intensive farming techniques (Watson, 1983: 2-3). The technology for improved and extended irrigation came not from new inventions, but the re-use of established techniques. “The Islamic contribution was less in the invention of new devices than in the application on a much wider scale of devices which in pre-Islamic times had been used only over limited areas and to a limited extent” (Watson, 1983: 108).

Watson's work is based primarily on literary sources (Watson, 1983: 3). The Arabic sources are relatively late, dating at the earliest to the 9th century, and in the main to the 10-12th centuries. They were thus mostly written after after the events Watson suggests took place. There is, however, sufficient pre-Islamic literary evidence to show that many of the crops discussed by Watson were well known and cultivated in the Near East and neighbouring regions prior to the Islamic period. This is demonstrated by the literary evidence collated by Ashtor (1985) and Aubaile-Sallenave (1984). Aubaile-Sallenave adds a substantial list of summer plants cultivated by the Romans (Aubaile-Sallenave, 1984: 253) to supplement Watson's brief inventory of “trimestre spring wheat”, millets (although by this Watson may mean sorghum?), sesame, “various legumes as well as a few garden crops” (Watson, 1983:123). Strangely Watson (1983: 123) relegates all of these to “a minor role in some parts of the northern Mediterranean, where the summer was relatively cool...”, although sesame and millets
thrive in hot temperatures. Ashtor and Aubaile-Sallenave conclude many summer crops were well dispersed at least by Roman times (Ashtor, 1985: 431; Aubaile-Sallenave, 1984). Indeed, Watson himself refers to evidence for the presence of cotton (p. 34-5, 164 n. 29), rice (p. 15), sesame (p. 123) and millet (p. 123) in the Near East prior to the advent of Islam, but concludes that these were rare local anomalies.

Ashtor commends Watson’s assessment of the history and spread of crops using literary sources, pointing out the difficulty of the endeavour, and applauds Watson’s use of some archaeological data (Ashtor, 1985: 421-2). Extensive and reliable archaeobotanical data are best suited to trace the domestication and dispersal of crops. This is because the identity of the crop can be clearly established and the data can show evidence for local production as opposed to importation. Since the publication of Watson’s book nearly 20 years ago, however, there is still too little archaeobotanical evidence to build an accurate and detailed picture of the use and spread of crops after the Late Bronze Age. Very few excavations from the Iron Age onwards incorporate systematic archaeobotanical recovery and analysis. Nevertheless, the archaeobotanical evidence currently available correlates well with the literary evidence, confirming that a sudden synchronised agrarian expansion of summer crops into new areas in the early Islamic period did not take place. Pre-Islamic archaeobotanical remains of summer crops have been found from geographically widely separated sites, and suggest that further work will reinforce the patchy pattern of crop husbandry which is just beginning to emerge.

It is too early to undertake a wholesale reassessment of this pattern based on archaeobotanical evidence, and an archaeobotanical survey of all the summer crops discussed by Watson is beyond the scope of this report. Many of these crops are discussed by Zohary and Hopf (1993). The finds from the middle Euphrates Medieval sites most relevant to Watson’s model are the four summer field crops together with hard wheat, and the current archaeobotanical evidence is summarised here for their presence in the Near East and adjacent regions in pre-Islamic times 1.

Watson is certain that the Muslim Arabs were responsible for the diffusion of hard wheat (Triticum durum, also durum wheat) throughout the Near East and the south and eastern Mediterranean (Watson, 1983: 21). Durum is, like all the other wheats, a winter crop in the Near East. Watson relies primarily on Vavilov’s conclusions (see Watson 1983: 20, 157 n. 5) on the origin of durum, and suggests that it probably arose from a mutation of emmer relatively recently. He implies this was some time after the Classical period (Watson, 1983:20). Watson presents an interesting culinary history on new dishes using durum, but this shows the development of cookery, not the effects of a “new” crop (Watson, 1983: 22).

The origins, genetics, and diversity of wheat is the subject of intensive study, because of its modern importance as a staple food. Genetics provides key data about the ancestors and evolution of different wheat species. There are two distinct main species of naked wheat. Durum or hard wheat (Triticum durum) has four sets of chromosomes (tetraploid). Bread wheat (Triticum aestivum) has six sets of chromosomes (hexaploid). Separation of ancient

---

1. Since this chapter was written, Kroll has tabulated further pre-Islamic archaeobotanical finds from the Near East and neighbouring regions of hard wheat, cotton, sesame and foxtail millet (Kroll, 2000: 54, 39, 51). The reconstruction of ancient historical agriculture is constantly improving as new analyses of ancient plant remains are undertaken.
remains of naked wheats is difficult. Zohary and Hopf state that it is impossible to distinguish between bread wheat and hard wheat on the basis of their grains (Zohary and Hopf, 1993: 48-9). Hillman and co-authors, in a thorough review of archaeobotanical wheat identification, confirm that identifying the grain of naked wheat is highly problematic (Hillman et al., 1996 for 1995: 204-6). As a result, archaeobotanical publications of grain either report the naked wheat species without adequate justification or leave the identification at the “naked (or free-threshing) wheat” level.

The pioneering work by Hillman has shown that well-preserved rachises of hard wheat and bread wheat can be separated (Hillman et al., 1996 for 1995: 202; Hillman, in press), and I have applied these criteria to the middle Euphrates Medieval assemblage (see page 441, Chapter 2 Identification criteria for the economic plants). The identification of naked wheat rachises to species requires reasonable preservation, and some intermediate forms that cannot be identified may occur. For example, the rachis fragments from the early Neolithic Syrian site of Ramad (van Zeist and Bakker-Heeres 1982) are indeterminate in form, but in practice most naked wheat rachises from the ancient Near East can be determined to species. Sufficient material is needed for intra-sample comparison, but identification is not limited to extreme forms, as stated by Zohary and Hopf (1993: 49). Hillman's criteria have been disseminated slowly in non-published form amongst archaeobotanists (Hillman et al., 1996 for 1995: 202-3) and have not yet been widely applied to Near Eastern assemblages. As a result there is currently little reliable archaeobotanical information about the cultivation of durum wheat in the region.

For example, the work done by Helbaek on plant remains from the site of Beycesultan, and quoted by Watson (1983: 21) as evidence for hard wheat in Islamic times, includes wheat rachises which can be reassessed using Hillman's criteria, thanks to the clear published photograph (Helbaek, 1961: pl. XVIIIc). On the basis of this illustration, it is possible to see that the 13th c. BC rachises identified as bread wheat are in fact a mixture of durum (upper right rachis) and bread wheat (lower right rachis). The remaining rachises shown are of uncertain identification given the limitations of this photographic reproduction (I am grateful to Gordon Hillman and Mark Nesbitt for assisting with this reassessment.) This example shows that a summary of reliable identifications of durum from the Near East and Mediterranean region requires a thorough reassessment of the archaeobotanical evidence.

The evidence for the earliest finds of Near Eastern naked wheat and their identification as durum has recently been summarised by Maier (1996: 48-9) and Nesbitt (in press). The first finds of naked wheat are from the first half of the 7th millennium BC (uncalibrated radiocarbon years) in Syria and southeast Turkey, but are not identified to species. Definite remains of tetraploid (durum) wheat are recorded from the Neolithic sites of Can Hasan III (6600-5800 BC) in central Turkey and El Kowm II - Caracol in Syria (5800-5700 BC). It is therefore certain that durum was widely distributed throughout the Near East from the earliest times, although specific reliable archaeobotanical examples are uncommon because of the lack of application of modern identification criteria.

Watson does not dispute that cotton was known and cultivated over a wide area before the advent of Islam (Watson, 1983: map 4, p. 33; 34-5). He refers to a number of written records for cotton cultivation outside India (thought to be its area of origin) in pre-Islamic times. His argument is that prior to Islamic times cotton was restricted to very warm regions and suggests
these areas were India, Malaya, South China and less extensively Abyssinia (Ethiopia) and the Sudan (Watson, 1983: 35). He suggests that the limiting factor for the spread of cotton prior to Islamic times was the lack of a variety adapted to regions with shorter and colder summers, and short days towards the end of the growing season (Watson, 1983: 35).

The presence of cotton cloth does not necessarily indicate local cotton cultivation since cloth, a processed and finished product, is widely traded (Rowley-Conwy, 1989: 134). Wild has summarised the written evidence for cotton cloth and cotton textile production in north-eastern Africa, the Near East and India in the Roman period (Wild, 1997). The numerous records which mention not only cotton clothing but also cotton cultivation in Egypt at this time provides very strong support for the interpretation that cotton husbandry was widespread in Egypt in Roman times (Wild, 1997: 289-90). This indicates a more northerly spread in Africa than that postulated by Watson (Watson, 1983: 33 map 4, 35).

There are currently very few archaeobotanical finds of cotton seeds and fruit capsules. Rowley-Conwy has found remains of cotton from the X horizon (late Roman period, 300-550 AD) and later levels from Qasr Ibrim in lower Nubia (Rowley-Conwy, 1989: 134), which according to Watson was the most northerly extent of pre-Islamic cotton cultivation in Africa (Watson, 1983: 33, map 4). Recently, large numbers of cotton seeds dating to the Late Sasanian period (6th - early 7th c. AD) have been found from the central Asian site of Merv in Turkmenistan (Nesbitt, 1993a: 57, Nesbitt, 1994: 72-3). This site is well into the northerly area which Watson believed could not have supported cotton husbandry prior to Islamic times, and to the west of eastern central Asia where he thought annual cotton forms first appeared (Watson, 1983: 33, map 4, 38).

On the basis of written evidence, Watson does not rule out the possibility that the Sasanians grew rice nor that it was grown in the Jordan valley between the third and eighth centuries (Watson, 1983: 15). Earlier archaeobotanical evidence for rice has been found in Iran, and rice has been recovered from a pre-Islamic Egyptian harbour site, although rice was not necessarily grown in Egypt at this time (Table 20).

<table>
<thead>
<tr>
<th>Date Period</th>
<th>Site</th>
<th>Region</th>
<th>Quantity</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st millennium BC</td>
<td>Iron Age</td>
<td>Hasanlu</td>
<td>NW Iran</td>
<td>+</td>
</tr>
<tr>
<td>late 8th/7th c. BC</td>
<td>Neo-Elamite</td>
<td>Susa</td>
<td>SW Iran</td>
<td>+</td>
</tr>
<tr>
<td>↑ 1st c. AD</td>
<td>Parthian</td>
<td>Susa</td>
<td>SW Iran</td>
<td>+++</td>
</tr>
<tr>
<td>1st/2nd c. AD</td>
<td>early Roman</td>
<td>Berenike</td>
<td>SE Egypt</td>
<td>+</td>
</tr>
<tr>
<td>5-early 6th c. AD</td>
<td>Byzantine</td>
<td>Berenike</td>
<td>SE Egypt</td>
<td>+</td>
</tr>
</tbody>
</table>

Table 20 — Archaeobotanical finds of rice from pre-Islamic Near Eastern and neighbouring regions. Quantity scale as follows: + 1-99; ++ 100-199; +++ >200. A dagger (↑) indicates the finds are mentioned by Zohary and Hopf (1994: 84-5).

Watson does not discuss sesame nor the temperate millets, but I have collated pre-Islamic archaeobotanical finds here because the middle Euphrates valley excavations demonstrate that they were important summer field crops there in the Medieval period. There has been extensive debate about the presence of sesame in ancient Mesopotamia (e.g. Bedigian, 1985) but until recently no archaeobotanical sesame finds. Charles has now identified sesame from the mid-third millennium BC in southern Iraq (Charles, 1993: 204; Matthews et al., 1994:...
Table 21 — Archaeobotanical finds of sesame from pre-Islamic Near Eastern and neighbouring regions. Quantity scale as follows: +: 1-99; ++: 100-199; +++: >200; *: quantity data unpublished; the information has kindly been provided by the author of the cited reference. A dagger (†) indicates the finds are mentioned by Zohary and Hopf (1994: 132-3).

<table>
<thead>
<tr>
<th>Date</th>
<th>Period</th>
<th>Site</th>
<th>Region</th>
<th>Quantity</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>mid 3rd millennium BC</td>
<td>Sumerian</td>
<td>Abu Salabikh</td>
<td>central Iraq</td>
<td>+</td>
<td>Charles 1993: 204; Matthews et al., 1994: 183</td>
</tr>
<tr>
<td>† 900-600 BC</td>
<td>Iron Age</td>
<td>Karmir Blur</td>
<td>Armenia</td>
<td>+++</td>
<td>Hopf and Willerdig, 1988: 296; Bedigian, 1985: 168-70</td>
</tr>
<tr>
<td>† 900-600 BC</td>
<td>Iron Age</td>
<td>Bastam</td>
<td>NW Iran</td>
<td>+</td>
<td>Hopf and Willerdig, 1988: 295-6</td>
</tr>
<tr>
<td>† c. 800 BC</td>
<td>Iron Age</td>
<td>Deir Alla</td>
<td>Jordan</td>
<td>++</td>
<td>Neef, 1989: 34</td>
</tr>
<tr>
<td>1st-2nd c. AD</td>
<td>Roman</td>
<td>Berenike</td>
<td>SE Egypt</td>
<td>+</td>
<td>Cappers, 1998: 295, 318</td>
</tr>
<tr>
<td>c. late 1st-2nd c. AD</td>
<td>Roman</td>
<td>Mons Claudianus</td>
<td>E Egypt</td>
<td>+*</td>
<td>van der Veen, 1998: 105; 1999: 176</td>
</tr>
<tr>
<td>c. late 1st-2nd c. to 4th/5th c. AD</td>
<td>Roman-late Roman</td>
<td>Mons Porphyrites</td>
<td>E Egypt</td>
<td>+*</td>
<td>van der Veen, 1999: 176</td>
</tr>
<tr>
<td>300-550 AD</td>
<td>late Roman</td>
<td>Qasr Ibrim</td>
<td>S Egypt</td>
<td>+++*</td>
<td>Rowley-Conwy, 1989: 135</td>
</tr>
<tr>
<td>5th-early 6th c. AD</td>
<td>late Roman</td>
<td>Berenike</td>
<td>SE Egypt</td>
<td>+</td>
<td>Cappers, 1998: 295, 311, 318</td>
</tr>
</tbody>
</table>

Note: All Pharaonic finds of sesame are highly problematic as they cannot be securely dated and may derive from later contamination (Serpico and White, 2000: 397-8). A single fragment of desiccated sesame capsule from a Ptolemaic context (332-30 BC) at el-Hibeh in the Egyptian middle Nile valley (Wetterstrom, 1984: 57, 73, Pl. 5.2D) may well be a contaminant from a later or modern period; there is insufficient information about the archaeological context and whether it was undisturbed. Sesame is an important summer crop in modern Egyptian agriculture.

There is no doubt that the introduction of summer field crops made a major impact on agricultural infrastructure, productivity and labour and resource scheduling. Watson (1983) has made a stimulating contribution to the study of ancient agriculture with the suggestion that a new season of agrarian production was opened up in the summer months (Rowley-Conwy, 1989: 136). However, both literary and archaeobotanical evidence demonstrate that this development did not spread rapidly as a result of the unification by Islam of a vast geographical area. The archaeobotanical evidence shows that summer cultivation of some field crops occurred much earlier in the Near East and adjacent regions, certainly by Classical times as the textual evidence suggests (Ashtor, 1985; Aubaile-Sallenave, 1984) and for some crops at least as early as the Iron Age. Current evidence demonstrates that the exploitation of summer as an agricultural season was already well in place by the advent of Islam, and may have been a more diffuse and gradual process than Watson’s “revolution” hypothesis suggests. Much work remains to be done to trace the pattern of the establishment and spread of summer agriculture, and the impact that it had on ancient economies.
Table 22 — Archaeobotanical finds of reliably identified broomcorn and foxtail millets from pre-Islamic Near Eastern and neighbouring regions. Quantity scale as follows: +: 1-99; ++: 100-199; +++: >200; *: quantity data unpublished; the information has kindly been provided by the author of the cited reference. A dagger (†) indicates the finds are mentioned by Nesbitt and Summers (1988).

Note: A record of broomcorn millet from the cemetery of Abri, N Sudan, dating to c. 1800-1650 BC (Middle - Classic Kerma) (Lopez-Garcia, 1982) is not certain as no identification criteria have been published. The definite identification of broomcorn millet from Ukma (van Zeist, 1987) shows that the crop was certainly present in the region at this period.

MEDIEVAL ISLAMIC AGRONOMY AND CROP USE IN THE MIDDLE EUPHRATES VALLEY

THE YEARLY AGRICULTURAL CYCLE

In Medieval times the villagers of the middle Euphrates valley exploited both the winter and summer seasons for agricultural production. The farmers maintained a busy schedule of crop-centred activities throughout the year, not only for planting and harvesting, but also for preparation of the land and clearing after the harvest. They would have had to apply careful scheduling of labour for the busiest times of year when, for example, winter annuals were ready for harvest and summer crops had to be planted. A number of factors would have been taken into account, including the flexibility of planting times for different crops, the weather patterns each year, the amount and quality of land for planting or left fallow, and the amount of labour available.
In addition to the season of growth, the crops raised in Medieval times have different agronomic requirements and tolerances. The farmers were therefore able to exploit a wide range of ecological zones in the middle Euphrates valley. D'Hont (this volume) discusses the zones within the valley and neighbouring steppe and their suitability for different types of agricultural production.

The most valuable crops were those which were grown primarily for export from the villages, the cash crops such as wheat, barley, cotton and rice. These would have been sited on the most fertile and well-watered land. Other crops yield well in good conditions but can tolerate poor soils or lower water inputs. For example, sesame and millet do not need highly fertile soil. Once established, sesame is resilient to drought. Sesame may therefore have been grown by the Medieval farmers on more marginal land and may not have received much water once the crop was established.

Table 23 summarises the agronomic requirements and characteristics of the crops found at the Medieval villages. The suite of crops allowed flexibility in resource scheduling for the farmers throughout the year and the exploitation of both fertile and more marginal land.

COMMENTS ON THE WINTER FIELD CROPS

Barley was one of the founder crops of Old World agriculture. It has been grown in the Near East since the beginnings of farming and is still an important crop today (Zohary and Hopf, 1993: 54-5). Barley is a hardy and reliable cereal which is tolerant of extreme conditions. The naked wheats developed between two and three millennia after agriculture was invented, and once established, have always maintained an important role in temperate Old World agriculture (Zohary and Hopf, 1993: 46). Abundant barley and wheat grain and chaff have been recovered from these Medieval sites throughout their settlement sequence.

In the Medieval Near East, cereals - especially wheat - were fundamental to agricultural production and were staples of the diet and the agricultural economy. Upper Mesopotamia was one of the most important regions for grain production in the Medieval Islamic world (Ashtor, 1976a: 41; Miquel, 1980: 398-9, 401). According to Ashtor, Arabic documentary sources indicate that barley was mainly grown in areas less well suited to the production of wheat (Ashtor, 1976a: 42). However, both wheat and barley were raised throughout the Medieval settlement of the middle Euphrates valley. Judging from their ubiquity and abundance in the archaeological record, both crops must have been amongst the staple crops for these Medieval farmers. They were probably both grown for the farmers' own use and for export. The very low frequency and late appearance of rye indicates that it was not a crop, but an occasional weed of the winter cereals.

Four winter field legumes were recovered: lentil (Figure 35), pea, chick pea (Figure 36) and broad bean (Figure 37). Today, the middle Euphrates valley farmers do not grow peas; they say the soil is not suited to this crop, which needs soft sandy soil. Lentils are grown by the local farmers now, but only for family use and not as a cash crop. The winter field legumes may have been grown only for local use in the Medieval period too. They are poorly represented at these sites but they may have played a more important role than their archaeological abundance might imply. The legumes are important in cereal-based agricultural systems throughout the world (Zohary and Hopf, 1993: 86).
Figure 35 — Lentil (*Lens culinaris*). From Balfour (1885: 168).

Figure 36 — Chick pea (*Cicer arietinum*). From Church (1886: 129).

Figure 37 — Broad bean (*Vicia faba*). From Balfour (1885: 136).
<table>
<thead>
<tr>
<th>Crop</th>
<th>When planted (for annuals)</th>
<th>When harvested</th>
<th>Water requirements</th>
<th>Salt tolerance</th>
<th>Soil preferences</th>
<th>Special agronomic requirements</th>
<th>Labour input</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barley</td>
<td>Oct-Nov</td>
<td>April-May</td>
<td>Moderate</td>
<td>Tolerant</td>
<td>Wide range of types</td>
<td>None</td>
<td>Moderate</td>
</tr>
<tr>
<td>Bread/compact wheat</td>
<td>Oct-Nov</td>
<td>May</td>
<td>Moderate</td>
<td>Moderately tolerant</td>
<td>Wide range of types but not poor or saline</td>
<td>None</td>
<td>Moderate</td>
</tr>
<tr>
<td>Durum wheat</td>
<td>Oct-Nov</td>
<td>May</td>
<td>Moderate</td>
<td>Tolerant</td>
<td>Wide range of types but not poor or saline</td>
<td>None</td>
<td>Moderate</td>
</tr>
<tr>
<td>Lentil</td>
<td>Dec-Jan</td>
<td>Early summer</td>
<td>Low to moderate</td>
<td>N/D</td>
<td>Wide range of types</td>
<td>None</td>
<td>Low</td>
</tr>
<tr>
<td>Pea</td>
<td>Mar-Apr</td>
<td>Mid-summer</td>
<td>Low to moderate</td>
<td>Sensitive</td>
<td>Wide range of types</td>
<td>None</td>
<td>Low</td>
</tr>
<tr>
<td>Chick pea</td>
<td>Feb-Mar</td>
<td>Early summer</td>
<td>Low to moderate</td>
<td>N/D</td>
<td>Wide range of types</td>
<td>None</td>
<td>Low</td>
</tr>
<tr>
<td>Broad bean</td>
<td>Feb-Mar</td>
<td>Early summer</td>
<td>Low to moderate</td>
<td>Moderately sensitive</td>
<td>Wide range of types</td>
<td>None</td>
<td>Moderate</td>
</tr>
<tr>
<td>Cotton</td>
<td>Apr-May</td>
<td>Sept-Nov</td>
<td>High</td>
<td>Tolerant†</td>
<td>Wide range of types</td>
<td>Hot summer temperatures essential</td>
<td>High</td>
</tr>
<tr>
<td>Rice</td>
<td>May</td>
<td>Sept-Oct</td>
<td>Very high</td>
<td>Sensitive</td>
<td>Wide range of types</td>
<td>High temperature best</td>
<td>Very high</td>
</tr>
<tr>
<td>Sesame</td>
<td>May-June</td>
<td>Sept-Oct</td>
<td>Early growth: moderate, then low</td>
<td>Sensitive</td>
<td>Wide range of types but not saline</td>
<td>High temperature best, frost sensitive</td>
<td>Moderate</td>
</tr>
<tr>
<td>Broomcorn millet</td>
<td>May-June</td>
<td>Aug-Sept</td>
<td>Low but good supply gives good yield</td>
<td>N/D</td>
<td>Tolerates poor soils</td>
<td>High temperature best, frost sensitive</td>
<td>Low</td>
</tr>
<tr>
<td>Foxtail millet</td>
<td>May-June</td>
<td>Aug-Sept</td>
<td>Low but good supply gives good yield</td>
<td>Moderately sensitive</td>
<td>Tolerates poor soils</td>
<td>High temperature best, frost sensitive</td>
<td>Low</td>
</tr>
</tbody>
</table>

Table 23 — Summary of agronomic requirements and characteristics of the economic plants recovered from the middle Euphrates valley Medieval sites. For sources of data, see references in the text. Salt tolerance data from Farnworth, 1997, Table 216, p. 305ff. Key: N/D - no data; † - cotton is sensitive to high sodium levels in water at germination (Farnworth 1997: 300).
<table>
<thead>
<tr>
<th>Crop</th>
<th>When planted (for annuals)</th>
<th>When harvested</th>
<th>Water requirements</th>
<th>Salt tolerance</th>
<th>Soil preferences</th>
<th>Special agronomic requirements</th>
<th>Labour input</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grape</td>
<td>N/A</td>
<td>July-Oct</td>
<td>Good supply gives good yield</td>
<td>Moderately sensitive</td>
<td>Must support extensive root development</td>
<td>Training and pruning</td>
<td>High</td>
</tr>
<tr>
<td>Pomegranate</td>
<td>N/A</td>
<td>Aug-Sept</td>
<td>Regular irrigation</td>
<td>Moderately tolerant</td>
<td>Tolerates poor and alkaline soils</td>
<td>None</td>
<td>Low</td>
</tr>
<tr>
<td>Fig</td>
<td>N/A</td>
<td>July-Sept</td>
<td>Can tolerate low levels</td>
<td>Moderately tolerant</td>
<td>Tolerates poor ground</td>
<td>None</td>
<td>Low</td>
</tr>
<tr>
<td>Peach</td>
<td>N/A</td>
<td>Late summer</td>
<td>Moderate</td>
<td>Sensitive</td>
<td>N/D</td>
<td>None</td>
<td>Low</td>
</tr>
<tr>
<td>Date</td>
<td>N/A</td>
<td>Autumn-winter</td>
<td>High but can be brackish</td>
<td>Tolerant</td>
<td>No special requirements</td>
<td>Artificial pollination</td>
<td>Moderate</td>
</tr>
<tr>
<td>Lemon</td>
<td>N/A</td>
<td>Autumn</td>
<td>Moderate</td>
<td>Sensitive</td>
<td>No special requirements</td>
<td>Long warm period for fruit ripening</td>
<td>Low</td>
</tr>
<tr>
<td>Plum</td>
<td>N/A</td>
<td>Summer-autumn</td>
<td>Moderate</td>
<td>Sensitive</td>
<td>No special requirements</td>
<td>None</td>
<td>Moderate</td>
</tr>
<tr>
<td>Melon</td>
<td>Spring-early summer</td>
<td>Mid-late summer</td>
<td>Moderate</td>
<td>Moderately sensitive*</td>
<td>Best on fertile ground</td>
<td>None</td>
<td>Moderate</td>
</tr>
<tr>
<td>Cucumber</td>
<td>Spring-early summer</td>
<td>Mid-late summer</td>
<td>Moderate</td>
<td>Moderately sensitive</td>
<td>Best in fertile ground, can grow on sand and gravel</td>
<td>Killed by frost</td>
<td>Moderate</td>
</tr>
<tr>
<td>Cow pea</td>
<td>Spring-summer</td>
<td>Summer-autumn</td>
<td>Low</td>
<td>Moderately tolerant</td>
<td>Alkaline-free</td>
<td>Hot summer temperatures</td>
<td>Low</td>
</tr>
<tr>
<td>Walnut</td>
<td>N/A</td>
<td>Sept-Oct</td>
<td>High</td>
<td>Moderately sensitive</td>
<td>Deep alluvial soils</td>
<td>None</td>
<td>Low</td>
</tr>
<tr>
<td>Almond</td>
<td>N/A</td>
<td>Late summer-autumn</td>
<td>Low</td>
<td>Sensitive</td>
<td>Tolerates poor soils but less well on calcareous soils</td>
<td>Susceptible to spring frosts</td>
<td>Low</td>
</tr>
<tr>
<td>Coriander</td>
<td>Spring-summer</td>
<td>Summer-autumn</td>
<td>Moderate</td>
<td>N/D</td>
<td>Sandy loam; can grow on loam and clay with good drainage</td>
<td>None</td>
<td>Low</td>
</tr>
<tr>
<td>Caper</td>
<td>N/A</td>
<td>Summer-late summer</td>
<td>Low</td>
<td>N/D</td>
<td>Poor, rocky and waste ground</td>
<td>None</td>
<td>Low</td>
</tr>
</tbody>
</table>

Table 23 continued — Summary of agronomic requirements and characteristics of the economic plants recovered from the middle Euphrates valley Medieval sites. For sources of data, see references in the text. Salt tolerance data from Farnworth 1997, Table 216, p. 305ff. Key: N/D - no data; N/A - not annual; * - data is for cantaloupe melon - other varieties may have different tolerances and the Medieval variety (if actually melon) is unknown.
Van Zeist and Bakker-Heeres discuss the question of low numbers of preserved legumes in an analysis of samples from Selenkahiye, a Bronze Age northern Syrian Euphrates valley site (van Zeist and Bakker-Heeres, 1985: 278). They point out that some sites yield large numbers of charred pulses, suggesting that if they were cultivated on a large scale, they might be expected to be quite well represented. As a representative survey, the sites examined by van Zeist and Bakker-Heeres in Syria and van Zeist and colleagues in Iran show that the majority have relatively few pulses, particularly of pea and chick pea remains (van Zeist and Bakker-Heeres, 1982; van Zeist and Bakker-Heeres, 1984a; van Zeist and Bakker-Heeres, 1984b; van Zeist and Bakker-Heeres, 1985; van Zeist et al., 1984). This suggests that the largest pulse assemblages may derive from the burning of crop stores, for example in catastrophic fires as at early Bronze Age Tell es-Sweyhat in the northern Syrian Euphrates valley (van Zeist and Bakker-Heeres, 1985: 309). An exception to the low frequency of pulses at the sites studied by van Zeist is the group of Neolithic Damascus sites (van Zeist and Bakker-Heeres, 1982). Even here, although lentils appear in most samples in reasonable amounts, and peas occur in most samples but in low numbers, overall the legumes are represented by many fewer remains than the cereals.

One possibility is that the legumes were consumed, but they were not a major staple at these Medieval sites. A range of butchered bones from sheep, goat and other animals, together with abundant fish remains and eggshell fragments, were recovered from the excavations, showing protein from animal-based foods was not highly restricted (see Chaix and Studer, this volume). Legumes such as lentil and chickpea are easy to grow, but they are difficult to harvest. They are fully mature when the more important cereal crops are ready for harvesting, and these two factors combine to make them less attractive as a main crop (Ann Butler, pers. comm.).

Legumes are a valuable part of the agricultural system because they are able to fix atmospheric nitrogen by means of bacteria in root nodules, replenishing soil fertility. They also make excellent fodder for animals, and this use is flexible: they can be grazed, cut and dried either at the vegetative stage or after seed has set, and the harvested stalks can be provided for forage (Charles, 1985: 40). The remains of cereals, legumes and other plants would be preserved if they were fed to animals for fodder and animal dung was used as fuel (Miller and Smart, 1984). If ripe legumes were not part of the fodder component, any charred legume remains from dung fuel would be difficult to recognise.

Charles provides a useful summary of legume biology, ecology and husbandry (Charles, 1985). As greens, the pods and immature seeds are highly palatable human food. They begin to ripen in spring, at a time when there are not many other fresh vegetables available. In the middle Euphrates valley agricultural system, they may have been more valued at their immature green stage than for their fully mature seeds. If so, they would have had a much reduced chance of preservation since greens have less chance of being directly exposed to fire, and even if burnt would be unlikely to survive in a recognisable state.

COMMENTS ON THE SUMMER CROPS

Of the four summer field crops, cotton and rice are valuable cash crops, sesame is useful primarily for oil, and broomcorn millet is generally a staple only in marginal areas where
other crops are difficult to grow. The circumstances of their recovery give some insight into their use in the Medieval middle Euphrates valley.

There is some archaeobotanical evidence to indicate that post-harvest processing of cotton took place at the villages, either for the villagers' own use, or as a cottage-industry preparation of the lint prior to the export and further processing into cloth elsewhere. Some of the ancient cotton seeds retain their outer layer, often with traces of lint still adhering. In the section on fuel resources (page 432), I suggest that these were derived from cotton sticks used as fuel. On other cotton seeds, however, such as the large concentration from n°23-205b (Period V hearth, Table 12), only occasional patches of the seed coat remain attached to the seeds. This suggests that these cotton seeds were burnt after the lint had been removed.

Rice appears in every category of deposit, and is fairly equally distributed amongst them. It is associated both with deposits containing a wide range of plant species, and those with very few. Such a random distribution suggests that rice was preserved and incorporated into deposits by burning of sweepings and waste, followed by removal to middens, with some scatter before or afterwards. Therefore, although remains of rice are the least abundant of the summer field crops, the evidence indicates that it was a crop which was eaten by the villagers and not only grown for export.

What status might broomcorn millet have had at these Medieval rural settlements? Archaeobotanical evidence shows that several other cereals were also grown there: wheat and barley in winter, rice in summer. This was a productive agricultural area and under such conditions, broomcorn millet is not normally a staple. Millet may have been grown on marginal land that would not otherwise yield a worthwhile summer crop. This would have made a useful supplement to the other cereals grown, and maximised the use of agricultural land. It is possible that a higher percentage of the more expensive crops, such as wheat or rice, may have been exported from the villages, while more millet may have been consumed locally.

The absence of a plant species in the archaeological record cannot be taken to indicate that the species was definitely absent from the ancient agricultural repertoire. Staple cereals, however, would certainly be expected to appear in archaeobotanical assemblages. Sorghum was an important summer-raised cereal in the middle Euphrates valley in the recent past (D'Hont, this volume). If it had been grown in the area in Medieval times, it should have been recovered from the excavations. Sorghum has large seeds which preserve well by charring, the crop has a similar place in agrarian practice as the temperate millets, and it is used in similar ways. The pattern of evidence suggests that sorghum had not spread to the Syrian middle Euphrates valley by Medieval times. Given its importance in modern times, this indicates that the agricultural regimes of the two periods were substantially different.

The perennial fruit trees require more intensive cultivation than the annual crops. They must be fertilised and pruned, and fruit harvesting is labour intensive. These crops must have been grown on well-watered prime land, for example adjacent to the main canals and on islands in the river, where the greatest silt load would have been deposited during irrigation. It is likely that some of the fruit trees were grown in orchards and gardens amongst villages and next to farm houses, providing attractive shady areas. This proximity would also allow easy access for gathering the ripe fruit as it was needed. The orchards may have been similar to the bustan described by Yusuf, a walled area densely planted with trees (Yusuf, 1985: 33). If the Medieval orchards were walled, they would have been protected from browsing animals.
and from flooding and waterlogging. Today, the fertile islands in the Euphrates at Deir ez Zor support a range of different fruit trees and create pleasant green oases in the valley (Figure 38). The Medieval orchards were probably similar cool and shady places.

POSSIBLE IMPORTS

There are a number of crops which may have been imported into the Medieval villages of the Syrian middle Euphrates valley. Agronomic data indicate that walnut and plum were imported, while dates may have been imported. Other candidates for importation are almond and peach. Walnut trees cannot grow in the shallow soils of the middle Euphrates valley. Although plum trees grow in the region today, they are a species recently introduced from China and unknown in the Medieval Near East (Thompson, 1986: 33 - see page 412). The species of plum recovered from the Medieval sites, *Prunus domestica*, is not suited to the local agronomic conditions and climate. Date palms are found today in the region, but this is the northern edge of date palm distribution. (See page 411).

The fruits of all these trees have good long-term keeping properties and apart from drying, require little or no preparation for storage. As delicacies, or for flavourings, they may all be used in small quantities as luxury items. They might therefore have been bought from time to time by the local farmers.

All these finds are rare in this archaeobotanical assemblage but that in itself is not a good indicator for a possible foreign place of origin, nor for the quantities in which the fruits were used. However, plum stones, nut shells, and especially date stones are likely to come into contact with fire because they burn well and make a useful supplementary fuel. Charcoal made from date stones is used today as a fuel, albeit mostly by metal-workers (Dowson, 1921; Nesbitt, 1993b: 34). Thus, if these species were produced locally they would have been abundant, and many more remains should have been preserved in the archaeobotanical record.

If imported, the dates were likely to have come from further south along the Euphrates river. The prunes, almonds and peaches probably came from western Syria, with its more
temperate climate. Walnuts may have come from the mountainous regions of north-eastern Iraq, or from western Syria.

The presence of prunes is attested by some remarkable fragments preserved in sample n°36-605. One plum pit is still embedded in the fleshy fruit covering, whose well-preserved surface is broadly wrinkled, just like a prune. If the fruit were fresh such good preservation of the surface and flesh is unlikely. The fruit structure would preserve best by charring if it were already dried. This sample also contains fruit flesh fragments without embedded pits, but with the same broadly wrinkled surface texture. They cannot be identified with certainty as prunes without accompanying stones, but they most likely derive from fruits dried prior to charring.

Throughout the period of Medieval Islamic settlement small numbers of luxury goods were retrieved, showing that the farmers were involved in economic exchange. Imported commodities include coins from Aleppo, Damascus and Mosul (see Gyselen, this volume) and ceramics (see Berthier, accompanying volume). The imported ceramics include luxury types of uncertain origin, culinary ceramics which may have come from western Syria, and ceramics with a western Iranian influence. The western Syrian and north-eastern Iraqi contacts to which these finds attest fit well with the most likely sources of the economic plant imports.

UNUSUAL SAMPLES

There are three samples from this assemblage whose contents are particularly striking. They are the Period V jar surroundings and jar fill from Tell Guftân, n°23-211i and n°23-211ii (Table 12) and the outstandingly rich sample n°36-605 (Table 11).

The jar fill and jar surroundings are unusual because the majority of their plant contents are mineralised. Mineralisation indicates that the plant remains had been waterlogged for a period of time. Waterlogging is also indicated by the fact that the seeds from these contexts are swollen (see measurements given for rice in Chapter 2 Identification criteria for the economic plants, Table 1, page 446). The arrangement of the jar, broken at the base and set into another jar, has close parallels with traditional sumps (puisards) for waste-water disposal in traditional Syrian villages prior to the acquisition of water pipes for drainage (Sophie Berthier, pers. comm.). The mineralised seeds support the interpretation that the broken stacked jars were for waste-water disposal.

There are two possible functions of this context. It may have been a toilet and the plant remains derived from cess, or, as Sophie Berthier has concluded, it may have been an area for the disposal of water derived from household activities such as cooking and cleaning. If the plant contents were derived from cess, a higher density of plant remains than was retrieved would have been expected. There is a particularly high concentration of cotton seeds from n°23-211i. It is unlikely that this came from unprocessed cotton lint used for cleaning the body, since the sharp beaks of the cotton seeds would be uncomfortable! The plant remains indicate that the more likely function of this installation was for the disposal of washing water, and this conclusion matches the archaeological interpretation. The cotton seeds may have come from unprocessed lint used for wiping and washing, but this would have been likely to clog the sump. The sump was perhaps in the vicinity of a cotton processing area and scattered seeds became mineralised through water seepage near the facility. The sump itself (n°23-211ii) must have been regularly cleared out since few plant remains were recovered from it.
The Period IV Qaryat Medād hearth sample n°36-605 (Table 11) is the richest of the entire assemblage, and contains nearly all the species found at these Medieval Islamic sites. It is dominated by fruit remains, of which grape seeds and berry stems, at 82% of the total quantified contents, are by far the most abundant. There are approximately twice the number of grape seeds to stems and this suggests that the bulk of the sample was produced from the disposal of grape processing by-products which were not fed to livestock. One possibility is the remains from the preparation of the thick fruit syrup made in the Near Eastern region today known as dibs (Nesbitt, 1993b: 33).

The sample is also particularly rich in pomegranate and fig seeds. The latter are mostly embedded in a fused matrix and cannot be quantified. The matrix may well be fragments of fig fruit. As well as over 300 pomegranate seeds, charred pomegranate peel was recovered, identifiable by the distinctive inner surface pattern where the seeds had been impressed. The pomegranate peel and plum remains from n°36-605, as well as a few pomegranate peel fragments from sample n°36-603 (Period V hearth) provide rare evidence for how fruits were handled (peels are not quantified in the score sheets; see Chapter 2, Identification criteria for the economic plants, pages 457-8).

One pomegranate gymnacium (the thick nipple-like structure surrounded by five pointed flaps at the tip of the fruit) from n°36-605 was cut cleanly in half. Other peel fragments from both samples had been twisted back and were charred in this position. Pomegranates must thus have been cut in half, and the peel pulled apart to expose the seeds inside. This is the way pomegranate fruit is most easily and naturally opened.

Other fruit fragments from this sample which may be prunes have cut marks. One such fragment has a very flat straight cut, as if excised with a knife. This was perhaps a damaged part of the fruit, but it is not possible to tell from the charred remains what the nature of the blemish may have been. Another piece of fruit has a small hole on either side, but the openings are not directly opposite each other; this may have been caused by an insect. There is evidence for cut marks on other fruit fragments: the very straight edges on some pieces look trimmed rather than torn. The shiny black caramelised surfaces of the straight planes indicate that these sharp edges were not caused by post-charring breakage. (A plum stone from sample n°36-107 (Period V floor, Table 13) has a deep nick along the keel which may have been caused from a knife or cutting instrument, but was definitely made before charring.)

The remarkable richness and diversity of sample n°36-605 suggests that the family which used this particular hearth had access to a wide range of plant resources, including imports. Because excavations at the Medieval Islamic sites were restricted in area, it is not possible to say whether this hearth was uniquely rich, or whether during Period IV the settlements had access to a particularly broad range of economic plants.

**FUEL RESOURCES**

Since most of the plant remains from this assemblage are charred, they derive from intentional or unintentional burning and were therefore part of the Medieval villagers' fuel resources. In the Near East, there are two major traditional resources for fuel: woody plants and dung. What were the primary sources of fuel at these sites?

The use of dung as fuel, particularly in arid and semi-arid regions, has been well attested ethnographically (Anderson and Ertuğ-Yaraş, 1998; Miller and Smart, 1984). Dung fuel is
acknowledged as an important source of charred plant remains from archaeological sites (Charles, 1998). A number of criteria have been suggested to identify the use of dung as fuel through the analysis of archaeobotanical assemblages and are shown in Table 24 (Charles, 1998; Miller and Smart, 1984).

One of the clearest indicators that dung was used as fuel is the recovery of fragments of dung or dung pellets in the archaeobotanical assemblage. No such items were recovered from this set of plant remains. Although the charcoal has not been analysed, the location of these sites on the Euphrates flood plain suggests that there would have been ample riverine woody species within easy gathering distance, as well as the less abundant but still significant quantities of wood derived from pruning the vines and orchard trees grown by the villagers.

Anderson and Ertuğ-Yaraş, in their ethnographic study of dung fuel use in central Anatolia, found that barley grain survives the digestive processes of different animals better than other cereals, but that over all there are few cereal grains and they are poorly preserved in dung, while chaff is more abundant. They also determined that seeds of wild and weed species survive better than cereal grain, and that wild and weed seeds together with rachises and culms (stalks of cereal ears) are the major components of dung from grazing and fodder-fed animals (Anderson and Ertuğ-Yaraş, 1998: 106-7).

Table 24 summarises the attributes of archaeobotanical assemblages which indicate the burning of dung as fuel compared to the middle Euphrates valley Medieval Islamic plant material. The wood charcoal has not been analysed, but large quantities were recovered, and some fragments are large chunks. The weed and wild seeds have also not been studied; they are a minor component of the assemblage. No culm nodes were recovered from these sites. If dung were burnt as fuel at these sites, the animals could not have been extensively grazed nor fed with straw.

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Criterion</th>
<th>Evidence from the Medieval middle Euphrates valley sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Likely availability of firewood.</td>
<td>Abundant riverine tree species likely to have been available; large quantities of recovered charcoal but not identified. Good evidence for cotton and sesame stalks used as fuel.</td>
</tr>
<tr>
<td>1</td>
<td>Presence of suitable animals.</td>
<td>Dung-producing animals present - see Chaix and Studer this volume.</td>
</tr>
<tr>
<td>1</td>
<td>Presence of recognisable dung fragments or pellets.</td>
<td>No dung fragments or pellets recovered.</td>
</tr>
<tr>
<td>1</td>
<td>Recovery of dung fragments or pellets from hearths.</td>
<td>No dung fragments or pellets recovered.</td>
</tr>
<tr>
<td>2</td>
<td>Biology and ecology of non-crop species.</td>
<td>Non-crop species not identified; not abundant.</td>
</tr>
<tr>
<td>2</td>
<td>Non-crop seeds in relation to crop processing sequence.</td>
<td>Non-crop species not identified; not abundant.</td>
</tr>
<tr>
<td>2</td>
<td>Relative proportion of chaff may be greater than grain.</td>
<td>On balance more grain than chaff or equal proportions; see table 25.</td>
</tr>
</tbody>
</table>

Table 24 — Archaeobotanical criteria to identify the use of dung as fuel, and their application to the middle Euphrates valley Medieval Islamic sites. References: 1 - Miller and Smart, 1984; 2 - Charles, 1998.
Table 25a shows the quantities of grain and chaff for both barley and wheat from these samples, together with their respective ratios. Where there are at least 50 items from one of these cereals in a sample the quantities of grain and chaff are presented for that sample, otherwise the figures are amalgamated by period. Apart from Periods Ia and II which were very poor in plant remains, all periods are presented. Although most of the assemblage samples are very mixed, winter cereals make up 80% or more of the contents of four samples. Six of the samples are from fire installations; the contents of these should be most representative of fuel use, although more than one burning episode may be represented. Table 25b summarises the ratio data and shows that the majority of samples have greater or equal quantities of grain compared to chaff. This pattern is consistent across all analysed periods.

It is unlikely that the domesticated animals at these settlements which produce suitable dung for fuel, such as sheep, goats, cattle, horses and donkeys (see Chaix and Studer, this volume), were consistently fed a diet rich in grain and were not allowed to graze. Today, sheep are allowed to graze on the steppe (D’Hont, this volume). Overall, the pattern of evidence from these sites indicates that the Medieval villagers were not using dung for fuel, or that it was little used for this purpose.

Dung is a valuable resource and one of its important uses is as manure. In the Euphrates flood plain, however, the river sediments deposited by irrigation water fertilise the agricultural land. This, together with crop rotation, especially the use of legumes, and fallowing, may have been sufficient for the field crops. The perennial crops grown in the orchards and vineyards would have particularly benefited from manuring, in addition to the sediments deposited by irrigation water.

<table>
<thead>
<tr>
<th>Sample and Period</th>
<th># barley grain</th>
<th># barley chaff</th>
<th>Ratio barley grain:chaff</th>
<th># wheat grain</th>
<th># wheat chaff</th>
<th>Ratio wheat grain:chaff</th>
</tr>
</thead>
<tbody>
<tr>
<td>† n° 165 (Ib)</td>
<td>25</td>
<td>5</td>
<td>* 5:1</td>
<td>46</td>
<td>216</td>
<td>* 1:4.5</td>
</tr>
<tr>
<td>† † n° 93-615 (Ib)</td>
<td>50</td>
<td>11</td>
<td>* 4.5:1</td>
<td>6</td>
<td>3</td>
<td>* 2:1</td>
</tr>
<tr>
<td>Total other Period Ib</td>
<td>17</td>
<td>12</td>
<td>1.5:1</td>
<td>39</td>
<td>51</td>
<td>1:1.5</td>
</tr>
<tr>
<td>n° 23-408 (III)</td>
<td>14</td>
<td>73</td>
<td>* 1:5</td>
<td>20</td>
<td>38</td>
<td>* 1:2</td>
</tr>
<tr>
<td>n° 23-409 (III)</td>
<td>58</td>
<td>17</td>
<td>* 3.5:1</td>
<td>20</td>
<td>21</td>
<td>* 1:1</td>
</tr>
<tr>
<td>Total other Period III</td>
<td>46</td>
<td>55</td>
<td>* 1:1</td>
<td>28</td>
<td>42</td>
<td>* 1:1.5</td>
</tr>
<tr>
<td>† n° 36-605 (IV)</td>
<td>21</td>
<td>18</td>
<td>1:1</td>
<td>52</td>
<td>62</td>
<td>1:1</td>
</tr>
<tr>
<td>Total other Period IV</td>
<td>14</td>
<td>5</td>
<td>* 3:1</td>
<td>25</td>
<td>8</td>
<td>* 3:1</td>
</tr>
<tr>
<td>† n° 36-203 (V)</td>
<td>40</td>
<td>132</td>
<td>* 1:4</td>
<td>14</td>
<td>176</td>
<td>* 1:12.5</td>
</tr>
<tr>
<td>† n° 36-107 (V)</td>
<td>21</td>
<td>35</td>
<td>1:1.5</td>
<td>9</td>
<td>11</td>
<td>1:1</td>
</tr>
<tr>
<td>† n° 36-603 (V)</td>
<td>840</td>
<td>1980</td>
<td>* 1:2.5</td>
<td>582</td>
<td>2082</td>
<td>* 1:3.5</td>
</tr>
<tr>
<td>Total other Period V</td>
<td>5</td>
<td>4</td>
<td>1:1</td>
<td>11</td>
<td>2</td>
<td>5.5:1</td>
</tr>
<tr>
<td>† † n° 36-101 (VI)</td>
<td>236</td>
<td>2</td>
<td>* 118:1</td>
<td>154</td>
<td>2</td>
<td>* 77:1</td>
</tr>
<tr>
<td>† † n° 23-403 (VI)</td>
<td>290</td>
<td>114</td>
<td>* 2.5:1</td>
<td>103</td>
<td>117</td>
<td>* 1:1</td>
</tr>
</tbody>
</table>

Table 25a.—Quantities of grain and quantities of rachises together with their approximate ratios, from amalgamated barley remains and amalgamated wheat remains at the Medieval middle Euphrates valley sites. When the total number of grain and rachises for either barley or wheat is greater than 50 items, individual samples are presented, otherwise data have been amalgamated by period. Periods Ia and II are not included here as they do not contain sufficient data. Key: † - at least 80% of the plant remains from the sample are winter cereals; † † - context is a fire installation (e.g. hearth, tannour); * - sample or amalgamated samples contain unquantified amounts of grain fragments, making the true ratio of grain:chaff higher than indicated.
<table>
<thead>
<tr>
<th>Ratios</th>
<th>Quantifiable samples (total: 10)</th>
<th>Amalgamated by period (total: 4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barley grain &gt; chaff</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Barley grain = chaff</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Barley chaff &gt; grain</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Wheat grain &gt; chaff</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Wheat grain = chaff</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Wheat chaff &gt; grain</td>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 25b — Summary of the pattern of grain to chaff ratios for wheat and barley.

The abundant quantities of wood charcoal in many of the samples from these Medieval Islamic sites indicates that wood was an important fuel. There is good archaeobotanical evidence to indicate that woody crop by-products were also used for fuel. These consist of the stalks of cotton and sesame collected after harvesting the crops.

Many cotton seeds occur in the samples in low numbers, but sample n°23-205b (Table 12), a Period V hearth, contains 273 cotton seeds out of a total of 332 economic plant parts. Two different hearths, n°36-605 (Period IV, Table 11) and n°23-203 (Period V, Table 12) contain cotton seeds and cotton boll bases (the base of the cotton fruit capsule, Figure 39). Only one boll base was found in sample n°23-203, but 41 were recovered from sample n°36-605. Since the traditional method of cotton harvesting is by picking out the lint with its seeds in the field (see page 381: Traditional cotton husbandry), it is unlikely that the by-products from subsequent processing at the village would contain many boll bases, and the large quantity found in sample n°36-605 requires explanation.

The pattern of cotton remains suggests that cotton was a fuel resource. Today, the woody cotton plants gathered after the cotton harvest are particularly used for baking bread in the Syrian Middle Euphrates valley and also in Egypt. Rizqallah & Rizqallah (1978: plate V.2) illustrate the use of cotton sticks as a fuel for bread baking in the Egyptian delta. Unopened bolls and unharvested lint can be seen still attached to the cotton plants. The unopened bolls are imperfectly developed and cannot be hand-harvested, but they contain mature seeds with attached lint. No experimental work was undertaken to examine the modern ash and charcoal.

![Figure 39 — Ancient cotton boll base from sample n°36-605. Left: attachment to the branch, with scalloped edge and undulating surface around the branch stub. Centre: side view, with branch stub to the right and interior of the boll to the left. Right: interior of boll base with smooth interior of the bracteole stub extending below. Drawn by Jane Goddard.](image-url)
from cotton stick fires, but it is likely to contain charred seeds and boll bases. Modern agricultural practice recommends that cotton stalks should be removed from the fields after harvest. This eliminates a possible haven for pests which could infect the next year’s crop (International Bank for Reconstruction and Development, 1955: 306-8). Burning cotton sticks would thus eliminate a source of infection as well as providing useful fuel.

The distribution, numbers and condition of the sesame seeds found in this assemblage suggests that sesame sticks were also used as fuel. Table 26 summarises the recovery of sesame from the Medieval Islamic sites. A few seeds are fused into pairs in two samples: hearths of different date from separate sites, n°93-612 and n°23-216d. All the other recovered sesame seeds are single. This seems to be unusual amongst archaeological finds. Apart from some pot impressions, many other charred sesame seeds have been found in bulk (Bedigian, 1985: 170). Finds from India, Pakistan and Iron Age Urartu are fused together in charred lumps (Bedigian and Harlan, 1986: 140). These must have been stored in large quantities at the time of burning. Bedigian (1985: 170) points out that charred sesame seeds are friable and fragile, and may not preserve well. Sesame seeds may be rare in charred assemblages, because their processing does not necessarily require exposure to heat (Gallant, 1985). Why are these Medieval Islamic seeds different?

Sesame seeds are most commonly associated with fire installations (Table 26) and are also present in four middens in which hearth cleanings would have been emptied. In the assemblage as a whole, fire installations and middens have yielded the largest quantities of sesame seeds. The paired seeds are also suggestive (see Figure 4b, page 450 Chapter 2 Identification criteria for the economic plants). As described in Chapter 2 Identification criteria for the economic plants (page 451), sesame seeds in the pod are stacked one on top of another, broad sides together. Since the ripe pods shatter easily and scatter their seeds, the recovered seed pairs strongly suggest that they had been charred while still in their capsule. The good preservation of individual seeds suggests that they may have been protected within capsules at the time of burning.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Context</th>
<th>Period</th>
<th>Main table</th>
<th># of sesame seeds</th>
</tr>
</thead>
<tbody>
<tr>
<td>n°93-4012</td>
<td>around tannour</td>
<td>Ia</td>
<td>14</td>
<td>3</td>
</tr>
<tr>
<td>n°93-610</td>
<td>hearth</td>
<td>Ib</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>* n°93-612</td>
<td>hearth</td>
<td>Ib</td>
<td>6</td>
<td>198</td>
</tr>
<tr>
<td>* n°23-216d</td>
<td>hearth</td>
<td>III</td>
<td>9</td>
<td>18</td>
</tr>
<tr>
<td>n°23-216d/f</td>
<td>hearth</td>
<td>III</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>n°36-605</td>
<td>hearth</td>
<td>IV</td>
<td>11</td>
<td>8</td>
</tr>
<tr>
<td>n°23-205b</td>
<td>hearth</td>
<td>V</td>
<td>12</td>
<td>17</td>
</tr>
<tr>
<td>n°23-221</td>
<td>midden</td>
<td>III</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>n°23-408</td>
<td>midden</td>
<td>III</td>
<td>10</td>
<td>26</td>
</tr>
<tr>
<td>n°23-409</td>
<td>midden</td>
<td>III</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>n°36-VD</td>
<td>midden</td>
<td>III</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>n°23-210</td>
<td>fill</td>
<td>IV</td>
<td>11</td>
<td>10</td>
</tr>
<tr>
<td>n°93-605</td>
<td>floor</td>
<td>Ib</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>n°23-213</td>
<td>floor</td>
<td>IV</td>
<td>11</td>
<td>1</td>
</tr>
<tr>
<td>n°26-107</td>
<td>floor</td>
<td>V</td>
<td>13</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 26 — Finds of sesame arranged by context. An asterisk (*) indicates that some recovered seeds from the sample are fused into pairs (see Chapter 2, page 454, Figure 4b).
Dried sesame stalks can be used for fuel in the same way as cotton sticks. When sesame is harvested and threshed, a few imperfectly developed pods remain shut and retain their seed, and sometimes the seeds at the base of the pods are not dislodged. As a result, some seeds can be burnt along with the stalks. This seems the most likely explanation for the abundant find of sesame seeds from sample n°93-612 (Table 6), a Period Ib hearth with virtually no other plant remains. Not all sesame seeds were necessarily burnt in this way. Some could have fallen into the fire accidentally or been scattered, swept up and burnt.

SIX HUNDRED YEARS OF AGRICULTURE

The plant assemblage from the Medieval villages of the middle Euphrates valley encompasses a diverse range of winter and summer crops with a variety of agronomic requirements, but all require irrigation in the local conditions. A few species were most likely to have been imports. The winter crops have been cultivated in the region since agriculture was first established there in the Neolithic period, but the summer crops were a later addition to the agronomic repertoire. Since the crops which were raised by the Medieval farmers have a variety of agronomic requirements, there was good potential for the exploitation of a range of ecological zones within the valley. From the earliest Medieval settlement at the end of the 7th century or early 8th century AD, a highly sophisticated agricultural regime was established, and it remained in place until at least the first half of the 13th century. By the time of final abandonment in the 14th century, the full agricultural potential of the area was apparently no longer exploited.

Although the evidence is scanty, sufficient archaeobotanical material has been retrieved from Period IA (Tables 5 and 14, Figure 6) to show that the basic agricultural system of winter and summer agriculture was in place from the beginning of the Medieval period. In winter the cereals barley and wheat were grown, along with the legumes lentil and chick pea. Summer agriculture is represented by rice, sesame and broomcorn millet. Of the fruits, only grape has been recovered, but this is a crop which needs a high degree of maintenance and good farming knowledge to raise successfully. From the closely succeeding Period Ib, the full range of winter and summer field crops have been recovered, and a garden crop, cucumber or melon, is added to the repertoire. From Period III onwards the plant remains are abundant and there is good evidence for a flourishing agricultural system encompassing winter and summer field crops, perennial and annual fruits, and some imports. It appears as if agricultural diversity was eroded in the final stage of settlement, Period VI. The full suite of winter crops were grown as well as the three most important perennial fruits, grape, pomegranate and fig, but of the summer field crops only evidence for broomcorn millet has been recovered.

The Medieval farmers who cultivated the middle Euphrates valley were highly skilled. They had to contend with difficult climatic conditions and, above all, soils which are highly vulnerable to degradation and salinisation. Farming here must strike a careful balance: without careful control of water resources, salts can be drawn up to the surface, rendering the land sterile for agriculture. Drainage is crucial because the valley is also vulnerable to waterlogging and the break down of soil structure if water is not regulated precisely (see page 352: Soils and irrigation). Yet sufficient water must be brought to the crops in order for them to grow.
A number of the Medieval crops are indicators of skilled farming technique in the region. Crops such as grape, cucumber, cow pea and sesame are all capable of growing on relatively poor soils, but they cannot tolerate flooding or waterlogging. A number of the crops have limited tolerance to salinity (see Table 23). Amongst them are rice, sesame and grape, which appear throughout almost the entire settlement sequence (Figure 6). Thus, the farmers were able to cope well with the local conditions. They successfully raised crops which, although suited to the climate, are sensitive to the difficult soil conditions of the area.

There is no historical evidence for the origin of the Medieval farmers who lived in the middle Euphrates valley. The archaeological record shows that during the previous late Roman (proto-Byzantine) period the valley between Buseire (site n°75) and Abu Kemāl was not settled. It was the border zone (the _limes_), with a garrison at Buseire. The very sparsely settled lower Khābūr region was occupied only by virtue of this military presence (Monchambert, this volume). The people who took up agriculture in the middle Euphrates valley at the end of the 7th century or beginning of the 8th century must therefore either have migrated from elsewhere, or they were local Arab tribes who became sedentary farmers.

The archaeobotanical evidence strongly supports the conclusion that the first settlers were immigrant farmers. From the start of Medieval occupation the new population implemented a sophisticated agricultural regime which required experience and expertise to establish and maintain. The Medieval settlers clearly understood how to cope with the vulnerability of the land to salinisation and soil degradation. This indicates that they came from a region with similar challenges and the most likely place is further south in Iraq.

When a complex society collapses or a region is abandoned by settled populations, degradation of agricultural resources is often invoked (Tainter, 1988: 44ff). Watson suggests that the Medieval Islamic agricultural system was exceedingly fragile and unable to sustain high levels of production (Watson, 1983: 140). The five and a half centuries of sophisticated agricultural production in the middle Euphrates valley, able to withstand periods of political instability and to overcome difficult agricultural conditions, indicates that claims for inherent agricultural instability are untenable. There is a clear link, however, with abandonment in the middle Euphrates valley and catastrophic political instability. From the end of Period V and throughout Period VI, the region was subject to constant Mongol invasion and became the frontier between the Mongols and the Mamluks (Berthier, this volume). Under such unstable and at times destructive conditions the archaeological evidence shows that maintenance of the all-important irrigation system could not be sustained and agriculture was no longer possible.
CHAPTER II
IDENTIFICATION CRITERIA FOR
THE ECONOMIC PLANTS

INTRODUCTION

This chapter describes most of the identification criteria applied to the archaeobotanical remains, primarily charred, recovered from the Syrian Medieval rural sites of this report. Identifications were made using the publications referred to throughout the text, and the extensive reference collection held at the British Institute of Archaeology in Ankara. I am indebted to the Institute for permission to use the collection, and to Mark Nesbitt for extensive assistance with identifications.

Terms have been kept to a minimum to prevent unnecessary jargon and confusion, but some technical words are unavoidable. Where descriptive botanical terms are used, they are defined throughout the text. The reader is referred to publications throughout this chapter which provide labelled diagrams of relevant plant structures. Plant scientific plant names follow Zohary and Hopf (1993) or Zeven and de Wet (1982), except for winter cereals which follow van Zeist (1984).

See chapter 1, page 357 for an explanation of the sample numbers used here, and tables 5-14 for archaeobotanical scoring data. Figure 6 of chapter 1 (page 358) presents a summary of the economic plants found at the sites which make up this study. Table 4 (chapter 1, page 360) enables any sample to be found quickly in the full set of plant records presented in Table 5-14 (chapter 1, pages 362-71).

BARLEY GRAIN: *Hordeum* spp.

HULLED AND NAKED BARLEY

On hulled barley, the light chaff surrounding the grain – the lemma and palea – is fused to the surface of the caryopsis (see Charles (1984: 28) for labelled diagrams of barley grains and chaff parts). In some varieties, called naked barley, chaff is not fused to the grain. The difference can be seen by the presence or absence of the ‘hull’ (fused lemma and palea), on the grain surface.

On the surface of well preserved ancient hulled barley grain, longitudinal striations and ridges are clear, caused by the moulding effect of the chaff on the developing grain. The chaff itself often falls off charred material, but patches of hull are often seen along the ventral furrow and sometimes elsewhere, and are useful for the identification of abraded or damaged
material. Hulled grain is long and slender, and elongated-hexagonal in cross section. The apex is chisel shaped: in lateral view it comes to a sharp point, and in dorsal or ventral view the end is squared-off. In contrast, naked barley has no longitudinal striations. The surface is finely horizontally wrinkled particularly along the edge of the ventral furrow, and on the dorsal side just above the embryo. The grain shape is rounded and plump, and the apex appears rounded in all views.

I consider that the presence of a chisel shaped apex is firm evidence of hulled barley. Unless grain is well preserved, however, a rounded apex is not indicative of naked barley, since damage by charring distortion or abrasion may alter the grain ends. The overall shape of the grain should be used with more caution, since it is not necessarily diagnostic, and the charring process often causes distortion. However, I identified hulled barley on the basis of a clear hexagonal cross section.

There is no evidence for naked barley in this archaeobotanical assemblage. All barley grains in reasonable condition are hexagonal in cross section, have chisel apices, longitudinal ridges and striations, and have no trace of horizontal wrinkles.

TWISTED AND STRAIGHT BARLEY

Two row barley (Hordeum distichum) has a single, central fertile spikelet on each rachis internode, while six-row barley (Hordeum vulgare) has three fertile spikelets on each rachis internode. All caryopses from two row barley are able to grow straight, as do the central grains of six row barley. The flanking fertile grains of six row barley are forced out laterally by the central spikelet as they develop, becoming twisted or curved (van Zeist, 1984: 10). This difference can be seen on archaeological material which is well preserved and twisted barley grains indicate the presence of six row barley.

I used three characteristics of lateral grains from six row barley to assign them to the twisted grain category.

i) The ventral furrow does not run straight from the apex of the grain towards the proximal (embryo) end. It may be either a sinuous curve along its length or distinctly bowed at the apex, distal end, or both.

ii) The embryo is offset. It is placed at an angle relative to the long axis of the grain.

iii) The grain itself is distinctly asymmetric in dorsal, ventral, or transverse view.

Not all these characteristics are present on all twisted grains, nor are they all of equal value in determining identity. The curved ventral furrow is most reliable, but a strongly skewed embryo is also a good characteristic. The shape of the grain is a feature which needs to be used with caution, as distortion during charring can alter the appearance dramatically. Twisted grains can be almost symmetrical in dorsal or ventral view. A useful method of determining whether a grain is twisted or straight is to look at its symmetry in transverse view using a sand bath to support the grain. This approach is particularly helpful for well preserved grains which are none-the-less difficult to assign by other criteria.

Most of the barley grain from these samples is quite well preserved. Grains which have suffered severely from charring were assigned to the indeterminate grain category as were poorly preserved grains which retain some evidence for either of these forms. In this assemblage
twisted grains tend to be smaller in all dimensions, but the indices which express their shape are essentially identical to those of the straight grains.

ESTIMATING WHOLE BARLEY GRAIN FROM FRAGMENTS

Whole grain equivalents were estimated from fragments using a discrete grain feature whose occurrence can be considered to represent one grain. On cereal grains, the embryo emplacement and apical tip are representative of one grain. Other grain fragments were not quantified. They are useful as a check: if there were very many large grain fragments and hardly any apexes and embryos, it could no longer be assumed that the latter were representative of the total original number of grains.

Apices and embryos were tallied separately. As expected they gave similar counts, and therefore only embryo numbers were used for scoring whole grain equivalents.

WHEAT GRAIN: *Triticum* spp.

Free threshing wheat grain falls easily from its surrounding chaff when processed, while hulled wheats require vigorous processing to separate the grain from the tough chaff (Nesbitt and Samuel, 1996b). Van Zeist and Bakker-Heeres (1982: 197) illustrate a range of free threshing wheat grains. They are readily distinguished by their plump and rounded shape. They have blunt apexes in lateral and dorsal or ventral views, and rounded flanks with none of the longitudinal impressions typical of hulled wheat. In transverse view the dorsal side is gently rounded, and the ventral cheeks curved.

All the wheat grain retrieved from the Medieval Syrian deposits is free threshing (*Triticum durum*/*aestivum*). Most of the well preserved grain is very plump and round, resembling grains 1-3, 5, and 7 shown by van Zeist and Bakker-Heeres (1982: 197, Figure 15). The majority of grains from sample n°23-210 (Period IV fill) tend to be narrower and longer (more closely resembling grain 8 in van Zeist and Bakker-Heeres, 1982: 197), but they have the usual blunt apex and low dorsal face. The 71 whole grains retrieved from sample n°23-403 (Period VI hearth) range greatly in size from very large, plump and robust, to small and very runty. They are mostly round, but vary from almost spherical to somewhat flattened.

WHEAT CHAFF: *Triticum* spp.

Wheat chaff was identified only for well preserved fragments. Often the attachment area, where the spikelets join the rachis internode, has been broken away from the rachis fragment. Never-the-less, the distinctive characteristics which separate bread wheat (*Triticum aestivum*) from durum wheat (*T. durum*) could frequently be seen. Many of the criteria I used to identify the wheat chaff fragments were developed and explained by Gordon Hillman; most of Hillman's criteria are published in Hillman *et al.* (1996 for 1995), Jacomet (1987) and Maier (1996).

The rachis fragments from these Medieval Islamic samples are mostly a mixture of *T. aestivum* and *T. durum* wheats. There is great variability in the free threshing wheats raised by the farmers of the period in this region. Some sample assemblages are full of wheat chaff but the material is not sufficiently well preserved to identify the rachises beyond free threshing wheat.
UPPER EAR WHEAT RACHIS FRAGMENTS

The most obvious difference between *T. durum* and *T. aestivum* rachises (Figure 1a and 1b) is the presence or absence of swollen pads beneath the glume attachment in abaxial view (side which faced outwards from the ear). In this assemblage, hexaploid bread wheats have a slight swelling at the glume attachment, but when the glumes have broken off, the two pads, one on either side, form two thin lips. The lips usually do not extend to the edge of the rachis body. Tetraploid durum wheats, in contrast, often have two thick lumps beneath the spikelet attachment zone. They usually swell well beyond the width of the rachis body.

The cleanness of the glume breakage is usually characteristic. Bread wheat glumes tend to break off completely, or even to tear away part of the rachis beneath their point of attachment. Durum glumes generally break off above this point, leaving small glume stubs behind. This differential breakage helps to accentuate the appearance of the thin lip of tissue on *T. aestivum*, and the prominent swelling of *T. durum* rachises.

Cereal ears can be either compact or lax. In the compact form of *T. aestivum*, (*T. compactum* - Figure 1c), the individual rachis internodes are very short, so that the spikelets they bear are packed close to one another and are pushed out from the central axis. Lax ears are formed by long rachis internodes. This distinction can be seen on archaeological material. Where the internode length is very short and the internodes sharply angled in a zig-zag pattern, the wheat was a compact form. Rachis fragments tend to shrink when charred, and thus may appear shorter than they were originally. The compact internodes are generally preserved in pairs or greater lengths, however, and their splayed arrangement relative to the central axis is clear.

A few terminal rachis internodes have been recovered from various samples. My examination of modern *T. durum* and *T. aestivum* terminal internodes shows no distinguishing features between the two. Durum terminal rachis fragments do not seem to retain any prominent swellings.
SUB-BASAL AND BASAL WHEAT RACHIS FRAGMENTS

Sub-basal wheat rachis internodes are much more robust and tend to be nearly cylindrical or squared off in cross section compared to central rachis fragments. Sub-basal wheat internodes are often heavily longitudinally wrinkled, but this may be a result of charring shrinkage. In abaxial view, both bread and durum wheat sub-basal internodes have a clear ridge across the width just below the spikelet attachment scar. On well preserved examples, durum sub-basal internodes are obvious, because they have two large swellings just above this ridge. Bread wheat sub-basal internodes are very flat above the ridge.

As far as I can determine, there is no difference between durum and bread wheat basal rachises. In practice they can occasionally be identified if sub-basal internodes remain attached. Where they are well preserved, wheat basal rachises can be distinguished from barley basal rachises by their much reduced basal collar which runs straight, rather than obliquely, across the internode.

RYE GRAIN: 

Rye grain in lateral view is drop shaped, with a long tapered embryo end. This is one of its most distinctive features. The dorsal side is slightly convex, curving around to the apical end which is sharply truncated. A small notch can sometimes be seen at the apical end in this view. The ventral edge is more or less flat along most of its length, but curves upwards towards the apical end.

Rye grain is slightly twisted, and this can best be seen in dorsal view. The twist can often be seen in ventral view as well. In ventral view, the cheeks are rounded. The apical end is slightly narrowed, and round; the embryo end is slightly tapered. The sides are clearly parallel. When viewed transversely, the grain has rounded sides at the ventral end, rising steeply to a high dorsal ridge. This makes it more or less triangular in cross section.

RICE: Oryza sativa

Rice is preserved as grain and as rachis internodes, but it is scarce in either form in this assemblage. Rice grains are relatively large and dense, and would be expected to char and preserve well in archaeological deposits. Rice chaff is small and papery, and is less likely to survive. Despite their tiny size, some rice rachises were recovered. Grain and rachises are described in detail because rice has rarely been recovered from archaeological deposits thus far in the Near East.

RICE GRAIN

A large, well preserved rice grain from no.23-409 (Period III midden) is illustrated in Figure 2a. It shows all the morphological features on which I have based my identification of rice grains. Table 1 presents the dimensions of all measurable rice grains recovered from this assemblage, together with selected modern and ancient material. The shape - blunt-ended, relatively short and broad, and rounded cross section - show that they all come from Oryza sativa subspecies japonica, the short-grain, temperate form of cultivated rice, rather than O. sativa subsp. indica, long-grain tropical rice (Grist, 1953: 94; Ho, 1977: 446).
The most distinctive feature of rice grain is the fluted sides. In well preserved material the two bands of prominent relief on the lateral sides are so obvious that it is very easy to identify small fragments of rice grains. The bands run longitudinally from end to end of the grain. Sometimes they extend right to the apex and embryo insertion, and sometimes the relief grades into the grain flanks somewhat before the grain tips. This fluted pattern is formed by close contact with the ridges on the inner surface of the tightly enclosing chaff (Winton and Winton, 1932: 131). On apical or dorsal slivers lacking these raised bands, large size and blunt features are generally enough to identify the fragments as rice. Where patches of chaff survive, the husk pattern is likewise unmistakable. This pattern is described below (page 446).

The rice grain is an elongated oval in lateral view. The ventral side is gently convex, curving smoothly up at both the apical and distal ends. The apical end is rounded and blunt, while the distal end is similarly rounded on the lower third. Some grains have even more blunt apical ends than the one illustrated. The embryo is inserted in the upper half to two-thirds of the distal end. The dorsal side is slightly convex with a hump towards the apical end. On most rice grains, the embryo emplacement drops nearly perpendicularly from the dorsal side and curves sharply around to the distal end.
The illustrated grain is divided by a superficial crack about half way along the dorsal ridge. This crack seems to be a characteristic of rice grains, rather than heat distortion. Although not a universal feature, many modern grains have such cracks in the same position. Not all ancient grains are cracked and this particular grain is the best example of cracked grain from these deposits.

In dorsal view on the illustrated grain, the embryo end is bluntly rounded, while the apex is slightly more pointed. The flanks are more or less parallel along most of the grain length. The dorsal ridge is slightly twisted, especially at the embryo end on this grain. The ridge of rice grains can vary from straight, to a slight twist at either end, to so strongly pronounced that the entire rice grain may be skewed.

The narrow rice hilum lies in a very shallow ventral furrow. It curves around to the distal end, ending somewhat below the embryo emplacement. In transverse view, the fluted sides are clear, and the ventral side forms a keel beneath them. The whole grain is laterally compressed. Its surface texture is shiny and somewhat wrinkled, especially in the depressions between the lateral bands and areas of low relief. The surface is covered in fine longitudinal striations, and coarser striations ringing the grain, particularly prominent over the outfolding lateral bands. This pattern is formed by the unusual structure of cell layers on the grain surface, and is distinctive to rice (Winton and Winton, 1932: 133). Where grains have been broken, the interior texture is dense but aerated. When the grain has been puffed with heat, the interior texture is much more spongy-looking.

A grain from sample no23-203 (Period V hearth) does not have features distinctive enough to be positively identified as rice. The sides are fluted, but the relief is much less pronounced than usual. The apical end is blunt, but rather more narrow than most rice grains. This grain resembles the wild/weed grass Phalaris (canary grass) in its gracile form, somewhat rounded dorsal and ventral sides in lateral view, and strong lateral compression. Since Phalaris grains are never fluted, I feel this grain is probably poorly formed rice. Because of the uncertain identification, it has not been included in Table 12, page 369.

All rice grains except those from sample no23-211i (Period V around jar) have been preserved by charring. The two exceptions, a whole grain and a fragment, have been mineralized, as with other remains from this context. The whole grain from no23-211i is much larger than the charred grain from elsewhere (see Table 1). Complete measurements are unfortunately prevented by a large amorphous lump adhereing firmly to the grain. The dorsal ridge is sharply twisted near the apical end, but the grain is twisted longitudinally in almost all views. Unlike the charred grains, this mineralized grain is almost enclosed in its husk. The embryo is covered, but the distal end can be distinguished by the scar where the rachis was attached. The chequered outer layer of husk is mostly worn away, surviving in protected small patches near the adhering lump. Otherwise the hull texture is longitudinally striated, in a coarser pattern than the grain surface lines.

The rice fragment from no23-211i is highly abraded and pitted in a way which suggests insects ate most of it. The surviving interior is dense and shiny. The original grain must also have been quite large, but what remains is so damaged that no useful measurements can be made.
Table 1 - Comparison of modern and ancient rice (*Oryza sativa*) grain measurements and indices. All measurable whole and fragmented rice grains from the Medieval Syrian Euphrates valley rural sites are included and are identified as *Oryza sativa japonica*. The grain marked with an asterisk (*) is illustrated in Figure 2a. Measurements are in millimetres. Abbreviations: *O.* - *Oryza*; *L* - length; *B* - breadth; *T* - thickness; *N* - number of seeds measured; *min* - minimum measurement; *avg* - average measurement; *max* - maximum measurement; *colln* - collection number (seed accession stored at the British Institute of Archaeology in Ankara).

<table>
<thead>
<tr>
<th>RICE SAMPLE</th>
<th>L</th>
<th>B</th>
<th>T</th>
<th>L:B</th>
<th>L:T</th>
<th>T:B</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Modern</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>O. sativa indica</em> (Grist, 1953: 94)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>O. sativa japonica</em> (Grist, 1953: 94)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>O. sativa japonica</em>, colln SP-103; <em>N</em> = 20 stored 13 years</td>
<td>min 5.0</td>
<td>1.7</td>
<td>2.0</td>
<td>248</td>
<td>179</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>avg 5.4</td>
<td>2.0</td>
<td>2.7</td>
<td>278</td>
<td>200</td>
<td>140</td>
</tr>
<tr>
<td></td>
<td>max 6.0</td>
<td>2.2</td>
<td>3.1</td>
<td>341</td>
<td>280</td>
<td>155</td>
</tr>
<tr>
<td><em>O. sativa japonica</em>, colln RMN-2080; <em>N</em> = 20 freshly harvested</td>
<td>min 4.9</td>
<td>1.8</td>
<td>2.6</td>
<td>196</td>
<td>167</td>
<td>132</td>
</tr>
<tr>
<td></td>
<td>avg 5.4</td>
<td>2.1</td>
<td>3.0</td>
<td>215</td>
<td>183</td>
<td>143</td>
</tr>
<tr>
<td></td>
<td>max 6.0</td>
<td>2.2</td>
<td>3.0</td>
<td>273</td>
<td>231</td>
<td>167</td>
</tr>
<tr>
<td><strong>Parthian, Susa</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>O. sativa ?japonica</em> charred; Ville <em>N</em> = 90 Royale II, 1st c. AD (Miller, 1981: 141)</td>
<td>min 3.8</td>
<td>0.9</td>
<td>1.3</td>
<td>237</td>
<td>-</td>
<td>115</td>
</tr>
<tr>
<td></td>
<td>avg 4.7</td>
<td>1.5</td>
<td>2.3</td>
<td>326</td>
<td>-</td>
<td>159</td>
</tr>
<tr>
<td></td>
<td>max 5.6</td>
<td>2.0</td>
<td>4.3</td>
<td>509</td>
<td>-</td>
<td>208</td>
</tr>
<tr>
<td><strong>Medieval Syrian</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>n°33-301</em>, Period I midden - charred</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.3</td>
<td>3.2</td>
<td>2.6</td>
<td>134</td>
<td>165</td>
<td>81</td>
</tr>
<tr>
<td>2</td>
<td>4.3</td>
<td>1.7</td>
<td>2.3</td>
<td>256</td>
<td>188</td>
<td>137</td>
</tr>
<tr>
<td>3</td>
<td>3.6</td>
<td>1.5</td>
<td>2.5</td>
<td>241</td>
<td>142</td>
<td>170</td>
</tr>
<tr>
<td>4</td>
<td>-</td>
<td>1.9</td>
<td>2.4</td>
<td>-</td>
<td>-</td>
<td>125</td>
</tr>
<tr>
<td>5</td>
<td>-</td>
<td>1.9</td>
<td>2.3</td>
<td>121</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>-</td>
<td>1.8</td>
<td>2.5</td>
<td>-</td>
<td>-</td>
<td>139</td>
</tr>
<tr>
<td>7</td>
<td>-</td>
<td>-</td>
<td>3.2</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>-</td>
<td>-</td>
<td>3.0</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td><em>n°23-405</em>, Period III midden - charred</td>
<td>6.5</td>
<td>3.4</td>
<td>-</td>
<td>189</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1</td>
<td>-</td>
<td>-</td>
<td>3.8</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>-</td>
<td>-</td>
<td>3.4</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>-</td>
<td>-</td>
<td>3.0</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

Since few rice grains were found, and rice is a rare archaeobotanical find in general, I have included in Table 1 measurements for all of the grains which I have retrieved. This table also includes comparative measurements from other ancient and modern rice grains.

**RICE CHAFF**

As with other cereals, rice chaff easily burns away to ash, and is therefore less common than grain in the charred archaeological record. Because of its high silica content it can sometimes be preserved in great quantity without charring (Costantini, 1979: 329).

The parts of charred rice chaff likely to be found are the pedicel at the base of the spikelet, the lemma and the palea. The glumes are much reduced appendages beneath the fairly robust lemma and palea, and do not seem to survive charring. Winton and Winton (1932: 132-133) illustrate the cellular arrangement peculiar to rice chaff. The cells of the outer epiderm (topmost layer on the lemma and palea) are laid end to end and side to side in rows. This pattern creates the macroscopic chequered or tesselate appearance of the chaff. The lemma and palea are deeply longitudinally grooved.
Figure 2b shows a rice pedicel from the fine fraction of sample n°36-605 (Period IV hearth). It measures as follows: length: 0.7 mm; breadth: 0.83 mm; thickness: 0.67 mm. It is conical, with the bases of the lemma and palea still attached at the widest end. When such remnants of lemma and palea survive, they help to identify rice pedicels, because of the typical chequered surface texture. On the upper surface is a small hole, which is the attachment scar of the pedicel to the panicle branch. It is surrounded by a raised circular ridge, which in turn is set into a rounded structure with scalloped edges. Beneath this towards the wider end is the thick, broad body of the pedicel. This view is the most distinctive (Figure 2b, centre).

In side view, the pedicel retains its conical shape, and the complex sculptured surface is shown. The top edge curves like a hood over the lemma base. In modern comparative material, the two tiny glumes are inserted between the pedicel and lemma/palea, but on charred examples they have burned away. The side view also shows the different surface textures on the lemma and palea bases. The smaller, lower palea is finely longitudinally striated but lacks large raised bumps. The upper glume base possesses the heavily silified, rounded knobs unique to rice chaff.

The under side of the rice pedicel is smooth and lightly longitudinally striated. It does not have the strong relief of the side and upper faces.

**MILLET: Panicum miliaceum and Setaria italica**

Two species of cultivated millet are preserved in these samples, as well as a variety of related wild grasses. Although the present study is not concerned with wild plants represented in the archaeobotanical record, because of the morphological similarities between wild and cultivated millets the wild varieties are briefly described below.

The most common cultivated millet in all but one of the samples is broomcorn millet, *Panicum miliaceum*. The other is foxtail millet, *Setaria italica*, which outnumbers *P. miliaceum* only in sample n°23-216d (Period III hearth). Seeds of both these cereals are shown in Figure 3. Table 2 gives measurements of two samples of broomcorn millet with and without hulls, and one sample of foxtail millet.

![Figure 3](image-url)

**Figure 3** — Temperate millet. a. Foxtail millet (*Setaria italica*) from n°23-216d. b. Broomcorn millet (*Panicum miliaceum*) from n°23-216d. Drawn by Fred Rumsey. For both grains: left - embryo view, centre - ventral view, right - grain cross section.
Table 2 – Measurements and indices of charred broomcorn millet (*Panicum miliaceum*) with and without hulls, from samples n023-216d (Period III hearth) and n036-101 (Period V1 hearth), and of randomly selected charred foxtail millet (*Setaria italica*) without hulls, from sample n023-216d. All measurements in millimetres. Abbreviations: L - length; B - breadth; T - thickness; N - number of seeds measured; e - embryo; min - minimum measurement; avg - average measurement; max - maximum measurement.

Identifications were made primarily on the basis of criteria described by Nesbitt and Summers (1988). Description details not given here, and more comparative illustrations, are available in this publication. The cultivated millets were distinguished by three main characteristics: the overall shape of the grain; the shape and length of the embryo; and the surface texture of lemma and palea fragments adhering to the grain.

Broomcorn millet is generally somewhat longer than broad, and the apex can be rounded or pointed in dorsal view. Where chaff clings to the apex of the grain, this point is accentuated. The embryo is relatively wide, and is about half the length of the grain. Often the embryo drops out, leaving a shallow but distinct notch which also extends about half the length of the grain. Measurements of notch length, rather than embryo length, were made, since the embryo is rarely retained. The chaff surrounding the grain (lemma and palea) is smooth and striated longitudinally.

Foxtail millet is nearly round in ventral or dorsal view, and can be broader than long. The apex is always rounded. In lateral view, the thickness is also relatively closer to length than for broomcorn millet. The embryo is long and narrow, extending to, on average, 80% of the grain length. The embryo is more commonly retained than that of broomcorn millet, and the notch underneath is deeper. Any remaining traces of chaff are distinctly punctate (marked with dots or small shallow pits) or finely wrinkled, except for the smooth edges of the palea (Nesbitt and Summers, 1988: 85).

Some of the wild millet-like grasses could be identified to species. *Echinochloa crus-galli* grains are smaller than the average millet cultivar. In lateral view, the ventral side (without
the embryo), is very flat. The dorsal side, containing the embryo, is more-or-less square in shape and often, but not always, distinctly domed. Modern comparative material shows that the embryo is well over half the length of the grain. Any traces of chaff are smooth, sometimes with clear longitudinal striations.

The two wild/weed species of Setaria, S. viridis and S. verticillata, cannot be distinguished by grain characters, and so have been grouped together. They are also smaller overall than the cultivated millets, and much more elongate. The chaff is finely punctate, so if it survives, S. viridis/verticillata is easy to distinguish.

The wild millets probably include tadpole shaped grass grains, similar to that illustrated by Nesbitt and Summers (1988: 89, Figure 2). Other Setaria grains were very round, and possibly represent immature or runt Setaria italica, although I have seen no parallel so far in comparative modern material. These grains have been provisionally identified as wild millets. I have made a few definite identifications of Sorghum halepense, a common weed grass of irrigated fields. The full identification of these wild millet-like grasses must await a thorough study of the wild and weed seeds from this assemblage.

COTTON: Gossypium herbaceum/arboreum

Winton and Winton (1932: 552) describe the cotton seed as a pointed ovoid shape, up to 12 mm long. The seed coat (spermoderm) surrounding the cotyledons has several layers which are illustrated by Winton and Winton (1932: 553). A clear illustration of the cotton kernel, or embryo, is also provided (Winton and Winton, 1932: 552, Figures 232 and 233). Not all the cell layers of broken ancient seeds are discernable, at least as seen under a low power light microscope. This is probably because charring tends to fuse organic material and destroys some delicate cell types. However, layers do flake off in a consistent pattern. I discuss these because, depending on which layers survive, archaeobotanical cotton seeds can look very different and the ideal, entire seed which has been illustrated (Figure 4a) is the exception. Stephens and Moseley (1974: 119) have found that modern seeds of G. barbadense (a New World cotton species) shrunk 3-7% upon charring, although the shape did not change.

The outermost layer of spermoderm cells is called the ‘outer epiderm’ (Winton and Winton, 1932: 553). Outer epidermal cells form the distinctive beak and the slight ridge (raphe) which runs from the apex to base of the seed, as well as the lint which makes cotton so useful. Under the microscope, well preserved seeds show all these features. The outer epidermal layer is pleated around the apex, and deeply wrinkled. Often it has a veined appearance, with distinct irregular lines running longitudinally from beak to base.

Beneath the upper cell layers of the spermoderm are palisade cells, in a structure highly distinctive to cotton (Winton and Winton, 1932: 554). In both modern and ancient material, this relatively thick layer shows clearly in cross section. The charring process accentuates the visibility of the cell walls which lie perpendicular to the curve of the seed coat. The external surface of the charred palisade layer is also distinctive, but can be confused with the surface of the inner layer of Prosopis seeds. It is smooth and densely covered in fine irregular cracks (crizzled).
The remaining cell layers of the spermoderm tend to cling to the interior of the palisade layer and the whole lifts away from the internal cotton seed kernel (the embryo). In charred material, such as the cotton seeds from sample n°23-205b (Period V hearth), these kernels have a very smooth surface, but are often superficially cracked, quite swollen, and distorted. Modern seeds, when dissected, clearly show how the embryo cotyledons are tightly rolled and folded, and studded with dark resin cavities (Winton and Winton, 1932: 552 and personal observation). The embryo is oil rich (Winton and Winton, 1932: 556).

Because the kernels have a high oil content, charring tends to cause fusing and distortion. On some archaeological kernels, however, the embryo convolutions can be made out, and small shiny raised spots dotted on their surface are probably the resin vesicles.

In summary, archaeobotanical cotton seeds may be well preserved, with the beak, slight ridge, and traces of lint retained (see Figure 4a). With slightly less perfect material, these features are lost, but the deeply wrinkled outer epidermal layer is clear. When the outer layer is lost, the crizzled surface and cross section of the palisade layer is distinctive and the cotton seed size and "pointed ovoid shape" (Winton and Winton, 1932: 552) is still distinctive. The internal embryo can be distorted and is considerably smaller than the whole seed, but is recognizable by its smooth shiny texture and, sometimes, convolutions and probable resin cavities. On damaged seeds, sometimes all these different layers are visible.

Figure 4 – a. Cotton seed (Gossypium herbaceum/arboreum) from n°36-605. Note how the outer layers can flake away to show the smooth surface of the palisade layer beneath (centre view). b. Pair of sesame seeds (Sesamum indicum) from n°23-216d. Centre - lateral view, right - transverse view. Drawn by Fred Rumsey.
I have been unable to identify the archaeological cotton seeds to species using morphological criteria. Because they date prior to New World contact they must be one of the Old World cottons, either *Gossypium herbaceum* or *G. arboreum*. Comparison to reference material of these two species shows no obvious difference in modern seeds. Chowdhury and Buth (1971: 310-311) have detected no difference in Old World cotton seed coats and lint anatomy.

**SESAME:** *Sesamum indicum*

Sesame seeds form within a four chambered pod (Winton and Winton, 1932: 598). Within each pod chamber, the seeds are sandwiched together with their broad sides against each other and the narrow ends pointing inwards. Figure 4b shows two complete charred seeds from sample n°23-216d (Period III hearth), still held broad sides together as they would have been in the pod. Their surfaces are somewhat damaged, but their shape and structure are clear.

Winton and Winton (1932: 599) describe the seed of sesame as ‘a flattened pear shape up to 3 mm long’. Some archaeological seeds are not flat, but somewhat bowed in lateral view. Seeds are composed of three main parts: the spermoderm (seed coat or hull); the endosperm beneath; and the two cotyledons surrounded by the endosperm. Each of these layers survive to a greater or lesser extent on ancient seeds depending on their state of preservation. Ancient charred sesame seeds are often badly distorted by puffing, bowing or flaking. This distortion and fragility is common for seeds with a high oil content.

On modern material, a longitudinal ridge runs down the center of one broad side, but this is no longer observable on any of the charred seeds from these deposits. Two ridges, formed by elongated outer epiderm cells (part of the spermoderm), run down the seed edge, one on each side (Winton and Winton, 1932: 599-600). The seeds in Figure 4b show these ridges, although only one on each seed is visible. These ridges are often exaggerated on charred sesame seeds, but often, as with those illustrated, only one per seed can be seen. Less well preserved seeds no longer have these ridges and others have lost some or most of their hull. The hull has a shiny texture with an uneven surface which varies from finely reticulate (marked with a network) and almost vericulose (minutely warty), to a coarsely reticulate, almost undulating texture. Frequently, the hull has been puffed out like a balloon around the charred seed.

Many archaeological sesame seeds have completely lost their hull and the visible surface is that of the seed endosperm. The hulls may have been deliberately removed during food processing. When charred the endosperm appears very shiny, no doubt because of the fat contained in its cells (Winton and Winton, 1932: 600). The surface texture ranges from very smooth and slightly undulating, to finely pustulate (covered in fine blister-like elevations). Once the hull is removed, the seed is broadly elliptic rather than pear-shaped, with a constricted ‘tongue’ frequently but not invariably protruding at the narrow end.
Table 3 compares measurements of complete sesame seeds with and without hulls from sample n°93-612 (Period Ib hearth), together with the largest sesame seeds in the assemblage, from sample n°36-605 (Period IV hearth). A comparison of the indices, particularly the thickness to length and thickness to breadth ratios, shows how the thin hull tends to puff out and exaggerate the thickness measurements.

<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>L</th>
<th>B</th>
<th>T</th>
<th>L:B</th>
<th>L:T</th>
<th>T:B</th>
</tr>
</thead>
<tbody>
<tr>
<td>n°93-612 N = 56 with hull</td>
<td>min</td>
<td>1.5</td>
<td>1.0</td>
<td>0.6</td>
<td>123</td>
<td>185</td>
</tr>
<tr>
<td></td>
<td>avg</td>
<td>2.4</td>
<td>1.3</td>
<td>0.9</td>
<td>179</td>
<td>259</td>
</tr>
<tr>
<td></td>
<td>max</td>
<td>2.7</td>
<td>1.5</td>
<td>1.1</td>
<td>219</td>
<td>338</td>
</tr>
<tr>
<td>n°93-612 N = 36 without hull</td>
<td>min</td>
<td>1.5</td>
<td>0.7</td>
<td>0.5</td>
<td>156</td>
<td>240</td>
</tr>
<tr>
<td></td>
<td>avg</td>
<td>2.2</td>
<td>1.2</td>
<td>0.7</td>
<td>193</td>
<td>341</td>
</tr>
<tr>
<td></td>
<td>max</td>
<td>2.8</td>
<td>1.4</td>
<td>0.9</td>
<td>233</td>
<td>492</td>
</tr>
<tr>
<td>n°36-605</td>
<td>1</td>
<td>4.2</td>
<td>1.3</td>
<td>0.8*</td>
<td>316</td>
<td>511</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>3.9</td>
<td>1.9*</td>
<td>1.0*</td>
<td>205</td>
<td>402</td>
</tr>
</tbody>
</table>

Table 3 — Measurements and indices of charred sesame seeds (*Sesamum indicum*) with and without hulls from sample n°93-612 (Period Ib hearth), and the largest seeds of the assemblage, from sample n°36-605 (Period IV hearth). Measurements are in millimetres. Abbreviations: L - length; B - breadth; T - thickness; N - number of seeds measured; min - minimum measurement; avg - average measurement; max - maximum measurement; * - somewhat distorted.

LEGUMES

Legumes such as lentil (*Lens culinaris*), pea (*Pisum sativum*), and chick pea (*Cicer arietinum*) have been well described and illustrated in various publications (see, for example, Hopf, 1962; Kroll, 1983; van Zeist and Bakker-Heeres, 1975: 249, Fig. 5). These species are briefly described here. I describe in greater detail the broad bean or horse bean (*Vicia faba*) and the cow pea (*Vigna unguiculata*), which are uncommon in Near Eastern archaeobotanical assemblages.

LENTILS: *Lens culinaris*; PEAS: *Pisum sativum*; CHICK PEAS: *Cicer arietinum*

Lentils, with their distinctive round and laterally compressed seeds, are easily recognized. In several contexts, lentils have been split into individual cotyledons, and are sometimes quite abraded. Peas occur in lower frequency, and sample n°36-605 (Period IV hearth) contains two specimens of wild pea, distinguished by their rough pimpled seed coats. One wild pea has its seed coat very well preserved; the other has lost all but a patch.

Chick peas are very scarce in these samples, and none is preserved whole. The dimensions of the surviving fragments indicate that the chick peas were large. Of the three samples that contained chick pea, sample n°93-617 (Period Ib tannour) and sample n°23-221 (Period III midden) had measurable fragments. The chick pea from site n°93 (Tell Shheil) had a half width of 3.8 mm, so that its original estimated width is 7.6 mm. The damaged chick pea from site n°23 (Tell Guftân) had a length greater than 7 mm, a height greater than 7.5 mm, and a width of about 8.6 mm. Although this chick pea is not complete, these measurements are provided to give an idea of its former large size.
BROAD BEAN: *Vicia faba*

Broad bean (Figure 5a) was recovered from two samples, n°23-203 (Period V hearth) and n°36-605 (Period IV hearth). In overall size, the three broad beans in sample n°23-203 do not differ from the peas in the same sample and all these legumes have lost their seed coats. The identity of the broad beans is indicated by their length to height ratio (see Table 4), and by the morphology around the radicle. On peas, the radicle extends out slightly from the rounded surface of the two joined cotyledons. On the broad beans, the radicle is inset somewhat, and the cotyledons form slightly protruding, rounded cheeks just below the base of the radicle. One of these broad beans is distinguished by its relatively greater width (see Table 4). This dimension does not seem to have been caused by charring expansion, and may indicate that this example had been a terminal bean in its pod.

![Figure 5 — a. Broad bean (Vicia faba minor) from n°36-605. b. Cow pea (Vigna unguiculata) from n°23-221. Drawn by Jane Goddard. For both specimens: left - interior cotyledon, centre - radicle view, right - cross section.](image)

<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>L</th>
<th>B</th>
<th>T</th>
<th>L:B</th>
<th>L:T</th>
<th>T:B</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Vicia faba</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>subsp. <em>minor</em></td>
<td>7-15</td>
<td>-</td>
<td>-</td>
<td>&lt;200</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>subsp. <em>faba</em></td>
<td>16</td>
<td>-</td>
<td>-</td>
<td>&gt;200</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>subsp. <em>equina</em></td>
<td>15-21</td>
<td>-</td>
<td>-</td>
<td>200-286</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Medieval Syrian</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n°36-605 (Period IV hearth)</td>
<td>10.3</td>
<td>6.2</td>
<td>6.4</td>
<td>165</td>
<td>161</td>
<td>103</td>
</tr>
<tr>
<td>n°23-203 (Period V hearth)</td>
<td>2.7</td>
<td>2.1</td>
<td>2.2</td>
<td>124</td>
<td>119</td>
<td>105</td>
</tr>
<tr>
<td><em>3</em></td>
<td>3.4</td>
<td>3.5</td>
<td>3.1</td>
<td>97</td>
<td>112</td>
<td>87</td>
</tr>
</tbody>
</table>

Table 4 — Measurements and indices of modern and ancient charred broad beans (*Vicia faba*). Modern measurements from Hanelt (1972). Measurements are in millimetres. Abbreviations: L - length; B - breadth; T - thickness; > greater than; < less than; e - estimated measurement; * - possibly terminal bean in pod.

The broad bean from n°36-605 (Period IV hearth) differs from those identified in sample n°23-203 by its much greater dimensions. Unfortunately, only one fairly abraded cotyledon was retrieved. The identification is based on the bean’s long shape (high length/height and length/breadth ratios - see Table 4), and the radicle emplacement morphology. One end of the cotyledon is a smoothly rounded swelling cheek, behind which, on the inside surface, the radicle indentation can be seen. This structure matches that of modern comparative *Vicia faba* specimens.

According to Hanelt’s (1972) definition, the ancient broad beans found in this assemblage belong to subspecies *minor* (see Table 4). Length measurements are less than 15 mm in all cases, even taking charring shrinkage into account. The length to breadth ratios also fall into the range of modern *Vicia faba minor*. 
COW PEA: *Vigna unguiculata*

Five individual cotyledons of the cow pea, *Vigna unguiculata*, were retrieved. Two separate cotyledons which match to make up one whole bean were recovered from sample n°23-221 (Period III midden). The other specimens were in sample n°36-605 (Period IV hearth). Table 5 sets forth their dimensions and an example is illustrated in Figure 5b.

The cotyledon in lateral view is a smooth oval with both ends bowed slightly upwards towards the hilum face (i.e. reniform). Looking down on the hilum face, a deep and relatively wide channel runs beneath where the radicle originally lay. Although the overall size of the charred cotyledons is closer to that of modern mung bean (*Vigna radiata*), the bowed oval shape and relatively wide channel are not features of *V. radiata*, but do match the morphology of cow pea.

<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>L</th>
<th>B</th>
<th>T</th>
<th>L:B</th>
<th>L:T</th>
<th>T:B</th>
</tr>
</thead>
<tbody>
<tr>
<td>n°23-221</td>
<td>5.0</td>
<td>3.2</td>
<td>2.8</td>
<td>154</td>
<td>181</td>
<td>85</td>
</tr>
<tr>
<td>n°36-605</td>
<td>7.7</td>
<td>5.1</td>
<td>4.5</td>
<td>152</td>
<td>171</td>
<td>89</td>
</tr>
</tbody>
</table>

Table 5 – Measurements and indices of charred cow pea (*Vigna unguiculata*) from samples n°23-221 (Period III midden) and n°36-605 (Period IV hearth). All measurements are in millimetres. Abbreviations: L - length; B - breadth; T - thickness; e - estimated.

The interior structure of the charred cotyledons also closely resembles modern cow pea. A deep channel runs from the embryo end along the middle of the cotyledon, and curves toward the hilum face at the other end. The interior surface is smooth but coarsely wrinkled parallel to the long axis of the cotyledon. This pattern was present in all the modern material which I was able to compare. On modern reference cow peas, a lobe folds out just below the radicle attachment from the interior of the cotyledon, making a small dart about half way along the hilum groove when viewed from above. This small outfolding is clear in the archaeological seeds also.

*Vigna unguiculata* has a very thin, wrinkled seed coat (testa), which is very likely to burn to ash or easily erode from the bean when charred. Not surprisingly, no trace of the seed coat remains on the ancient cotyledons.

**FIG: Ficus carica**

Although fig seeds are generally easily recognizable, they can vary considerably in form. Two examples from sample n°36-603 (Period V hearth) are illustrated in Figure 6a. Although more or less uniform in size, fig seeds range from very prominently beaked, to nearly spherical. The degree of lateral compression also varies greatly.

The charred fig seed exterior surface is matt, while the interior surface is smooth and glossy. Sometimes broken fig seeds contain a small rounded cotyledon. This can be plump and very glossy, or shrivelled and shiny. The “classic” fig seed shape is more or less spherical, often somewhat laterally compressed, with a small beak-like protrusion. Usually a slight to
pronounced ridge runs along the top of the seed, terminating at the beak. Beneath this beak is the hilum. There are actually two indentations, but frequently only one is visible. The openings are set into a thickened area of seed wall. These indentations surrounded by thickened wall sometimes look like a small groove beneath the beak. The hilum structure is absolutely characteristic of fig, and its presence makes identification certain, no matter what extreme shape the seed may have.

Figure 6 — a. Fig seeds (Ficus carica) from n°36-603. Left - hilum view, right - lateral view. Drawn by Delwen Samuel. b. Grape pedicel (Vitis vinifera) from n°36-605. Drawn by Jane Goddard.

GRAPE: Vitis vinifera

GRAPE PIPS

Entire grape pips are easily distinguished, and have been well illustrated in numerous publications (e.g. Renfrew, 1973: 128; Kroll, 1983). Detailed descriptions and illustrations are therefore not provided here. In this section I discuss estimates of whole pip numbers from fragments, and describe charred grape pedicels. Features of grape pips fragments which distinguish them from those of pomegranate seed fragments are described on page 458.

I have used the same method to estimate entire whole grape pip numbers from fragments as for cereal grain fragments (see page 441). Partially fragmented pips were counted as complete if parts of the front and back along with the stalk survived. Grape kernels were not counted, as either fragments or whole, because they could be accounted for by fragments of outer shell. The exception was when only kernels remained, or if kernels outnumbered tallied fragments. These exceptions applied to very small assemblages of grape remains.

The feature I have used to count one entire pip is the thick, robust stalk. This usually survives complete, from where it joins the pip body to its tip. In very occasional samples, such as the residue of sample n°36-605 (Period IV hearth), the stalks themselves are fragmented. In this case it is possible to separate out half and quarter stalks, and divide the totals by two and four respectively to get an estimate of whole stalks, and therefore, original number of whole grape pips.
GRAPE PEDICELS

Grape pedicels are the slender woody stems which attach the individual grape berries to the more robust stem network supporting the bunch of fruit. Pedicels were found in various samples. The richest assemblage occurs in sample n°36-605 (Period IV hearth), which also contains the greatest number of grape pips. An ancient pedicel is illustrated in Figure 6b.

The morphology of grape pedicels is highly variable. The stems can be slender or stout, long or short. They are often wrinkled longitudinally. Towards the berry end, the pedicel sometimes gradually but usually abruptly widens into a thickened ring or ruffle. This ruffle varies in morphology, from a thin and fragile-looking narrow ring, to a thick and solid ridge. On the stem extension and the ruffle, warty protrusions are often but not invariably apparent. When they appear they are very distinctive, and are common. Attached beneath the ruffle is a small spindle-shaped extension, which tapers to a point or rounded end. Sometimes charred shreds of grape adhere to this projection.

The features which distinguish grape pedicels from small bits of twig or stem are the thickened ruffle, the warty protrusions when they occur, and the spindle-shaped attachment. With a good microscope, the spindle-shaped attachment can clearly be seen as a separate but firmly connected structure.

Two features of the grape pedicel have been documented as useful variety indicators (International Board for Plant Genetic Resources, 1983: 75-76). These are length from insertion to ramification, and ease of separation from the berry. Both are difficult to identify on archaeobotanical material. Observed surviving length is not necessarily original length, because the pedicel may have been broken before or after charring. Ease of separation may be judged to a certain extent by the appearance of the spindle-shaped attachment: whether it is small and clean, long and jagged, and whether bits of grape adhere to it.

POMEGRANATE: Punica granatum

POMEGRANATE SEEDS

Pomegranate seeds are extremely variable in form, reflecting their development tightly packed against each other within the fruit. All seeds have a rounded end and a more or less pointed end. The body of the seed just below the rounded end is usually irregularly marked with bumps and broad grooves. In cross section it is often angular (see Figure 7), but the degree of angularity is highly variable, and some seeds can be completely rounded. Running down the seed is a broad groove which can be very pronounced or quite faint. It is present on every seed but at different locations. It may be along the broadest face, a narrow face, or even on an angle of the seed. Hjelmnqvist (1979: 112) states that these typical markings are sometimes lacking on both ancient and modern pomegranate seeds but I found them on every ancient and modern seed which I examined.

Figure 7 shows one fairly long and slender ancient seed. Some ancient seeds were still embedded in their fleshy covering. Table 6 summarises the measurements of thirty randomly selected whole seeds from sample n°36-605 (Period IV hearth).
Table 6 — Measurements and indices of thirty charred pomegranate (*Punica granatum*) seeds from sample n°36-605 (Period IV hearth). Measurements are in millimetres. Abbreviations: N - number of seeds measured; L - length; Bmax - maximum breadth; min - minimum measurement; avg - average measurement; max - maximum measurement.

When broken, rounded end fragments can be confused with fragments of *Galium* seeds. With a good microscope and careful observation, seed fragments of these two species can be separated. The surface texture of *Galium* is slightly wrinkled and bumpy. It usually has a thicker cross section, which looks like many layers of loosely stacked crêpe paper. There are no contours or ridges on *Galium* and when present these markings allow a definite identification of pomegranate. The contours and ridges, however, do not appear on all pomegranate seed fragments.

I tallied larger pomegranate seed fragments to obtain whole seed equivalents. Either end can be used as the diagnostic feature.

A large amount of pomegranate peel was recovered in sample n°36-605 (Period IV hearth) and a few peel fragments were found in sample n°36-603 (Period V hearth). These finds are not recorded in the score sheets (Chapter 1, Tables 11, page 368 and 13, page 370). The peel was first identified by the interior reticulation, caused by the seeds in their fleshy covering pressed against the inner fruit wall. Some preserved peel fragments still retain the raised attachment points of the seeds to the fruit wall. The exterior surface has a leathery texture and is covered in small bumps.
Upon further examination, I was able to pick out some fruit attachment scars and swollen calyx bases on bits of peel from sample n°36-605. In total, the remains of three scars and three calyx bases survive in this sample. Two bases are complete, while the third one has been cut in half. The halves match perfectly, and suggest that this fruit had been cut with a knife while fresh. At least one other fragment of peel has a cut mark on it. This sample contains the debris from at least three fresh fruits.

DIFFERENTIATING GRAPE AND POMEGRANATE SEED FRAGMENTS

Kroll (1983) points out that the shiny internal surface texture of grape pips is distinctive. However, identifying small grape pip fragments can be difficult if this surface is poorly preserved, or if another, similar type of material such as pomegranate seeds is present in the assemblage. This section presents my methods for identifying all seed fragments from these fruits which lack clear morphological features, from both these fruits. There are three parts of each seed fragment which can be examined for distinctive features: the exterior surface, the internal surface, and the cross section.

Often some morphological feature is retained on the exterior surface, even if slight, which can make the identification clear. If these features are not present, the exterior surface texture cannot be used to differentiate between these seeds. They are both matt, with an irregular, sometimes slightly flaking surface, although grape can have a smooth exterior. The best identification features of grape are the chalaza on the dorsal side, the two striae on the ventral side, the often warty stalk at the apex, and somewhat less clear, the various saddle shapes at the base. The pomegranate seed is angular with ridges, bumps and grooves at the broad end, and ridges extending down the length of the body. A broad shallow groove runs down one side of the seed, to the nearly pointed, narrow end.

On well preserved fragments, the interior surface texture is the best way to distinguish between the seeds of grape and pomegranate. When this surface abraded or obscured, other features must be studied.

On well preserved material, the internal grape seed surface is smooth and glossy. On pips from these medieval Syrian deposits, the interior colour was generally a deep rich brown, rather than carbon black. The brown colour does deepen to black around the interior chalaza surface, but in this case the chalaza structure is clear. At other spots where the interior has turned black, the surface is no longer smooth, but shiny and irregular. This may be caused by kernel material adhering to the interior pip shell surface or by higher temperatures.

The interior surface texture of pomegranate seeds in this assemblage varies considerably. Sometimes it is black, and absolutely smooth and glossy like a thin layer of tar. It may be black and shiny, but with long wrinkles laid down in regular lines. The black surface can also be irregular and sticky-looking. This black shiny layer can flake off to reveal a black-brown matt surface beneath. The tarry glossy black layer has no equivalent on the grape pip, and the matt surface beneath is not at all like the rich brown interior of the grape.

Examining the structure of the seed cross section is painstaking for small fragments, but it is almost always possible to do with a microscope of reasonable quality. It is worth doing if large numbers of fragments are retrieved, as their identification can affect the tally of the
quantity of each species. When the surfaces of fragments are abraded or lacking any clear features, cross sections usually retain their typical, distinctive structures.

The cross section of the grape pip seed wall has a very distinctive palisade cell-like pattern. Ladder-like partitions run perpendicular to the line of the pip wall. These partitions can be laid down in a dense or open arrangement. At their most compact, the partitions can be difficult to see. In this case, the fragment must be adjusted under the light source, until such an angle is reached that thin striations become visible. If the surface break has vitrified and become shiny, it can resemble pomegranate, but again, adjusting the cross section at different angles will show whether striations are visible.

The palisade pattern occurs all over the grape pip, including the body, throughout the chalaza, and on the thin infolding of the striae. The thickness of the cross section varies greatly across these areas, being thinnest along the infoldings, thickened over the stalk area and where the body joins the stalk, and quite swollen over the chalaza.

Breaks across pomegranate seeds are often shiny and reflective, and can be confused with that of grape, as described above. Otherwise they are matt, and in both cases, under a standard dissecting microscope, no ladder-like pattern can be seen. Sometimes, on very thick shiny breaks, the cross section of vessels running down the length of the seed can just be made out. Because pomegranate seeds tend to be narrow and have several thickened ridges running down the seed angles, it is rare that a fragment does not show a thickening somewhere in the cross section.

PLUM: Prunus domestica

MODERN SUBSPECIES OF PLUM

Zohary and Hopf (1993: 169) divide the Old World plum, Prunus domestica, into three subspecies: domestica, the true or ‘European’ plums; insititia, the damsons and bullaces; and italica, the greengages. The naming and identification of subspecies is difficult, however, because not all taxonomists make such precise divisions. This is due in large part to the abundant hybridization of the species, and consequent lack of easily definable characters. Turkish cultivars are simply named Prunus x domestica by Browicz (1972: 10). Webb (1966: 79) groups the numerous European cultivars and naturalized plants into subspecies domestica (the plums) and subspecies insititia (the damsons and greengages). Under the latter he includes what others have called subspecies italica. Mouterde (1970), writing on the Syrian flora, does not cover cultivated Prunus. For Iraq, Meikle (1966: 156) gives only the variety italica, and notes that there is no record of cultivation for damson or bullace. The other cultivated plum in Iraq is Prunus cerasifera (Meikle, 1966: 155).

Meikle’s (1966: 155) description of a smooth, wide stone of Prunus cerasifera does not match any of my archaeological specimens. The smooth P. cerasifera stones illustrated by Stika and Frank (1988: 68) are also unlike these Medieval Islamic stones. Since the middle Euphrates valley below Deir ez Zor is more like Iraq than the western part of Syria, the Flora of Iraq (Meikle, 1966) is probably the best botanical guide to the region.
<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>L</th>
<th>B</th>
<th>T</th>
<th>B:L</th>
<th>T:L</th>
<th>T:B</th>
<th>SHAPE</th>
<th>SURFACE TEXTURE</th>
<th>KEEL FORM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medieval German</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>± Broad</td>
</tr>
<tr>
<td>subs. insititia Form A</td>
<td>min</td>
<td>10.2</td>
<td>4.4</td>
<td>7.6</td>
<td>43</td>
<td>57</td>
<td>108</td>
<td>Blunt stones, round sides, broad ventral edge</td>
<td>Quite heavy</td>
</tr>
<tr>
<td>Haithabu, 9-10 c.</td>
<td>avg</td>
<td>14.4</td>
<td>8.2</td>
<td>11.0</td>
<td>57</td>
<td>76</td>
<td>134</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>max</td>
<td>17.6</td>
<td>10.4</td>
<td>13.7</td>
<td>73</td>
<td>97</td>
<td>166</td>
<td></td>
<td></td>
</tr>
<tr>
<td>subs. insititia Form A</td>
<td>min</td>
<td>10.3</td>
<td>6.1</td>
<td>8.3</td>
<td>44</td>
<td>61</td>
<td>105</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alt-Schleswig 11-16/17 c</td>
<td>avg</td>
<td>14.3</td>
<td>8.3</td>
<td>10.9</td>
<td>58</td>
<td>76</td>
<td>132</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>max</td>
<td>17.8</td>
<td>10.9</td>
<td>13.5</td>
<td>80</td>
<td>94</td>
<td>156</td>
<td></td>
<td></td>
</tr>
<tr>
<td>subs. insititia Form B</td>
<td>min</td>
<td>11.8</td>
<td>5.1</td>
<td>8.3</td>
<td>30</td>
<td>51</td>
<td>147</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alt-Schleswig 12-16/17 c</td>
<td>avg</td>
<td>15.3</td>
<td>6.8</td>
<td>9.6</td>
<td>36</td>
<td>58</td>
<td>159</td>
<td>More flat than Form A, pointed at ends</td>
<td>Prmnt sculpture</td>
</tr>
<tr>
<td></td>
<td>max</td>
<td>18.1</td>
<td>8.8</td>
<td>11.0</td>
<td>44</td>
<td>67</td>
<td>187</td>
<td></td>
<td></td>
</tr>
<tr>
<td>subs. insititia Form C</td>
<td>min</td>
<td>12.6</td>
<td>4.5</td>
<td>7.2</td>
<td>30</td>
<td>51</td>
<td>147</td>
<td>Slender form, ends pointed, ± flattened in</td>
<td>Low relief</td>
</tr>
<tr>
<td>Alt-Schleswig 12-16/17 c</td>
<td>avg</td>
<td>14.4</td>
<td>5.2</td>
<td>8.2</td>
<td>36</td>
<td>58</td>
<td>159</td>
<td>ventral view</td>
<td></td>
</tr>
<tr>
<td></td>
<td>max</td>
<td>16.2</td>
<td>5.7</td>
<td>9.1</td>
<td>44</td>
<td>67</td>
<td>187</td>
<td></td>
<td></td>
</tr>
<tr>
<td>subs. insititia Form D</td>
<td>min</td>
<td>8.9</td>
<td>5.1</td>
<td>6.6</td>
<td>39</td>
<td>54</td>
<td>113</td>
<td>Bent like long S, often both ends very</td>
<td>Fairly low relief</td>
</tr>
<tr>
<td>Alt-Schleswig 12-16/17 c</td>
<td>avg</td>
<td>13.2</td>
<td>6.2</td>
<td>8.2</td>
<td>47</td>
<td>62</td>
<td>132</td>
<td>sharply pointed, rounded sides</td>
<td></td>
</tr>
<tr>
<td></td>
<td>max</td>
<td>15.5</td>
<td>7.6</td>
<td>9.3</td>
<td>58</td>
<td>77</td>
<td>155</td>
<td></td>
<td></td>
</tr>
<tr>
<td>subs. domestica</td>
<td>min</td>
<td>16.4</td>
<td>4.9</td>
<td>9.7</td>
<td>27</td>
<td>53</td>
<td>157</td>
<td>Large, flat</td>
<td>Rugged relief</td>
</tr>
<tr>
<td>Alt-Schleswig 12 &amp; 16/17 e</td>
<td>avg</td>
<td>19.7</td>
<td>6.4</td>
<td>11.3</td>
<td>32</td>
<td>57</td>
<td>177</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>max</td>
<td>22.2</td>
<td>7.5</td>
<td>12.4</td>
<td>37</td>
<td>65</td>
<td>206</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 7.— Ancient *Prunus domestica* stone measurements and forms: stones from sample n°36-605 (Period IV hearth) compared to Medieval German stones (from Behre, 1978). Measurements are in millimeters. Abbreviations: L - length; B - breadth; T - thickness; min - minimum measurement; avg - average measurement; max - maximum measurement; > - greater than; < - less than; e - estimated measurement; ± - more or less; prmnt - prominent.
<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>L</th>
<th>B</th>
<th>T</th>
<th>B:L</th>
<th>T:L</th>
<th>T:B</th>
<th>SHAPE</th>
<th>SURFACE TEXTURE</th>
<th>KEEL FORM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medieval Syrian subsp. instiitia ‘tapered’</td>
<td>15</td>
<td>6.5</td>
<td>8</td>
<td>43</td>
<td>53</td>
<td>123</td>
<td>Long, slender; lower end tapered &amp; pointed; top pointed;</td>
<td>Low relief</td>
<td>Not prnt, shallow groove down one side, ± broad in</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>rounded in ventral view</td>
<td></td>
<td>ventral view</td>
</tr>
<tr>
<td>subsp. instiitia ‘tapered’</td>
<td>18</td>
<td>6</td>
<td>9</td>
<td>33</td>
<td>50</td>
<td>150</td>
<td>As above</td>
<td>Low relief</td>
<td>Not prnt, shallow groove down one side, ± broad in</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ventral view</td>
</tr>
<tr>
<td>subsp. instiitia ‘tapered’</td>
<td>&gt; 14.5</td>
<td>5.5</td>
<td>8.5</td>
<td>&lt; 38</td>
<td>&lt; 59</td>
<td>155</td>
<td>Tapered end severed; top</td>
<td>Low relief</td>
<td>Not prnt, shallow groove down one side, ± broad in</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>rounded, not pointed; sides</td>
<td></td>
<td>ventral view</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>gently rounded in ventral view</td>
<td></td>
<td></td>
</tr>
<tr>
<td>subsp. instiitia ‘tapered’</td>
<td>17</td>
<td>6</td>
<td>8</td>
<td>35</td>
<td>47</td>
<td>133</td>
<td>Long and slender; pointed at both</td>
<td>Low relief</td>
<td>Not prnt, shallow groove down one side, ± broad in</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ends; tapered lower end;</td>
<td></td>
<td>ventral view</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>sides gently rounded in ventral view</td>
<td></td>
<td></td>
</tr>
<tr>
<td>subsp. instiitia, like Behre’s Form D</td>
<td>13</td>
<td>6.5</td>
<td>9</td>
<td>50</td>
<td>69</td>
<td>138</td>
<td>Ovate; both ends sharply pointed;</td>
<td>Low relief, except at keel</td>
<td>Sharp-edged; deep groove down one side, not prnt, but distinct &amp; heavy</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>S-shaped; sides in ventral view quite rounded</td>
<td></td>
<td></td>
</tr>
<tr>
<td>subsp. domestica, embedded in fruit</td>
<td>23.5</td>
<td>e 6.6</td>
<td>14</td>
<td>e 28</td>
<td>60</td>
<td>e 212</td>
<td>Large, flat, oblong-ovate; rounded top;</td>
<td>Coarse, heavy, especially at base</td>
<td>Prnt, several heavy ridges; thick blade protruding from centre.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>blunted angle at base</td>
<td></td>
<td></td>
</tr>
<tr>
<td>subsp. domestica</td>
<td>22</td>
<td>7</td>
<td>&gt; 12</td>
<td>32</td>
<td>&gt; 55</td>
<td>&gt; 171</td>
<td>Large, flat, non-keel edge missing</td>
<td>Coarse, heavy, especially at base</td>
<td>Prnt, several heavy ridges; thick blade protruding from centre.</td>
</tr>
<tr>
<td>subsp. domestica</td>
<td>21.5</td>
<td>7</td>
<td>12</td>
<td>33</td>
<td>56</td>
<td>171</td>
<td>Non-keel edge nearly straight in lateral view</td>
<td>Coarse, heavy, especially at base</td>
<td>As above, except lacking such distinct blade</td>
</tr>
</tbody>
</table>

Table 7 — continued. Ancient *Prunus domestica* stone measurements and forms: stones from sample no 36-605 (Period IV hearth) compared to Medieval German stones (from Behre, 1978). Measurements are in millimetres. Abbreviations: L - length; B - breadth; T - thickness; min - minimum measurement; avg - average measurement; max - maximum measurement; > - greater than; < - less than; e - estimated measurement; ± - more or less; prnt - prominent.
ARCHAEOLOGICAL FINDS OF PLUM

Because of the difficulties in determining subspecies of modern material, archaeological material is also hard to identify precisely. However, once the barrier of subspecies name is dealt with, analysis of plum stones shows that they have several different and distinct forms. A variety of plum stones are illustrated in Behre (1978) and Gregor (1985). Röder (1940), cited by Behre (1978: 161), found that *P. domestica* stones have characteristics which are constant, and useful for separation into both subspecies and type.

The characteristics which separate *Prunus domestica* subsp. *domestica* (true plums) from *P. domestica* subsp. *insititia*/*italica* (damsons and bullaces/greengages) are their measurement indices, surface texture, and keel appearance. I am unaware of characteristics which separate *P. domestica* subsp. *insititia* (damsons and bullaces) from *P. domestica* subsp. *italica* (greengages), so they are grouped together here. Since Meikle (1966: 156) states that there are no modern records of *P. domestica* subsp. *insititia* cultivated in Iraq, the ancient *insititial*/*italica* plums are perhaps more likely to be *Prunus domestica* subsp. *italica*.

Although several samples from these Medieval Islamic deposits contain fragments of plum stones, and kernels which may come from plums, only sample n°36-605 (Period IV hearth) contains whole plum stones which can be measured and identified. Examples are illustrated in Figure 8. Table 7 summarizes Behre’s (1978) measurements of plum stones, and compares them to measurements and descriptions of each whole plum stone found in sample n°36-605. At least two subspecies are preserved, *Prunus domestica domestica*, and *P. domestica italica/insititia*.

Figure 8 — Plum stones (*Prunus domestica*) from sample n°36-605. a. European plum stone, *P. domestica domestica*. b. Damson/greengage plum stone, *P. domestica italica/insititia*, long slender form. c. Damson/greengage plum stone, *P. domestica italica/insititia*, squat form; resembles Behre’s “Formenkreise D” (Behre 1978: 176, Figure 8). Drawn by Jane Goddard.
The thickness to length (T:L) and breadth to length (B:L) ratios do not separate out the two subspecies, but thickness to breadth (T:B) ratios are substantially different. Relative to breadth, subsp. *domestica* is much flatter than subsp. *italica/insititia*. The keel is distinct but not markedly heavy on subsp. *italica/insititia*, whereas on subsp. *domestica*, the keel is prominent, and may have a narrow 'blade' projecting from the center. Surface texture is also clearly different: although both subspecies have rugged-looking surfaces, that of *domestica* is much heavier than *insititia/italica*. The three stones identified as subsp. *domestica* are similar to those illustrated by Behre (1978: 176, Fig. 9) and Gregor (1985: Plate 6, no. 62 and 63).

On the basis of surface texture and keel morphology, a few fragments of plum stone from n°36-605 could be assigned to subspecies. Low surface relief and narrow tapered ends indicate the remains of at least 3 more stones from the *italica/insititia* form. Fragments with very heavy keels and prominent surface texture come from at least three different *P. domestica* stones (Figure 8a). Since many fragments are small, these counts are probably an underestimate of both subspecies. The remaining fragments in all samples containing plum stones could only be assigned to species.

ANCIENT PLUM VARIETIES

Groupings within subspecies are likely to reflect actual fruit varieties, because cultivated plums are clones propagated solely by grafting (Zohary and Hopf, 1993: 169), and therefore should retain their individual traits. Such a study of different forms has been made successfully by Behre (1978) for archaeological material (see Table 7).

Plum stones of the *italica/italica* form from n°36-605 can be separated into two groups. Four stones are long and slender in lateral view, and rather plump in ventral view (Figure 8b). The clearest distinguishing feature is the long and narrowly tapering base. All these stones have a rounded apex, but three of them have a slight beak. They do not correspond to any of the *Formenkreise* illustrated by Behre (1978), nor to the several forms shown by Gregor (1985: Plate 6, nos. 48-59).

The other group is represented by one stone. It is more squat in lateral view and thick in ventral view (Figure 8c). It bears a strong resemblance to *Formenkreise D* shown by Behre (1978: 162 & 176, Fig. 8), including the measurements and indices, S-shape and sharply pointed ends. Like Behre’s *Formenkreise D*, it has a deep groove down one side and relatively low relief on its surface. With only one such stone found in this assemblage, it would be unfounded to say that the two different archaeological finds from 12th-16th/17th c. Germany and from 12th c. Syria are from the same or closely related varieties, but the similarities are striking.

CHARRED FRUIT

One *P. domestica domestica* stone from n°36-605 is still surrounded by half the plum fruit. The charred fruit is 22 mm thick, but the thickness of the original fresh fruit must have been somewhat more. This suggests that the size of the fresh plum was about 5 centimeters wide, which is large for plums.
Its surface is heavily wrinkled, precisely like the surface of a prune. Other fruit fragments, without stones, were recovered from the same sample. They look the same as the plum, but they could have come from another large fleshy fruit, like peach.

The use of a knife can be seen on several pieces of charred fruit. Many edges are straight, suggesting that they were neatly trimmed rather than torn or bitten. The shiny vitrification on some edges, probably caused by sugar carmelization, is strong evidence that the sharp surfaces were made before charring occurred. Another piece of evidence for the use of a knife on plum fruits is the clean, shiny break on one of the stones.

One fruit fragment has a very flat straight cut, as if it had been excised from the rest of the fruit. This part may have been discarded because of a blemish or damage, but the charred remains do not indicate what the flaw may have been. Another piece of fruit flesh is more suggestive: it has a small tunnel running through it. It looks very much as if part of a fruit, attacked by an insect, was cut out. A further bit of fruit flesh is shaped more or less like a cone or top, with a channel running down one side. This too, looks like excision of insect damage.

**PEACH: Prunus persica and ALMOND: Amygdalus communis**

Two samples contain remains of peach stones, but unfortunately neither example is whole. The most complete comes from sample nº85-109 (Period Ib midden). It is deeply furrowed, but has no pits. Part of the keel is very prominent, while the remainder is less conspicuous. The kernel is still inside. Although its original length cannot be determined, it appears to have been a short, round peach stone, rather than elongated. It measures as follows: length: >15.5 mm; breadth: >9 mm; thickness: >12 mm.

The second example of peach comes from sample nº36-605 (Period IV hearth) and is illustrated in Figure 9a. It is in several fragments, but all the pieces seem to come from one individual. The surfaces are heavily furrowed, and a few fragments are also marked with deep pits. At least one of these pits penetrates to the interior surface, which is smooth and glossy. The keel is bordered by several grooves. The base is rounded with a small, thin tapered point, typical of peach stones. Cross sections of the fragments range from 1.67-3.33 mm across the body, and up to 4.76 mm across the keel.

Sample nº36-605 is the only context which contains almond. The remains of at least two fragmented almond stones are present, and possibly a piece of one almond kernel. The latter compares in texture and shape to plum kernels, but is much larger. It is also shiny and puffed, indicating its high oil content. It resembles the rounded end of one almond cotyledon.

The stone fragments are unmistakably that of the cultivated almond. They are deeply pitted, with heavier pits on the central body fragments, becoming shallow near the keel. The keel itself has heavily incised grooves on both the exterior and interior surfaces, but does not protrude beyond the face of the stone. The apical end is blunt and has grooves radiating from it. The inner surface can be smooth but is often densely covered in little blisters.

The cross section shows two layers separated by a series of channels running from the apical to distal ends of the stone. These channels help to identify small fragments of almond stone which lack surface features. The thickness of the stone varies from 1.76 mm across the body near the apical end, to 2.62 mm across the keel.
MELON: *Cucumis melo* and CUCUMBER: *C. sativus*

IDENTIFICATION PROBLEMS

Modern comparative seeds of melon (*Cucumis melo*) and cucumber (*C. sativus*) have no obvious morphological differences. The thickness of the seed coat cross section also seems to be the same. Although Butt (1979) describes the cellular anatomy of different seed coat layers in various Cucurbita, unfortunately the surviving layers on the archaeological seeds do not seem to be diagnostic. Cucumber seeds may be somewhat more elongated than those of melon, but there is no clear differentiation, and the breadth to length ratio is not a reliable characteristic for archaeological finds. This is particularly true when there are only one or two seeds in each sample. From the seeds alone, I am not able to distinguish between melon and cucumber.

*Cucumis* seeds are long, slender, and usually flat. When the seed coat is well preserved, the apical end is blunt, and the elongated attachment scar is visible. Running along the narrow edge is a line or slight ridge. Modern comparative melon and cucumber seeds which I have studied have small thin phlanages on either side of the apical end.

*Prosopis* kernels can look disconcertingly similar to *Cucumis* cotyledons in size and shape. However, the two genera can be distinguished quite well on reasonably well preserved examples by the embryo. The embryo end of *Prosopis* is rounded rather than tapered to a point, and extends into the body of the cotyledon by a narrow ‘neck’, grasped by small flaps of cotyledon. *Cucumis* has a sharp-tipped embryo protruding from the body of the cotyledon. The embryo grades smoothly into the cotyledon, without flaps. The distal end of the cotyledon is broad and smoothly rounded, not narrow and extended like *Prosopis*. At least in modern material, *Prosopis* cotyledons are much thicker.

ARCHAEOLOGICAL FINDS

The best examples of *Cucumis* from these samples are preserved by mineralization in sample n°23-211i (Period V around jar). Among them is the single seed in the assemblage which clearly shows the typical apical phlanages of *Cucumis*. Some seeds retain the cellular pattern on the cotyledon and the inner layer of the seed coat. These mineralized seeds are much rounder in cross section than usual. This may be due to waterlogging prior to mineralization, which would cause the seeds to swell. Because of the thin seed coat surface over the broad face, and the more robust ridge around the seed edge, swelling would tend to be most pronounced across the seed thickness rather than its breadth.

*Cucumis* seeds preserved by charring are much smaller than mineralized seeds, and smaller than modern cucumber and melon seeds. The tiny size of some of these cotyledons and seeds suggests that they come from a small seeded variety of melon or cucumber, or that they are not fully developed. In the latter case, however, one would not expect them to survive exposure to fire. Sometimes the seed coat is cracked, and no surface pattern is visible. Charred cotyledons are shiny, and heavily crizzled and pitted.
OTHER OCCASIONAL FINDS

DATE: *Phoenix dactylifera*

Date stones were recovered only from sample no 36-605 (Period IV hearth). Of these, one was whole, and three were unmatching halves. The whole stone is relatively short and fat. It is blunt-ended, as is one of the fragments. The other two pieces have more pointed ends. The surfaces are slightly wrinkled, usually in rings down the length of the stone. All date stones have a deep furrow down the ventral face, and a dorsal groove. The whole stone also has a small ‘navel’, or indented ring half way along the dorsal groove. The broken cross sections are very much fissured in a radial pattern. Table 8 gives all surviving measurements.

<table>
<thead>
<tr>
<th>LENGTH</th>
<th>MAXIMUM BREADTH</th>
<th>MAXIMUM THICKNESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.5</td>
<td>6.5</td>
<td>6.0</td>
</tr>
<tr>
<td>-</td>
<td>6.0</td>
<td>5.0</td>
</tr>
<tr>
<td>-</td>
<td>5.0</td>
<td>4.5</td>
</tr>
<tr>
<td>-</td>
<td>5.0</td>
<td>4.7</td>
</tr>
</tbody>
</table>

Table 8 — Measurements of charred date stones (*Phoenix dactylifera*) from sample no36-605 (Period IV hearth). Measurements in millimetres.

LEMON: *Citrus limon*

Two lemon seeds have been recovered from this assemblage, one mineralised seed from sample no23-211i (Period V around jar) and a charred seed from sample no36-605 (Period IV hearth).

The lemon seed from sample no23-211i is better preserved (Figure 9b). It is long and slender; one end is a pointed tip and the other is smoothly rounded. The seed is slightly flattened, with a ridge running in a band around its long circumference. Another longitudinal ridge runs down one of the seed’s broad sides. The seed coat has a typical fibrous appearance.

The charred seed no36-605 has collapsed and the surface has become contorted, with several ridges and folds which are not part of the seed’s original structure. The thickened tissue of the original ridges can still be made out, however, as well as the coarse striations of the fibrous seed coat. Despite the distortion, the shape of the seed when fresh can be reconstructed. As with the mineralised seed, it would have been long and slender, with one rounded end and one tapered, more pointed end.

Sample no36-605 contains a few fragments of peel which may be from lemon (Figure 9c). In thickness they correspond to the peel of modern small round lemons, rather than the thicker peel found on larger modern varieties. On each peel fragment, one side is covered in a regular pattern of raised blisters in a matte surface, while the other side is irregular and featureless.
WALNUT: *Juglans regia*

Walnut is definitely represented in the archaeobotanical record by a few fragments of dense, heavy shell from sample n°36-605 (Period IV hearth). An example is illustrated in Figure 9d. A single shell fragment which could be from walnut was found in sample n°36-603 (Period V hearth) but since it has not been positively identified it has not been scored.

One fragment was recovered which came from the suture edge, or fracture plane, of the shell. This has a ridged edge, and shelf-like fold on the interior which corresponds to the surface of the fracture plane. Both this and other pieces have the distinctive coarse network of grooves on the external surface, and irregular interior surface marked by partitions, typical of walnut. Illustrations of walnut showing these features can be found in Renfrew (1973: 156, Fig. 101; Plate 47, nos. 8 & 9).

The possible walnut fragment from sample n°36-603 has a similar surface groove, and its thickness compares well to fragments from the other sample. However, its tiny size prevents a definite identification.

![Walnut Shell Fragments](image)

CORIANDER: *Coriandrum sativum*

The most distinctive feature of coriander fruit is the wavy primary ridges. This, combined with the spherical shape of the two joined mericarps, makes coriander unmistakable in well preserved material. Renfrew (1973: 171, Fig. 115) has a good drawing of a coriander fruit.

A single poorly preserved umbellifer mericarp from sample n°36-603 (Period V hearth) is from coriander. The mericarp has been quite flattened although some curvature is retained. It is possible that this is the result of charring, for coriander fruits, despite their round and robust appearance, are fairly thin walled. The primary ridges are worn and are in very low relief but are wavy. The secondary ridges are much better preserved and more prominent. The stylodium (distal tip of the fruit) is small and half-conical, as with modern reference fruits. One other coriander fruit was found in sample n°93-401/3 (Period Ia around tannour).
CAPER: Capparis

Caper seeds have been described and well illustrated in van Zeist and Bakker-Heeres (1982: 213, 216, Fig. 24.1; 1984b: 181, 182, Fig. 6.10 and 6.11). As with their finds, the caper seeds from these Medieval Islamic deposits are rounded, plump, and have a prominent radicle.

I am unable to distinguish between C. spinosa and C. ovata, both of which have several varieties (Zohary et al., 1980: 9-10). The botanical literature is somewhat confusing about distribution of the two species, partly because of mixed terminology. Mouterde (1970: 79-80) records only C. spinosa growing in Syria. He mentions two varieties, one of which is canescens Coss. Zohary et al. (1980: 9) list this name as a synonym of Capparis ovata Desf. Mouterde’s second variety, parviflora Boiss., is not mentioned as either name or synonym in Zohary et al. (1980). The two species are very similar and are used in the same way.

A greater difficulty is distinguishing some Capparis seeds from an unidentified wild legume. This problem was encountered with samples n°23-216d (Period III hearth) and n°23-216d/f (Period III hearth), where a large number of both types of seed are present. The confusion is compounded by poor preservation, for the seeds are broken, abraded, and the surfaces are damaged. Although the ‘sucker mouth’ of the hilum at first seemed a good way to distinguish Capparis, many seeds with this round protruding hilum definitely have two cotyledons. Capparis has a single coiled cotyledon, as shown by van Zeist and Bakker-Heeres (1984b: 182, Fig. 6.11). Because of this dilemma, Capparis seeds from these two samples have not been precisely quantified, but their presence is recorded.

ACKNOWLEDGEMENTS

I am indebted to Sophie Berthier for inviting me to participate in this project and making it possible for me to do so. I thank her and Olivier D'Hont for their support. Helga Seeden kindly provided the flotation machine for sample processing. Adil Awad assisted with flotation and translation in 1989. I thank Cheryl Ward for bringing various references to my attention. François Sigaut and Marcel Gast made helpful comments on the millet section, for which I am grateful. I drew on the invaluable archaeobotanical bibliographies initiated by J. Schultz-Motel and continued by Helmut Kroll and I pay tribute to their efforts. I thank the Institut Français d'Études Arabes à Damas and the British Institute of Archaeology at Ankara for accommodation and the use of their facilities. Funding is very gratefully acknowledged from the Fondation Max van Berchem for research and the Molly Cotton Foundation for illustrations. I owe a great debt to Mark Nesbitt for his extensive practical help and constant support and encouragement.
REFERENCES

AMBASTA, S. S. P. (ed.)

ANDERSON, E. N.,

ANDERSON, S. and ERTUG-YARAS, F.,

ASHTOR, E.,
1976b « The Venetian cotton trade in Syria in the later Middle Ages », Studi Medievali, 17, p. 675-715.

AUBAILE-SALLENAVE, F.,

BAILEY, A. E., (ed.)

BALFOUR, J. H.,

BEAUMONT, P., BLAKE, G. H. and WAGSTAFF, J. M.,

BEDIGIAN, D.,

BEDIGIAN, D. and HARLAN, J.,

BEDIGIAN, D., SMYTH, C. A. and HARLAN, J.,

BEDOUCHA, G.,

BEHRE, K.-E.,


Bonaparte, G., 1903, *A manual of Egyptian farm crops and vegetables*. Politis, Cairo.


CHANG, T.-T.,

CHARLES, M. P.,

CHOWDHURY, K. A. and BUTH, G. M.,

CHURCH, A. H.,
1886 *Food-grains of India*. Chapman and Hall, London.

COBLEY, L. S. and STEELE, W. M.,

COLIN, G. S.,

COSTANTINI, L.,

CRITOPoulos, P.,

CROWFOOT, G. M.,
1924 « The handspinning of cotton in the Sudan », *Sudan Notes and Records*, 7/2, p. 82-9.

DIEDERICHSSEN, A. and RUGAYAH,

DIETRICH, A.,

DOWSON, V. W. H.,

Duchesne, E. A.,
DUKE, J. A.,

DUNN, R. P. J.,
1952    Cotton in the Middle East. The National Cotton Council of America, Memphis, TN.

EDMONDSOIN, J. R.,

EL-SAMARRAIE, H. Q.,

FAHD, T.,

FARNWORTH, J.,

FISHER, W. B.,

FOGG, W. H.,

FRYXELL, P. A.,
1979    The natural history of the cotton tribe (Malvaceae, Tribe Gossypieae). Texas A & M University Press, College Station TX.

GALLANT, T. W.,

GILDEMACHER, B. H. and JANSEN, G. J.,

GOOR, A.,
1965    « The history of the fig in the Holy Land from ancient times to the present day », Economic Botany, 19, p. 125-35.

GOOR, A. and NUROCK, M.,

GREGOR, H.-J.,
GRIST, D. H.,

GUTHRIE, M.,

HALDANE, R. C.,
1886 Subtropical cultures and climates. William Blackwood and Sons, Edinburgh.

HANELT, P.,

HARRIS, M. V.,

HASTORF, C. A. and POPPER, V. S. (eds),

HELBAEK, H.,
1961 «Late Bronze Age and Byzantine crops at Beycesultan in Anatolia», Anatolian Studies, 11, p. 77-97.

HILLMAN, G. C.,

HILLMAN, G. C., MASON, S., DE MOULINS, D. and NESBITT, M.,

HJELMQVIST, H.,
1979 «Some economic plants and weeds from the Bronze Age of Cyprus», Studies in Mediterranean archaeology, 45/5, p. 110-33.


Jennings, P. R., 1966 «The evolution of plant type in *Oryza sativa*», *Economic Botany*, 20, p. 396-402.


Joshi, A. B., 1961 *Sesamum*. Indian Central Oilseeds Committee, Hyderabad.


LIBRARY OF ENTERTAINING KNOWLEDGE,


1832 *Vegetable substances used for the food of man*. Charles Knight, London.


MILL, R. R.,

MILLER, N. F.,

MILLER, N. F. and SMART, T. L.,

MIQUEL, A.,

MOJTACHE, A.,

MOUTERDE, P.,

NAYAR, N. M. and MEHRA, K. L.,

NEEF, R.,

NESBITT, M.,

1993b « Archaeobotanical evidence for early Dilmun diet at Saar, Bahrain », *Arabian Archaeology and Epigraphy*, 4, p. 20-47.


NESBITT, M. and SAMUEL, D.,


NESBITT, M. and SUMMERS, G. D.,
NICHOLSON, B. E., HARRISON S.G., MASEFIELD, G.B. and WALLIS, M.

NICHOLSON, G. E.,
1960 « The production, history, uses and relationships of cotton (Gossypium spp.) in Ethiopia », Economic Botany, 14/1, p. 3-36.

OKA, H.-I.,

ONG, H. C. and SIEMONSMA, J. S.,

PAJE, M. M. and VAN DER VOSSEN, H. A. M.,

PEARSEALL, D. M.,

POPPER, V. S.,

PURSEGLOVE, J. W.,

RAGIQ, M.,

RENFREW, J. M.,

RIFAI, S. and RIFAI, M. A.,

RIZQALLEH, F. and RIZQALLEH, K.,

ROBBINS, W. W.,

RODER, K.,

ROSENGARTEN, F.,
Rowley-Conwy, P.,

Sakamoto, S.,

Sakamoto, S., Gul, A. and Kawahara, T.,

Sanlaville, P.,

Schlingloff, D.,

Serjeant, R. B.,

Serrico, M. and White, R.,

Short, E. H.,

Spiegel-Roy, P. and Goldschmidt, E. E.,

Stephens, S. G. and Moseley, M. E.,

Stevens, J. H.,

Stika, H.-P.,

Stika, H.-P. and Frank, K.-S.,

Stol, M.,


Van Zeist, W., 1984 «List of names of wild and cultivated cereals», *Bulletin on Sumerian Agriculture*, 1, p. 8-16.


van Zeist, W. and Bottema, S.,

van Zeist, W., Smith, P. E. L., Palfenier-Vegter, M., Suwun, M. and Casparie, W. A.,

Viré, F.,

Watson, A. M.,


Watt, G.,


Webb, D. A.,

Weiss, E. A.,


Wetterstrom, W.,

Weulersse, J.,

Whitney, M.,

Wild, J.-P.,

Winton, A. L. and Winton, K. B.,
Woodroof, J. G.,

Yusuf, M. D.,

Zeven, A. C. and de Wet, J. M. J.,

Zohary, D. and Hopf, M.,

Zohary, M., Heyn, C. C. and Heller, D.,