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The Origin and Development of Plant Cultivation in the Near East

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In the present paper aspects of early Neolithic plant cultivation in the Near East, as revealed by archaeological plant remains, are reviewed. The crop plants of the early Neolithic farmers included cereals, pulses and linseed. Plant cultivation resulted in the loss of an efficient seed-dispersal mechanism. Archaeobotanical evidence of plant collecting by late Palaeolithic hunter-gatherers is still scarce. Fair numbers of potential wild food plants have been demonstrated for early Neolithic sites, but the role of these food resources in the diet of early farming communities remains a matter of speculation. There are indications that already in an early stage of plant cultivation use was made of (near-)surface water to compensate for insufficient precipitation. In the final section a few comments are made on the expansion of plant cultivation from its Near Eastern nuclear area and on the introduction of fruit-tree growing.

Keywords: PLANT DOMESTICATION, EARLY NEOLITHIC, ARCHAEOBOTANY, WILD PLANT COLLECTING, FRUIT GROWING.

INTRODUCTION

The present publication is the revised version of a paper read at the Symposium on Environment and Civilization in the Middle East, held on 27 February 1991 at the International Research Center for Japanese Studies, Kyoto. It is the aim of this paper to discuss some aspects of archaeobotanical or palaeoethnobotanical research in the Near East, with emphasis on the earliest stages of plant cultivation. The examination of plant remains preserved in archaeological sites provides us with information on the exploitation of cultivated and wild plants by man in ancient times. In addition, the archaeobotanical record contains a wealth of information on farming practices, on the field-weed flora, on crop-processing methods and also on the effects of the impact of man on the environment, e.g. the local depletion of timber resources. Admittedly, the further one wishes to go into details of ancient plant husbandry the more speculative the interpretation becomes.

For the study of ancient agriculture the Near East is of great interest, because it was there that very important staple crops of prehistoric and early-historical man in the

Old World, such as barley, wheat, pea and lentil, were brought into cultivation. The designation "Old World" includes Southwest Asia, Egypt and Europe. It is difficult to imagine what the cultural and material history of this part of the world would have been without an economy based upon the production of food.

By far the greatest part of the archaeobotanical evidence from Near Eastern sites consists of carbonized plant remains. It is true that imprints in burnt clay and pottery play a part, and in extremely arid areas one may find plants in a desiccated or mummified state, e.g. in Egypt. However, one may safely state that we owe most of our knowledge of ancient plant husbandry in the Near East to carbonized seeds and fruits. Occasionally concentrations of charred cereal grains or other seeds come to light during excavations, but usually the plant remains occur dispersed in the occupation deposits, not visible to the naked eye, and they have to be retrieved through flotation of large volumes of soil. The introduction of water-flotation methods in archaeological field work in the Near East has resulted in a spectacular increase of archaeobotanical data in the last few decades. Another factor that has contributed to the development of archaeobotanical research is the greatly improved cooperation between archaeologists and botanists. Nowadays, the archaeobotanist is often a member of the excavation team.

For a review of archaeobotanical research in the Near East, the reader is referred to Miller (1991). The locations of the sites mentioned in this paper are indicated in Fig. 1.

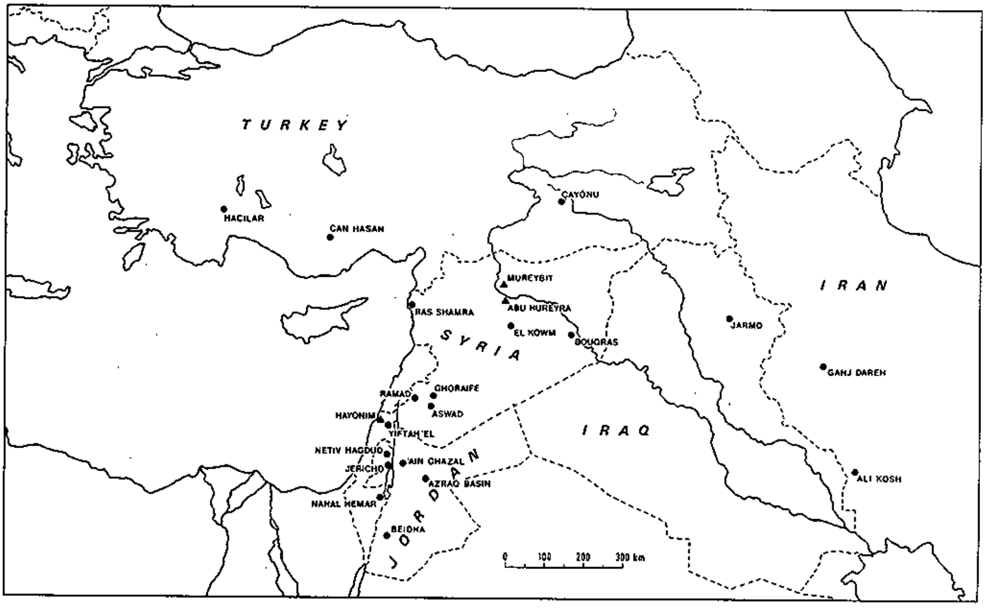

Fig. 1. Early Neolithic sites and some late Palaeolithic sites (triangles) for which plant remains have been published.

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THE EARLY-NEOLITHIC CROP-PLANT ASSORTMENT

According to our present knowledge, plant cultivation in the Near East started about 10,000 BP in uncalibrated radiocarbon years, which is about 9000 BC in calendar years (calibrated ^{14}C years). Two thousand years later, by 7000 BC, most of the crop plants that the Near East has contributed to food production had been brought into cultivation. At about 7000 BC village farming had become firmly established and agriculture had started to spread beyond its Near Eastern nuclear area.

To date we are relatively well informed on the early Neolithic (9000–7000 BC) plant husbandry in the Near East. An appreciable number of early farming sites, distributed over a large area, from Jordan to southwestern Iran, have yielded plant remains (Fig. 1). The crop-plant assortment that was available by 7000 BC (Table 1) gives occasion to the following comments.

Table 1. Crop plants attested at early Neolithic sites in the Near East. An asterisk indicates that it is not certain whether the species had already been brought into cultivation (only a few seeds found so far).

Triticum monococcum	– Einkorn wheat (hulled)
Triticum dicoccum	– Emmer wheat (hulled)
Triticum durum/aestivum	– Hard wheat/bread wheat (free-threshing)
Hordeum distichum	– Two-rowed hulled barley
Hordeum vulgare	– Six-rowed hulled barley
Hordeum vulgare var. nudum	– Naked (free-threshing) barley
Lens culinaris	– Lentil
Pisum sativum	– Field pea
Vicia ervilia	– Bitter vetch
Vicia faba var. minor	– Broad bean (Celtic bean)
Lathyrus (sativus)	– Grass pea*
Cicer arietinum	– Chick pea*
Linum usitatissimum	– Linseed (flax)

Among wheats (*Triticum*), hulled and naked or free-threshing forms are distinguished. In hulled wheats, such as einkorn and emmer wheat, stiff glumes firmly enclose the kernels and a special treatment is required to free the grains. In contrast, in free-threshing wheats the kernels are loose in the ears when mature and they can easily be freed by threshing. The charred remains of naked wheats present an identification problem. It is not possible to make a distinction between the carbonized grains of hard wheat or *durum* wheat (*Triticum durum*) and bread wheat (*Triticum aestivum*). Tetraploid hard wheat (with 28 chromosomes: 4×7) is a mutant of emmer wheat; bread wheat (with 42 chromosomes: 6×7) was formed by hybridization and subsequent chromosome doubling of emmer-*durum* wheats with the wild grass species *Aegilops squarrosa*. Also in barley (*Hordeum*) hulled and naked forms occur.

As for the pulses (leguminous crop plants), bitter vetch (*Vicia ervilia*) is at present not utilized for human consumption; it is grown only as stock feed. Bitter vetch seeds are toxic to man, but the poisonous substance can be removed by soaking the seeds in water before cooking. The rather great numbers of bitter vetch seeds, which together with the seeds of other food plants have been found in prehistoric sites, suggest that in ancient times this species was consumed by man.

The crop-plant assortment attested for the various early Neolithic sites varies considerably, which may in part be due to chance factors (e.g. the degree of detail of the botanical sampling), but which should also reflect the preferences of the farmers regarding the crop plants that were grown.

PLANT DOMESTICATION

Most of the crop-plant species listed in Table 1 have a wild ancestor which formed, and still forms, part of the natural vegetation. It was this ancestor that was brought into cultivation by prehistoric farmers and that as a result of man's manipulations developed into the domesticated form. What is the fundamental difference between the wild and the domesticated form? Let us take the example of the cereals. The ear or spike of wheat, barley and various other grasses has a central axis or rachis, the continuation of the stem. This rachis is articulated; it consists of so-called rachis internodes. In wheat (schematically illustrated in Fig. 2), at the top of each internode, just above the junction between two internodes, one spikelet is found, consisting of one or a few grains enclosed by bracts.

In wild cereals the rachis is brittle, that is to say, the individual spikelets disarticulate at maturity: the ear falls apart. This property guarantees an efficient seed dispersal. Very rarely, as the result of a mutation, plants with a tough rachis occur in wild cereal populations. In these mutants the mature ear does not break into its component spikelets. The mutant with the tough rachis is poorly equipped for the struggle for life; it is unable to reproduce as its spikelets are not efficiently disseminated and protected from predation (cf. Hillman & Davies, 1990). Through their arrowlike form and the action of their awns, the spikelets of wild, shattering cereals can bury themselves in the soil, where they are safe from birds and rodents and in a favourable position for germination the next season. Under natural conditions the mutant with the stiff rachis will soon disappear.

However, when this mutant occurred in the fields of the earliest farmers, it was not doomed to disappear. In this case man had taken care of the protection and dispersal of the seeds. As a result of selection—unconsciously in the early stages of cultivation and later deliberately—eventually the form with the brittle rachis disappeared from the fields and the non-shattering form remained as the cultivated crop. This mutant is the domesticated form, no longer capable of surviving without man's help.

The loss of an efficient seed-dispersal mechanism can also be observed in other crop plants. In wild field pea and lentil, the pods open at maturity and the seeds are flung

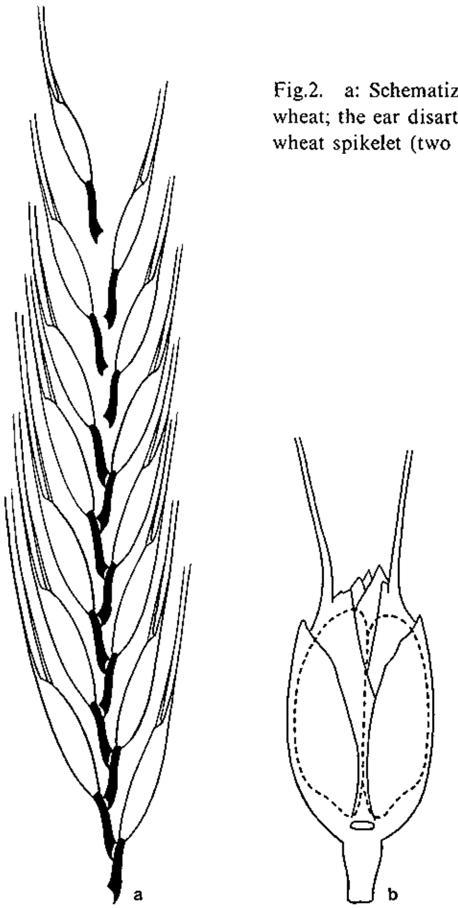

Fig.2. a: Schematized ear (spike) of wild emmer wheat; the ear disarticulates at maturity. b: Emmer wheat spikelet (two grains enclosed by bracts).

away, but in the domesticated forms the pods remain closed. Similarly, cultivation of flax resulted in a shift to non-dehiscent capsules from which the seeds are not spontaneously released. After the wild plants had been brought into cultivation, morphological and physiological changes took place which made them into domesticated, man-dependent forms.

There has been much speculation on the length of time required for morphologically defined wild crop plants to become of the domesticated type. For how many hundreds or thousands of years could, for instance, cereals have been cultivated without an appreciable increase in the tough-rachised form; in other words, without a shift to the domesticated type? On the basis of experimentally-obtained domestication rates in wild wheats and barley, Hillman & Davies (1990) calculated that under specific conditions, viz. uprooting or sickle-reaping when partially or nearly ripe and shifting cultivation (to virgin plots), the crop could have become fully domesticated within 200 years, without any conscious selection. However, other husbandry practices could seriously have delayed or even have precluded domestication. Thus, harvesting of cultivated wild cereals while completely unripe would not have led to an increase in the proportion of the tough-rachised, non-shattering mutant.

Is it possible to distinguish between the carbonized remains of domesticated crop plants and their wild ancestors? To some extent the answer can be positive. For instance, in wild barley only separate rachis internodes showing an intact disarticulation scar are to be expected (Fig. 3a). In contrast, two or more rachis internodes still adhering together point to the domesticated form with a tough rachis (Fig. 3b). As for the grains of cereals, a satisfactory differentiation between wild and domestic forms is not always possible.

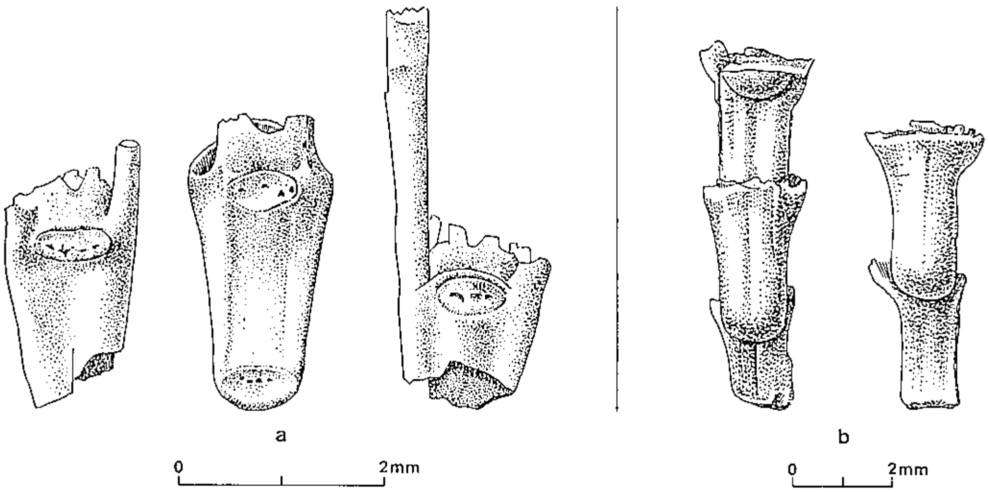

Fig.3. *Hordeum* rachis internodes from archaeological sites. a: Wild barley (*H. spontaneum*), Ramad. b: Domestic six-rowed barley (*H. vulgare*), Ukma, Sudan (desiccated).

A distinction between the seeds of wild and domesticated field pea, lentil and other pulses is usually not possible. The wild field pea has a rough seed wall, whereas in the domestic form the wall is smooth. However, in charred peas only seldom has (part of) the wall been preserved. Wild lentils are, on the average, smaller than the seeds of the domestic form, but there is a considerable overlap.

The very first farmers had no domesticated crop plants; they must have started to grow wild cereals and wild legumes. This implies that only morphologically-defined wild crop plants should be represented in a very early farming site. However, only if remains of the domestic type are found are we absolutely certain that the species concerned was cultivated and not collected in the wild, and that consequently we are dealing with farmers and not with hunter-gatherers (see also the discussion in the following section). It will be clear that, at least on the basis of the floral remains, it will never be possible to pinpoint exactly when and where plant cultivation started, when and where the first farmers lived.

PRE-NEOLITHIC PLANT HUSBANDRY

It is reasonable to speculate that the plant species that were brought into cultivation had already played an important part in the late Palaeolithic (pre-Neolithic) food-collecting economy. It was in this way that man had become acquainted with the useful properties of these plants. Wild cereals and pulses must have been attractive to food gatherers, and these wild crop plants may, as it were, have presented themselves for being cultivated. Unfortunately, factual evidence of the collecting of plants for human consumption by pre-agricultural societies is rather scarce.

The tool assemblage of the late Palaeolithic Natufian sites in the Syro-Palestinian area points to the collecting and processing of vegetable food. There are sickle blades, pestles and mortars, and grinding stones. A few Natufian sites in this area yielded modest numbers of charred seeds and fruits, but the wild ancestors of the early Neolithic cereal crop plants are hardly represented and are confined to a few grains of wild barley (*Hordeum spontaneum*) recovered from Hayonim Cave. The same site yielded a fair number of lupin seeds (*Lupinus pilosus*), but this potential pulse crop has never been cultivated (Hopf & Bar-Yosef, 1987).

Pre-Neolithic sites which yielded appreciable quantities of wild cereal grains are Abu Hureyra and Mureybit, on the Euphrates River of northern Syria. From the late Palaeolithic layers of these sites pistachio, wild lentil, wild barley, wild rye and wild

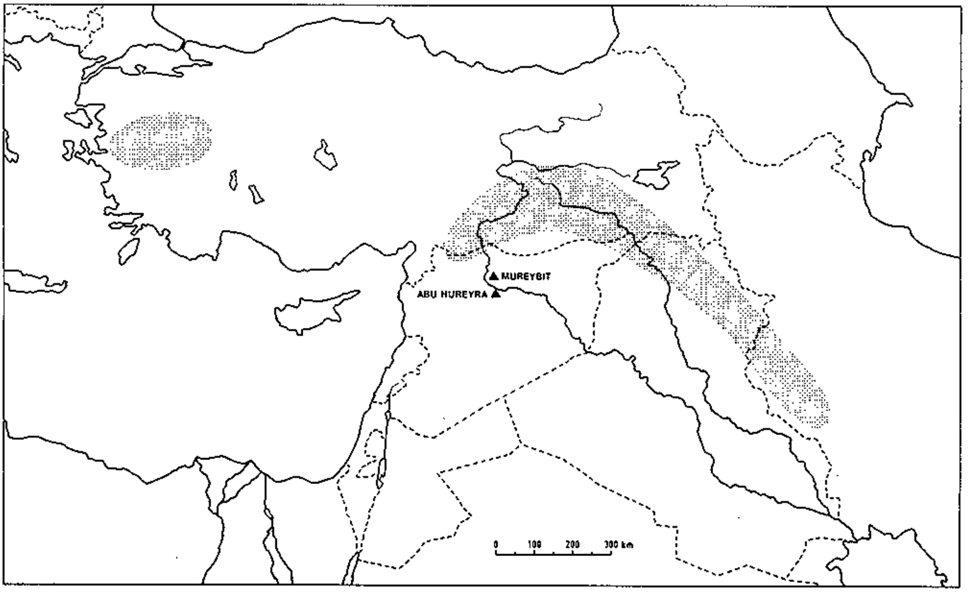

Fig.4. Regions (shaded) in which wild einkorn wheat (*Triticum boeoticum*) occurs in primary habitats.

einkorn wheat have been recovered in addition to many other species. Particularly wild einkorn wheat is quite abundant in both sites (Hillman *et al.*, 1989; van Zeist and Bakker-Heeres, 1984 [1986]).

With respect to wild einkorn wheat the following should be remarked. This wild cereal has a wide distribution area, from the southern Balkans (Greece, Bulgaria) through Turkey and northern Iraq to western Iran. The species occurs in primary habitats as well as in segetal localities, such as grain fields and roadsides. There are two regions in which wild einkorn occurs naturally in massive stands, viz. the West Anatolian centre, and the area embracing Southeast Anatolia, North Iraq and West Iran (Fig. 4). Two ecogeographic subspecies are distinguished: one-grained wild einkorn (*T. boeoticum* ssp. *aegilopoides*) develops one seed in a spikelet and is found in the West Anatolian centre. In two-grained wild einkorn (*T. boeoticum* ssp. *thaoudar*), the spikelets contain two seeds; this is the predominant type in the eastern distribution area. There is a clear difference between the grains of the two types of wild einkorn: the grains of the one-seeded subspecies have a lengthwise curved ventral side, whereas in the grains of the two-seeded form the ventral side is straight in lateral view (Fig. 5).

The Abu Hureyra and Mureybit einkorn wheat belongs to the two-seeded subspecies, which is in conformity with the fact that this type of wild einkorn is naturally distributed in the adjacent part of Turkey (Fig. 4). The late Palaeolithic wild einkorn has already evoked much discussion. Three possible sources for the wild einkorn wheat can be suggested: (1) natural stands were found in the vicinity of the site; (2) the wild einkorn was gathered at a greater distance, in the adjacent part of Turkey; or (3) this wild cereal was cultivated (Hillman, 1975).

It is unlikely that under the present-day climatic conditions wild einkorn wheat could naturally have occurred in the Mureybit/Abu Hureyra area. In adjacent southeastern Turkey wild einkorn is present in massive stands on basaltic soils. Transportation of the harvested grain over a distance of 100 to 150 km. must have presented great difficulties. The pollen record obtained for a sediment core from the Orontes valley in northwestern Syria is thought to point to moister climatic conditions in the period between 10,000 and 8000–7000 BC (van Zeist and Woldring, 1980). This could imply that at the time of the late Palaeolithic occupation of Mureybit and Abu Hureyra, wild einkorn stands were present in the area of both sites or at least were found at a much shorter distance than nowadays.

The palynological examination of soil samples from Mureybit induced Leroi-Gourhan (1974) to suggest that the inhabitants of the site practised a kind of proto-agriculture (Cerealia-type pollen values up to 8%). This means that man promoted the growth of the wild cereals by means of weeding and watering. The hypothesis of a proto-agricultural stage was subsequently adopted and advocated by Cauvin (1977, 1978) and Moore (1979), the excavators of Mureybit and Abu Ḥureyra, respectively. A careful evaluation of the Abu Hureyra plant material led Hillman *et al.* (1989) to the conclusion that most probably the cereals were gathered from wild stands.

The discussion of the wild einkorn wheat illustrates the difficulties that are encountered in interpreting plant remains in terms of plant-exploitation practices.

IMPETUS TO PLANT DOMESTICATION

The introduction of animal breeding and plant cultivation required the presence of animals and plants which were attractive as well as suitable for domestication.

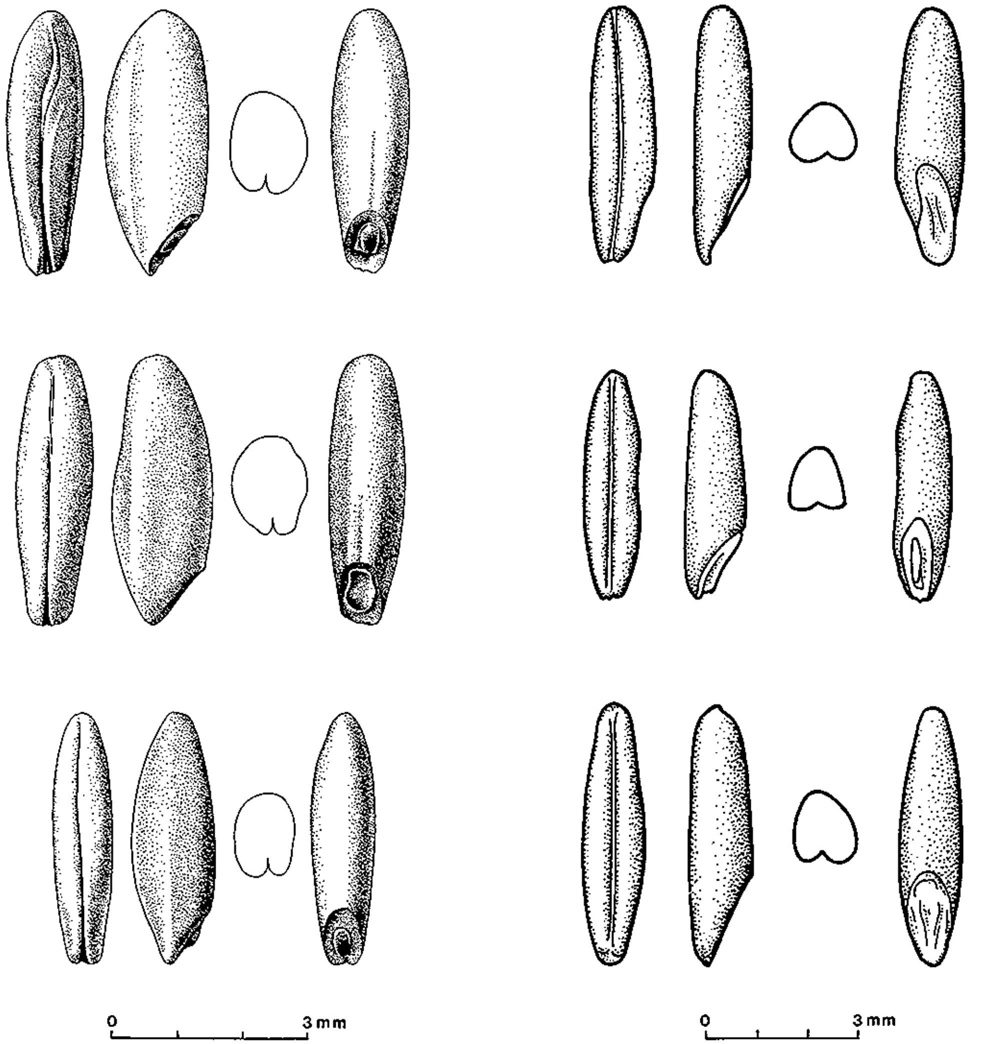

Fig.5. Left: one-grained wild einkorn wheat (Ramad). Right: two-grained wild einkorn wheat (Mureybit).

Moreover, man must have reached a certain level in his cultural and technical evolution; he had, as it were, to be ready for this step. But the compliance with both these conditions would not automatically have led to the production of food. Why did man change the economic basis of his existence? Why did it start 11,000 years ago: why not earlier or later? Was there a stimulus which gave the impetus to this development?

For a long time the opinion prevailed that a drastic change in climate had been the direct inducement to the domestication of plants and animals in southwestern Asia. During the last glacial, the climate of the Near East (and North Africa) was thought to have been much moister than nowadays; the present-day deserts and semi-deserts would have been lush grasslands with an abundance of game animals. After the glacial period, in the early Holocene, it became drier. Only river valleys and oases could still provide suitable habitats for the original flora and fauna, and it was in these places that man, plants and animals clustered. This enforced close contact would have induced man to protect the animals which were most useful to him against their natural enemies; and from protecting to animal breeding is a relatively small step. The necessity to exploit plant-food resources as intensively as possible would have resulted in the cultivation of plants.

This simple explanation of the how and why of the beginning of food production had to be abandoned. Palynological studies have convincingly demonstrated that in the greater part of the Near East, the climate did not become drier 11,000–10,000 years ago, but that, on the contrary, it had become moister since the last glacial period (van Zeist and Bottema, 1982). Some scholars still recognize late Pleistocene/early Holocene changes in climate and vegetation as important conditioning factors in the development of agriculture in Southwest Asia (cf. Moore, 1989). Other explanations for the abandonment of a life as hunter-gatherer and the development of a food-production economy are more of a demographic nature. It has been argued that overpopulation forced people to move to environmentally marginal zones, where food scarcity necessitated them to find ways to increase the food resources by cultivating plants and breeding animals (Binford, 1968). It has also been hypothesized that a sedentary way of life resulted in the adoption of food production. As long as the community was small, the wild resources in the surroundings of the site were sufficient to support the population. However, with increasing numbers of inhabitants the wild food resources could no longer meet the demand and the only way to survive was the introduction of food production (Bar-Yosef and Kislev, 1989). It is evident that this kind of discussion falls outside the scope of this paper, particularly because it is very doubtful whether archaeological plant remains can be of much help in this respect. Attention should also be drawn here to Harris' (1989) discussion of the evolution of people-plant interactions.

THE ROLE OF WILD PLANTS IN THE DIET OF EARLY NEOLITHIC MAN

To what extent was the diet of cultivated cereals and pulses supplemented by wild plants? One could speculate that in the early stages of agriculture, plant cultivation could not sufficiently meet the demands for vegetable food and that the collecting of fruits, seeds and other parts of wild plants remained necessary. After all, it is not to be expected that with the introduction of plant cultivation the gathering of wild plants, that had been practised for many thousands of years, was suddenly abandoned. Seeds and fruits of wild plants which could have played a part in the diet of ancient man are, indeed, found in early Neolithic and later sites, but it is often uncertain whether they were used as human food.

In some instances there can be no doubt. Thus, one may safely assume that the fruits of wild pistachio (*Pistacia atlantica*) and wild almond (*Amygdalus* sp.), the nutshell remains of which have been recovered from various early farming sites in fairly large amounts, had been collected for human consumption. Pistachio and almond fruits are very rich in fat and must have constituted a welcome supplement to the carbohydrates and proteins provided by the cereal and pulse crops.

In some early Neolithic sites seeds of wild grasses and legumes are found in appreciable quantities. In his report on the palaeobotany of Ali Kosh, in Southwest Iran, Helbaek (1969) emphasizes the importance of the seeds of wild legumes in the diet of the occupants of the site. In the Bus Mordeh phase, the earliest occupation phase of Ali Kosh, indigenous wild legumes, such as *Astragalus* (milk vetch) and *Trigonella* (trigonel), make up 94% of the number of seeds, and domestic cereals only 3.4%. Converted for weight, cereals and wild legumes would each have contributed about equal proportions to the vegetable human diet.

It has been questioned whether the predominance of small-seeded legumes at Ali Kosh is evidence of the intentional collecting of these seeds for human consumption. The seeds in question were recovered from refuse deposits which, in addition to seeds of wild and cultivated plants, yielded large quantities of cereal threshing remains. Thus, it looks as though the leguminous seeds were the waste of crop cleaning and not the remains of a wild food harvest. At a few more early Neolithic sites large numbers of seeds of wild legumes and grasses were secured from refuse deposits, e.g. at Ramad (Fig. 6). These deposits yielded also large quantities of chaff (threshing remains).

It will be clear that with respect to the role of seeds and fruits of wild plants in the diet of early farming communities, we are faced with a problem. Various wild seeds could have been collected for human consumption, but their mere presence in archaeological deposits is not necessarily proof of their use as such. It is hard to avoid the impression that some authors are more readily inclined than others to assume that potential wild food plants attested archaeobotanically were indeed used as such by the inhabitants of the site concerned.

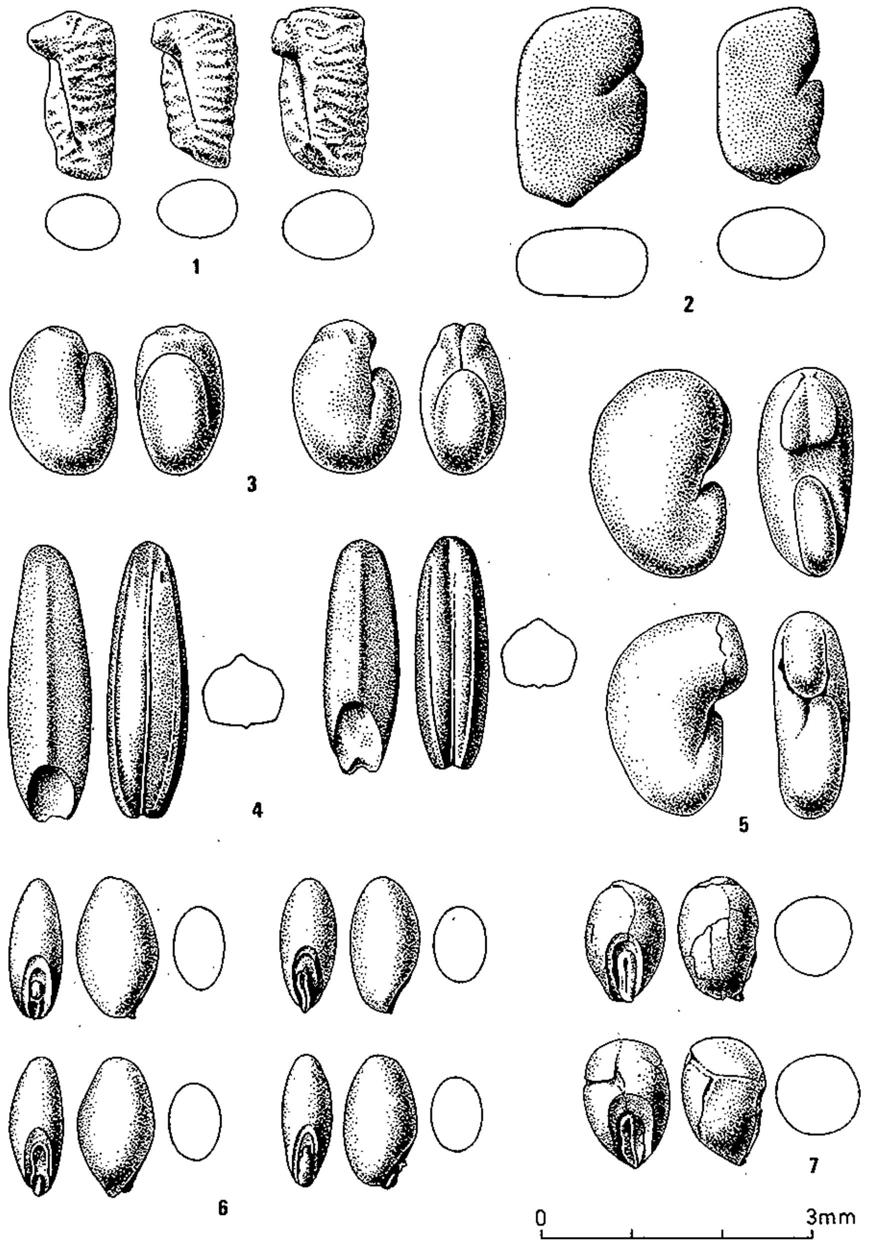

Fig.6. Wild leguminous seeds and wild grass caryopses from Ramad and Aswad. 1 *Trigonella astroites* type; 2 *Astragalus* spec.; 3 *Melilotus* spec.; 4 *Eremopyron* (*buonapartis*); 5 *Medicago* spec.; 6 *Phalaris* spec.; 7 *Echinaria capitata.*

UTILIZATION OF SURFACE WATER

It is obvious to take the line that plant cultivation started in the distribution area of the wild ancestors of the early Neolithic crop plants (Fig. 7). This implies that the earliest plant cultivation was carried out in areas in which precipitation was high enough to rely on for rain-fed agriculture. On the other hand, it is striking that various early Neolithic sites are situated in areas where rainfall is marginal or altogether insufficient for dry-farming.

One such site is Jericho, in the lower Jordan valley, with a mean annual precipitation of 140 mm. One must assume that the early Neolithic inhabitants knew how to make use of the powerful spring near the site for agricultural purposes. At present this spring feeds a large oasis. It must have been rather easy to divert the water from the spring over the fields. In this way it should have been possible to grow cereals and pulses under the hot and arid climatic conditions at Jericho (Hopf, 1983).

An indication of the use of high groundwater is provided by Tell Aswad, in the Damascus basin, the basal layers of which date back to almost 9000 BC. Present-day precipitation in the Aswad area is below 200 mm. annually, which is too low to rely on for rain-fed agriculture. The seeds and fruits recovered from this site include high proportions of sedge (*Carex* spec.) and sea club-rush (*Scirpus maritimus*), two species from marsh vegetations (van Zeist and Bakker-Heeres, 1982 [1985]). Where could marsh vegetations have been found at the time? At present, there is no question

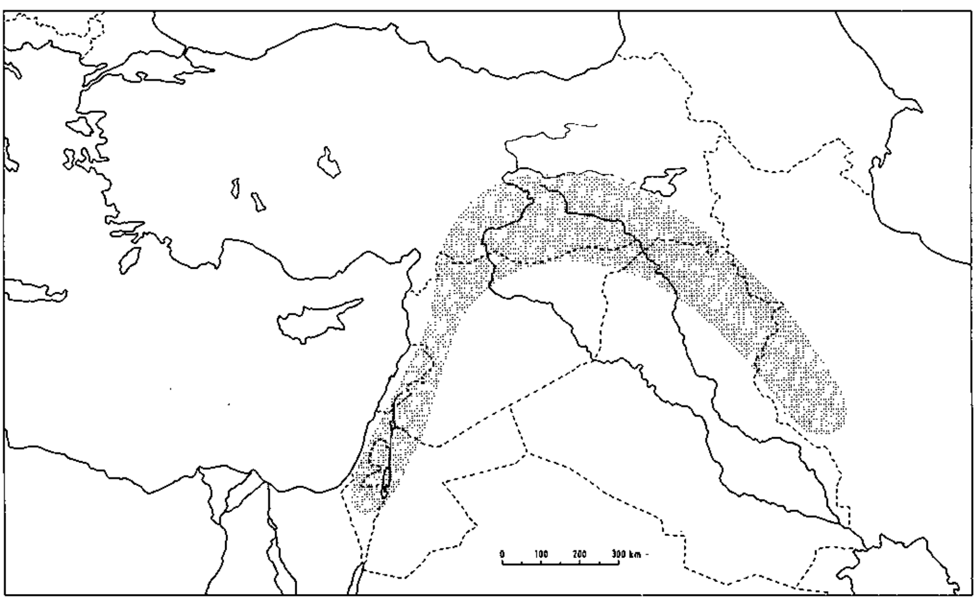

Fig.7. Common distribution area (shaded) of the wild ancestors of early Neolithic crop plants. Wild crop plants may be found in only part of the area and also outside it (cf. Fig.4).

of marshy areas in the vicinity of Tell Aswad, but it is very likely that in early Neolithic times Lake Aateibê (Fig. 8) extended up to the site. In this respect the observations of the British geographer J. L. Porter, who visited the area around 1850, are of great interest. From a map published by Porter (1855) and from his detailed travel account, the extent of the lake in the middle of the last century can accurately be determined. In Fig. 8, the historical lake shore is indicated by a broken line. Porter mentions that the lake was surrounded by extensive marsh vegetations. Thus, the archaeobotanical evidence of marsh vegetation in the vicinity of Aswad is corroborated by the historical record.

Of importance for the economy of the site may have been the fact that the nearby marshes offered the farmers an opportunity to compensate for insufficient precipitation. The farmers could have laid out their fields in the marshy zone, thus providing the crop with several weeks of extra moisture at the beginning of the dry season. Similarly, the seeds of *Scirpus maritimus* and *Suaeda* spec. induced Helbaek (1969) to suggest that the fields of the earliest occupants of Ali Kosh (Bus Mordeh phase)

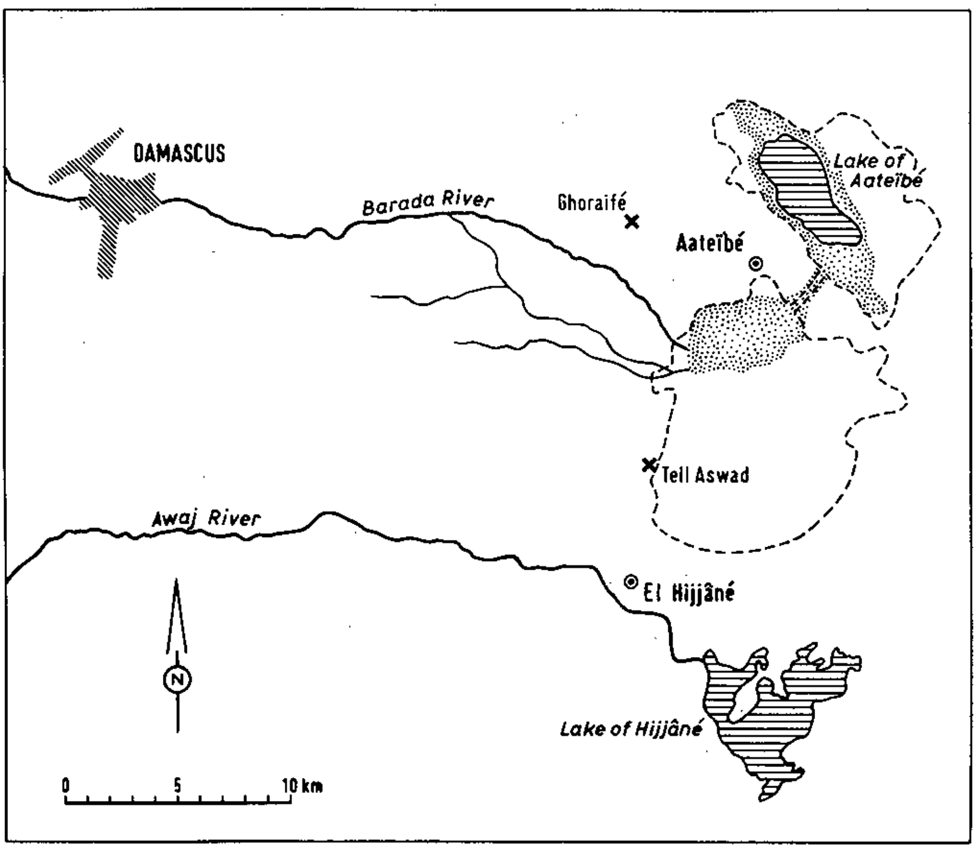

Fig.8. Map of the Aswad area. The extent of Lake Aateibê around AD 1850 is indicated by a broken line. Tell Aswad is situated near the former lake border.

ran down to the marshy zone of a lake that at the time would have existed close to the site.

It is true that there is no firm proof for the utilization of the marshy zone for plant cultivation by the Aswad and Ali Kosh farmers. On the other hand, there is accumulating circumstantial evidence that already in an early stage of plant cultivation, skilful use was made of surface water and a high groundwater table. This leads to the intriguing question of whether perhaps crop-growing did not start in areas where precipitation was sufficient for dry-farming, but rather in areas with low precipitation but with abundant surface-or groundwater. In this connection mention should be made of a paper by Sherratt (1980) in which it is suggested that the initial cultivation should be visualized as a form of small-field horticulture dependent on ground-and surface water.

FARMING ESTABLISHED

As mentioned before, by about 7000 BC (8000 BP in uncalibrated radiocarbon years) agriculture was well established in the Near East and by that time an appreciable number of crop plants, particularly cereals and pulses, were available to prehistoric farmers. It was from about 7000 BC onwards, or perhaps already somewhat earlier, that from its Near Eastern nuclear area agriculture and the associated crop plants expanded in various directions: to Europe, to Egypt and North Africa and eastwards towards Pakistan. Agriculture was introduced to areas with environmental conditions very much different from those in the region in which plant cultivation had developed. For instance, on the one hand, farmers settled in densely forested temperate Europe and, on the other hand, in the Nile valley of Egypt and the Mesopotamian lowland, where arid climatic conditions necessitated an elaborate irrigation system. Most amazing is the flexibility, the ability at adaptation, of some of the crop plants. Thus, in Europe barley is cultivated as far north as the polar circle, under harsh climatic conditions which are almost the opposite of those in the homeland of its wild ancestor.

The development of plant cultivation between 9000 and 7000 BC may be indicated as the first period of domestication. The second period is characterized by the expansion of plant cultivation from its Near Eastern nuclear area. A third period started about 4000 BC with the introduction of fruit-tree growing (Zohary and Spiegel-Roy, 1975; Zohary and Hopf, 1988: chapter 5). One wonders why fruit growing had a rather late start, why fruit production did not begin until many thousands of years after the introduction of agriculture. Could it be that socio-economic conditions played a decisive role, e.g. that fruit-tree growing did not develop until after the establishment of centres of political and economic power where there was a market for these products? We may never know the answer.

At least in two respects fruit-tree cultivation differs from that of cereals and pulses. With fruit trees, it takes several years after planting until the first fruits can be harvested and it may take several decades before the tree has reached full maturity, yielding a satisfactory crop. Thus, fruit-tree cultivation is a kind of long-term investment. Another difference concerns the reproduction. Whereas cereals, pulses and other annual crop plants reproduce from seed, in fruit-tree cultivation vegetative propagation is practised, such as grafting, transplanting off shoots and planting cuttings. The earliest domesticated fruit trees were fig (*Ficus carica*), date palm (*Phoenix dactylifera*), olive (*Olea europaea*) and grapevine (*Vitis vinifera*). Three of them, viz. fig, date palm and olive, have highly caloric fruits. Dried figs, dates and grapes (raisins) and olives in pickled form can be stored over a long period and they lend themselves to long-distance transportation. Olive oil and wine were important trade commodities already in ancient times. It is evident that fruit-growing added a new dimension to plant cultivation with far-reaching economic implications.

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