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On Macroscopic Traces of Food Plants in Southwestern Asia (with Some Reference to Pollen Data)

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On macroscopic traces of food plants in southwestern Asia (with some reference to pollen data)

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By about 6000 B.C. a fairly large number of crop plants were already present: 3 wheat species, 3 barley species, 4 leguminous species, and linseed. For a reconstruction of the history of early agriculture in the Near East the botanical information is still insufficient.

The origin of *Triticum dicoccum* has recently been questioned. The evidence from Çayönü pleads in favour of the opinion that *Triticum dicoccoides* is the wild ancestor.

The carbonized remains of free-threshing wheat constitutes a problem. Neither the grains nor the rachis internodes seem to provide clues for distinguishing between *Triticum aestivum* and *Triticum durum*.

The evidence from Ramad suggests that linseed cultivation must have started in the second half of the seventh millennium B.C., if not earlier.

Pollen analysis has already provided valuable information on prehistoric environments in southwestern Asia. In the Near East, the prospects to demonstrate palynologically the activity of Neolithic farmers seem to be less favourable than in Europe. In the pollen diagram prepared for a sediment core from Lake Beyşehir an early-historic land occupation phase could be demonstrated.

Introduction

In the last 25 years the study of plant remains from early settlement sites in southwestern Asia has expanded considerably. Up to about 1965, palaeo-ethnobotanical work in the Near East was the exclusive domain of Hans Helbaek. Thereafter, more people have taken up palaeo-ethnobotanical work in this region. This development is to a large extent due to a change in the attitude of the archaeologists, who began to realize that for the reconstruction of life in earlier times animal bones and plant remains are as important as architecture, pottery, tools, and other artefacts. Formerly, plant remains collected by the excavator, mainly from storage pits and jars or from other conspicuous deposits of charred seeds, were submitted to a botanist for species identification. At present, a botanist is usually a member of the excavation team; he does not just wait until the excavator turns up with vegetable remains, but is himself actively engaged in extracting his study material from the soil.

The study of plant remains from early settlement sites should provide information on the role of food plants, both wild and cultivated, in the economy of the inhabitants of the site concerned. The results for the individual sites should together lead to the reconstruction of plant husbandry over larger areas. By means of synthesis and comparison of the botanic evidence general tendencies should be established, such as the introduction or abandonment of crop plants and shifts in the relative importance of wild and cultivated plants.

The discussion of food plants in southwestern Asia will mainly be confined to the period up to *ca.* 6000 B.C. (conventional radiocarbon dates). This restriction finds its justification in the fact that by that date most of the crop plants that the Near East has contributed to food production were already present. By about 6000 B.C. village farming had become firmly established and agriculture had started to spread beyond the Near East. When I speak here of crop plants, I mean the annual species, such as cereals and pulses. Fruit trees, the domestication of which started at a later date (Zohary & Spiegel-Roy 1975), are not included in this category.

Prehistoric sites up to *ca.* 6000 B.C. which have so far yielded botanical remains are shown in figure 1. Late Palaeolithic food plants were recovered from Nahal Oren and Moureybit; the other sites provide information on early Neolithic plant husbandry. At some sites, such as Ali Kosh, Can Hasan III and Ramad, water separation or froth flotation have been applied, whereas Jericho and Hacilar were excavated before the introduction of these field techniques. Some sites yielded large amounts of vegetable remains originating from various contexts, whereas at aceramic Hacilar only a tablespoon full of charred seeds was recovered (Helbaek 1970, p. 195).

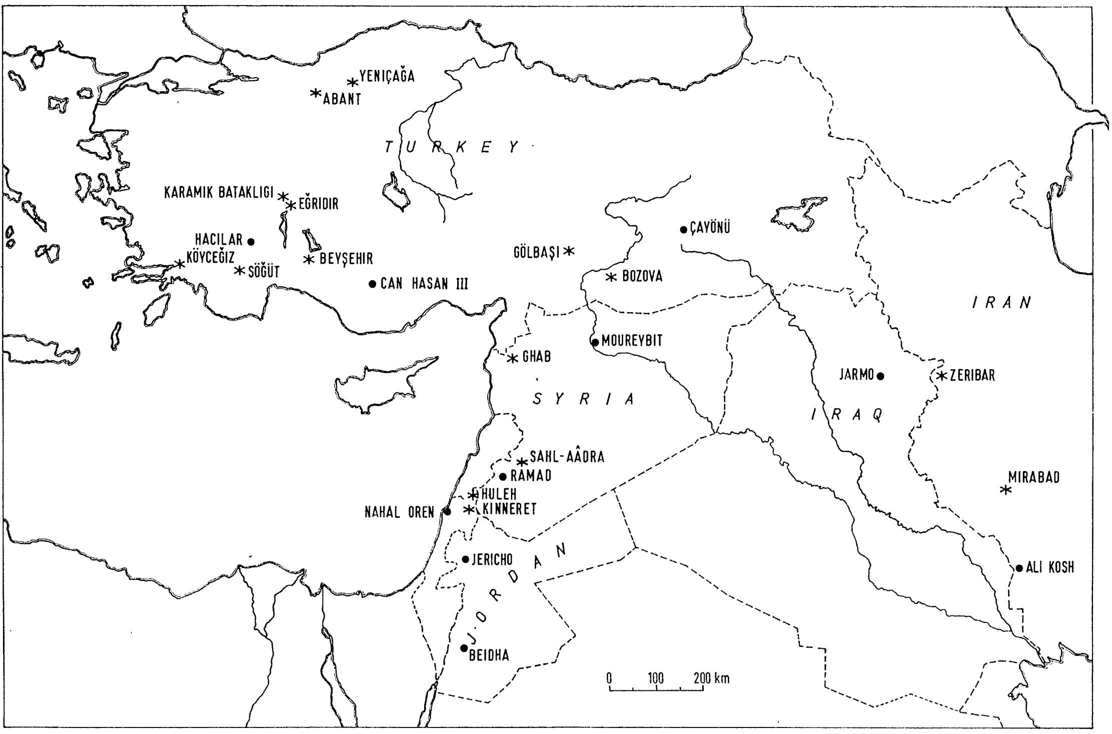

FIGURE 1. Map of the Near East showing the location of prehistoric sites referred to in this paper and of Late Quaternary pollen diagram sites (indicated by a star-shaped symbol).

The bulk of the plant remains in most of the sites under consideration consists of charred seeds and fruits, but our knowledge of the Beidha plant husbandry is largely based on imprints in burnt clay. Moreover, for various sites only preliminary results have been published. It is clear that the dissimilarity in the available information on the plant husbandry at the individual sites is a handicap to a comparison between sites. Differences in the food plant assemblages established between sites may be an artifact of the sampling methods or due to the nature of the evidence.

If one wants to compare the botanical data for various sites with a view towards establishing possible developments in the plant husbandry over a larger area, it is necessary to have well-dated information. At least the relative dating of the sites concerned should be assured. Unfortunately, many uncertainties still adhere to the dating of the sites under consideration. To give a few examples. For the Bus Mordeh phase at Ali Kosh three radiocarbon dates are available, namely 7950, 5720 and 5430 B.C.; but Hole, Flannery & Neely (1969) assume a date of 7500–6750 B.C. for this phase. The radiocarbon dates for Jarmo display a wide scatter, from 7090 to 4950 B.C. (leaving aside the very early dates of 9250 and 9300 B.C.). Braidwood (1975, p. 127) is of the opinion that 'the most reasonable group of determinations from Jarmo averages about 6750 ± 200 B.C.'

TABLE 1. DOMESTICATED PLANTS AND POTENTIAL WILD FOOD PLANTS IN LATE PALAEOLITHIC AND EARLY NEOLITHIC SITES IN THE NEAR EAST

(For explanation see text (p. 30). Nahal Oren: R. W. Dennel in Noy *et al.* (1973); Moureybit: van Zeist (1970) and unpublished data; Ali Kosh: Helbaek (1969); Jarmo: Helbaek (1959); Çayönü: van Zeist (1972); Can Hasan III: French *et al.* (1972); Hacilar: Helbaek (1970); Beidha: Helbaek (1966*b*); Jericho: Hopf (1969); Ramad: van Zeist & Bottema (1966) and unpublished data.)

	Nahal Oren (Kebaran)	Nahal Oren (Natufian)	Nahal Oren (Pre-Pottery)	Moureybit	Ali Kosh (Bus Mordeh phase)	Ali Kosh (Ali Kosh phase)	Jarmo	Çayönü	Can Hasan III	Hacilar (Pre-Pottery)	Beidha	Jericho (Pre-Pottery)	Ramad
Hordeum spontaneum	.	.	.	+	+	.	+	+	.	+	+	.	.
H. distichum	.	.	.	.	.	+	.	.	+	.	.	+	+
H. vulgare	.	.	.	.	.	.	.	.	.	.	.	.	+
H. 'nudum'	.	.	.	.	+	+	.	.	+	+	.	.	+
Triticum boeoticum	.	.	.	+	+	+	+	+	+	+	.	.	.
T. monococcum	.	.	.	.	+	+	+	+	+	.	.	+	+
T. dicoccoides	.	.	.	.	.	.	+	+	.	.	.	.	.
T. dicoccum	+	.	+	.	+	+	+	+	+	+	+	+	+
T. durum/aestivum	.	.	.	.	.	.	.	.	+	.	.	.	+
other wild grasses	+	+	+	+	+	+	.	.	?	.	.	.	?
Lens	.	.	+	+	.	+	+	.	+	+	.	+	+
Vicia ervilia	.	.	.	+	.	.	.	+	+	.	.	.	+
Pisum	.	.	.	.	.	.	+	+	.	.	.	+	+
Cicer	.	.	.	.	.	.	.	+	.	.	.	?	+
Lathyrus cf. *cicera*	.	.	.	.	.	.	+	+	.	.	.	.	+
Prosopis stephaniana	.	.	.	.	+	+	.	.	.	.	.	.	.
small-seeded wild legumes	+	+	+	+	+	+	.	+	?	.	.	.	?
Linum cf. *bienne*	.	.	.	.	+	+	.	+	.	.	.	.	.
Linum usitatissimum	.	.	.	.	.	.	.	.	.	.	.	.	+
Quercus	.	.	+	.	.	.	+	+	.	.	.	.	.
Pistacia	.	.	.	+	+	+	+	+	.	.	+	.	+
Amygdalus	.	.	.	.	.	.	.	+	.	.	.	.	+
Juglans	.	.	.	.	.	.	.	.	+	.	.	.	.
Olea	.	.	+	.	.	.	.	.	.	.	.	.	.
Ceratonia siliqua	.	.	+	.	.	.	.	.	.	.	.	.	.
Capparis spinosa	.	.	.	.	+	+	.	.	.	.	.	.	.
Celtis	.	.	.	.	.	.	.	+	+	.	.	.	.
Vitis	+	+	.	.	.	.	.	.	+	.	.	.	.
Ficus	+	.	.	.	.	.	.	.	.	.	.	+	.
Punica granatum	.	.	+	.	.	.	.	.	.	.	.	.	.
Crataegus	.	.	.	.	.	.	.	.	+	.	.	.	+

From the above, and from the fact that the relatively few early Neolithic sites for which botanical information is available are scattered over a large region and are situated in different habitats, it will be clear that, at least for the time being, reconstructions of the early history of crop plants in the Near East must remain very speculative. Each new site may force us to change drastically our poorly founded theories. Consequently, I will here neither indulge in speculations nor will I present a general survey of early agriculture in the Near East, including cultural, environmental and phylogenetical aspects. Instead, I will bring up for discussion some specific points which will, among other things, touch upon the limitations of palaeo-ethnobotanical research.

A summary of the finds of domesticated plants and of possible other food plants in the prehistoric sites shown in figure 1, is presented in table 1. The presence of a species in a site is indicated by a plus-sign. Wild grasses other than wild cereals and small-seeded legumes, such as *Vicia* spec. and *Astragalus*, are only given a plus-sign if from the numbers of their seeds as compared to those of the other species listed in the table it may be assumed that they played a not insignificant part in the diet of the inhabitants of the site concerned. In case of uncertainty in this respect a question-mark is shown. It should be admitted that this table is far from satisfactory. Because of the inequality of the information for the various sites no quantitative estimates are given. Moreover, the results for the various levels from one site are taken together, which is not always justified. Thus, in Çayönü, *Triticum dicoccoides* is only represented in the lower layers, whereas *Lens culinaris* is conspicuously absent in the bottom layers of the site.

Wild food plants

With the introduction of agriculture wild food plants by no means ceased to play a part in the economy of prehistoric man. When I speak of wild food plants, I mean plants the seeds or other parts of which were harvested for starch, protein or fat. This category does not include wild vegetables, medicinal herbs, condiments, dye plants and the like.

The Bus Mordeh phase at Ali Kosh presents a well-known example of the dominant part of wild plants in the diet of an early farming community. One third of the vegetable food would have been made up of the tiny seeds of the wild legumes *Astragalus*, *Trigonella* and *Medicago radiata*. The harvesting and threshing of these seeds must have required a tremendous amount of labour. It is a matter of debate whether the part played by wild plants in the diet of the Bus Mordeh people was, indeed, as considerable as is suggested by the numbers of seeds. However, there can be little doubt that at Ali Kosh wild plants constituted a very substantial supplement to the cultivated plants.

On the other hand, it goes too far to assume, as Helbaek (1969) did, that the spikelet forks and glume bases of the hulled wheats *Triticum dicoccum* and *T. monococcum*, large numbers of which were found together with the leguminous seeds mentioned above, were eaten 'because primitive people would not always have realized that this portion of the spike is completely devoid of food value'. It is clear that in this case threshing remains are concerned which were no spill of food, but which had simply been thrown away on the dung-hill. And this leads us to a problem in the interpretation of plants remains from midden deposits, the kind of cultural fill that has been attacked so successfully by more sophisticated field methods, such as water separation and froth flotation. Together with the threshing remains, weed seeds which were removed from the crop may have landed on the muck-heap. In addition, other plant refuse would have ended up on the garbage heap, while some plants may have grown on the rubbish itself. The plant remains in midden deposits are usually of heterogeneous origin.

For many wild plants represented in settlement sites it is impossible to establish whether they were of some particular use to prehistoric man. The circumstantial evidence only rarely provides us with clues. And those cases warn us not to assume too easily that the plants concerned were of no economic importance. Thus, nobody would have attached any particular value to the presence of some scattered seeds of *Capsella bursa-pastoris*. This species is a common weed of roadsides and cultivated grounds, and a few of its seeds could easily have arrived in the settlement. However, if one finds a whole cache of them as in Çatal Hüyük (Helbaek 1964), there is no alternative than to believe that these seeds were collected intentionally.

From the heavy reliance of the people of the Bus Mordeh phase at Ali Khosh on the seeds o wild plants we cannot necessarily conclude that a similar dependence on wild food plants was common at all early Neolithic sites. In this respect the evidence for Çayönü is illustrative. This site is situated in the area in which primary habitats of twin-grained wild einkorn wheat (*Triticum boeoticum* ssp. *thaoudar*) and of wild barley (*Hordeum spontaneum*) occur (Harlan & Zohary 1966). However, the representation of both wild cereals at the site is so scarce that one must conclude that these potential wild crop plants were not harvested by the Çayönü people. Apparently, from the beginning of the site on, the cultivated cereals covered the demand for carbohydrates. Only wild *Vicia* seeds, probably from field weeds, may have supplemented the plant protein provided by the cultivated pulses.

The differences in the plant husbandry of Ali Kosh and Çayönü can be explained by the different environmental conditions. Ali Kosh is situated in an area which must always have been rather marginal for farming, whereas the Çayönü region, with a mean annual precipitation of *ca.* 700 mm and with deep soils, is well suited for agriculture.

Emmer wheat

It is striking that both the sites, which so far have yielded kernels of wild emmer wheat, Jarmo and Çayönü, are situated in areas where *Triticum dicoccoides* is still found (figure 2). The kernels of *T. dicoccoides* differ enough morphologically from those of domesticated emmer wheat (*T. dicoccum*) to allow a species identification on the basis of the carbonized fruits (figure 3). In contrast to *T. dicoccum* grains, which are spindle-shaped in outline, those of *T. dicococcoides* show nearly parallel lateral sides. In wild emmer wheat, the dorsal side is longitudinally straight or only slightly curved, whereas in domesticated emmer the dorsal side is distinctly curved. Further, the grains of *T. dicoccoides* are markedly more slender than those of *T. dicoccum*.

For Jarmo (Helbaek 1959, 1960) no information is yet available on the stratigraphical distribution of the remains of both emmer species. In Çayönü, morphologically defined wild emmer wheat kernels were recovered only from the lower levels, together with those of the domesticated type.† In the deposits assigned to later phases, the emmer wheat kernels are all of the domesticated type. It looks as if we are dealing here with a very early stage of emmer cultivation. At first the crop consisted of a mixture of morphologically defined wild and

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† In the publication on the palaeobotanical results of the 1970 season at Çayönü (van Zeist 1972) it is stated that in the lower levels of the site only wild emmer wheat was established. Professor Robert B. Stewart (Huntsville, Texas, U.S.A.) informed me that during the 1972 campaign, domesticated type emmer grains were also recovered from the lowermost levels, in addition to those of *T. dicoccoides*.

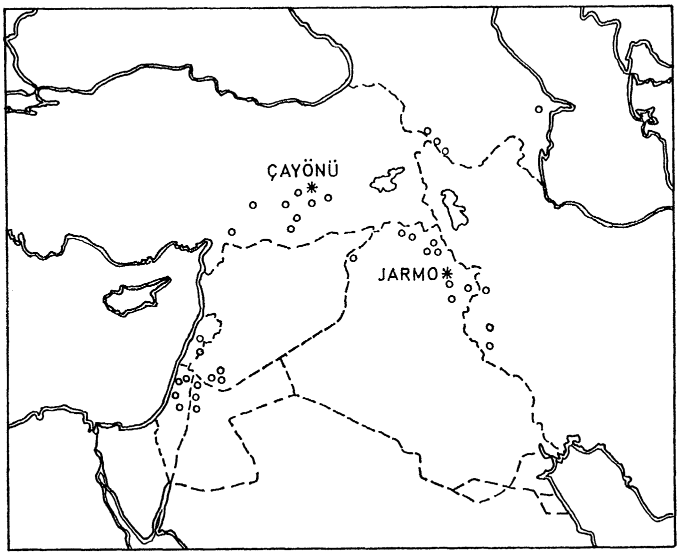

Figure 2. Distributon of *Triticum dicoccoides* (after Zohary 1969) and location of Jarmo and Çayönü.

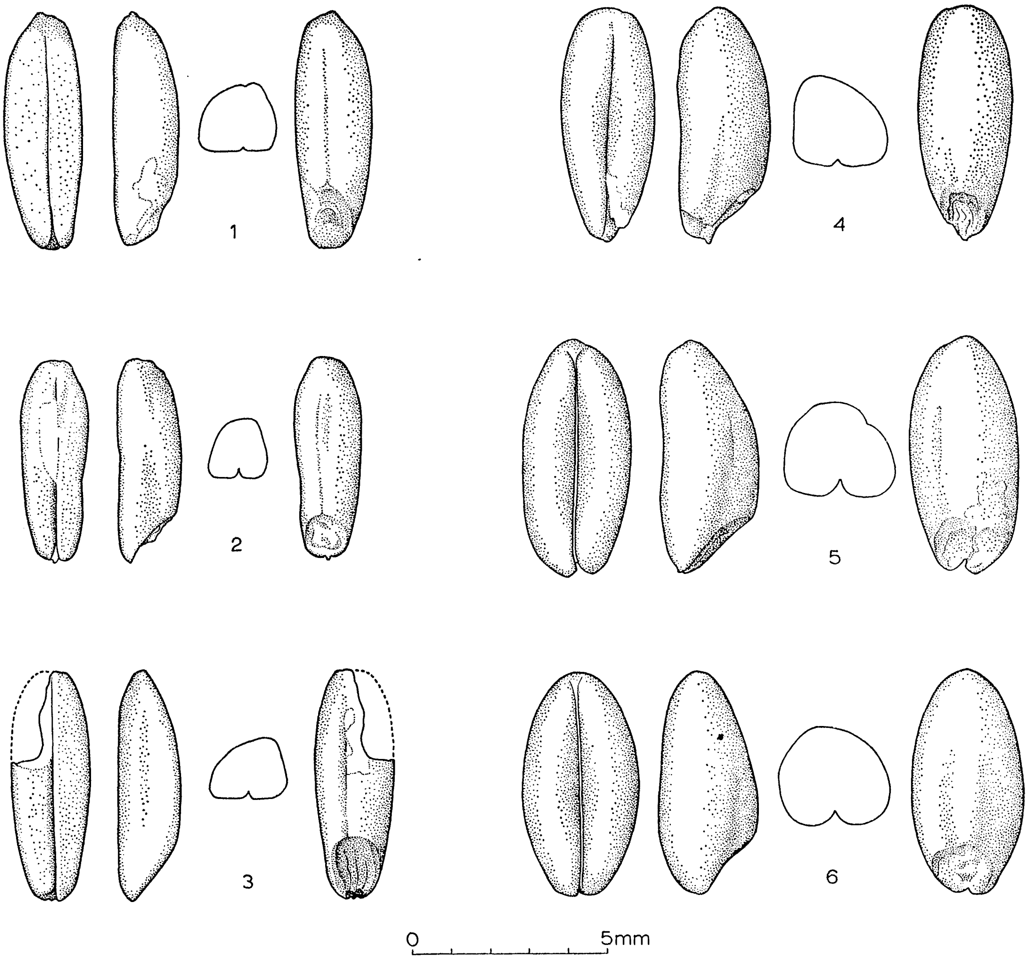

Figure 3. Çayönü. 1–3, *Triticum dicoccoides*; 4–6, *T. dicoccum*.

domesticated emmer wheat, while in later stages *T. dicoccoides* had disappeared from the crop as a result of conscious or unconscious selection. It is tempting to suppose that the foothills region of southeastern Turkey and northern Iraq was the area, or one of the areas, where wild emmer wheat had been taken into cultivation and where the domesticated type came into existence.

This assumption was shaken by the find of three wheat grains, identical to those of *T. dicoccum*, in Kebaran deposits at Nahal Oren, in Israel (Dennell 1973). Two radiocarbon determinations for samples from above the layer with the plant material suggest a date of 16000–17000 B.P. for these grains (Noy, Legge & Higgs 1973). The representation of *T. dicoccum* in a Kebaran context would imply that this wheat species already existed before domestication began. I do not feel able to reconcile this surprisingly early find of morphologically defined domesticated emmer grains with the existing theory on the origin of *T. dicoccum*. As a point in favour of Dennell's hypothesis of the existence of a brittle-rachis *T. dicoccum* in pre-agricultural time, it can be brought forward that this wheat species is present in all early Neolithic sites which so far have yielded vegetable material (table 1). On the other hand, if in earlier times a brittle-rachis form of *T. dicoccum* had existed, it is strange that this type would have disappeared completely.

The assumption that *T. dicoccoides* could be a feral offshoot of *T. dicoccum* is not supported by the facts. Thus, *T. dicoccoides* has no weedy characters (Zohary 1969). Moreover the evidence for Çayönü pleads against this hypothesis.

Dennell is right in claiming that it has not been proven archaeo-botanically that *T. dicoccoides* is the ancestor of *T. dicoccum*. On the other hand, one should be a bit cautious in suggesting far-reaching conclusions on the ground of a few seeds recovered from one or more cubic metres of deposit.

Free-threshing wheat

In addition to the grains of the hulled wheats *Triticum dicoccum* and *T. monococcum*, kernels of a free-threshing wheat species are reported for Can Hasan III and Ramad. This free-threshing wheat has so far been attributed to the hexaploid *T. aestivum*. However, the identification as *T. aestivum* has recently been questioned (Zohary 1973). Why should the tetraploid free-threshing *T. durum* not come into consideration?

Triticum durum is a mutant of *T. dicoccum*, and this free-threshing wheat could have originated anywhere inside the area where hulled emmer wheat was grown. *T. aestivum* originated from the combination of *T. dicoccum* and the diploid wild grass species *Aegilops squarrosa* (Zohary 1969, 1971).

As has already been pointed out by Zohary (1969), *T. aestivum* must have come into existence inside the distribution area of *Aegilops squarrosa*, which is situated southwest and south of the Caspian, extending eastwards to northern Afghanistan, Turkmenistan and Uzbekistan (figure 4). This could not have taken place until the Neolithic wheat agriculture had reached the distribution area of *A. squarrosa*. Unfortunately, radiocarbon dated evidence for early Neolithic habitation in the distribution area of *A. squarrosa* is virtually non-existent. Consequently, the course of Braidwood's (1975, p. 143) isochronic lines indicating the spread of village farming is at most a fair guess for the area southwest and south of the Caspian. Nevertheless, for want of anything better, those lines are drawn on the distribution map of *A. squarrosa*. Figure 4 suggests that between 6000 and 5000 B.C. agriculture arrived in the area, in which primary habitats of *A. squarrosa* occur. Consequently, *T. aestivum* could not have come into

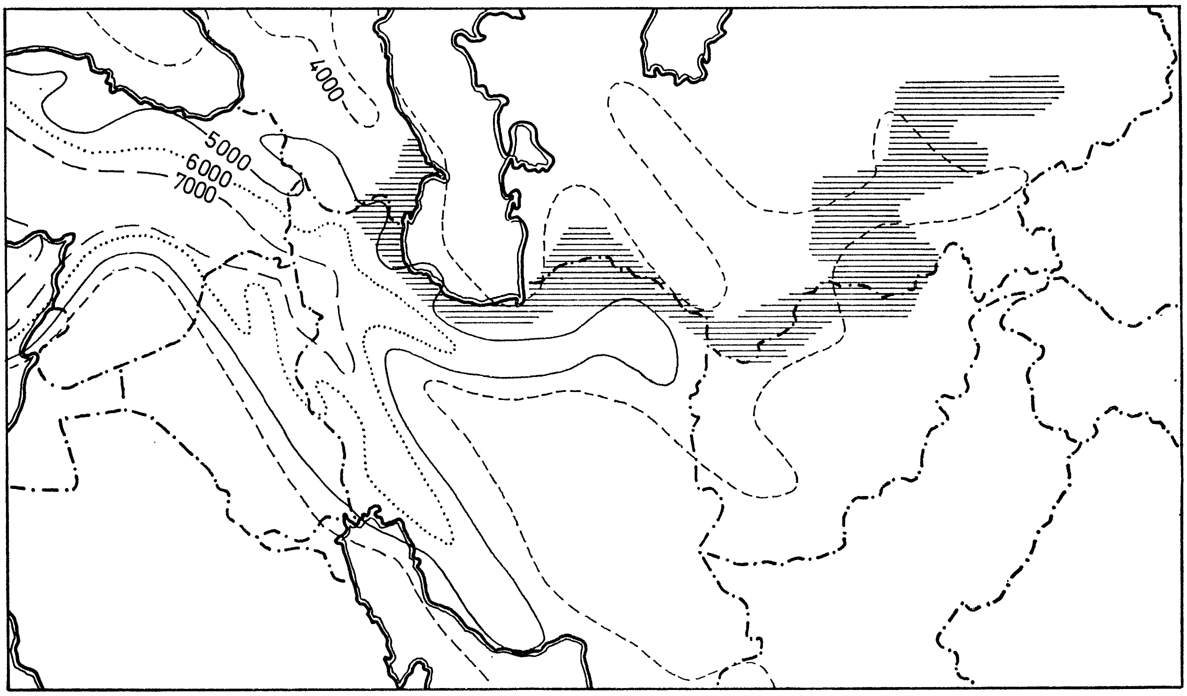

Figure 4. Distribution of *Aegilops squarrosa* (after Zohary 1969) and isochronic lines (in years B.C.) indicating the spread of village farming (after Braidwood 1975, p. 143).

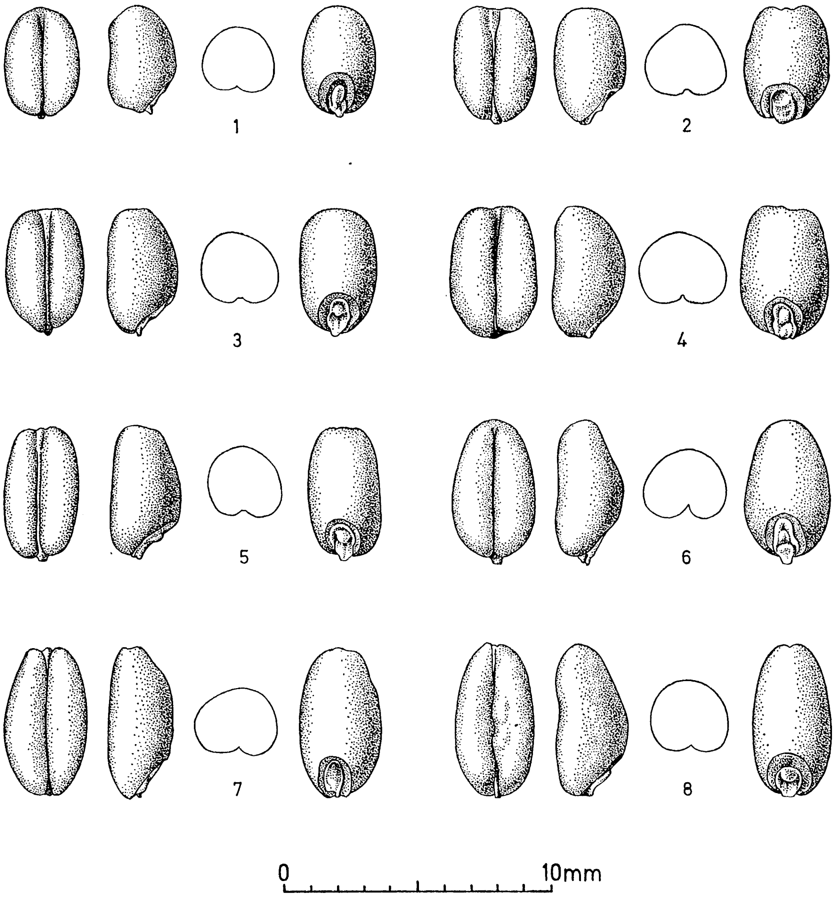

Figure 5. Ramad: carbonized grains of *Triticum durum/aestivum*.

existence until after 6000 B.C. This, in its turn, would imply that the free-threshing wheat at Can Hasan III and Ramad could not possibly have been *T. aestivum*, and that for that reason it should be attributed to *T. durum*. It should, however, be stressed that this is no firm proof. Neither the spread of agriculture in an easterly direction is satisfactorily known, nor is it certain that the distribution area of *A. squarrosa* of some 8000 to 9000 years ago was the same as the present-day one.

Could the carbonized remains themselves provide information on the identity of the wheat? Some of the free-threshing wheat kernels from Ramad are depicted in figure 5. A study of the modern fruits of *T. aestivum* and *T. durum* suggests that very probably the shape of the grains does not allow a species identification. No more is the variation in slenderness, which has been established for the grains from Ramad, of any help in determining the species. In *T. aestivum* plump grains of the club wheat-type (the former *T. compactum*) as well as more slender grains of the bread wheat-type are found. The grains of *T. durum* show a similar variation in shape, although short, plump kernels seem to be rare (Schiemann 1948, p. 37).

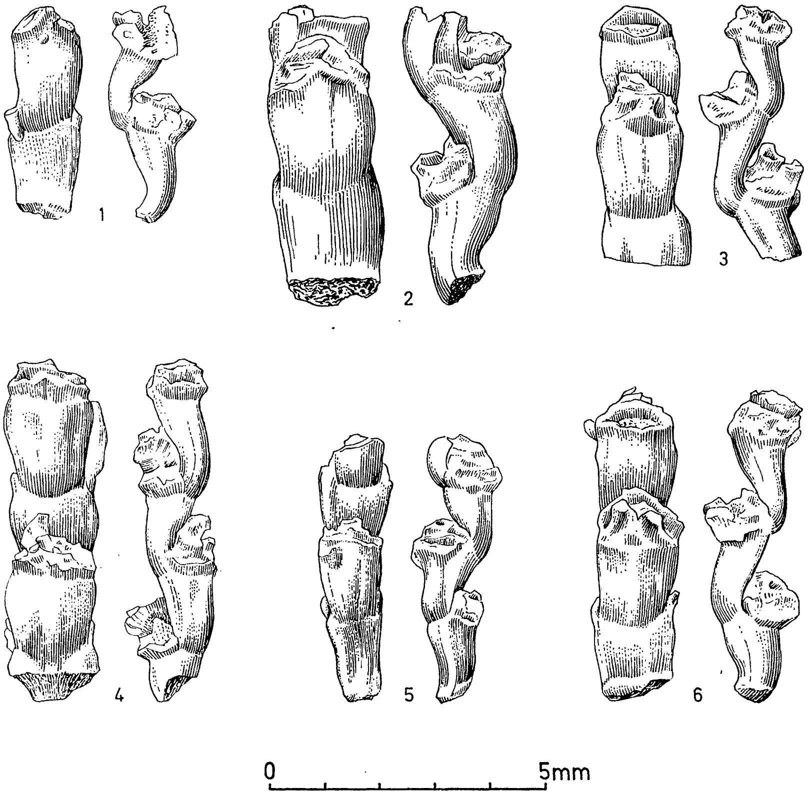

FIGURE 6. Ramad: carbonized rachis fragments of free-threshing wheat.

In addition to the grains, rachis fragments of the free-threshing wheat have been preserved at Ramad. Some of the fragments, consisting of more than one internode, are shown in figure 6. Could these rachis fragments perhaps provide a clue for the identification of the species? In order to test this possibility the central axes of the ears of modern *aestivum* and *durum* wheats have been compared with each other and with the charred fragments from Ramad. To facilitate the comparison, the modern rachis internodes, which are about twice as large as the charred internodes, are shown at half the size of the latter ones (figure 7). Moreover, as hairs are no longer present on the carbonized material, the hairs on the modern rachis internodes are not shown (they had been burnt off). The internodes of *aestivum* wheats as well as of *durum* wheats show a fairly large variation in shape. In both wheats slender as well as more compact internodes occur. The Ramad internodes are fairly plump, even allowing for the fact that the carbonization may have caused a greater shrinkage in length than in breadth. From the above it will be clear that the compact internodes from Ramad can be found in *aestivum* as well as in *durum* wheats.

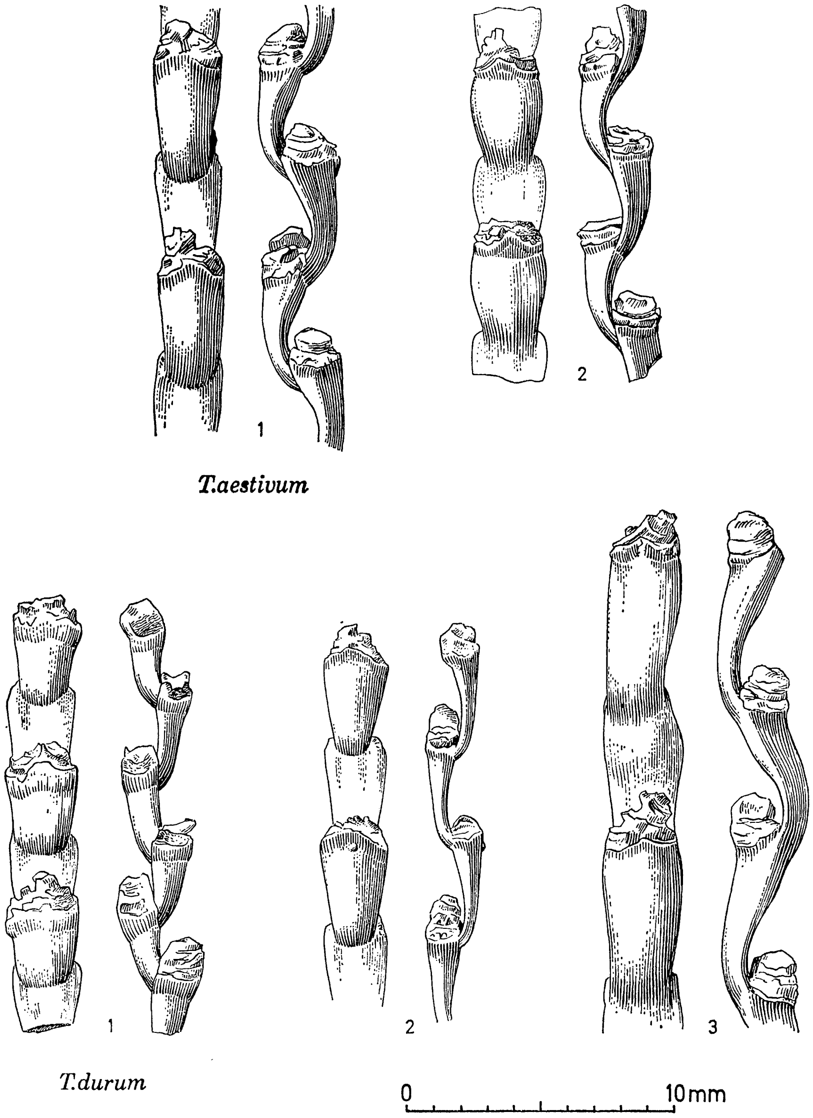

FIGURE 7. Rachis fragments of modern *Triticum durum* and *T. aestivum*.

Nor does the arched joint between the rachis internodes seem to be of help in distinguishing between both groups of free-threshing wheats. In specimens 1 and 2 of *T. durum* (figure 7) this joint is sharp. This is particularly clear from the side view which shows a distinct bend at the transition between the internodes. In the right specimen of *T. durum*, on the other hand, this transition is very gradual. Similar differences can be observed between both *T. aestivum* rachis fragments. The charred rachis fragments from Ramad (figure 6) likewise show variations in the structure of the joints. In specimen 2 the transition between the internodes is fairly gradual, whereas in specimens 1, 3 and 6 a distinct bend can be observed in lateral view. Although it should be admitted that the examination of the rachis internodes presented here is of very preliminary character, the first results do not leave much hope for a species identification on the ground of these remains.

In summary, one must conclude that it seems impossible to determine whether carbonized grains and rachis internodes of free-threshing wheat are of *T. durum* or of *T. aestivum*.

The hulled hexaploid wheat species *Triticum spelta* has never been reported for prehistoric and early-historic sites in the Near East. It is probable that this species came likewise into existence inside the distribution area of *Aegilops squarrosa*. It is true that the naked grains of *T. spelta*, which are very variable in shape, may be difficult to distinguish from those of free-threshing wheats and emmer wheat, but the very sturdy spikelet remains can easily be recognized as those of spelt wheat. The earliest reports of *T. spelta* are from Moldavia, in southwestern Russia, where this wheat crop was found in sites dated to *ca.* 4500 B.C. (Janouchevitch & Markevitch 1971). It looks as if *T. spelta* after its origin in the South Caspian area, migrated only in a northwesterly direction.

Oil plants

In addition to cereals, pulses were taken into cultivation at an early date. At least, for Çayönü it could be demonstrated that already before 7000 B.C. lentil (*Lens culinaris*), pea (*Pisum sativum*) and bitter vetch (*Vicia ervilia*) were grown. This implies that already in early Neolithic times the demand for carbohydrates (starch) and vegetable protein could largely have been covered by cultivated plants. On the other hand, for vegetable fat the complete dependence on wild plants probably lasted longer.

Up to recently, evidence for linseed cultivation did not date back beyond *ca.* 5500 B.C. The earliest finds of *Linum usitatissimum* which have so far been published are from three sites in the Mesopotamian plain, dated to 5500–5000 B.C. (Helbaek 1966*a*, 1969, 1972). On the basis of the fairly large size of the linseeds, Helbaek arrived at the conclusion that the flax had been grown in irrigated fields.

It is unlikely that pale flax, *Linum bienne*, which is believed to be the wild ancestor of domesticated flax, was directly brought from the foothills of the Zagros/Taurus Mountains into the irrigated fields of the hot Mesopotamian lowland. Flax must have been domesticated under dry-farming conditions, before 5500 B.C. The first factual evidence for flax cultivation before 5500 B.C. does not come from the foothills region to the east and the north of the Mesopotamian plain, but from Tell Ramad in western Syria (van Zeist & Bakker-Heeres 1975). The length of the Ramad linseeds, recovered from levels dated to 6250–5950 B.C., varies from 2.8 to 3.6 mm. As for the original size, one should take into consideration that through carbonization linseeds shrink in length and width. After a correction for 13% shrinkage the length of the linseeds from Ramad varies from 3.2 to 4.1 mm, with an average value of 3.62 mm. This means that these linseeds fall within the size class of the seeds of *Linum usitatissimum*, the lower limit of which lies at 3 mm (Brouwer & Stählin 1955, p. 357). Moreover, for none of the wild *Linum* species which may be expected in the Ramad area the size of the seeds conforms to that of the Ramad linseeds. Consequently, one necessarily arrives at the conclusion that the linseeds from

Ramad are of *Linum usitatissimum*. This implies that the cultivation of flax must have started in the second half of the seventh millennium B.C., if not earlier.

The oil plants *Papaver somniferum* and *Camelina sativa*, which were grown in prehistoric Europe, have not been reported for prehistoric and early-historic sites in the Near East. Apparently, there was no need to grow other annual oil plants in addition to flax, because the oleaginous fruits of various trees were available. Thus, *Pistacia* and *Amygdalus* are represented in various early Neolithic sites (see table 1), while *Olea* would become the most important source of vegetable oil in the Mediterranean basin.

Palynological evidence for early agriculture

One may wonder as to how far, in addition to the macroscopic plant remains, pollen grains can contribute to the study of early agriculture in the Near East. In Europe pollen analysis has proved to be an excellent tool for tracing the activity of prehistoric farmers.

In the Near East, the study of vegetations of the past is handicapped by the fact that pollen-bearing sediments are scarce. Moreover, palynological investigations in this area had a late start, so that information on the vegetational and climatic history is not yet particularly abundant. Sites for which pollen diagrams have been prepared are indicated in figure 1.

The available palynological evidence has already forced us to a radical change in our thinking concerning a possible impetus for the beginning of food production. The palynological results have demonstrated convincingly that in the Near East there can be no question of a desiccation after the last glacial period. On the contrary, the humidity increased markedly in the period preceding the introduction of agriculture and stock-breeding. The beginning of food production cannot have been induced by a reduction of the area which was suitable for a food-collecting economy.

One may expect that in not too remote a future we will be able to reconstruct satisfactorily the environment of prehistoric man in larger parts of the Near East. Will it, however, be possible to demonstrate the presence of Neolithic farmers by reference to the pollen record?

In pollen diagrams from central, western and northwestern Europe the most decisive evidence for the activity of prehistoric farmers is provided by the Cerealia-type pollen. This pollen type, which includes the pollen of cultivated barley, wheat, oats and rye, is characterized by the large size (more than 40 μm in silicone oil mounted slides), by the thick wall and by the pronounced annular ring around the pore. The presence of Cerealia-type pollen is often associated with indications of changes in the vegetation attributed to the influence of man. It is true that it cannot be ruled out that Cerealia-type pollen had come from a wild grass species, but this would only rarely have been the case. Moreover, by means of phase-contrast microscopy pollen grains of these wild grasses can mostly be distinguished from those of the cereal crop plants.

In the Near East, in addition to wild cereal species, various other wild grasses produce pollen of the Cerealia-type. The pollen of those wild grasses can often not be separated from that of the cultivated cereals. Near Eastern pollen diagrams may show fairly high Cerealia-type percentages in sections representing periods from long before the introduction of agriculture. Thus, comparatively high Cerealia-type pollen values are in themselves no proof of the earlier presence of farmers in the area.

The same holds for the *Plantago lanceolata* pollen type. In the Postglacial pollen diagrams from temperate Europe, *Plantago lanceolata* may be considered as another indicator of the activity of prehistoric farmers. Before the arrival of Neolithic man this species was not found there according to the pollen record. In Near Eastern pollen diagrams, on the other hand, *Plantago lanceolata*-type pollen is not necessarily associated with the activity of farmers in the past. *Plantago* species are constituents of the natural vegetation in southwestern Asia, and consequently they do not mark the beginning of agriculture there.

In the larger part of Europe, Neolithic farmers settled in areas which had a continuous forest cover. The settlers had to make openings in the forest to obtain arable land. The opening up of the forest caused an expansion of light-demanding herbs, which is reflected in the fossil pollen record by increased percentages for herbaceous pollen types. In theory indications of a similar reaction of the vegetation on the activities of Neolithic man may be expected in pollen diagrams from the Near East.

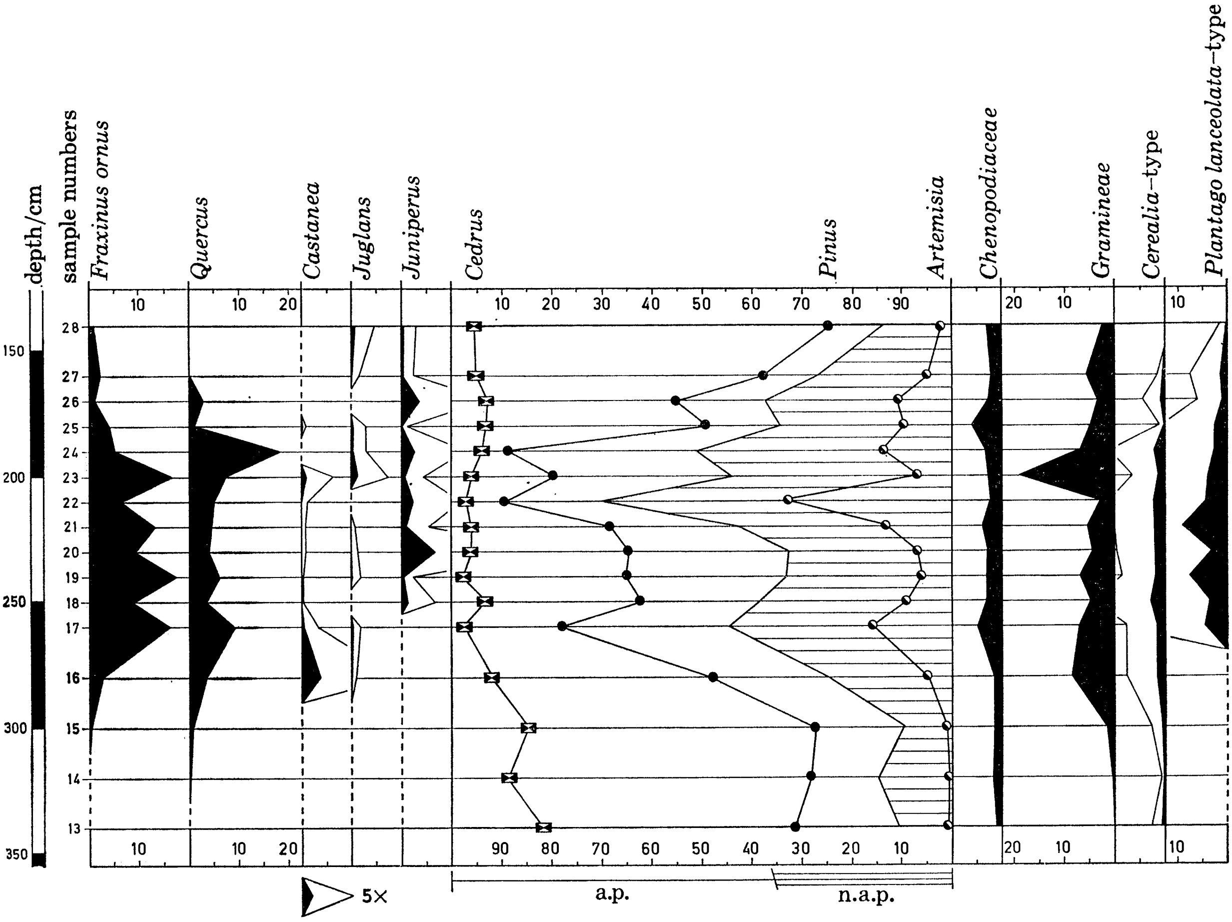

Figure 8. Section of the Beyşehir pollen diagram.

Near Eastern pollen diagrams have not yet provided evidence for the activity of Neolithic farmers. In this region, distinct indications of the interference of man with the vegetation have so far only been recorded for early-historic times. In a few pollen diagrams, which have recently been prepared for lake sediments from southwestern Turkey (van Zeist, Woldring & Stapert 1975), the effects of forest destruction and farming activities show up clearly. For one of these diagrams, viz. for the diagram from the south side of Lake Beyşehir, the section with the distinct land occupation phase is shown in figure 8. In this pollen diagram section only a few curves are represented. The ratio between arboreal and herbaceous pollen is shown in the main diagram in the centre, in which the curves for *Cedrus*, *Pinus* and *Artemisia* are also drawn. To the left of the main diagram a few arboreal taxa are represented, to the right some herbaceous pollen types.

The lower part of the diagram, covering spectra 13, 14 and 15, is characterized by high arboreal pollen values. By far the larger part of the arboreal pollen is made up of that of *Pinus*, while *Cedrus* shows pollen values of over 10 %. This section reflects the then natural vegetation cover in the area south of Lake Beyşehir, viz. coniferous forest consisting of pine and cedar.

Above spectrum 15 drastic changes in the vegetation are reflected in the pollen diagram. *Pinus* and to a lesser extent *Cedrus* show a decline, whereas the percentages for herbaceous pollen types increase. Not only herbs, but also *Fraxinus ornus*, *Quercus*, *Juniperus*, *Castanea* and *Juglans* increase above spectrum 15 or appear for the first time. Above spectrum 24 the *Pinus* pollen curve rises again, whereas the percentages for herbaceous pollen types and for *Fraxinus ornus* and *Quercus* decrease.

The course of the pollen curves in the section between spectra 15 and 28 undoubtedly reflects the activities of farmers at the south side of Lake Beyşehir. The strong decline in coniferous pollen percentages suggests large-scale forest clearings; considerably large areas must have been stripped of the natural forest cover. The opening up of the forest favoured the expansion of Gramineae, *Artemisia* and other herbs.

The Cerealia-type pollen may, at least in part, have originated from the cereal crop plants grown by the Beyşehir farmers. Oak and juniper profited from the clearing activities; along forest edges and on abandoned fields these species would have expanded. *Juglans* and *Castanea* must have been planted by the Beyşehir farmers. Of particular interest are the high pollen percentages for *Fraxinus ornus*. Manna ash does not profit from forest clearances. From *Fraxinus ornus* a sweetish exudate, called manna, can be obtained by making incisions in the bark. The dried up exudate of the manna ash is used as food as well as for medicinal purposes. It is tempting to assume that manna ash was planted by the Beyşehir farmers for its manna.

The course of the pollen curves above spectrum 24 indicates that the area was abandoned by the farmers. Pine took again possession of the area, but cedar failed to recover.

The human activities affected not only a large area, they were also of long duration. Interpolation on the basis of two radiocarbon dates obtained for the Beyşehir core leads to the conclusion that the clearing activities started between *ca.* 1500 and 1300 B.C. The area was largely or completely abandoned between *ca.* 300 and 150 B.C. This implies that the area was exploited intensively for about 1250 years.

It is clear that the interference of man with the vegetation discussed above is many times greater in extent than may be expected for Neolithic times. However, under fortunate circumstances, namely, a pollen-bearing sediment in an area with rather intensive Neolithic habitation, the activity of the farmers concerned may find expression in the pollen record. Besides, the experience gained from the interpretation of distinct land occupation phases as the one discussed above may be of use in discovering minor palynological indications of the activity of prehistoric farmers.

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