

M. Feldman

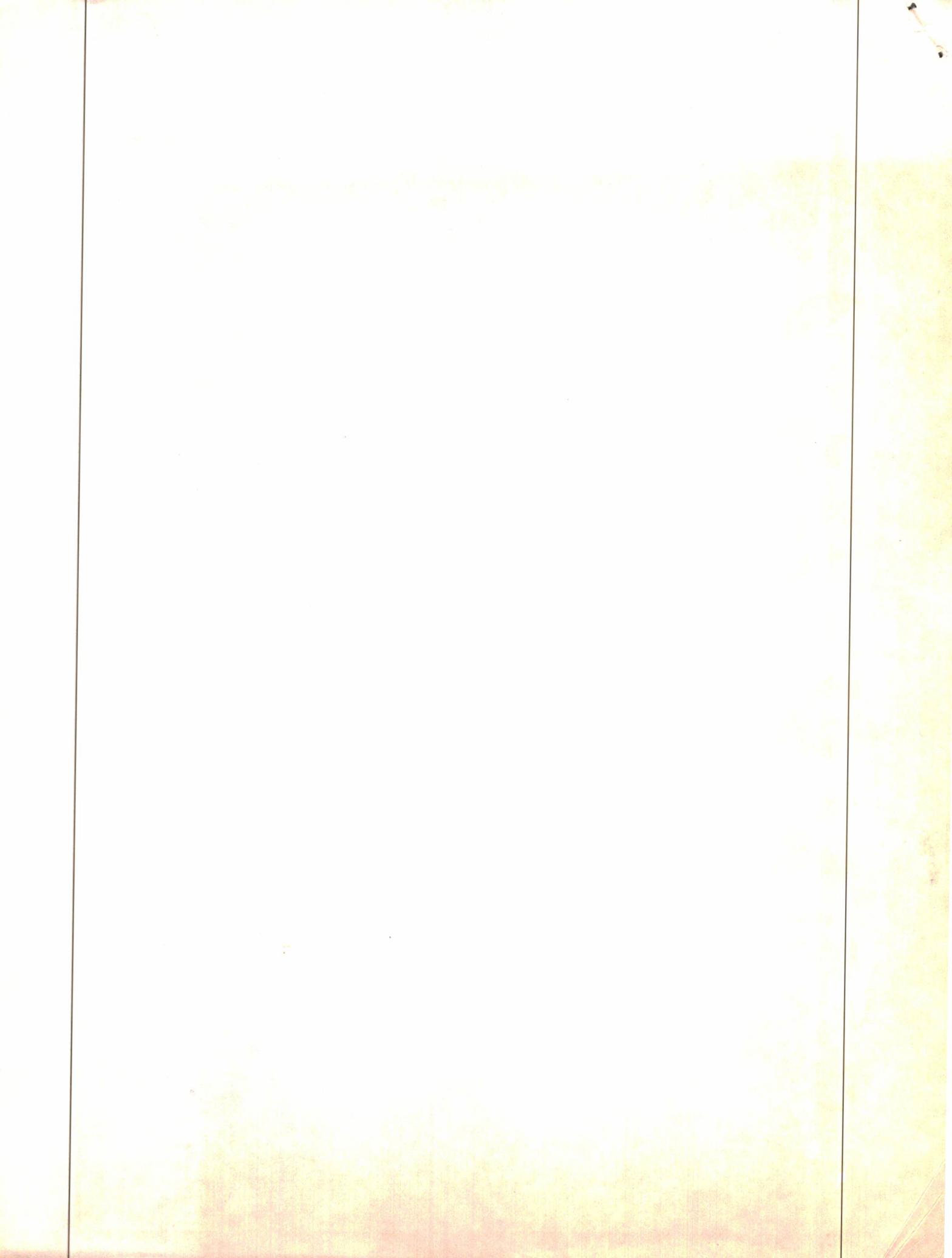
THE ORIGIN OF CULTIVATED CEREALS AND PULSES
IN THE NEAR EAST

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1. INTRODUCTION

In the last few years considerable progress has been made in our understanding of the origin of Old World cultivated plants. Critical evidence came from two disciplines. Archaeologists have progressively intensified their examinations of Mesolithic and Neolithic sites in West Asia and Europe, and carefully examined Carbon-14 dated plant remains from representative sites. Archaeological information has already resolved: (a) the time and place of the origin of agriculture in West Asia and Europe; and (b) the nature of the early domesticated plants which were involved in this technological development, the so-called "Neolithic Agricultural Revolution". A parallel contribution has been made by geneticists and evolutionists who concentrated on the identification of the wild progenitors of crop plants. This involved botanical and cytogenetic studies of the genera to which the crops belong, and assessment of the genetic affinities between the wild species and their cultivated derivatives. The wild progenitors of most of the primary crops that founded the Old World Neolithic agriculture are now known and their geographic distribution and ecological specificities have been surveyed. The information obtained from the living plants now complements the archaeological evidence.

The present paper reviews the progress already achieved through this new synthesis and deals with the origin of the five principal crops of the Old World Neolithic agriculture: einkorn and emmer wheats, barley, pea and lentil.

2. ARCHAEOLOGICAL BACKGROUND

Definite signs of farming first appeared in the Old World around 7000 B.C. But at this early stage farming villages seemed to be restricted to the hilly belt that spans the western flanks of the Zagros Mountains in Iran and Iraq, southern Anatolia, western Syria and Palestine. By the 6th millennium B.C., this new way of life (Neolithic agriculture) was already well established in the Near East. In the 6th and 5th millennia B.C. agriculture expanded rapidly, first into the Aegean area, the Balkans and the Mesopotamian basin and subsequently into the central and western parts of the Mediterranean basin, Central Europe, Iran and the Caspian belt.

Plant remains have been critically examined in several 7th and 6th millennia B.C. sites in the Near East and Greece. Table 1 and figure 1 give representative sites and references. We also have considerable information on cultivated plants from later Neolithic sites in the Balkans, Central Europe and the West Mediterranean basin. The early crop inventory is satisfactorily known: the establishment of the Neolithic agriculture and its rapid and successful expansion was primarily based on cultivation of cereals (wheats and barley) and several companion pulses (mainly pea and lentil).

TABLE 1

Principal cultivated plants in early farming villages in the Near East and Greece: Summary of finds in representative 7th and 6th millennia B.C. sites

Archaeological site and approximate C-14 dates	Plant remains	References
1. Ali Kosh, Deh Luran Valley, Khuzistan, west Iran (7500–6000 B.C.)	Einkorn wheat (rare), emmer wheat (common), hulled two-rowed barley (common), lentil (occasional), flax (occasional)	Helbaek, 1969
2. Tepe Sabz, Deh Luran Valley, Khuzistan, west Iran (5500–5000 B.C.)	Einkorn wheat (rare), emmer wheat (common), free-threshing wheat, hulled two-rowed barley (common), hulled six-rowed barley (occasional), lentil (common), flax (quite common)	Helbaek, 1969
3. Jarmo, Kurdistan, Iraq (about 6750 B.C.)	Emmer wheat (common), hulled two-rowed barley (common), flax	Helbaek, 1959
4. Tell es Sawwan, Middle Tigris, Iraq (5800–5600 B.C.)	Emmer wheat (common), free-threshing wheat, hulled two-rowed barley (common), flax	Helbaek, 1965
5. Çayönü, southeastern Turkey (about 7000 B.C.)	Einkorn wheat, emmer wheat (common), bitter vetch, lentil (common), pea (common)	Zeist, 1972
6. Can Hasan, southern Turkey (about 7000 B.C.)	Einkorn wheat (rare), emmer wheat (common), free-threshing wheat (common), hulled two-rowed barley (common), naked barley (rare), lentil, bitter vetch	French, 1972
7. Çatal Hüyük, southern Turkey (5850–5600 B.C.)	Einkorn wheat (common), emmer wheat (common), free-threshing wheat, hulled two-rowed barley, naked six-rowed barley (common), pea (common)	Helbaek, 1964, 1966
8. Hacilar, southern Turkey		
(i) Aceramic stage (about 7000 B.C.)	Emmer wheat, hulled two-rowed barley, naked six-rowed barley, lentil	Helbaek, 1970
(ii) Later Neolithic stage (5400–5000 B.C.)	Einkorn wheat (common), emmer wheat (common), free-threshing wheat, hulled two-rowed barley, hulled and naked six-rowed barley (common), pea (common)	Helbaek, 1970
9. Tell Ramad, southern Syria (6250–5959 B.C.)	Einkorn wheat, emmer wheat, hulled two-rowed barley, lentil, pea	Helbaek, 1966
10. Jericho, Jordan rift valley (prepottery B stage, 7000–6250 B.C.)	Einkorn wheat, emmer wheat, hulled two-rowed barley, lentil, pea	Hopf, 1969

11. Beidha, south Jordan (about 7000 B.C.)
12. Knossos, Crete (about 6000 B.C.)
13. Nea Nikomedia, Macedonia, Greece (about 5500 B.C.)
14. Argissa, Thessaly, Greece (6000–5000 B.C.)

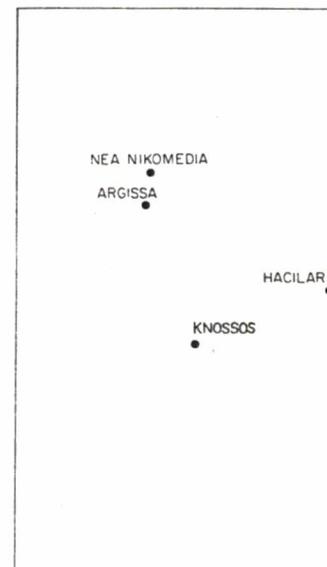


FIG. 1. — Main 7th and 6th millennium B.C. sites where plant remains have been examined.

Carbonized wheat kernels from early farming villages in the Near East account for the bulk of the finds (table 1). Wheat remains also date to the start of cultivation. Already at the time of the aceramic stage, wheats are very specialized in their behavior upon maturity and the incidence of the glume to insert the ripe seed into the soil for survival in the wild. The shift to agriculture under cultivation. In other w

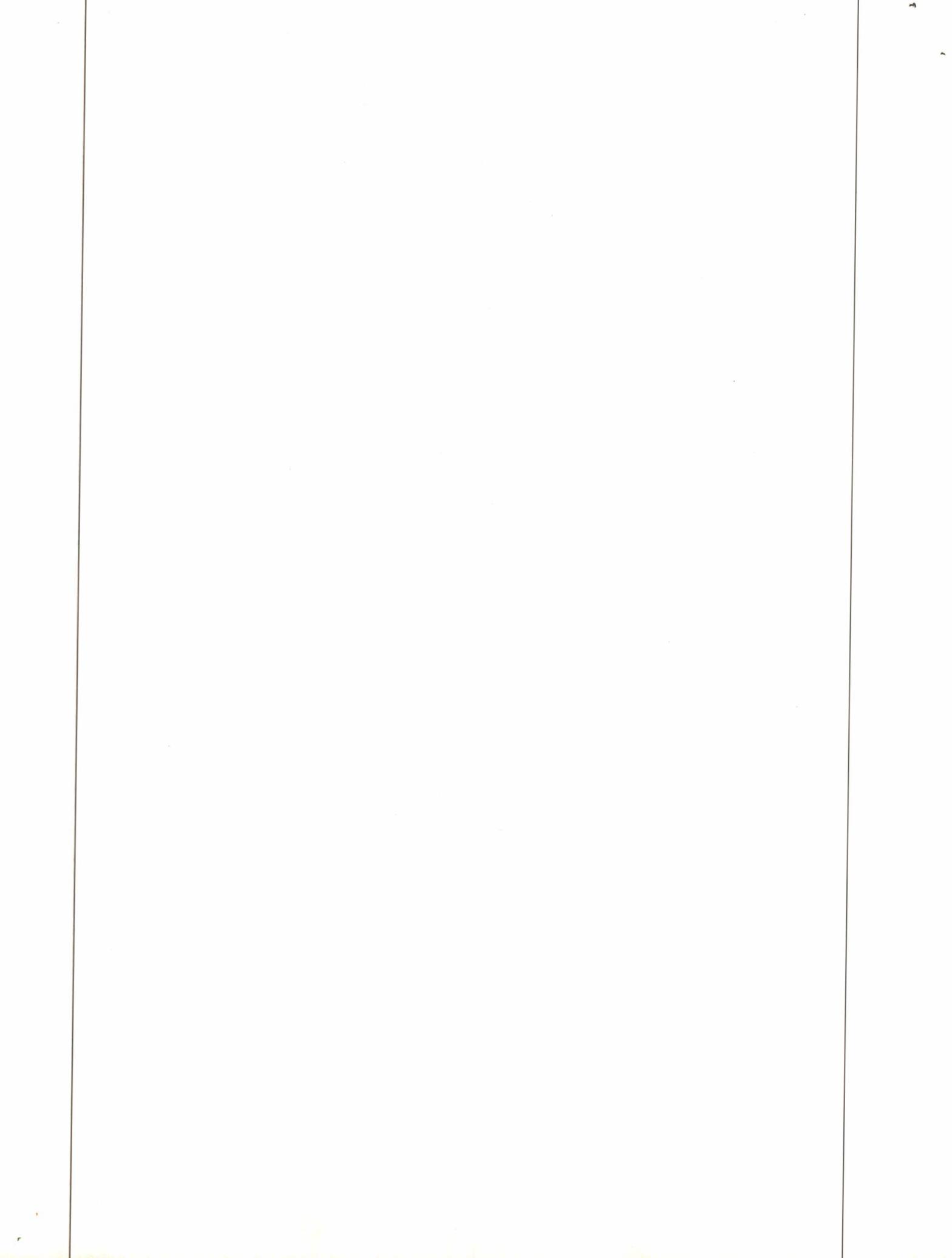


TABLE 1 (contd.)

11. Beidha, south Jordan (about 7000 B.C.)	Emmer wheat, hulled two-rowed barley, lentil	Helbaek, 1966
12. Knossos, Crete (about 6000 B.C.)	Einkorn wheat, emmer wheat, free-threshing wheat, hulled and naked two-rowed barley	Evans, 1968
13. Nea Nikomedia, Macedonia, Greece (about 5500 B.C.)	Einkorn wheat (rare), emmer wheat (common), naked six- rowed barley (common), lentil (common)	Zeist and Bottema, 1971
14. Argissa, Thessaly, Greece (6000-5000 B.C.)	Einkorn wheat, emmer wheat, hulled six-rowed barley, lentil, pea	Hopf, 1962

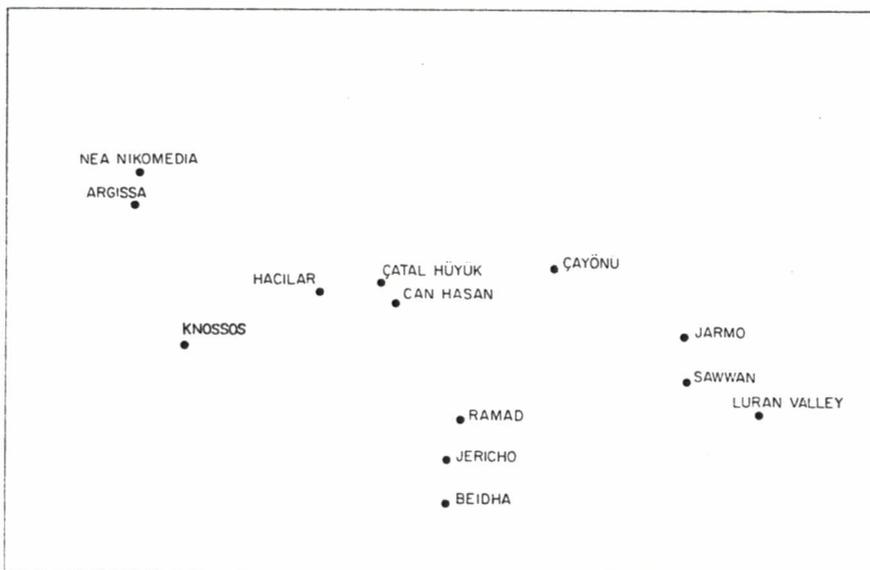
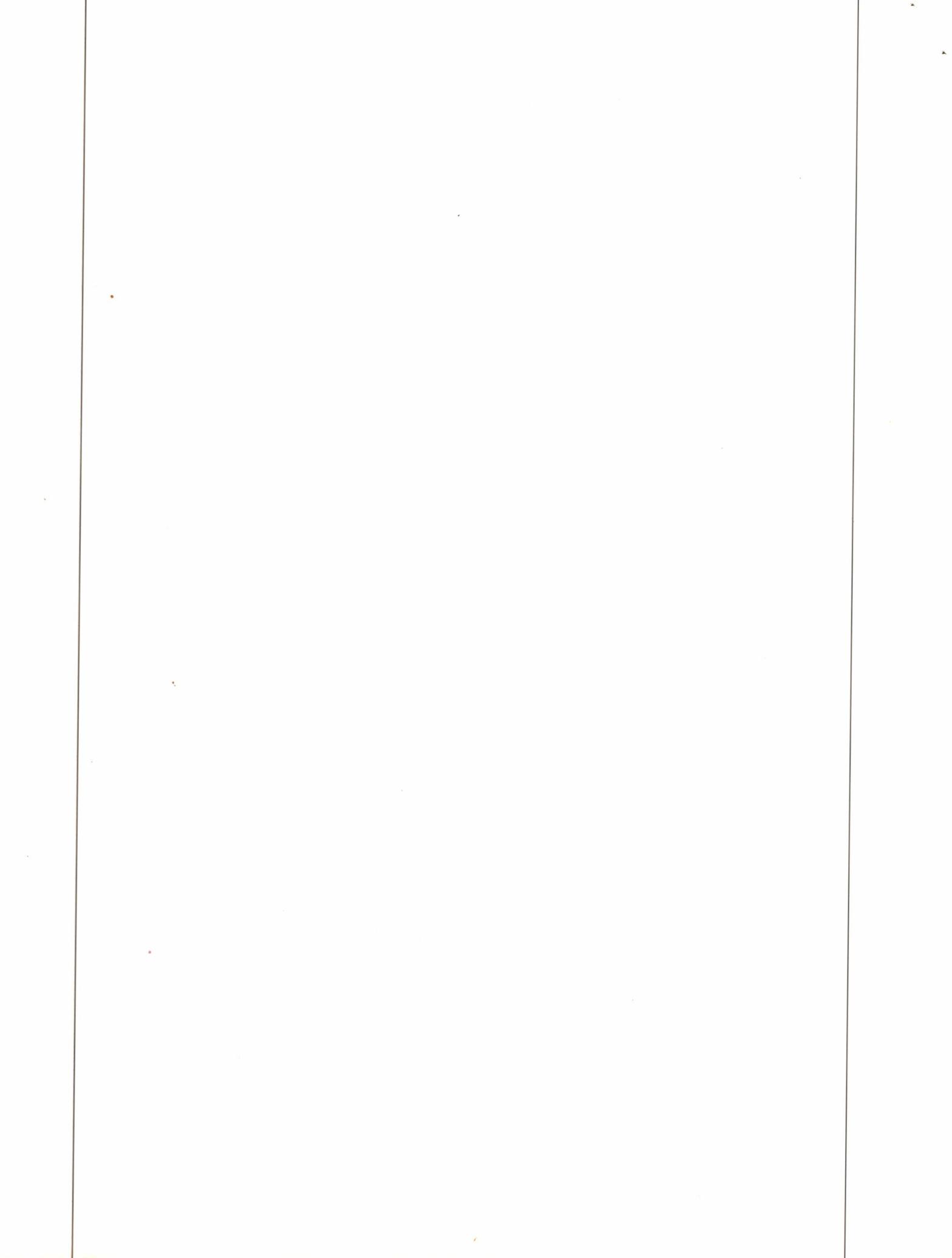


FIG. 1. — Main 7th and 6th millennia B.C. sites in the Near East and Greece from which plant remains have been examined.

3. WHEATS, *TRITICUM*

Carbonized wheat kernels (and chaff) are present almost universally in the early farming villages in the Near East. Together with barley, such remains account for the bulk of vegetable food material unearthed in Neolithic sites (table 1). Wheat remains also furnish the earliest and most reliable indications of the start of cultivation. Already in the 7th millennium sites the remains clearly manifest non-brittle ears, i.e., forms which could not survive in the wild. Wild wheats are very specialized in their mode of seed dispersal. Their spikes disarticulate upon maturity and the individual spikelets act as effective arrow-shaped devices to insert the ripe seed into the ground. Brittle spikes are thus essential for survival in the wild. The shift to non-shattering ears could have taken place only under cultivation. In other words, the discovery of non-shattering forms in these

Near East and Greece: Summary of
References
Helbaek, 1969
Helbaek, 1969
Helbaek, 1959
Helbaek, 1965
Zeist, 1972
French, 1972
Helbaek, 1964, 1966
Helbaek, 1970
Helbaek, 1970
Helbaek, 1966
Hopf, 1969



early sites clearly indicates cultivation. Then and there wheats were already grown under a system of planting, harvesting and threshing.

Three main morphological types of cultivated wheats can be recognized among the Near East Neolithic remains. From the very start (table 1) one encounters two types of hulled, non-shattering wheats: cultivated einkorn and cultivated emmer. These have received considerable attention from students of wheat domestication (Helbaek, 1959, 1966a; Harlan and Zohary, 1966; Zohary, 1969, 1971). But it has recently become increasingly clear that "modern" free-threshing wheats also made their appearance remarkably early, and considerable quantities of wheats with naked grains have been found at several 6th millennium B.C. Neolithic sites (table 1).

(a) *Einkorn wheat*, *Triticum monococcum* L.

Hulled, diploid ($2n=14$) einkorn (genomic constitution AA) is one of the primary cereals of the Old World Neolithic agriculture. Together with tetraploid emmer and barley this "primitive" wheat apparently founded cereal cultivation in the Near East. Einkorn remains are almost universally present in the early farming villages of the Near East (table 1). It was also a common food element in the subsequent Neolithic and Bronze-Age settlements in the Near East and Europe, but it was not grown in warm climates such as the Nile basin and the lower Mesopotamian basin. Today einkorn wheat is a relict crop cultivated only sporadically in the Balkans and Anatolia where it is being rapidly replaced by modern wheats.

The wild progenitor of cultivated einkorn has been satisfactorily identified. Combined evidence from comparative morphology and cytogenetics (and more recently comparative biochemistry) implicates in its ancestry a wild wheat conventionally known as *T. boeoticum* Boiss. emend. Schiem. (fig. 2). Wild and cultivated einkorns are indeed morphologically very similar; their most conspicuous difference is in their mode of seed dispersal. Wild einkorn has brittle ears while the spike axis in cultivated einkorn breaks up only on threshing. Wild and cultivated einkorns are completely interfertile, manifest full chromosome homology and both contain the A genome of wheats.

The distribution of wild einkorn admirably fits the archaeological evidence on the start of einkorn cultivation. *T. boeoticum* is distributed from Iran in the east to the southern Balkans in the west (fig. 3). Yet wild einkorn is massively spread (and genuinely wild) mostly in south Turkey, north Iraq and the adjacent territories of west Iran and north Syria (Harlan and Zohary, 1966). In other words, the center of wild einkorn distribution corresponds closely with the known location of early farming villages in the Near East.

(b) *Emmer wheat*, *Triticum dicoccum* Schübl.

Tetraploid ($2n=28$) emmer wheat (genome constitution AABB) is the second primary cereal obviously involved in the emergence of the Near East Neolithic agriculture. The remains of this "primitive" wheat, with its characteristic hulled grains, are also almost invariably present in the string of early farming villages. Emmer is a staple grain in the subsequent Neolithic and Bronze-Age settlements throughout West Asia, the Mediterranean basin and Europe. Today it is almost totally replaced by more advanced free-threshing tetraploid and hexaploid wheats, although it is still extensively cultivated in Ethiopia. However, while 2x einkorn represents, in terms of crop plant evolution, a blind alley, 4x emmer



FIG. 2. — Spikes of the
Agricultural Revolution
Center: wild emmer, *T.*

does not. Emmer seeds
cultivated wheats were
fully interfertile and
obviously derived from
of the emmer. They re
and constitute fusion
D genome of *Aegilops*.

The wild progenitor
"modern" free-threshing

these wheats were already threshing.

Wheats can be recognized from the very start (table 1) one can distinguish three types: cultivated einkorn and wild einkorn. Attention from students of Harlan and Zohary, 1966; Zohary, 1970 is very clear that "modern" free-threshing wheats are probably early, and considerable evidence has been found at several 6th millennium sites.

Genotype AA) is one of the earliest. Together with tetraploid wheat, it is the first founded cereal cultivation. It is generally present in the early Neolithic, a common food element in the Near East and in the Nile basin and the Taurus region, a relict crop cultivated only in some areas being rapidly replaced by modern wheats.

It has been satisfactorily identified. Its cytogenetics (and more recently its ancestry a wild wheat, *Triticum boeoticum*, Schlemmer, (fig. 2). Wild and modern wheats are very similar; their most conspicuous difference is that wild einkorn has brittle ears which shatter only on threshing. Wild and modern wheats manifest full chromosome complement.

Archaeological evidence on wheat is abundant from Iran in the east and Iraq and the adjacent regions (Zohary, 1966). In other parts of the Near East it corresponds closely with the archaeological evidence.

Genotype AABB) is the second of the Near East Neolithic wheats with its characteristic hulled grains. It is the first of early farming villages. It is found in the Neolithic and Bronze-Age settlements in the Near East and Europe. Today it is almost extinct in the Near East, tetraploid and hexaploid wheats. However, while 2x wild einkorn, a blind alley, 4x emmer



FIG. 2. — Spikes of the wild progenitors of the three founder cereals of the Neolithic Agricultural Revolution in the Near East. Left: wild einkorn, *Triticum boeoticum*; Center: wild emmer, *T. dicoccoides*; Right: wild barley, *Hordeum spontaneum*.

does not. Emmer served as the tetraploid stock from which more modern cultivated wheats were derived. Free-threshing 4x *durum-turgidum* forms are fully interfertile and genomically identical with 4x hulled emmer and are obviously derived from them. The 6x bread wheats contain the A and B genomes of the emmer. They represent additional hexaploids formed under domestication and constitute fusion products of the A and B emmer genomes with the D genome of *Aegilops squarrosa*.

The wild progenitor of cultivated 4x emmer (and less directly also of the "modern" free-threshing 4x *durum-turgidum* wheats) is well recognized (Harlan

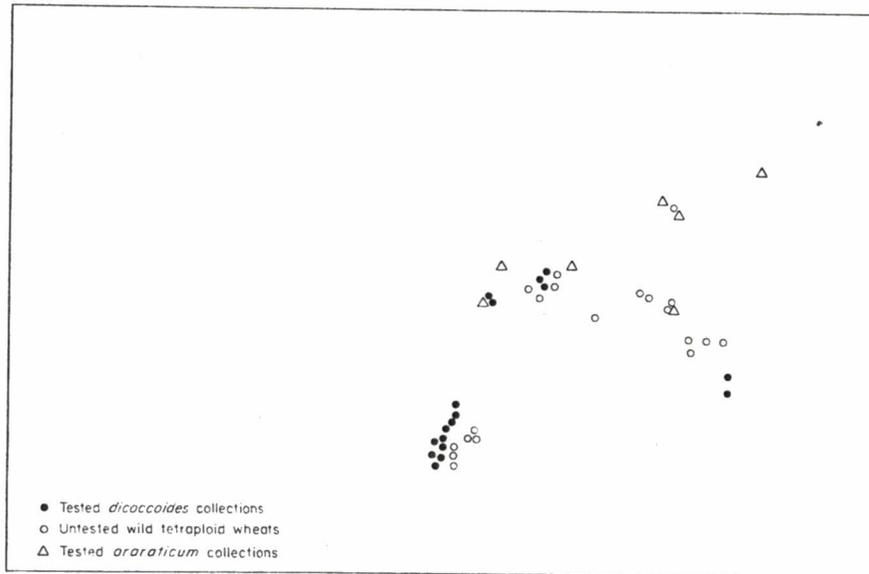
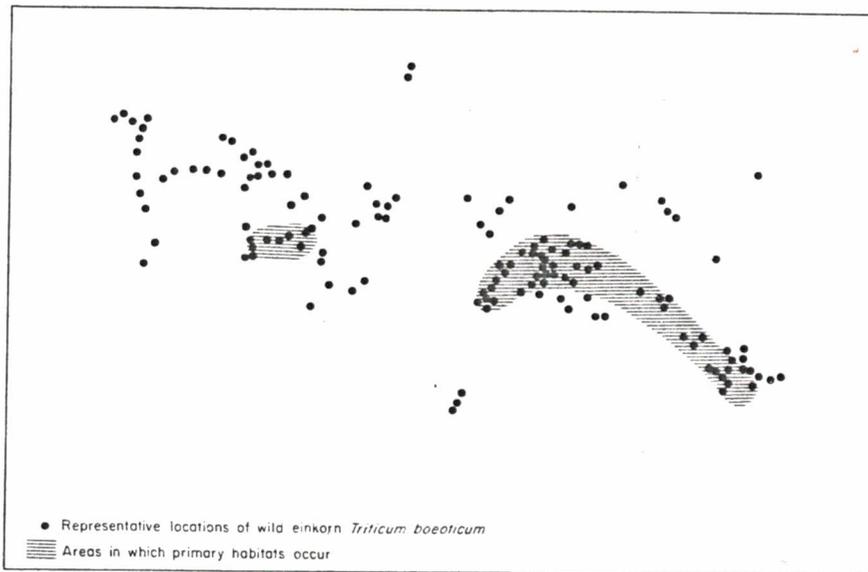


FIG. 3. — Present distribution of wild einkorn, *Triticum boeoticum*. Adapted from Harlan and Zohary (1966).

FIG. 4. — Distribution of wild emmer, *Triticum dicoccoides*. Note that a second tetraploid wild wheat, *T. araraticum*, occurs in the northeastern part of the Near East, but is intersterile with the *dicoccoides-dicoccum-durum* aggregate. The cytogenetic affinities of wild tetraploid wheats from several other locations are as yet undetermined.

and Zohary, 1966; Zohary, 1971). Cultivated emmer is obviously derived from wild 4x *T. dicoccoides* (fig. 2). Hulled *dicoccum* cultivars, the more advanced free-threshing *durums* and *turgidums* and wild *T. dicoccoides* all have the same genomic constitution and are fully interfertile. Parallel to the case of 2x einkorns

there is at the tetraploid level of forms that actually comprise a significant difference in seed dispersal is again wild from cultivated forms. Wild forms have arrow-shaped diaspores, while cultivated forms have specialized diaspores. This specialization has broken down and

The distribution of wild emmer in the Near East pattern of Early Neolithic farming in the eastern territory of *T. dicoccoides* complex (Zohary, 1970) however, *dicoccoides* forms, intersterile with *T. dicoccoides* (Zohary, 1970) have been discovered in southeast Turkey (Zohary, 1970) and on the western part of the Near East (Zohary and Zohary, 1970). Thus the introduction of wild plants complemented the founder crop of the Neolithic agriculture brought into cultivation in the Neolithic

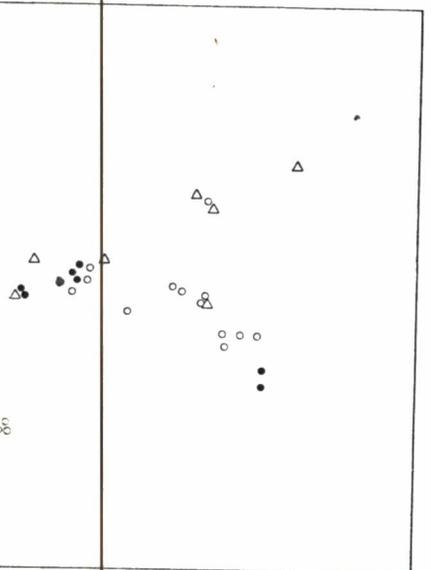
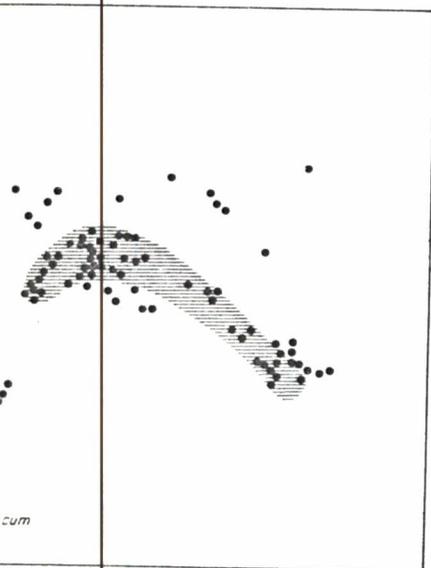
(c) Derived, "modern", free-threshing

One of the major surprises in the discovery of considerable quantities of naked wheat at Neolithic sites (table 1). These "modern" wheats (Zohary, 1970) as hexaploid bread wheat, have attracted the attention of archaeologists and palaeo-ethnobotanists of considerable interest for the cytogenetic origin of the D genome to wheat was a major step in agriculture: only 1000–1500 years before the present cultivation.

But while it is clear that Neolithic wheats were raised naked wheats, the polyploid wheats of the Near East. Free-threshing kernels occur both in hulled and naked wheats of early naked wheats consisted of chaff. Even in living material there is considerable variation of 4x and 6x naked wheats. It is difficult to distinguish between 4x *durum* and 6x *durum* by morphology. In archaeological material, the degree of carbonization often considerably varies. In all, the notion of the very early origin of free-threshing wheat is not firmly established. The naked wheats of the Near East B.C. could represent either 6x bread wheat (Zohary, 1970) or author more likely) only 4x *durum* bread wheat derived from hulled cultivated emmer

4. BARLEY

Remains of barley, the third major cereal crop of the Neolithic culture, are common in the early Neolithic sites of the Near East and the subsequent Neolithic and Bronze Age sites of Europe. In contrast to wheats, barley is not complicated by polyploidy. It is interfertile and comprise a single



Triticum boeoticum. Adapted from Harlan

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there is at the tetraploid level of *Triticum* an aggregate of wild and cultivated forms that actually comprise a single biological species. In these tetraploids the difference in seed dispersal is again the most conspicuous feature distinguishing wild from cultivated forms. Wild emmer is characterized by brittle ears and arrow-shaped diaspores, while in the cultivated 4x wheats this adaptive specialization has broken down and ears do not shatter.

The distribution of wild emmer coincides rather closely with the known pattern of Early Neolithic farming villages (compare figs. 1 and 4). The classic territory of *T. dicoccoides* comprises Palestine and south Syria. More recently, however, *dicoccoides* forms, interfertile with *dicoccum* and *durum* wheats, have been discovered in southeast Turkey (Rao and Smith, 1968; Zohary, unpublished) and on the western flanks of the Zagros Mountains in Iran (Dagan and Zohary, 1970). Thus the information from archaeology and the evidence from the wild plants complement each other rather well. Emmer is obviously a founder crop of the Neolithic agriculture and all the indications are that it was brought into cultivation in the Near East.

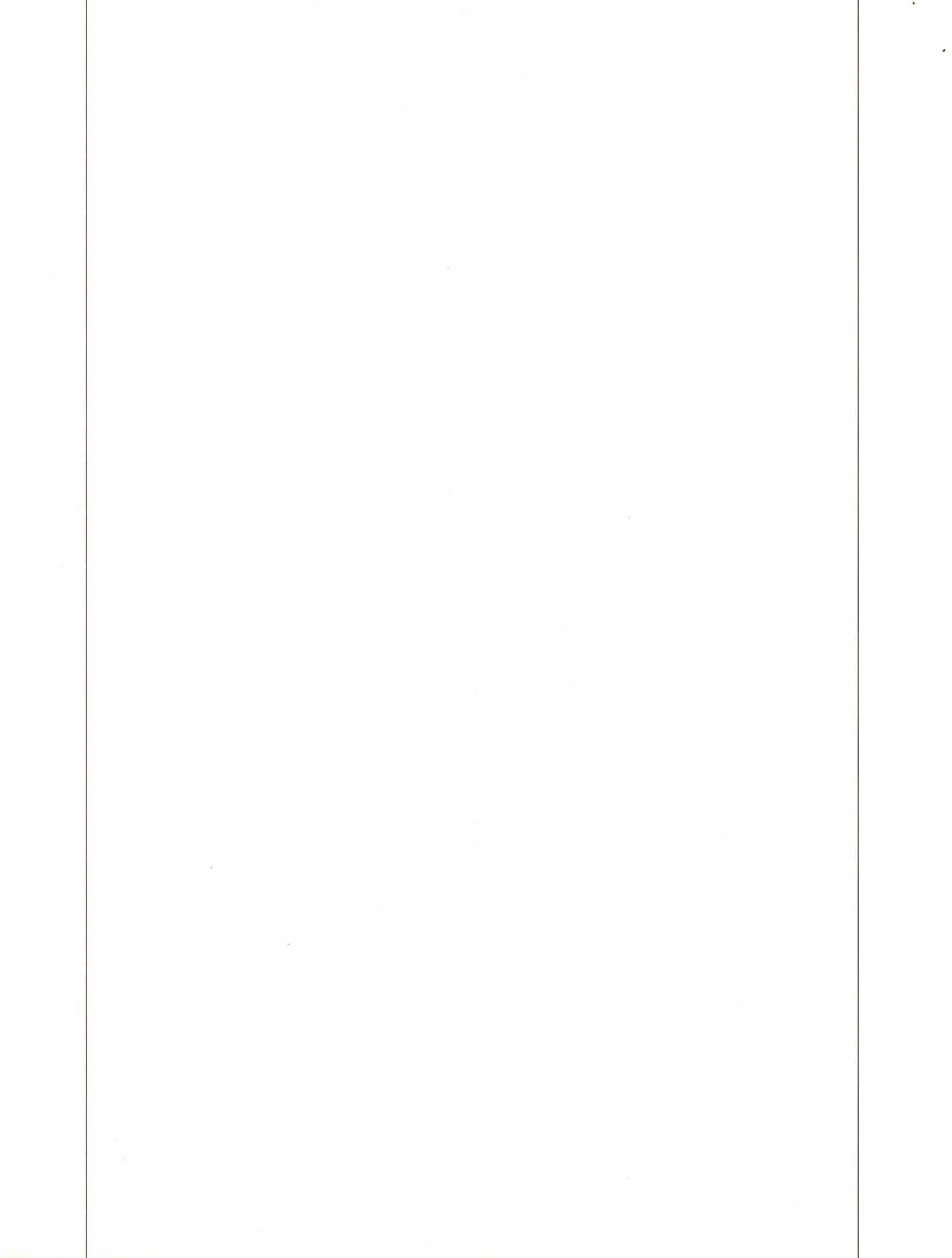
(c) *Derived, "modern", free-threshing wheats*

One of the major surprises of recent years has been the discovery of considerable quantities of naked or free-threshing wheat in Near East Neolithic sites (table 1). These "modern" forms were regarded by Halbaek (1966a, 1969, 1970) as hexaploid bread wheat, *T. aestivum* L., a notion shared today by many archaeologists and palaeo-ethnobotanists. If Halbaek is correct, his finds hold considerable interest for the cytogeneticist. They would mean that the addition of the D genome to wheat was accomplished remarkably early in the history of agriculture: only 1000–1500 years after the initiation of tetraploid wheat cultivation.

But while it is clear that Neolithic farmers in the 6th millennium B.C. did raise naked wheats, the polyploid level of the remains is far from certain. Free-threshing kernels occur both in 4x and 6x cultivars of *Triticum*. The finds of early naked wheats consisted exclusively of carbonized grains and fragments of chaff. Even in living material there is considerable overlapping in grain shape variation of 4x and 6x naked wheats. In fact, it is frequently impossible to distinguish between 4x *durum* and 6x *aestivum* varieties on the basis of kernel morphology. In archaeological remains such a separation is even less reliable. Carbonization often considerably swells and distorts the shape of the kernels. All in all, the notion of the very early emergence of hexaploid bread wheat is far from firmly established. The naked wheat remains of the 6th and 5th millennia B.C. could represent *either* 6x bread wheats *or* (and, in the view of the present author more likely) only 4x *durum* or *durum*-like forms, i.e., varieties directly derived from hulled cultivated emmer.

4. BARLEY, *HORDEUM VULGARE* L.

Remains of barley, the third founder cereal of Old World Neolithic agriculture, are common in the early farming villages (table 1). Barley is a staple in the subsequent Neolithic and Bronze-Age cultures throughout the Near East and Europe. In contrast to wheats, the evolution of barley under domestication is not complicated by polyploidy. All cultivated barley forms are diploid (2n=14), interfertile and comprise a single biological species, *Hordeum vulgare* L. But in



many ways domestication of barley strongly resembles that of wheats. Wild barleys also have brittle ears and are highly specialized in their mode of seed dispersal. The arrow-shaped diaspores consist of triplets of spikelets; the reduced lateral ones serve as wings of the arrow-head device while the median spikelet contains a single large seed. Domestication of barley too resulted in the breakdown of the wild mode of seed dispersal and the establishment of non-brittle mutants. In early archaeological remains of barley non-brittleness serves as a reliable sign that the cereal is already man-dependent and under cultivation.

In the earliest finds of non-brittle barley (7th millennium B.C.) we are confronted with hulled, "two-rowed" cultivars, i.e., forms that still retain the "primitive" condition of reduced lateral spikelets and invested kernels characteristic of wild barley. Such cultivars (ssp. *distichum*) are common in cultivation even today. However, remarkably early in barley cultivation (6th millennium B.C., see table 1), we already find forms with fertile lateral spikelets ("six-rowed" cultivars, ssp. *hexastichum*) and also forms in which the grains are naked. The genetic basis for these changes is relatively simple, each character difference being governed by a single major gene. In fact, in some 6th and 5th millennia B.C. sites six-rowed and naked forms of barley are already very common.

The wild ancestry of cultivated barley is now relatively well understood. Only a single wild species of *Hordeum* shows close morphological and genetic affinities with the ensemble of cultivars, namely, the two-rowed, brittle *H. spontaneum* Koch (Zohary, 1969, 1971; see also fig. 2). Both cultivated and wild cereals are diploid ($2n=14$) and manifest complete interfertility and full chromosome homology.

The geographic distribution and ecological specificities of *H. spontaneum* have been documented by Harlan and Zohary (1966). Wild barley is spread

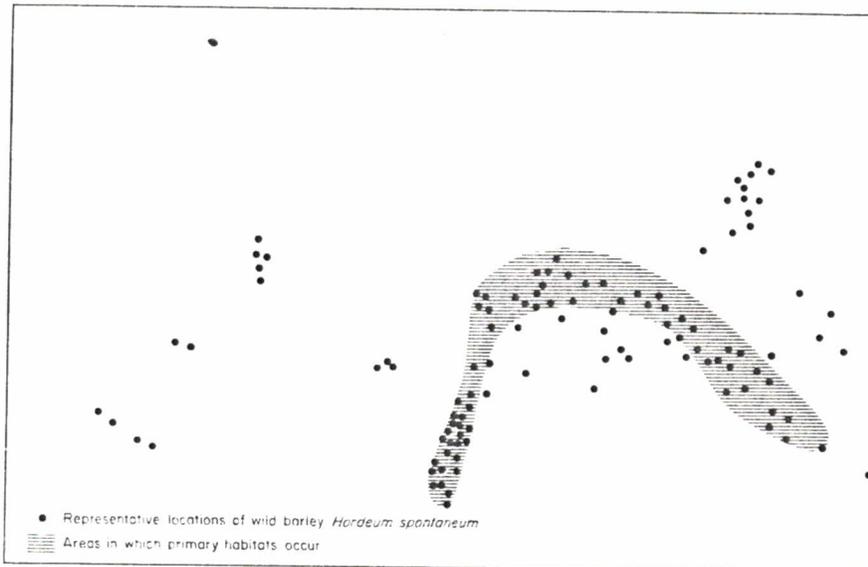


FIG. 5. — Present distribution of wild barley, *Hordeum spontaneum*. Adapted from Harlan and Zohary (1966).

over the East Mediterranean region and center of distribution lies in the Near East in the southwest, stretching north to the southeast towards Iraqi Kurdistan and Syria. They are continuously and massively spread in park-forest habitats. They constitute an important component of the vegetation of the Taurus formations, and are particularly common in the park-forest belt, east, north and west of the Taurus basin, and on the slopes facing the Jordanian Rift. They spill over to the drier steppes and semi-deserts.

In summary, also in the case of barley, comparative morphology, ecology, genetics and well-documented history. The information implicates *H. spontaneum* as the ancestor of cultivated barley. It is also evident that *H. spontaneum* conforms strikingly with the conditions of early farming villages. Finally, the process of domestication can be meaningfully traced to the fixation of non-brittle mutants from six-rowed forms and types with naked grains.

5. PEA, *PISUM*

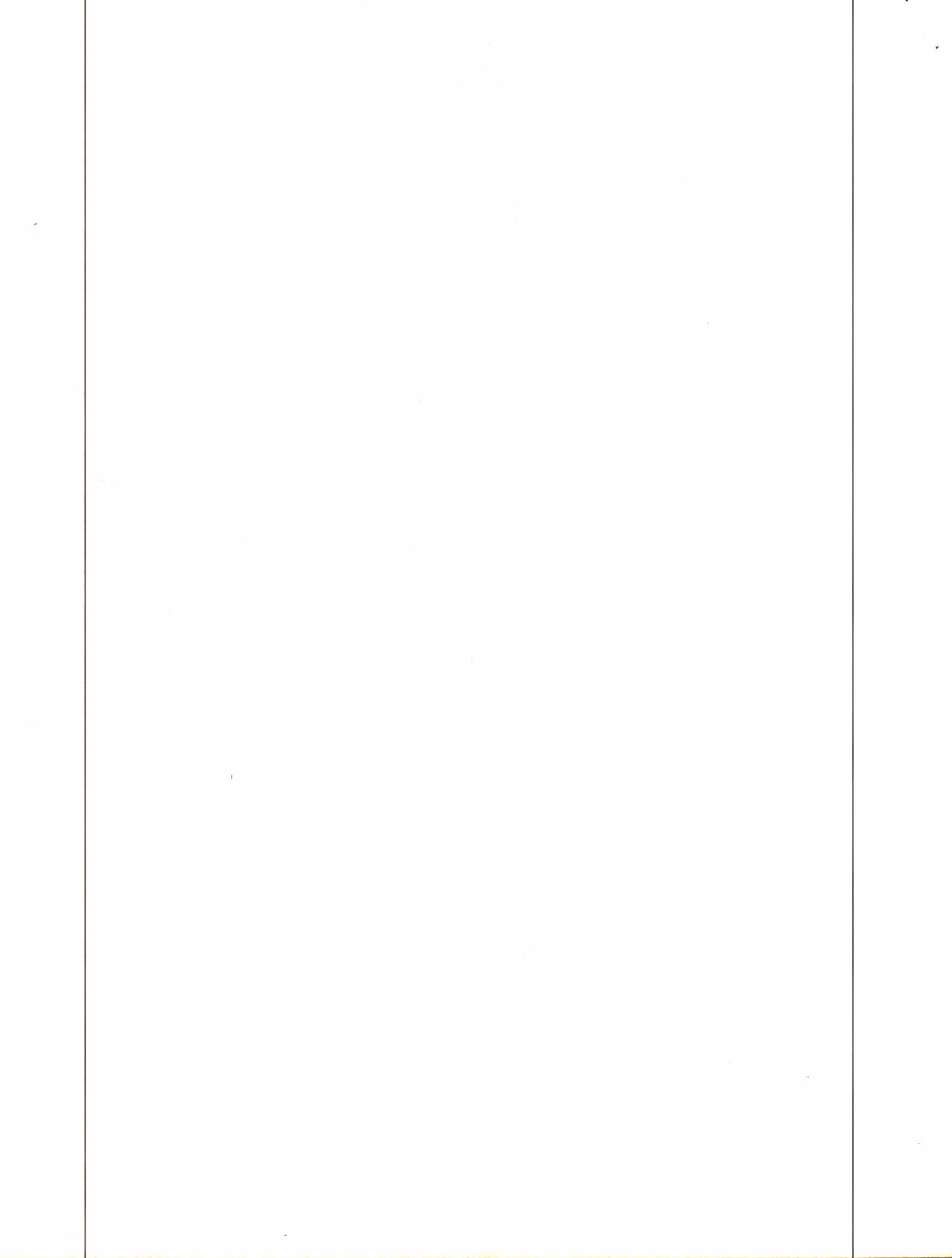
Numerous and relatively well-preserved forms are found at several Near East and Greek sites (table 1). At least some of these sites characterize cultivated forms only. Peas are associated with Bronze-Age settlements throughout the Near East in close association with wheat and barley.

Two wild *Pisum* types are closely related:

1. A tall, "maquis-type", omnium-ferens, with purple-blue flowers, conventionally associated with the maquis formations. Sporadically, *elatius* is found in cultivation.

2. A smaller, annual, "steppe-type", *Boiss. et Noë* [= *P. syriacum* (Berg.) Link. 6-7]. It grows in the oak park-forest and in the same life zones that harbor the wild *Hordeum*. Beyond the limits of such primary, steppe and secondary habitats as a weed; occasionally it has a general habit *humile* pea (fig. 6) closely related to *elatius*.

Cytogenetically wild *humile* and *elatius* varieties are indeed very closely related (Berg. 1966). Equally important is the fact that in nature these types are one another. Morphological boundaries are blurred and intergrading forms fuse together with weeds and cultivated varieties. Cytologically, the main chromosomal types occur in *sativum* peas. Israeli and Italian *elatius*

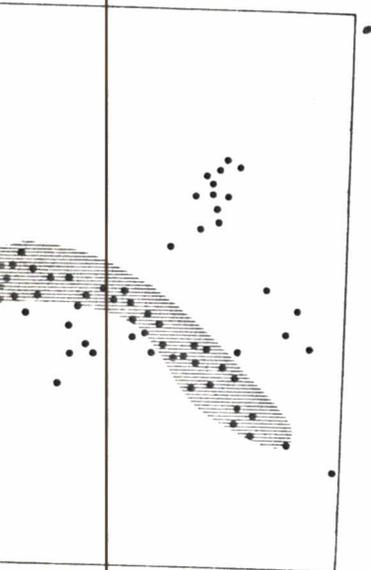


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H. spontaneum. Adapted from Harlan

over the East Mediterranean region and the countries of West Asia (fig. 5); the center of distribution lies in the Near East, starting from Israel and Transjordan in the southwest, stretching north towards southern Turkey, and curving southeast towards Iraqi Kurdistan and southwest Iran. Here, *H. spontaneum* forms are continuously and massively spread in both primary and segetal, man-made habitats. They constitute an important annual component of open herbaceous formations, and are particularly common in the summer-dry deciduous oak park-forest belt, east, north and west of the Syrian desert and the Euphrates basin, and on the slopes facing the Jordan rift valley. From here, *H. spontaneum* spills over to the drier steppes and semi-deserts.

In summary, also in the case of barley the combined evidence from comparative morphology, ecology, genetics and archaeology provides a coherent and well-documented story. The information from living plants strongly implicates *H. spontaneum* as the ancestral stock from which cultivated barley was derived. It is also evident that the center of distribution of wild *H. spontaneum* conforms strikingly with the distribution of the preceramic, early farming villages. Finally, the main modifications of barley under domestication can be meaningfully traced in the archaeological remains. First comes the fixation of non-brittle mutations and subsequently the emergence of six-rowed forms and types with naked grains.

5. PEA, *PISUM SATIVUM* L.

Numerous and relatively well-preserved, carbonized pea seeds have been found at several Near East and Greek sites dated to the 6th millennium B.C. (table 1). At least some of these show smooth seed coats, a trait which characterizes cultivated forms only. Peas are common in subsequent Neolithic and Bronze-Age settlements throughout the Near East and Europe, always in close association with wheat and barley cultivation.

Two wild *Pisum* types are closely related to the cultivated pea *P. sativum* L.:

1. A tall, "maquis-type", omni-mediterranean, annual climber with large purple-blue flowers, conventionally known as *P. elatius* Beib., which is distributed over the more humid parts of the Mediterranean region and thrives in maquis formations. Sporadically, *elatius* peas also colonize hedges bordering cultivation.

2. A smaller, annual, "steppe-type" pea, conventionally called *P. humile* Boiss. et Noë [= *P. syriacum* (Berg.) Lehm.], is restricted to the Near East (figs. 6-7). It grows in the oak park-forest belt and in open formations, i.e., in the same life zones that harbor the wild progenitors of the wheats and barley. Beyond the limits of such primary, steppe-like habitats *P. humile* also spills over to secondary habitats as a weed; occasionally it even infests cereal cultivation. In its general habit *humile* pea (fig. 6) closely resembles the cultivated legume.

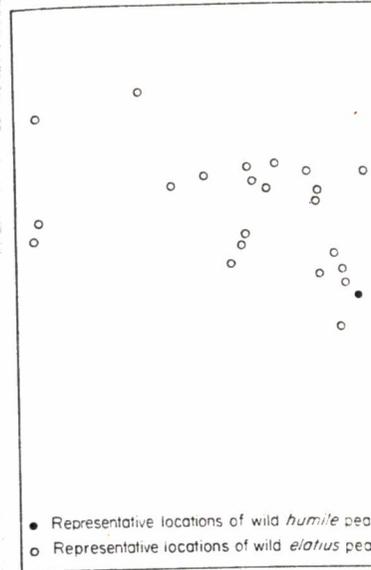
Cytogenetically wild *humile* and *elatius* peas, and the cultivated *sativum* varieties are indeed very closely related (Ben-Zeev and Zohary, 1973); hybrids between all these types show full chromosome pairing and are fertile or semi-fertile. Equally important is the fact that in nature these peas are not fully isolated from one another. Morphological boundaries between the main types are occasionally blurred and intergrading forms fuse them into a single complex of wild forms, weeds and cultivated varieties. Cytology provides us with yet another clue. Two main chromosomal types occur in the variable complex of *elatius-humile-sativum* peas. Israeli and Italian *elatius* forms differ from the *sativum* cultivars by



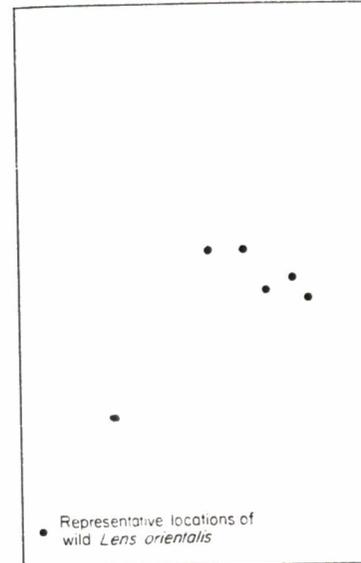
FIG. 6. — Wild steppe pea, *Pisum humile*.

a single translocation. The same chromosomal interchange is present also in *humile* in southern Israel. In contrast, the chromosomes of wild *humile* forms from northeastern Israel and Turkey are identical with those of *sativum* cultivars.

The evidence from genetics and botany in pea seems to complement the archaeological data. The earliest indications on utilization and cultivation come from the Early Neolithic farming settlements in the Near East. This region also harbors the closest wild relatives of the cultivated pea. One is therefore led to the conclusion that *P. humile* should be regarded as the primary wild progenitor and that the Near East is the most likely territory where pea domestication was initiated.



● Representative locations of wild *humile* pea
○ Representative locations of wild *elatius* pea



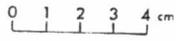
● Representative locations of wild *Lens orientalis*

FIG. 7. — Present distribution of w
FIG. 8. — Present distribution of w

6. LENTIL

Lentils appear to be closely cultivated in the Near East. millennium B.C. preceramic far in diameter) and not abund discovered in somewhat late Hacilar and Tepe Sabz, see t





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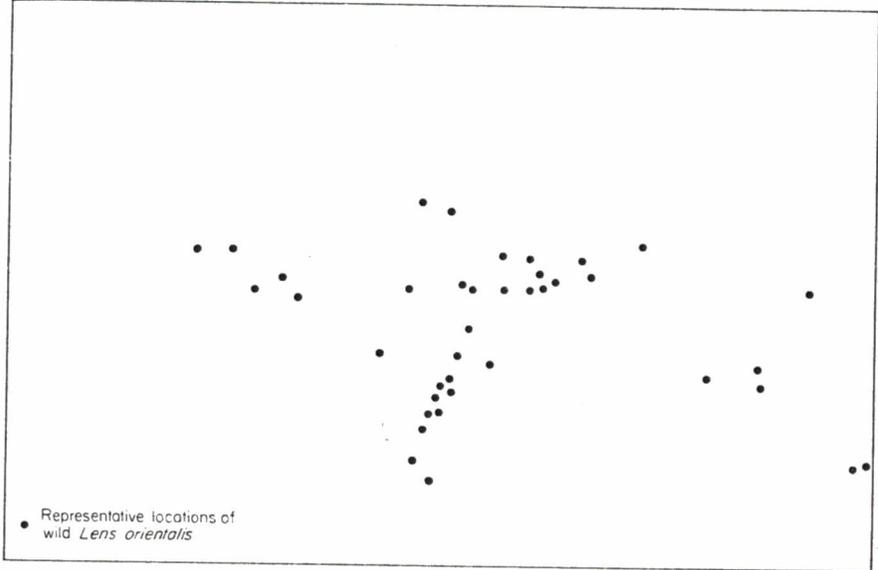
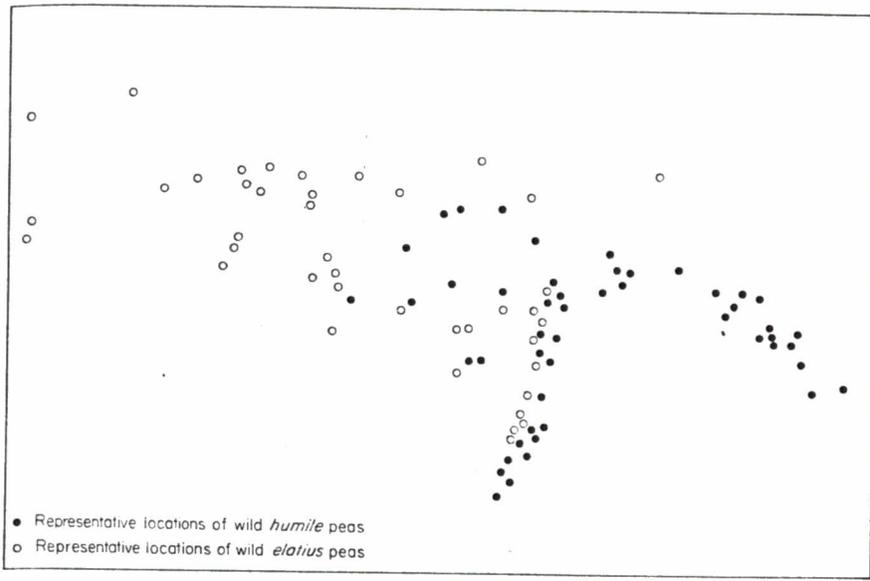
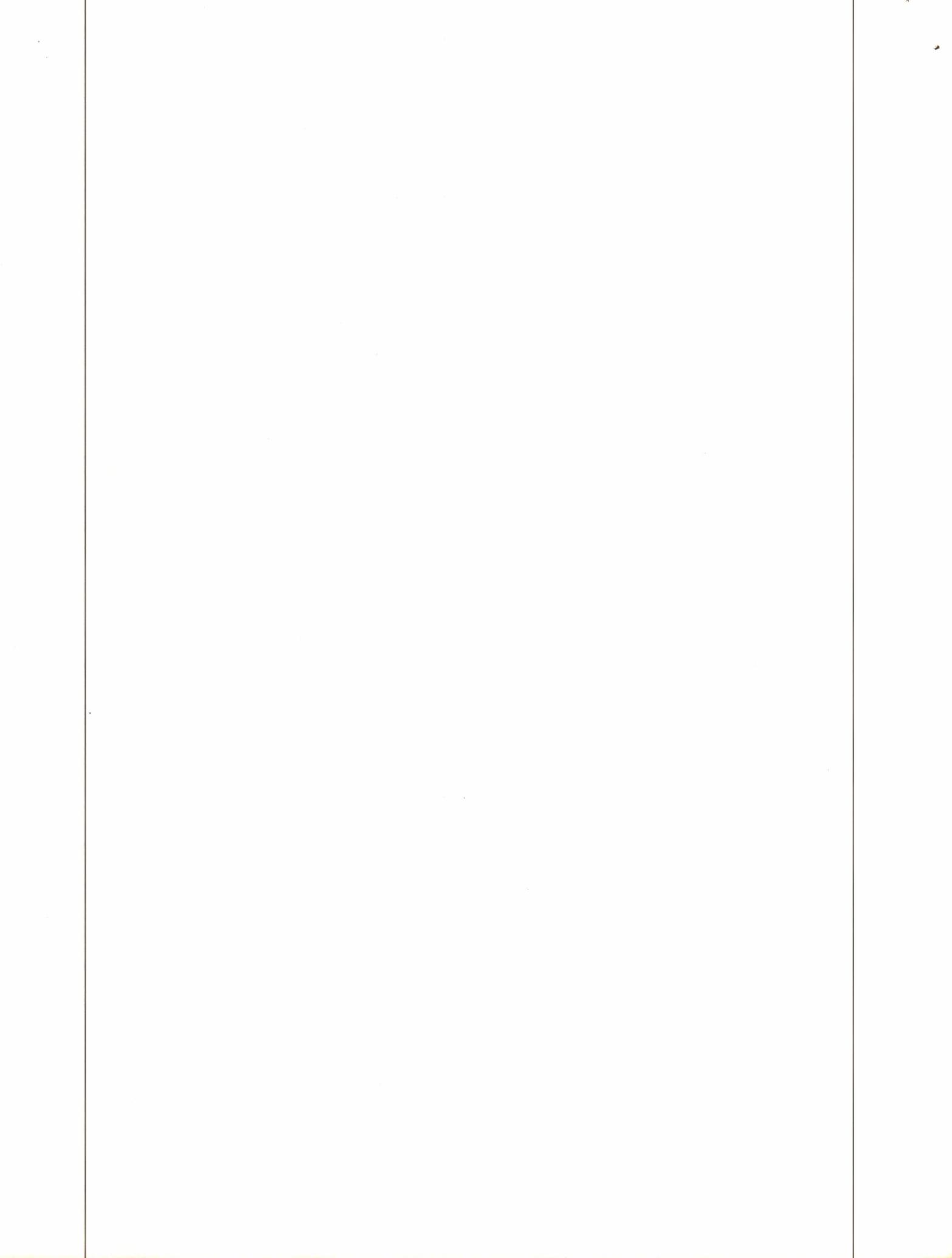


FIG. 7. — Present distribution of wild peas, *Pisum humile* and *P. elatius*.

FIG. 8. — Present distribution of wild lentil, *Lens orientalis*.

6. LENTIL, *LENS CULINARIS* MEDIK.

Lentils appear to be closely associated with the early start of wheats-and-barley cultivation in the Near East. Carbonized lentil seeds are present in the 7th millennium B.C. preceramic farming villages (table 1). They are small (2.5–3.0 mm in diameter) and not abundant. Larger amounts of lentil seed have been discovered in somewhat later phases of Neolithic settlement (Tell Ramad, Hacilar and Tepe Sabz, see table 1). Significantly, Tepe Sabz remains already



show relatively large seeds (up to 4.2 mm in diameter), an obvious development under domestication.

Lentils are also closely associated with the spread of Neolithic agriculture to Greece and adjacent Bulgaria; remains abound in Nea Nikomedia and in the settlements of the Karanovo culture in the Balkans. Subsequently they accompany wheat and barley in Neolithic and Bronze-Age settlements throughout the Near East, the Mediterranean basin and Central Europe.

Lens orientalis (Boiss.) Hand.-Mazz. was recently identified as the wild progenitor of the cultivated lentil (Zohary, 1972), and as its name implies it is a Near Eastern plant (fig. 8). This wild lentil is a slender, ephemeral legume with small pods that burst immediately on maturity and release and disperse the characteristically lenticular seed (fig. 9). It is distributed mainly over Turkey, Syria, Israel, north Iraq and west and north Iran, where small and sparsely

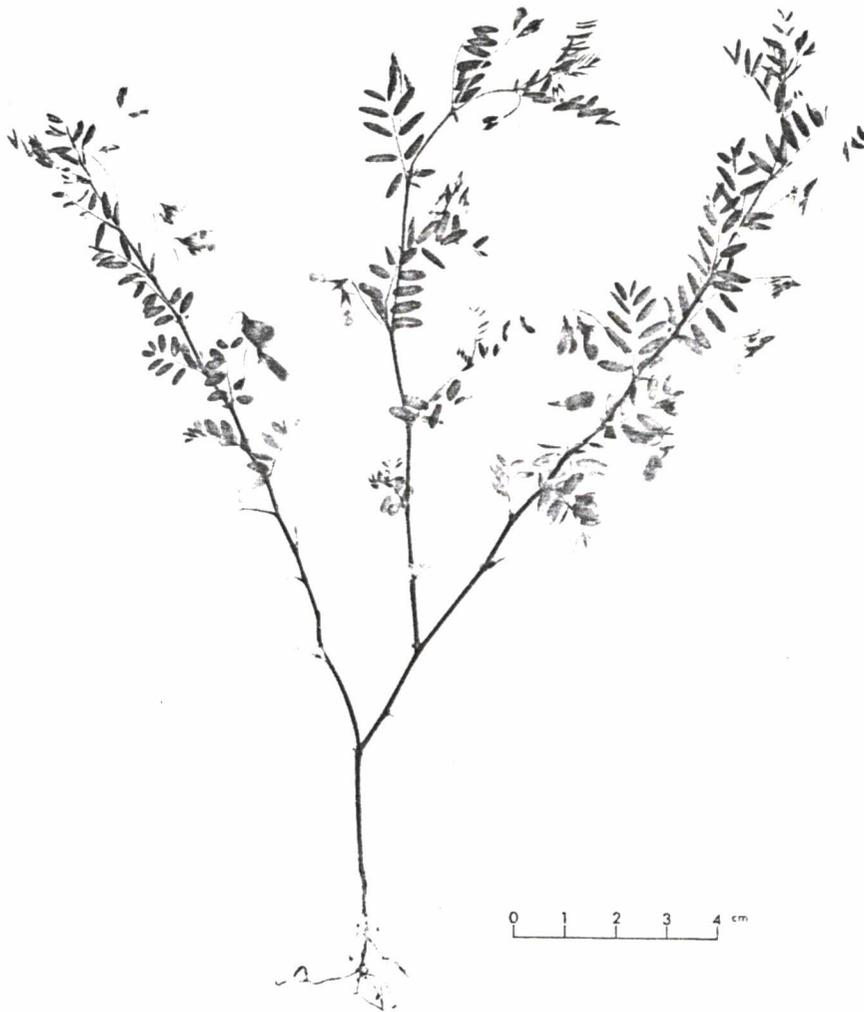


FIG. 9. — Wild lentil, *Lens orientalis*.

distributed colonies occupy shallow formations. Similar to wild peas,

The biological information from archaeological data. The earliest Neolithic settlements in the Near East where *L. orientalis* is distributed.

1. Evidence from archaeological excavations during the Neolithic Revolution in the Old World shows that the first cultivation appear in the 7th millennium B.C., primarily on domestication of (d) pea and (e) lentil.

2. The wild progenitors of (a) *Triticum dicoccoides*, (b) *T. dicoccoides*, (c) *Hordeum orientalis*.

3. A close correlation exists between the living plants and the distribution of the wild progenitors. The companion pulses is centered in the Near East. These crops also come from this region.

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distributed colonies occupy shallow soils and stony localities in steppe-like, open formations. Similar to wild peas, *L. orientalis* is rarely a dominant plant.

The biological information on wild *L. orientalis* thus complements the archaeological data. The earliest indications of lentil cultivation come from Neolithic settlements in the Near East – the very territory over which *L. orientalis* is distributed.

7. SUMMARY

1. Evidence from archaeology indicates that the Neolithic Agricultural Revolution in the Old World started in the Near East. Definite signs of plant cultivation appear in the 7th and 6th millennia B.C. This development was based primarily on domestication of (a) einkorn wheat, (b) emmer wheat, (c) barley, (d) pea and (e) lentil.

2. The wild progenitors of these founder crops are: (a) *Triticum boeoticum*, (b) *T. dicoccoides*, (c) *Hordeum spontaneum*, (d) *Pisum humile* and (e) *Lens orientalis*.

3. A close correlation exists between the genetic and botanical evidence obtained from the living plants and the "fossils" from archaeological digs. The distribution of the wild progenitors of the three founder cereals and the two companion pulses is centered in the Near East. The earliest signs of cultivation of these crops also come from this very region.

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