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Domestication of Pulses in the Old World

Legumes were companions of wheat and barley when agriculture began in the Near East.

Daniel Zohary and Maria Hopf

Pulses accompany the cereals throughout the Old World Belt of Mediterranean agriculture. Where the old-type grain agriculture is still practiced, legumes like pea, lentil, broad bean, and chickpea are universal companions of wheats and barley. They constitute an essential element of food production and comprise an important ingredient in the peasant's diet. But while the mode of origin of the cultivated cereals was intensively studied both by archeologists and plant geneticists, and the fundamental role that these grasses played in the establishment of Old World Neolithic agriculture is now widely recognized (*1–4*), the Mediterranean pulses were relatively neglected. In the last few years a considerable amount of carbonized remains of legumes have been excavated in Neolithic and Bronze Age sites in the Near East and in Europe. Furthermore this archeological evidence was complemented by botanical and genetic examination of the wild relatives of the main legumes. In the cases of pea and lentil, the wild progenitors of the domesticated crops are already satisfactorily identified and their ecology and distribution surveyed (*5, 6*). More fragmentary information is at hand on several other Mediterranean legumes. Thus a critical assessment of the domestication of pulses in the Old World can be attempted on basis of the combined evidence from archeology and from the living plants.

This article aims at such a synthesis. Evidence is brought to bear on the questions as to which were the main legumes utilized in the early history of the Old World agriculture and where, when, and from what wild sources these cultivated pulses evolved. We have also attempted to evaluate the role that these food plants played in the development of Neolithic agriculture in the Near East and the rapid spread of this new technology west, north, east, and south.

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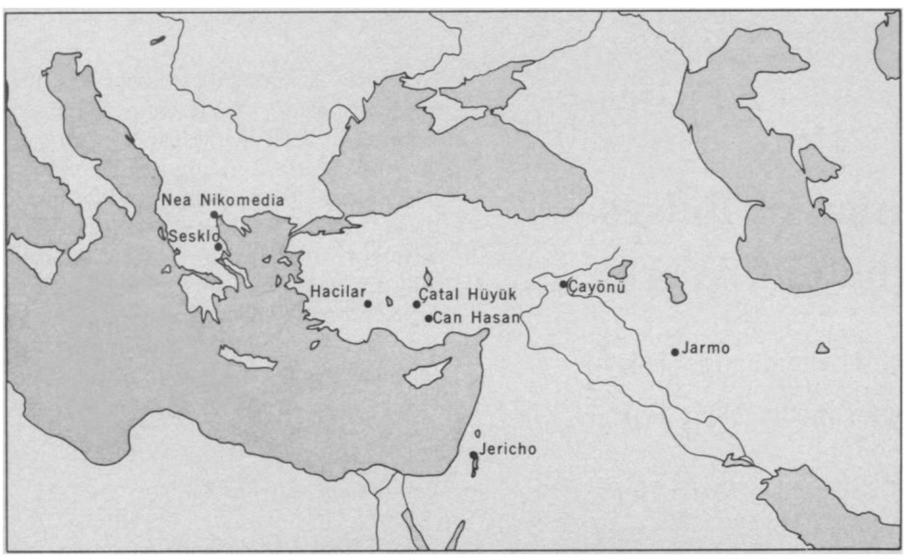
Pea (Pisum sativum L.)

Peas make their appearance in the early Neolithic farming villages of the Near East (7000 to 6000 B.C.). Well-preserved carbonized pea seeds were discovered (Map 1) in aceramic Jarmo, north Iraq (*4, 7*), Çayönü, southeast Turkey (*8*), and in the prepottery B level in Jericho (*9*). Much richer remains of peas are available from somewhat later Neolithic phases in the Near East—from the sixth millennium B.C. Large quantities of carbonized pea seed accompany the finds of cultivated wheats and barley in Çatal Hüyük, 5850 to 5600 B.C. (*10*); Can Hasan (*11*); and Hacilar, 5400 to 5000 B.C. (*12*). The remains from the upper levels of Çayönü, Çatal Hüyük, and Can Hasan already show the smooth seed coat characteristic of domesticated peas.

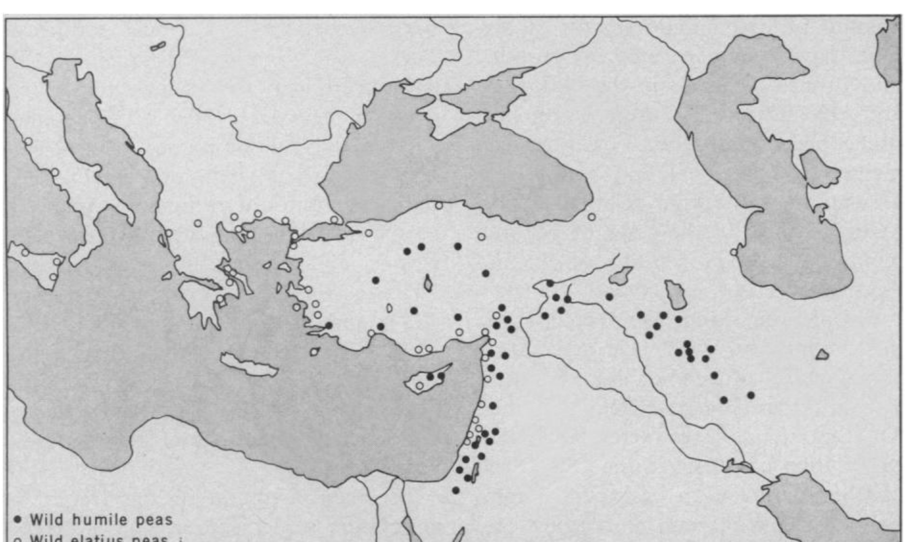
Peas are common in the Neolithic agriculture settlements in Europe. Here again they are closely associated with the wheat and barley production. Representative sites in Greece include early Neolithic Nea Nikomedeia, about 5500 B.C. (*13*), and aceramic Ghediki, Sesklo, and Sofli (*14*). Also the Nea Nikomedeia carbonized seed are well preserved and reveal a smooth coat. Peas are further present in early Neolithic Bulgaria. Finds from Tell Azmak (equivalent to Asmaka Moghila), were dated by the carbon-14 method about 4330 B.C. (*15*). But further north along the Danube and in the Alps we still lack any early remains of this legume. The earliest finds of pea from Romania, Czechoslovakia, Austria, and Switzerland come from either very late Neolithic or from Bronze Age sites. But in the lower Rhine Valley peas are common in the early Bandkeramik villages dated 4400 to 4200 B.C., and in central Germany huge amounts of carbonized pea seed have been produced (*16–18*). Also in these samples seed coats are frequently well preserved and show smooth surfaces characteristic of the domestic crop. Peas have also been reported from Bandkeramik sites in Poland and Russia (*19*), but unfortunately without any details. So far there are no definite records of Neolithic peas in Western Europe, and the oldest specimens in this region come from Bronze Age deposits. Finally, all over Europe the Bronze Age finds of peas are fewer and sparser compared to Neolithic finds. This situation repeats itself in the case of other pulses. Rich deposits of pulses (lentil and broad bean included) occur again in the European settlements of the Iron Age (*20*).

In contrast to the wheats and barley, the archeological remains of peas [practically all the material consists of carbonized seed (Fig. 1a)] do not provide us with simple diagnostic traits for easy and foolproof recognition of cultivation (*21*). In the Near East cereals (such as einkorn, emmer, barley), the presence of a nonbrittle rachis serves as a critical indication for cultivation. Wheats or barley with nonshattering ears are dependent on cultivation and cannot survive under wild conditions. Thus we have evidence for cereal cultivation in the string of early farming villages already in the seventh millennium. But in remains of peas (and all other pulses) we lack comparable yes-or-no morphological indications for safe demonstration of cultivation. Peas under cultivation show a general trend in that the size of the seed and the length of the hilum increases. But such changes occur very gradually, and there is a considerable overlapping between wild and cultivated forms. In peas, perhaps the most reliable indication for domestication is provided by the surface of the seed coat. Wild peas are characterized by a rough or granular seed surface. Cultivated varieties have smooth seed coats. Significantly, the carbonized seed from seventh millennium Çayönü (*8*), sixth millennium Çatal Hüyük (*12*) and Nea Nikomedeia (*13*) already show smooth surfaces. This smoothness strongly suggests that cultivation of peas in the Near East is as old, or almost as old, as the cultivation of wheats and barley.

The relationships between the wild species of peas and the cultivated crop have already been analyzed (*5*). Two types of wild *Pisum* are genetically closely related to the cultivated pea: (i) A tall omni-Mediterranean wild pea with large purple-blue flowers, conventionally known as *P. elatius* Beib., is distributed over the more humid parts of the Mediterranean Basin (Map 2) and thrives in maquis formations where it climbs on bushes and shrubs. Sporadically *P. elatius* also colonizes hedges bordering fields and thickets at roadsides. (ii) A smaller wild pea, conventionally referred to as *P. humile* Boiss. et Noë [synonymous to *P. syriacum* (Berg.) Lehm.], is geographically restricted to the Near East (Map 2). In its general habit, *humile* pea closely resembles the cultivated legume (Fig.



Map 1. Early agricultural settlements (seventh and sixth millennia B.C.) containing pea remains.



Map 2. Distribution of wild peas, *Pisum humile* and *P. elatius*.

2). In contrast to the previous wild pea, *P. humile* is decidedly an element of open vegetation. It occurs mainly in steppe or steppelike formations. In northeast Israel, Syria, south Turkey, and the western flanks of the Zagros Mountains, *humile* peas thrive in the belt of the oak park forest—that is, in the same life zone that harbors the wild progenitors of the cultivated wheats and barley. In addition to thriving in such primary places, *P. humile* invades also secondary habitats. In the Near East it is scattered as a weed at edges of cultivation and even infests cereal fields.

Cytogenetically wild *humile* and *elatius* peas and the cultivated *sativum* varieties are indeed very closely related. Hybrids between these types show full chromosome pairing and are fertile or semifertile (*5*). 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. As already suggested by several botanists (*22, 23*), *P. elatius* and *P. humile* should not be regarded as independent species. They represent only main wild races. Together with the cultivated pea they should be lumped into a single biological species.

Cytology provides us with another clue. Two main chromosomal types occur in the variable complex of *elatius, humile*, and *sativum* peas. *Elatius* forms tested so far differ from the *sativum* cultivars by a single translocation. The same chromosomal interchange is present in *humile* peas in south Israel. In contrast, wild *humile* forms collected in northeast Israel and in Turkey were found to contain chromosomes identical with those of *sativum* cultivars. Thus the botanical and genetic evidence shows that both *elatius* and *humile* belong to the general wild stock from which the cultivated peas could have been derived. But the data available also indicate which segment within this variable aggregate of wild peas could have served as the primary source for pea domestication. Strongly implicated are the *humile* forms which contain chromosomes identical to the standard karyotype present in the cultivated pea. Furthermore, *humile* peas show closer morphological similarities to *sativum* peas and grow in steppe or steppelike habitats, that is, under open conditions not very different from those prevailing in the cultivated field.

All in all, the evidence from genetics and botany complements the archeo-

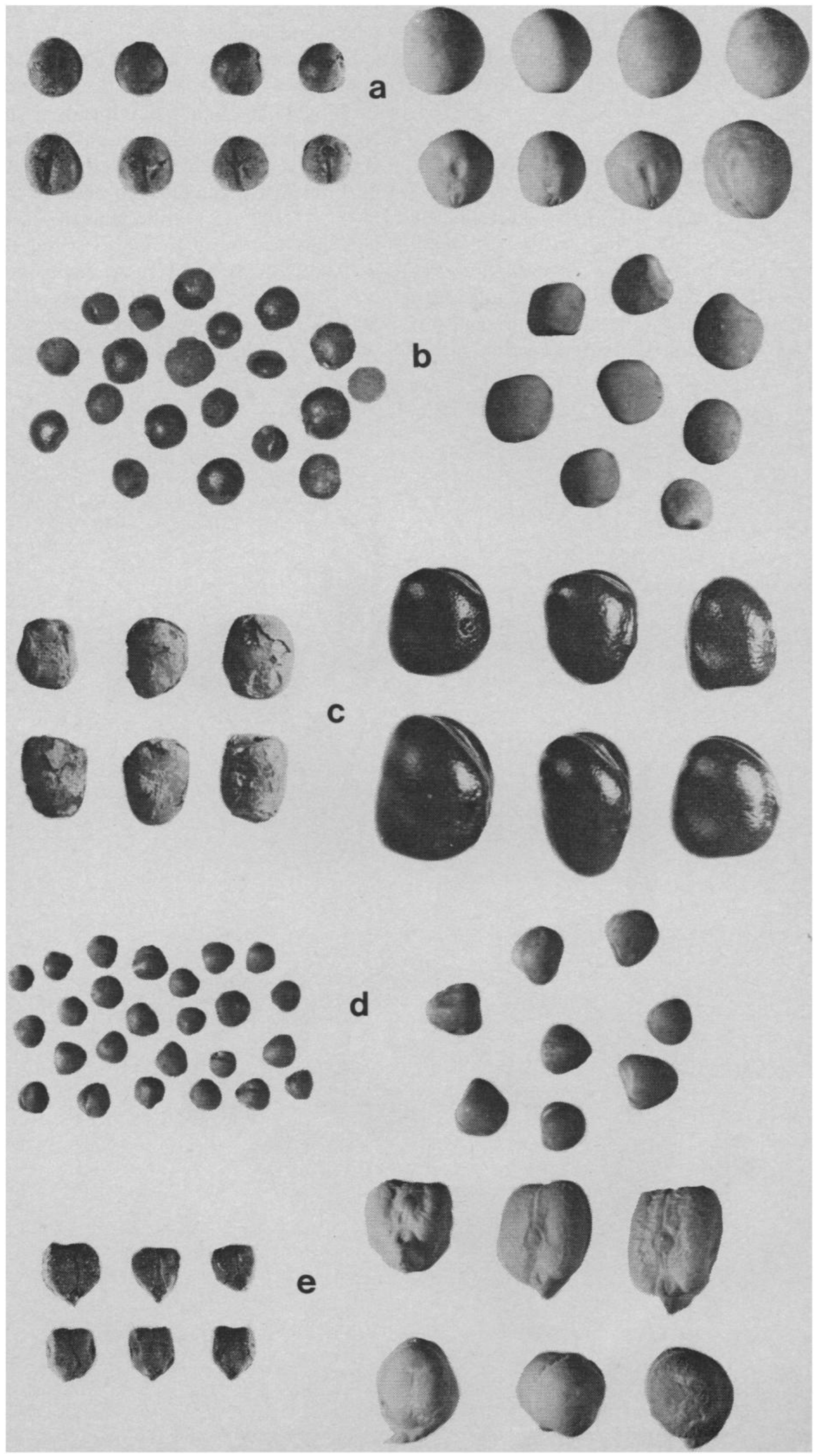


Fig. 1. Seed remains (left) and, for comparison, seed from recent varieties (right) of the five cultivated pulses. (a) Pea, carbonized seed from Early Bronze Age Arad, Israel. (b) Lentil, carbonized remains from Late Bronze Age Manole, Bulgaria. (c) Broad bean, carbonized seed from Copper Age Chibanes, Portugal. (d) Bitter vetch, remains from Late Bronze Age Manole, Bulgaria. (e) Chickpea, carbonized seed from Early Bronze Age Arad, Israel. (Magnification about 1.8.)

logical data. The earliest indications on utilization and cultivation of peas come from the string of the early farming settlements in the Near East. This belt also harbors the closest wild relatives of the cultivated pea. The Near Eastern *humile* peas should be therefore regarded as the primary wild stock from which the cultivated pea was derived, and the Near East life zone of the oak park forest may be regarded as the most likely territory where pea domestication could have been initiated (*24*).

Lentil (Lens culinaris Medik.)

As already succinctly expressed by Helbaek (*25*), "the history of lentil reaches back as far as agriculture itself." In parallel to peas, lentils seem to be closely associated with the start of wheat and barley cultivation in the Near East. Lentils were apparently utilized in the Near East even before the firm establishment of farming villages. Van Zeist (*26*) reports the presence of small lentil seed among remains retrieved from prefarming Mureybit, north Syria (8000 to 7500 B.C.). In this incipient settlement we are apparently faced with the collection of the wild pulse together with the harvesting of wild wheat and barley.

Somewhat later lentils make their appearance in the string of aceramic farming villages that developed in the Near East arc in the seventh millennium B.C. A few small lentil seeds (2.5 to 3.0 mm in diameter) were detected by Helbaek (*4*) in Jarmo, north Iraq, and they were also found subsequently in Ali Kosh, Iran (*27*). A single seed was also retrieved from aceramic Hacilar (*12*) and few more were dug out at Can Hasan, Anatolia (*11*). Hopf (*9*) reports similar small lentils in prepottery B in Jericho, and remains from aceramic Beidha, Jordan, also contain this pulse (*12*). Lentils appear also in several levels in Çayönü, Turkey (*8*). All in all, lentils are present in the majority of early farming villages of the seventh millennium in the Near East—in which plant remains were carefully analyzed (Map 3). They are small (2.5 to 3.0 mm in diameter) and do not occur in large quantities. But they do show close association with the early cultivation of einkorn, emmer, and barley.

Large amounts of lentil seeds were discovered in somewhat later phases of the Neolithic settlement in the Near East: in Tell Ramad, Syria, 6250 to 5950 B.C. (*28*); in ceramic Hacilar, Turkey, 5800 to 5000 B.C. (*12*); and in Tepe Sabz, Deh Luran Valley, Iran, 5500 to 5000 B.C. (*27*). At that time Tepe Sabz lentils had already attained 4.2 mm in diameter. This is an obvious development under domestication.

In the sixth millennium B.C. lentils seem also to be closely associated with the spread of Neolithic agriculture to Greece and adjacent southern Bulgaria. Here too they occur together with einkorn wheat, emmer wheat, and barley. Lentils are common in Nea Nikomedeia, Macedonia, about 5500 B.C. (*13*) and appear also in aceramic Ghediki, Thessaly (*14*), in the preceramic basal level of Argissa-Magula, Thessaly (*29*), in Knossos, Crete, about 6000 B.C. (*30*), and in early Bulgarian sites such as Tell Karanovo (*31*).

In Hungary, lentils are reported from Neolithic Lengyel (*32*) and early Bronze Age Baracs (*33*). Finds from Czechoslovakia are younger. They come from early Bronze Age Barca and late Bronze Age Nitransky Hradek (*34*). In Switzerland, too, lentils were recovered from early and later Bronze Age lake dwellings (*35*). Similar finds are available from Le Bourget, Savoy (*32*), although until now we possess very little information on food plants in early French sites. In Germany, lentils are present in almost all Bandkeramik villages in which peas were uncovered (*36*) as well as Bronze Age Taltitz and Dobeneck, Saxony (*35*). As in the case of pea, lentils in Bronze Age Europe seem to be sparser than in Neolithic times. Again an increase in lentil finds is noted in the Iron Age settlements (*18*).

In archeological finds of lentils (for representative sample see Fig. 1b) it

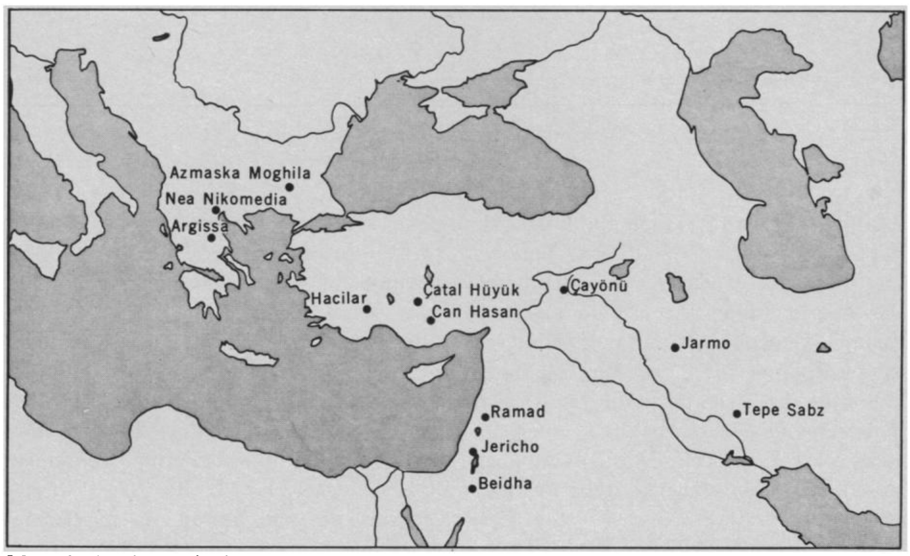
Fig. 2. The wild progenitor of the cultivated pea: *Pisum humile* Boiss. et Noë.

is frequently difficult to decide whether one is confronted with wild material or with cultivated varieties. This is particularly true in the early sites. Seed of wild *Lens* are morphologically very similar to the seed of the cultivated forms. The only conspicuous development under domestication is an increase in size. Wild lentils have relatively small seed (2.0 to 3.2 mm in diameter), whereas seed of modern cultivated forms reach 5 to 8 mm in size. Yet this change under domestication was obviously a very gradual process, and not a universal one. Some of the present-day cultivated varieties (conventionally grouped in ssp. *microsperma*) still retain small seed sizes (3 to 4 mm). Almost all Neolithic finds consist of relatively small seed, and in most of the early Neolithic farming villages the excavated remains are not only small-sized but also few in number. Thus a reliable distinction between wild and cultivated *Lens* is impossible on morphological grounds. Larger forms of lentils start to appear only 1000 to 1500 years later. As Helbaek (*27*) stresses, the Tepe Sabz material clearly represents a cultivated crop.

But though the morphological studies of early material are indeed inconclusive, circumstantial evidence does indicate that lentil cultivation in the Near East is probably as old as agriculture itself. The first indication comes from the ecology of the wild *Lens* species. Wild lentils rarely form sizable stands. In most places, collection of a considerable amount of seed from these sparsely distributed small plants (which burst their pods and shed their seed immediately after ripening) would be practically impossible. Second, wild lentils today do not grow in the vicinity of many of the sites in which lentil remains were unearthed. A typical case is Jericho. Wild lentils are absent today in the lower Jordan Valley. The place is much too dry for them. All in all, finds of sizable amounts of lentils, particularly in areas where wild lentils are very rare or absent, strongly suggest cultivation. Such situations occur in Jericho, Beidha, Ali Kosh, Nea Nikomedeia, and all European sites.

In summary, in *Lens* we have no telltale diagnostic traits that would make it possible to determine the initial stages of lentil domestication. Moreover, it is very doubtful whether comparative morphology will provide us with such clues in the future. Yet once Neolithic agriculture is soundly established in the Near East and in Greece (second half of the sixth millennium), cultivation of lentil is part of it. Together with pea, the lentil seems to have been an integral food element of Neolithic and Bronze Age cultures—all over the Near East and Europe.

The wild ancestry of the cultivated lentil is satisfactorily established. *Lens orientalis* (Boiss.) Hand.-Mazz. (Fig. 3) was recently shown to be the wild progenitor of the cultivated lentil (*37*). Geographically *L. orientalis* is a Near Eastern element. It is distributed mainly over Turkey, Syria, Israel, north Iraq, and west and north Iran (Map 4). *Lens orientalis* grows primarily on stony shallow soils and gravelly hillsides in open or steppelike habitats. Over most of its distribution area *L. orientalis* is rather inconspicuous or even rare. It usually forms small scattered colonies. Yet, on the slopes of Mt. Hermon and the Anti-Lebanon



Map 3. Early agricultural settlements (seventh and sixth millennia B.C.) containing lentil remains.

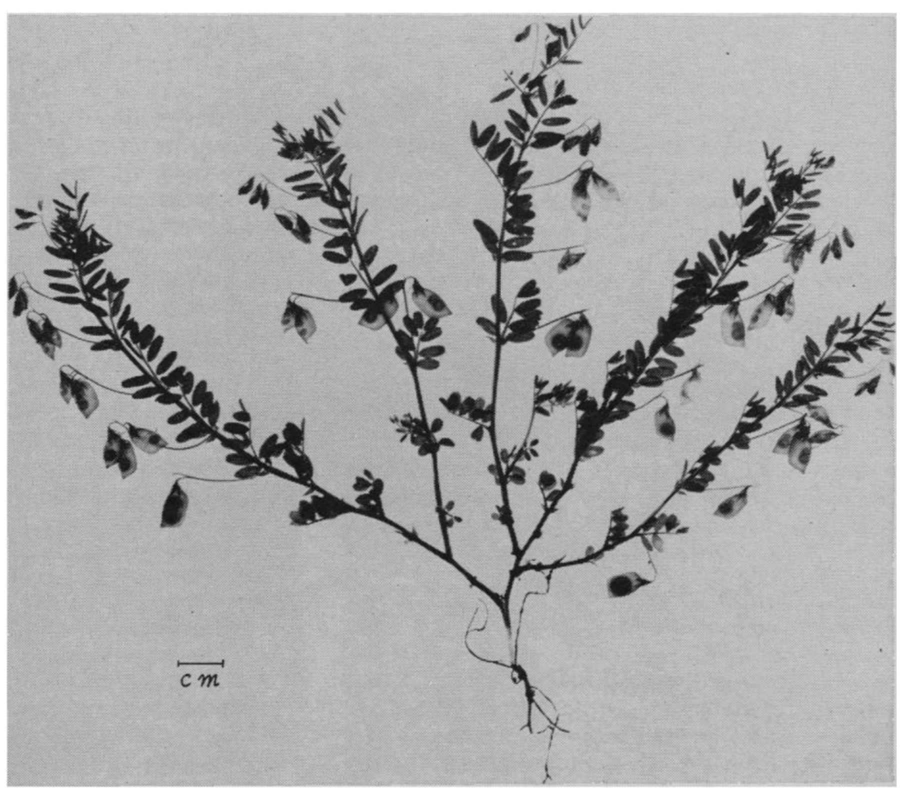
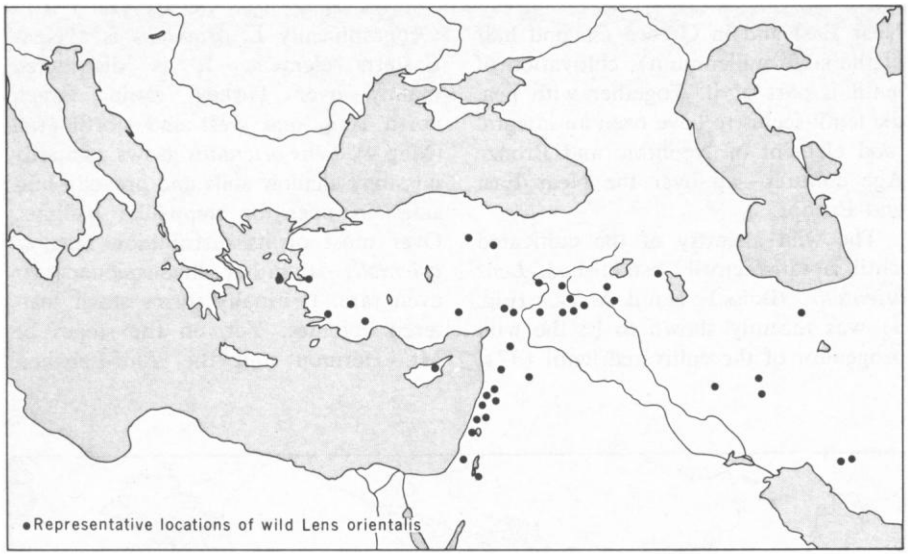


Fig. 3. The wild progenitor of cultivated lentil: *Lens orientalis* (Boiss.) Hand-Mazz.



Map 4. Distribution of wild lentil, *Lens orientalis.*

(altitude, 900 to 1500 meters), in the oak park-forest belt of southern Turkey, and over the western escarpments of the Zagros range, *L. orientalis* is occasionally locally common. In addition to occupying more or less primary habitats, the oriental wild lentil also penetrates disturbed habitats, such as stony patches in cleared up maquis or stone heaps bordering orchards and cornfields.

The biological evidence regarding *L. orientalis* fits very well with the available archeological information. Parallel to those of the pea, the earliest archeological indications on utilization and cultivation of lentil come from the Near East. This is the very territory over which the wild ancestor is distributed. Again the conclusion is reached that the Near East is the most probable area where lentil was domesticated.

Other Pulses

In addition to pea and lentil several other pulses make their appearance in the Neolithic and Bronze Age cultures in the Near East and Europe. The cultivation of each of them seems to have been extensive at least in some segments of the belt of Mediterranean agriculture. Most conspicuous among these pulses are the broad bean (*Vicia faba* L.), the bitter vetch [*Vicia ervilia* (L.) Wild.], and the chickpea (*Cicer arietinum* L.). But our knowledge of the early history and the origin of these cultivated legumes is admittedly rather fragmentary. In the cases of the broad bean and the chickpea even the wild progenitors of the cultivated crops are yet not definitely identified.

1) Broad bean (*Vicia faba* L.). There are almost no reports on the presence of broad beans in the early Neolithic farming villages in the Near East. The only exception is the discovery of a few seeds resembling *faba* in prepottery level B in Jericho (*9*). But these scanty remains do not permit us to decide whether one is faced with the cultivation of broad beans or with the collection of local wild species belonging to section *Faba* of the genus *Vicia* (such as *V. narbonesis* L.). In contrast, carbonized remains of broad beans appear in several Bronze Age sites of the East Mediterranean and Aegean. Broad beans are even more common in the late Neolithic times of western Europe and in Bronze Age sites in central Europe. The available finds seem to cluster around the following main areas. (i) The Iberian Peninsula—both in Portugal (*38*) and in Spain (*39*), and with extensions as far as Malta (*40*); (ii) the lake dwellings in western Switzerland (whereas in eastern Switzerland, Austria, Czechoslovakia, and Italy finds are restricted to the late Bronze Age); (iii) Greece and the Aegean area including Lerna (*41*), Crete (*42*), and an extension to Lengyel (*32*) in southeast Hungary; and (iv) the east Mediterranean belt including sites like Beit-Shan (*43*), Arad (*44*), and Jericho (*9*) in Israel and Apliki (*25*) in Cyprus.

All Bronze Age broad beans have relatively small seed (see sample in Fig. 1c) and thus belong to *V. faba* var. *minor*. Forms with larger seeds (*V. faba* var. *major*) are much more modern, and start to appear much later in the history of this crop. But already in the Bronze Age one encounters in the broad bean a wide variation in seed shape and perhaps some geographic divergence. Both oblong and rounded beans are present, but their relative frequencies vary from one geographic belt to another. Oblong forms prevail in the West, whereas rounded beans are more common in the East.

The identity of the wild progenitor of the cultivated broad bean is not yet certain. The cultivated broad bean belongs to a cluster of large-seeded wild vetch forms and species grouped in section *Faba* of the genus *Vicia*. Geographically this section is almost exclusively restricted to the Mediterranean Basin and the Near East. But the more specific wild ancestor of the cultivated broad bean (within section *Faba*) is yet not satisfactorily identified. For some years students of the origin of cultivated plants regarded *V. narbonesis* L., a widely distributed Mediterranean species, as the probable ancestor of *V. faba*. But cytogenetic analysis showed that this vetch is genetically widely divergent from the cultivated pulse (*45*). An attractive candidate for the ancestry is *V. galilea* Plitm. et Zoh., a Near Eastern endemic (*46*). Morphologically this wild legume of the *faba* type shows close resemblance to the cultivated broad bean. But for critical assessment of the wild ancestry of the cultivated *V. faba*, it is imperative to have a clarification of cytogenetic affinities between the various wild and cultivated members of section *Faba*.

In conclusion, we still lack a satisfactory answer to the basic questions where and when *V. faba* was domesticated. In the Bronze Age we suddenly find that broad beans are already cultivated over the entire Mediterranean Basin, from Spain in the West to the Levant in the East. But we do not yet have reliable archeological clues on the very beginning of the cultivation of this pulse, and so far our information on the wild relatives is deplorably deficient. At present all we can say is that section *Faba* is the *general wild stock* from which cultivated *V. faba* is derived. This section contains Mediterranean and Near Eastern wild species. Hence the domestication of the broad bean should have been initiated somewhere in this general area. More precise answers will be possible only when we secure additional early archeological evidence on *V. faba* and after a satisfactory identification of its wild progenitor. But if *V. galilea* should indeed turn out to be the ancestor from which *V. faba* evolved, the answer to the question of the place of origin will be rather simple. *Vicia galilea* is endemic in the Near East. It grows mainly in the oak park-forest belt; that is, in the same life zone that harbors the wild progenitors of wheats, barley, pea, and lentil.

2) Bitter vetch [*Vicia ervilia* (L.) Wild.]. The characteristic angular seed of the bitter vetch (Fig. 1d) were unearthed in several seventh and sixth millennia B.C. sites in Anatolia. Bitter vetch is rather common in remains obtained from the early farming village of Çayönü, Turkey, carbon dated 7500 to 6500 B.C. (*8*). But as van Zeist remarks it is impossible to determine whether the finds represent wild or domesticated material. *Vicia ervilia* seed have also been unearthed in aceramic Can Hasan (*11*). Helbaek (*10*) found two large deposits of *V. ervilia* at Çatal Hüyük, about 5800 B.C., and a smaller sample in the ceramic level of Hacilar, about 5400 B.C. (*12*). In both sites *V. ervilia* seed also occurred as an occasional contaminant of other grains.

A considerable amount of *V. ervilia* seed has been discovered in Neolithic sites in Greece and the Balkans. Representative samples come from early Neolithic Nea Nikomedeia, Macedonia (*13*), Aeneolithic Tell Karanovo and Tel Azmak, Bulgaria (*47*), and Neolithic Cáscioarele, Romania (*47*). Finally, numerous finds of bitter vetch are reported from Bronze Age sites in the Near East and the Balkan countries. In the latter this pulse seems to be particularly common. Some finds include huge quantities of pure seeds.

The wild ancestor of the cultivated bitter vetch is already satisfactorily recognized. *Vicia ervilia* presents us with an aggregate of interconnected wild forms, weedy races, and cultivated varieties. The cultivars are morphologically very similar to the weedy types and the wild forms. Thus the identification of the ancestry of this pulse is a relatively simple matter. Truly wild forms of *V. ervilia* (that is, forms that grow on primary habitats) are rather restricted in their distribution. They are definitely known from Anatolia alone (*23*). Weedy races, however, are much more widely distributed. They infest grain crops and edges of fields all over the Near East and the southern Balkans.

Thus, on the basis of the available evidence, one arrives at the conclusion that the early development of *V. ervilia* as a man-dependent plant should have taken place in Anatolia—in the general area where this vetch still grows wild. Less clear is whether one should regard this legume as a primary or as a secondary crop. As already pointed out by van Zeist and Bottema (*13*) one lacks reliable diagnostic traits for a clear-cut distinction between weeds and domesticants in *V. ervilia.* The nature of the early Turkish and Greek archeological finds can be interpreted in either way. Yet the numerous large samples of this pulse in the Neolithic and Bronze Age sites in the Balkans and Turkey strongly suggest that then and there *V. ervilia* was already extensively cultivated.

Finally one is faced with the problem of the mode of utilization of this legume by the Neolithic and Bronze Age farmers. *Vicia ervilia* obviously belongs to the ensemble of east Mediterranean pulses and in places where the old type agriculture is still practiced it constitutes a characteristic and common crop, though as its name implies, its seeds are bitter. Today (and at least since Roman times), the seed of *V. ervilia* are utilized primarily as an animal food. It is regarded as a relatively inferior pulse for human consumption, and is consumed only by the very poor or in times of famine. We know nothing about the usage of the bitter vetch in Neolithic or Bronze Age sites.

3) Chickpea (*Cicer arietinum* L.). Chickpeas are only very scantily represented in plant remains obtained from early stages of agriculture in the Near East. Helbaek (*12*) found two badly damaged grains in Hacilar deposits, 5400 to 5000 B.C. Van Zeist (*8*) reports four *Cicer* sp. seed in aceramic Çayönü. Finally one broken seed was unearthed in prepottery B Jericho (*9*). Near Eastern Bronze Age finds are, however, more revealing. Chickpeas are present—for example, in early Bronze Age Lachish (*48*), Jericho (*9*), and Arad (*44*). In all these places fairly large seeds were obtained (Fig. 1e). This is a clear indication of domestication, since the only wild chickpea growing in Palestine (*C. pinnatifidium* Jaub. et Sp.) has significantly smaller seed.

The wild ancestry of the cultivated chickpea is not yet definitely known. Several Near Eastern wild species of *Cicer* are morphologically rather similar to the cultivated pulse. But we still lack critical evidence on genetic affinities between wild and cultivated species in *Cicer.* The most attractive candidate for the ancestry of the cultivated chickpea is *C. echinospermum* Davis, a wild annual *Cicer* which was recently described (*23*). This chickpea grows in the oak forest and steppelike formations in southeastern Turkey. It shows close morphological resemblance to *C. arietinum,* but it differs from the cultivated pulse by its conspicuously echinate seed.

Conclusions

If we accept the evidence from archeology at face value, we are led to the conclusion that the domestication of pulses in the Old World started simultaneously with that of the cereals, or was initiated very shortly afterward. At least pea and lentil are well under cultivation in the Near Eastern and Greek Neolithic settlements as early as the sixth millennium B.C. Furthermore, from the very start these pulses emerge as close companions of cultivated einkorn, emmer, and barley. The establishment of food production in the Near East and the rapid spread of this new technology to Europe were dependent not only on domestication of cereals but also on cultivation of legumes.

There occurs an obvious parallelism between the ensemble of early domesticants in the Near East and the combination of early agricultural plants (maize and beans) in Mesoamerica. In both centers of origin, the new technology was based on production of easy-to-store and highly nutritious seed. In both centers we face dual utilization of (i) grass kernels rich in starch and (ii) leguminous seed rich in protein, that is, two food elements that largely complement each other and contribute to a balanced human diet.

Also apparent is the close correspondence between the available information on the distribution of the wild progenitors and the evidence extracted from archeological digs. Critical for such comparisons are pea and lentil. As already stressed, in both pulses the wild ancestors are already satisfactorily identified. Significantly, the distribution of wild *Pisum humile* and *Lens orientalis* is centered in the Near East, and in both pulses the earliest signs of cultivation are also detected in this territory (compare Maps 1 and 3 with Maps 2 and 4).

Finally one has to point out also the ecological similarities between the ancestors of pea and lentil and the progenitors of wheats and barley (*49*). All thrive more or less in the same ecological belt. They are all annual components of the Near East oak park-forest formation. Very probably the wild ancestors of the founder cereals and their companion pulses were appreciated and collected by man long before the initiation of agriculture. Subsequently, all were brought under cultivation not only more-or-less in the same period but also under similar field conditions.

Summary

This article reviews the available information on the place of origin and time of domestication of the cultivated pea (*Pisum sativum*), lentil (*Lens culinaris*), broad bean (*Vicia faba*), bitter vetch (*V. ervilia*), and chickpea (*Cicer arietinum*). On the basis of (i) an examination and evaluation of archeological remains and (ii) an identification of the wild progenitors and delimitation of their geographic distribution, it was concluded that pea and lentil should be regarded as founder crops of Old World Neolithic agriculture. Most probably they were domesticated, in the Near East, simultaneously with wheats and barley (certainly not later than the sixth millennium B.C.). Bitter vetch shows a similar mode of origin. The evidence on the broad bean and the chickpea is much more fragmentary and the wild progenitors of these legumes are yet not satisfactorily identified. But also these two pulses emerge as important food elements in Bronze Age cultures of the Near East and Europe.

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