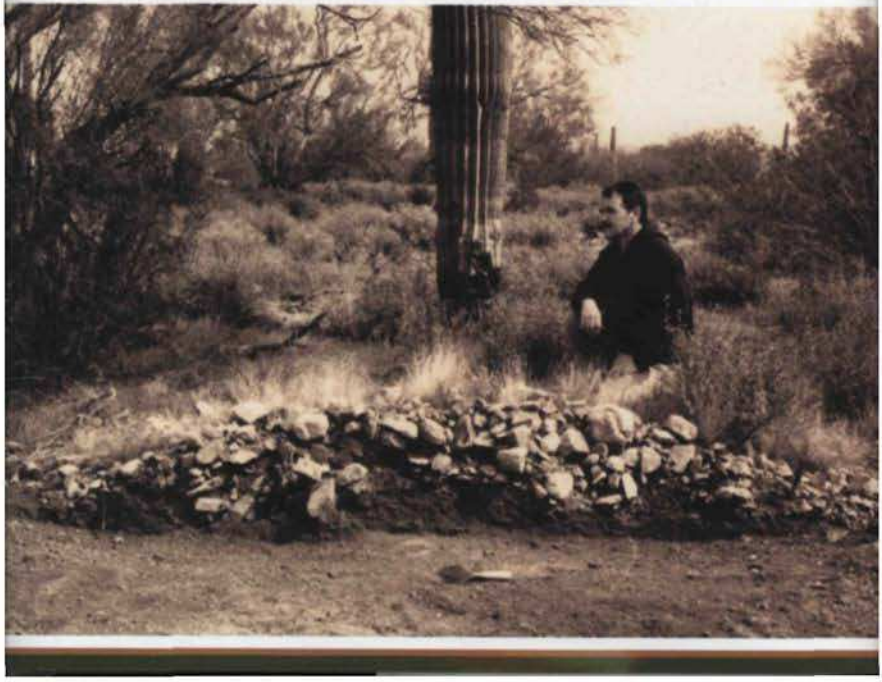
New Lives for Ancient and Extinct Crops

Edited by PAUL E. MINNIS



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CHAPTER NINE

Bitter Vetch (Vicia ervilia)

Ancient Medicinal Crop and Farmers' Favorite for Feeding Livestock

Naomi F. Miller and Dirk Enneking

Vicia ervilia (bitter vetch) is one of the Near Eastern founder crops. Originally grown for food, its importance was soon surpassed by other pulses. After animals were domesticated, it became a fodder plant, too. Its popularity ultimately declined, and nowadays it is grown primarily as a fodder and cover plant (Townsend and Guest 1974). Yet, even less desirable plants may have useful traits, especially at a time of global climate change. Bitter vetch is a short, bushy grain legume grown today as a forage crop mainly in Mediterranean-type climates. Agronomists are working to improve it, other vetches (see ICARDA 2006; Larbi et al. 2011), and other underappreciated early domesticates, such as grasspea, *Lathyrus sativus* (e.g., Kumar et al. 2011; Mikić et al. 2011).

Basic Botanical Information

Vicia ervilia is a herbaceous annual pulse. It has a dense network of roots. The seed pods are constricted between the roughly tetrahedral seeds, and up to five may grow from a single node. Its habit of growth is somewhat bushy, and it grows up to about 70 cm (Davis 1970, 299). Its nonshattering pods allow for mechanical harvesting.

Wild forms of *Vicia ervilia* are characterized by a rosette growth habit under glasshouse conditions, and they show pod shattering. The latter trait is controlled by two dominant loci. Chromosome number (2n=14) is the same in wild and cultivated genotypes, and the two gene pools are

interfertile (Ladizinsky and Van Oss 1984). In addition to wild forms, there are landraces (see, e.g., Frison and Serwinski 1995) and, more recently, bred cultivars. The cultivar O-4, for example, was developed by Panos, Sotiriadis, and Fikas (1961) in Greece from germplasm collected during the 1930s and introduced from other countries, and the "ammara" variety was developed in Lebanon. In Spain there are five commercial cultivars: Huly, Taranto, Moro DA 5, Moro DA 131, and Moro DA 291 (Nadal et al. 2012). Work at ICARDA (International Center for Agricultural Research in Dry Areas) has identified promising and diverse material for dryland farming (Larbi et al. 2011).

Agronomy

Modern genotypes of bitter vetch are characterized by rapid germination and nonshattering pods. The seedlings establish very quickly after seeding. Levels of the toxic amino acid canavanine are relatively low (0.01–0.2 percent seed weight) (all data in this section are based primarily on Esteban 1996; Kernick 1978; Nadal et al. 2012; see also Enneking 1995).

Because of their compact growth habit, the plants are easily harvested and collected by uprooting (Bohrer 1972). The mature plants curl up on the ground during drying, thus necessitating the use of lifters to facilitate mechanical harvesting (Esteban 1996). Seed yields of up to 3 metric tons/ha have been achieved in Spain, and the crop is easy to cultivate (Prudencio Lopez Foster, pers. comm.). Herbicide options for weed control in the crop are limited (Esteban 1996; Nadal et al. 2012), and considerable scope exists to select better herbicide tolerance within the species. *Vicia ervilia* is drought and cold tolerant and does well in shallow soils (Enneking et al. 1995; Guinea Lopez 1953; Kernick 1978). Nitrogen fixation in bitter vetch is effective (Nadal et al. 2012). A study by Tang and Thomson (1996) suggests that the species is poorly nodulated by commercial *Rhizobium inoculum* that usually works well with other Vicieae species in Australia, so care is needed with the introduction of the crop to new areas.

Bitter vetch seeds are high in protein (20–27 percent) and are valued as feed for cattle, sheep, and camels, although ruminants like sheep and goats should not have more than 25 percent of their diet as bitter vetch. Processing of the seed (cracking, steeping in water, fermentation) has been practiced even for ruminant feeding. The species has been implicated in several cases of human neurolathyrism, an irreversible neurotoxic crippling disorder (Grmek 1980; Schuchardt 1885). Its seeds and herbage

can be toxic to monogastric animals, such as poultry (Sadeghi et al. 2004, 2009) and swine (Jean-Blain 1949; Wilczek and Tschumi 1919; see also Lopez Bellido 1994).

Taxonomy of Vicia ervilia *(L.) Willd.*

Vicia ervilia (L.) Willd. (syn. *Ervum ervilia* L.) is in the section Vicieae, family Fabaceae (sometimes placed in Papilionaceae). Worldwide, there are 140–200 species of *Vicia*, most of which grow in temperate regions of the northern hemisphere (Bryant and Hughes 2011; Lock and Simpson 1991, 213; van de Wouw et al. 1999). Economically important species include fava bean (*Vicia faba* L.), grown for food and fodder, along with fodder plants such as common vetch (*Vicia sativa* L.), broad-leaved vetch (*V. narbonensis* L.), hairy vetch (*V. villosa* Roth), and Hungarian vetch (*V. pannonica* L.) (Bryant and Hughes 2011; Francis, Enneking, and Abd El Moneim 2000; Townsend and Guest 1974; van de Wouw et al. 1999). The vetches are closest taxonomically to chickpea (*Cicer*), lentil (*Lens*), and grasspea (*Lathyrus*) (Davis 1970). Vetch seeds contain significant levels of toxic amino acids and other antinutritional factors (Berger, Robertson, and Cocks 2003; Enneking 1995) that help to inhibit pest infestation but also render them unpalatable to toxic without processing (Barbour, Kallas, and Farran 2001). Nevertheless, major pests are parasitic weeds (*Orobanche* species) and aphids.

Alphonse de Candolle (1882) concluded that the diversity of common names for a species was an indication of an ancient and general culture, but in the case of bitter vetch, we seem to have a few terms that were applied to several different but related genera. Complicating matters is ancient plant nomenclature and ethnotaxonomy. An Akkadian word, *kiššanu*, appears in Mesopotamian texts of the second millennium BC and is thought to refer to vetch in general (Stol 1985). This word is related to the modern Arabic term for bitter vetch, *al-karsanah*. If one accepts the literal translation of a Sumerian composite ideogram comprising the signs for "bitter" and "legume" as "bitter vetch," then our earliest textual sources for *Vicia ervilia* are Hittite (Stol 1985).

The term *orobos* (ancient Greek) and the related *ervum* (Latin) had varied meanings (see Bretzl, cited in Schnebel 1925). *Orobos*, *erebintos*, and *ervum* were also words applied to the pulses *Cicer*, *Lens*, *Pisum*, and *Lathyrus sativus* (Hegi and Gams 1924). It is interesting that the folk nomenclature reflects our scientific understanding of the close relationships of these genera. In Diocletian's *Edict de pretiis rerum venalium*, *orobos* is

equated with *ervum*, thus meaning *V. ervilia* (Schnebel 1925). According to Hegi and Gams (1924), *ervum* was the name of a pulse mentioned by Columella and Pliny the Elder (cf. *V. ervilia*; Hegi and Gams 1924, 1512). The word is related to the Greek *orobos* and *erebinthos* (=*Pisum* and *Cicer*) and with the Old High German *arawiz*, from which the German name for pea evolved (*Erbse*) (Hegi and Gams 1924).

There are names for bitter vetch in many modern languages. The Spanish name (variants including *alcarceña, alcaruna*) comes from the Arabic *al-karsanah*, which is related to the Persian *kerseneh*. The classical Greek (*orobos*) and related Latin (*ervum*) are the source of many terms in the Romance and Germanic languages (Fr.: *ers, ervilière*; Eng.: *ervil*; Port.: *orobo, ervilha-de-pombo*), and its leguminous relations are acknowledged in such terms as the French *lentille ervillière* and *lentille bâtarde*, the German *Linsenwicke* and *Ervenlinse*, the Spanish *lenteja bastarda*, and English *pigeon's pea* (see USDA 2010). The Turkish *burçak* (bitter vetch) and *karaburçak* (black vetch), however, seem unrelated to the Indo-European and Arabic terms. The Italian *ingrassabue* (ox fattening) (Hegi and Gams 1924) attests to its nutritive value for cattle.

Distribution and Area of Cultivation

Vicia ervilia cultivation is widespread across Eurasia, including Afghanistan, Uzbekistan, Iran, Iraq, Israel, Jordan, Lebanon, Syria, and Turkey. The plant grows wild in Asia Minor and the Fertile Crescent (Zohary, Hopf, and Weiss 2012). Its main distribution is in the Mediterranean region and southwest Asia (Davis 1970).

Historically, *V. ervilia* was cultivated in the whole of the Mediterranean and Balkan areas. It was especially common in Spain, Italy, and Greece (Barulina 1930; Fischer 1937; Hegi and Gams 1924). Its area of cultivation extends to the Caucasus (Dzyubenko and Dzyubenko 2008), to altitudes up to 3,100 m in Afghanistan (Vavilov and Bukinich 1929). In Cyprus, Syria, Lebanon, and Palestine, *V. ervilia* cultivation was widespread as recently as the first half of the twentieth century (Dinsmore 1932, as cited in Townsend and Guest 1974; Mann 1947). In Israel, it is grown as a fodder plant but also appears subspontaneously or as an escapee from cultivated ground (Zohary 1973). It is still cultivated in Turkey (Durutan et al. 1990; Ertuğ 2000), Spain, Greece (including Crete), and Cyprus (Barulina 1930; Esteban 1996; Fischer 1937; Mateo Box 1961; Nadal et al. 2012). In Morocco it is cultivated in the Arbaoua, Ouezzane, Pre-Rif, Rif, Fès, and Taza regions (Enneking et al. 1995), where germplasm was collected by

joint INRA/Centre for Legumes in Mediterranean Agriculture/ICARDA missions (Francis, Bounejmate, and Robertson 1994).

In northern Iraq, for example, Van Der Veen (1960) found that annual winter legumes cultivated for fodder were grown on a very limited scale in small fields. They were planted for seed, which was fed as a concentrate in the following winter. In a region east of Erbil, *V. narbonensis* was used for this purpose, in other areas *V. ervilia* was the main legume seed crop. It was found that *Lathyrus sativus* and *V. narbonensis* were the most promising legume crops for the submontane, rain-fed (400–600 mm annual precipitation) wheat belt area because they did not suffer much bird damage in midwinter (January–February).

Though broadly cultivated in southern and central Europe in the modern era, bitter vetch has become a minor crop with the disappearance of draft animals such as oxen, due to its low yield compared with other crops and because of neglect by most plant breeders. In recent times the cultivation of the crop has been mechanized in Spain (Esteban 1996; Nadal et al. 2012), where its area of cultivation increased to more than 100,000 ha as a consequence of European financial incentives (Enneking and Tate 2006).

Archaeological Evidence of Domestication

In contrast to domesticated bitter vetch, the wild form has "dehiscent pods and slightly smaller seeds" (Zohary, Hopf, and Weiss 2012, 92). Evidence for its domestication (i.e., genetic change induced by selection as a crop) can best be inferred by changes in seed size. The most secure archaeological argument that the seeds were economically useful is if they are present in a relatively pure concentration. Given the further requirement that most preservation comes through charring, one is most likely to find seed concentrations either in an accidentally burned food storage area or, if the seeds were habitually processed by fire, in some kind of roasting pit. Available archaeobotanical reports have varying level of details about the context of bitter vetch finds, but broad comparisons are possible. There are no reports of bitter vetch from Lower Mesopotamia or the Iranian Plateau, so we limit our discussion of the west Asian remains to Upper Mesopotamia, which is broadly northern Syria and Iraq; the "Hilly Flanks" of the Zagros and Taurus mountains, which cover southeastern Turkey and northeastern Iraq; central Anatolia, Mediterranean Anatolia; the Levant (Israel, Jordan, Lebanon, Palestine, coastal Syria); and the Iranian Zagros. Because seed concentrations of any type tend to be restricted to sites with

burnt structures, absence of bitter vetch concentrations may merely reflect absence of burning. For that reason, we consider the presence or absence of other crop plant concentrations as well (see figure 9.1).

History of the Crop

Wild forms of the plant grow in the southern part of Turkey and in an arc from upland regions of Lebanon, Syria, and Jordan, through southeastern Turkey and northeastern Iraq (Zohary, Hopf, and Weiss 2012). The Early Holocene distribution may have been somewhat different, as Upper Mesopotamia in particular appears to have been moister and more wooded at that time (Hillman 1996, 190; Savard, Nesbitt, and Gale 2003).

Plant cultivation in West Asia appears to have begun in the tenth millennium cal. BC (Willcox, Fornite, and Herveux 2008). Bitter vetch is a minor component of assemblages at a number of sites and is one of the earliest cultivated plants. As Willem van Zeist (1988), George Willcox (Willcox et al. 1996), and others point out, however, we cannot pinpoint use, cultivation, or domestication from such finds.

An examination of occurrences of bitter vetch and other crop plants from West Asia suggests several patterns. The earliest occurrences are sporadic, occasional finds of bitter vetch at the edge of the modern distribution, which, 12,000 years ago, was probably in the natural habitat zone. They appear in two sites dating to around 10,000 cal. BC, Jerf el Ahmar and Qaramel. Those sites have similarly early evidence of cereal cultivation (Willcox et al. 2008; Willcox, Buxo, and Herveux 2009). It is not certain whether the vetch was cultivated. Because there are no seed concentrations, its importance as a collected food plant is also not clear. Bitter vetch first occurs in a concentration at the ninth millennium cal. BC sites of Çayönü (van Zeist and de Roller 2003b) and Gritille (Miller 2002), well within the present natural habitat zone. Scattered bitter vetch finds at the approximately contemporary site, Aşıklı, have a similar distribution to that of the clearly cultivated cereals. Because that site has no domesticated animals, van Zeist and de Roller (2003a) argue the seeds are food crop remains. Its cultivated status in the fairly frequent, scattered finds from Upper Mesopotamian sites suggest that cultivated or not, its distribution in the ninth millennium BC was broader than today (and consistent with Hillman's [1996] vegetation reconstruction).

By the time agriculture became fully established during the Prepottery Neolithic B period (seventh millennium BC), occurrences of bitter vetch as crop or wild plant are most frequent in the present natural habitat

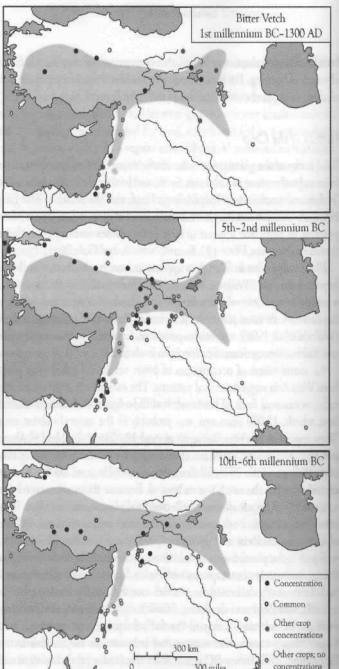

Figure 9.1. Sites with archaeobotanical evidence for bitter vetch as a crop plant. Minor occurrences not included. Shaded areas represent present-day distribution of wild populations (Zohary, Hopf, and Weiss 2012, map 11).

zone on the Anatolian Plateau. As sheep and goat came increasingly under human control, pulses in general, but especially bitter vetch, tended to decline in importance. One explanation for this phenomenon is that as milk and meat entered the diet, protein from pulses was less necessary to complement the incomplete protein provided by the cereals (Miller 2002). Given its toxicity and attendant processing cost, it is not surprising that the popularity of vetch would suffer even more than that of other pulses.

During the Prepottery Neolithic B period in Upper Mesopotamia, frequent scattered occurrences suggest it was a minor crop or field weed. In the "Hilly Flanks" area, it seems to have been important in the Early Neolithic, but soon dropped out as a major crop. It remained important in central Anatolia, and in the Later Neolithic its cultivation spread to the coast as well as becoming increasingly important in southeastern Europe (see references in Kroll 1991). At the third millennium BC site of Yenibademli, on an island in the Aegean, burnt layers yielded large amounts of bitter vetch. This site also yielded a jug containing millions of clover seeds, probably seed stock for fodder (Dönmez 2005). Because barley had been grown for fodder for millennia, this find may be evidence that people had begun to understand that legumes improve soil fertility as well as animal nutrition.

In the Levant, bitter vetch became most important in the second millennium BC. This may be associated with establishment of horse riding and chariot warfare (see Moorey 1986; Vila 2006). Bitter vetch never became an important crop in the Zagros, although the Iron Age sites of Hasanlu and Nush-i Jan have small amounts. Miller saw it under cultivation in the 1970s in the southern Zagros (pers. obs.).

Very early occurrences of bitter vetch in southeastern Europe (Franchthi, in the Argolid; Hansen 1991) and southwestern Europe (Mesolithic Balma Abeurador, France, ca. 10,000 BP; Vaquer et al. 1986) probably represent collected plants. Helmut Kroll's summary of crop remains from southeastern Europe (Kroll 1991) shows Macedonia as a center of spread for bitter vetch cultivation from northwestern Anatolia toward Bulgaria to the northeast, Thessaly and the Argolid to the south, and Vojvodina and Bosnia to the northwest.

Nature of Bitter Vetch Use in the Past

The bitter vetch (*Vicia ervilia*) plant has toxic seeds that can, with proper processing, be eaten by people or animals (Sadeghi et al. 2009; Valamoti,

Moniaki, and Karathanou 2011). Boiling the whole seed in several changes of hot water until most of its bitterness is removed produces a product with agreeable texture and a pleasant nutty flavor (Enneking, pers. obs.). There are ancient text references to medicinal uses for the seeds as well (Gerarde 1636; Grmek 1980; Luce 2000; Riddle 1985). The plant itself can be used for forage or as a green manure. Unfortunately, there is no direct way to tell how the plants were grown or used from the archaeobotanical remains, which consist only of seeds.

Although there are many mentions of words for various pulses in Sumerian and Akkadian texts from Mesopotamia, it is unclear whether any can be translated as bitter vetch. Harry Hoffner concludes that the sumerogram GÚ.ŠEŠ refers to bitter vetch in Hittite texts (second millennium BC). It is listed in a context that includes other foods: chick pea, broad bean, lentil, and sour bread (Hoffner 1974, 98).

Skipping many centuries and moving west, we note that Classical references dating to the first millennium BC and later concern fodder, food, and, primarily, medicinal uses (Luce 2000). In a discussion of pulse cultivation, Theophrastus (b. ca. 370 BC) comments, "If one sows vetches [Gr.: *orobos*] in the spring, they become quite harmless and are not indigestible like those sown in autumn" (Theophrastus 2.4.2), implying that they can be grown in either season. It may be interplanted among radishes against spider infestations (7.5.4). Although the seeds on one plant do not ripen uniformly (8.2.5), he considers bitter vetch and chickpea to be the most pest resistant of the cultivated pulses (8.11.2), assuming the term *orobos* has a one-to-one correspondence with *Vicia ervilia*. In modern Greek, *V. ervilia* is still called *rovi*, *robi*, *orobo*, or *rhobidia*. Columella (AD 4 to ca. AD 70) advises not to sow bitter vetch after the first of March as cattle can then get hot-headed from feeding on the crop (Columella 1954).

Pliny the Elder (b. ca. AD 23) repeats several of Theophrastus's comments but adds more detail. Most of his discussion of bitter vetch (L.: *ervum*) concerns the seeds, usually ground into meal, as an ingredient for skin treatments (Pliny the Elder 1938, 18:65, 20:20, 22:151–53, 23:26), other ailments (17:118, 22:29; 26:60, 63, 38:139), and a poison antidote (20:264, 23:127). Apparently sometimes eaten (33:139) and used as leaven for barley bread (18:139), "this vetch makes unwholesome human food, causing vomiting, disturbing the bowels, and causing heaviness in the head and stomach, besides enfeebling the knees" (22:151–53). Other deleterious effects for man and beast (38:139) and the vine (22:240) are mentioned. The plant is fed to animals (13:130), as are the seeds (38:139), which should be soaked for several days (22:153) before being fed to cattle

and "beasts of burden." The pods, stalk, and leaves also serve as a black hair dye (22:153). Pliny does recognize that the growing plant enriches the soil (17:56) and that it is "not difficult to cultivate . . . [and] needs weeding more than the vetch" (38:139). He mentions insect pests (18:156), harmful weeds (18:155), seeding rates compared with other pulses and cereals (18:198), and, probably citing Theophrastus, its value interplanted with root crops.

An interesting lead to the pharmacological virtues of bitter vetch seed is given by Gerarde (1636) whose main sources are Dioscorides and Galen: "By how much it is bitter, by so much it cleaneth, cutteth, and removeth stoppings: but if it be overmuch used it bringeth forth blood by urine." According to John Riddle (1985), who discovered that Dioscorides arranged his pharmacopoeia according to the biological activity of the drugs, bitter vetch may have anticarcinogenic properties. If an obscure report on the cholinergic activity of water extracts made from bitter vetch seed and the toxic crystals isolated by Almazan Gil (1974) and the interesting immunological effects in poultry (Barbour et al. 2001) are any indication, then a closer look at the pharmacological properties of this species may help to explain its intriguing bitterness and toxicity. Although nonspecialists, like the present authors, should use translated ancient texts with special care, the Perseus Digital Library (http://www.perseus.tufts.edu) has searchable texts for classical and later authors such as Hippocrates's *De prisca medicina* and Celsus's *De medicina*, whose mentions of bitter vetch reflect their interests in plants on the food-medicine-poison continuum rather than the economic uses of the plant.

Discussion and Summary

One of the more surprising aspects of bitter vetch is that it appears to have been cultivated first for human food and only later for fodder. The earliest archaeological occurrences are from sites that antedate or are on the cusp of animal domestication. The earliest concentrations of seeds appear to have been intentionally processed by fire. By the time of the early civilizations, human consumption of bitter vetch was probably limited to a few sites in Turkey and the Levant. But by then, its value as a fodder would have been apparent. The spread of cultivation to Europe may have started accidentally with seeds growing in fields of lentil (see Erskine, Smartt, and Muehlbauer 1994), and bitter vetch became an important pulse crop in Bulgaria and Greece (Zohary, Hopf, and Weiss 2012, 94).

It is unlikely that bitter vetch will once again be grown as a staple food. Nevertheless, it has potential as a delicacy in the boutique food market. Perhaps the ancient profession of vetch selling (Schnebel 1925) still has a rosy future? Yet, in a time when climate is becoming increasingly erratic and desertification is an ever present problem, crop biodiversity is an important thing to preserve. The very toxicity of the seeds keeps them relatively safe from pests, and the plant is somewhat stress tolerant. If we could improve the yield of the crop through a focused plant breeding effort and learn to use its pharmacological and qualitative properties advantageously, bitter vetch can once again become a useful and widespread crop to sustain the well-being of cultivators and their flocks.

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