

Review

Pistachio (*Pistacia vera*) Domestication and Dispersal out of Central Asia

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Abstract: The pistachio (*Pistacia vera* L.) is commercially cultivated in semi-arid regions around the globe. Archaeobotanical, genetic, and linguistic data suggest that the pistachio was brought under cultivation somewhere within its wild range, spanning southern Central Asia, northern Iran, and northern Afghanistan. Historically, pistachio cultivation has primarily relied on grafting, suggesting that, as with many Eurasian tree crops, domestication resulted from genetically locking hybrids or favored individuals in place. Plant domestication and dispersal research has largely focused on weedy, highly adaptable, self-compatible annuals; in this discussion, we present a case study that involves a dioecious long-lived perennial—a domestication process that would have required a completely different traditional ecological knowledge system than that utilized for grain cultivation. We argue that the pistachio was brought under cultivation in southern Central Asia, spreading westward by at least 2000 years ago (maybe a few centuries earlier to the mountains of modern Syria) and moved eastward only at the end of the first millennium AD. The seeds remain rare in archaeological sites outside its native range, even into the mid-second millennium AD, and may not have been widely cultivated until the past few hundred years.

Keywords: archaeobotany; history; linguistics; arboriculture; tree crop

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1. Introduction

The global production of pistachios has increased dramatically over the past few decades, from around 50 thousand tons in 1970, to 500 thousand tons produced globally in 2000, to more than 1 million tons in 2020 [1]. Based on the FAOSTAT data [1], the most significant increases in area of cultivation, almost tripling, occurred in Jordan, Madagascar, Kyrgyzstan, California in the United States, Turkey, Uzbekistan, Azerbaijan, and Mexico. However, Iran, Turkey, and the USA continue to maintain the highest pistachio production. The edible seed is fixed within a drupe, protected by a thin endocarp (shells), and they have attracted human attention for millennia. The pistachio is sometimes called the golden tree in Turkey, Iran, and Syria, referencing its economic value [2]. The pistachio is an important ingredient in traditional cuisines across west Asian and Arabic countries. While, many scholars have discussed the origin of the pistachio, there remain disputes over the two proposed centers of origin: (1) Syria, eastern Anatolia, and Central Asia [3,4]; and (2) southern Central Asia [5–7]. The lack of archaeobotanical data has, thus far, limited discussions, and most scholars simply assume an origin within the modern wild range—in the southern Central Asian foothills. In addition to a lack of agreement regarding the geographic center of domestication, dates for domestication have been proposed for as far back as 8000 years ago [8]. Combining a review of archaeobotanical, historical, archaeological, and linguistic data, we attempt to

find out when, where, and via what routes, the cultivated pistachio evolved domestication traits and then was dispersed. Ultimately, we argue that the pistachio was brought under cultivation in southern Central Asia and spread south and west by the end of first millennium BC and east by the end of first millennium AD. There is a lack of evidence for widespread cultivation of the shrubby tree as a commercial crop from before one millennium ago, and no clear evidence for commercial-scale cultivation outside southern Central Asia until a few centuries ago; although, there is evidence for a deeper history of cultivation in Syria.

1.1. Botany and Ecology

Pistacia vera—the progenitor of all commercial pistachios—is a diploid ($2n = 30$), xerophytic [9], subtropical [10], and woody perennial; it is a wind-pollinated and avian-dispersed, deciduous, and dioecious shrubby plant [9,11]. The species lineage is estimated to date back to between 1.82 and 3.38 million years ago [12]. It is not only heat tolerant but also cold resistant [11]. Due to its tolerance of harsh environmental conditions, the pistachio grows in both semi-arid deserts and dry slopes of low mountains and foothills [13]. Its deeply penetrating roots allow it to weather arid periods [6], and the production of jasmonic acid provides salt tolerance [8]. Despite these adaptations, *P. vera* maintained a restricted wild range during the late Holocene, clearly placing its center of origin in Central Asia at the heart of the Silk Road trade routes. Notwithstanding the established trade networks and long tradition of arboriculture in this part of the world, the pistachio appears to have taken longer to disperse across Eurasia than other tree crops. The delay in dispersal may be due to its reproductive biology, notably a need for mating pairs, large closely clustered populations to facilitate wind pollination, and knowledge of grafting and artificial propagation for maintaining clonal variants. Despite its tolerance to the numerous environmental factors discussed above, a recent study in the Edremit Gulf Region of Turkey [14] shows that productive pistachio cultivation requires special environmental conditions. Although, Tekin et al. [15] confirm that high yield production can be reached even if the trees are grown on clay or sandy loam or on deep and partially calcareous soils. Areas with a high-water table are worse for pistachio cultivation. There are numerous recommendations for soil requirements, see for more details [14], and experts suggest that one of the most important variables in pistachio production [14–16] is a hot and long summer (25–35 °C), with low humidity. *P. vera* rootstocks express sensitivity to specific climatic and environmental conditions and have varying levels of tolerance to fungus. For example, Ferguson [17] describing a case study of pistachio cultivation in California wrote, “the industry was developed on the *Pistacia atlantica* rootstock but large number of losses from the soil borne fungus *Verticillium dahliae* led to replacement with the tolerant rootstock” (p. 112).

Understanding the beginnings of perennial crop cultivation, especially for long-generation perennials, is a topic of considerable interest, as it illustrates very different concepts of land tenure, trans-generational forethought, and complex cultivation practices, including grafting, and, in some cases, artificial pollination. The earliest clear evidence for the cultivation of a long-generation perennial in Central Asia comes from grape pips at urban sites in the Kopet Dag Mountains, dating to 2500 BC [18,19]. Gradually, after this point, other ancient Central Asian arboreal crops were brought under cultivation (at least in part within the region), including a number of rosaceous fruit trees, such as apples (*Malus pumila* Mill.), possibly also quinces (*Cynodon* spp. Rich.), medlars (*Mespilus germanica* L.), as well as Russian olives (*Elaeagnus angustifolia* L.), walnuts (*Juglans regia* L.), and almonds (*Prunus amygdalus* L.). Many of these species, such as the walnut and the apple, had expansive ranges and domestication was, in part, the result of hybridization of individuals from different parts of those ranges. In the case of the pistachio, anthropogenic dispersal would have been particularly difficult, due to the complexities of its genetics. As a dioecious and wind-pollinated plant, it would not have been enough for an entrepreneurial farmer to collect a few seeds and plant them

elsewhere; early pistachio cultivators would have had to transplant a full population of multiple male and female plants into a suitable new area. The fact that this appears to have occurred during the Hellenistic period (323–31 BC), marked by the expansion of pistachios into the area of modern Syria, is testament to the awareness that ancient people had regarding the anatomy and reproductive cycle of this complex plant.

1.2. Progenitor Range and Ecology

Studies of the wild range of *P. vera* have led most scholars to conclude that the crop originated in Central Asia, where the only extant wild populations occur [6,7,11,20]. Zeng and colleagues [8] also suggested that a genetic bottleneck during the Pleistocene may have segregated insular populations of pistachios in ice-free valleys across southern Central Asia. Interestingly, despite being dispersed by birds, the wild pistachio appears to have remained isolated in these small glacial refugial pockets through the Holocene until humans began dispersing it. It is also possible that wild pistachios could have occupied a larger area, likely to the west of the extant wild range, possibly stretching into what is now the Turkmen or Kurd mountains of northern Syria [21]. The current wild range covers select foothill zones in Turkmenistan, Uzbekistan, Tajikistan, Kyrgyzstan, southeastern Kazakhstan, northern Afghanistan, and northeastern Iran. Wild pistachios grow along a narrow ecotone between 500 and 800 masl in Central Asia [11]; although, given variations in orographic conditions, pistachio trees may be found to the extremes of 450 or 2000 masl [22]. The most northern distribution of pistachio forests is located in southeastern Kazakhstan—in that area, they grow between 700 and 1100 masl.

Botanists have reported three ecological pockets of wild *P. vera* across southern Central Asia [10,11]. The northern or Tian-Shan Region, an area of only around 30,000 ha of forest, which is mainly distributed in the Tian-Shan of northwestern Kyrgyzstan—on foothills (800–1600 masl) of the Fergana and Chingir-Tash mountains, in Uzbekistan and southern Kazakhstan. The central or Central Pamir-Alay Region is where most extant pistachio forests are located; this region covers the Pamir-Alay Region and southwestern Tajikistan (130,000 ha), southern Uzbekistan (15,000 ha), and in eastern Turkmenistan (5000 ha), at an altitude of 500–1800 masl. The southern or South Kopet Dag Region covers almost 75,000 ha, distributed within southwestern Turkmenistan and the Badkhis (Badkhyz) region at an altitude of 600–1000 masl. Old pistachio trees have been recorded at Damghan, Ghazvin, and Ardekan, and a 700-year-old pistachio tree was reported in Kerman [6]. Given their growth habits, scholars often refer to *P. vera* populations in Central Asia as “groves” or “savannas” rather than forests [10].

Today, only 300,000 ha of Central Asia is covered with wild *P. vera* [16], but a few centuries ago, much larger territories were populated with pistachio groves. In his ethnographic essay, Arandrenko [23] mentioned pistachio forests nearby Panjakent, which were cut down and used for charcoal production. In the 1950s, Whitehouse [6] reported that “the pistachio is seen everywhere from mountainous Bokhara through the region of Samarkand and the whole of Fergana up to the western Tian-Shan”. In addition to the above-mentioned countries and regions, wild pistachio trees are abundant in northern Afghanistan [22,24] and northeastern Iran [25]. The valuable tree is over-exploited in Central Asia, due to a lack of enforcement of government conservation policy. The main problems for the pistachio are unregulated grazing [10] and the harvesting of the tree for firewood [26], leading to slow regional extirpations. Half a century ago, Whitehouse [6] observed the impacts of heavy pasturing of cattle among some *P. vera* patches. Other early explorers into Central Asia over the past few centuries have noted the prominence of pistachio cultivation. For example, traveling near Bagdad in the late seventeenth century, Bembo [27] (p. 57) stated: “In the same hills I saw many wild pistachio trees. On the outside the fruit looks like beans, but inside one sees that they are of the color of good pistachios. They salt them, and then people in both Persia and Turkey eat them with great satisfaction”. Traveling through Central Asia in the late nineteenth century, Schuyler [28] noted pistachio cultivation in Tashkent and Jizzakh, Uzbekistan,

and made particular reference to the fact that the trees can be cultivated up to 3500 masl in the especially mild Khujand Valley, Tajikistan. He also noted being presented dishes of dried fruit and nuts, containing pistachios, during his travels through Central Asia. Marvin [29] (p. 307), when traveling along the Heri River in Turkmenistan, stated that “the sides of the mountains in the valley of the Heri Rood are almost exclusively covered with wild pistachio-trees”. Fraser [30] noted pistachio nuts as being one of the main commodities while passing through Herat, Afghanistan, along with saffron (*Crocus sativus* L.), asafetida (*Ferula assa-foetida* L.), almonds, dried fruit, and silk; he goes on to also note the prominence of pistachio trees in Ferghana.

2. Domestication

Although wild pistachio drupes are smaller than domesticated ones [8], it is impossible to confidently differentiate individual specimens of the morphotypes, due to the wide reaction norm of developmental plasticity in the species. Even nuts collected from the same tree may vary considerably in shape and size, one recent morphological study showed that domesticated pistachio endocarps range from 9.91 to 19.15 mm in length and between 6.54–11.65 mm in width [31]. Talebi and colleagues [32] linked a high level of genetic diversity among *P. vera* to the different geographic distribution zones of analyzed accessions.

This diversity makes differentiating between wild and cultivated forms in the archaeological record complicated, but it remains very easy to differentiate *P. vera* (the only species that we discuss in this paper) from other species in the genus, as all other species bear fruits around 4.00 to 8.00 mm in diameter and they are usually roughly spherical [6]. While small-seeded species primarily appear in archaeological sites in the Mediterranean, we will not discuss them in this paper. It is worth noting that at least a few of these species have been economically significant as sources of resin, notably *Pistacia atlantica* Dest., *Pistacia terebinthus* L. (terebinth), and *Pistacia lentiscus* L. (mastic), and in East Asia, *Pistacia chinensis* Bunge., *P. terebinthus*, and *P. atlantica* have also been used during recent cultivation programs as hardy rootstocks for grafting *P. vera*, since *P. vera* scions can take to rootstocks of species across the genus [9,33,34].

2.1. Grafting and Pollination

Domestication for many long-generation perennials is characterized by a shift from sexual reproduction to vegetative propagation [35]. In the case of the pistachio, the acquisition of grafting techniques (seen by some scholars as instant domestication) would have been essential for domestication, as the tree does not lend itself to simple vegetative propagation [25]. Today, grafting is used to improve resistance to diseases, pests, and other biotic and abiotic stress [36]; grafting can also lend to the creation of unusual growth forms, repair damaged plants, and reduce overall plant size and mass; however, in the past, the principal use for grafting would have been for vegetative propagation of woody perennials that are difficult to propagate sexually or which might lose a favorable trait if grown from seeds [33]. There are three key processes in a plant affected via grafting: water and nutrient transportation, production and transportation of hormones, and the large-scale movement of mRNAs, small RNAs, and proteins [37] (p. 426). We speculate that there were two independent diffusions of the pistachio from Central Asia: one to the Irano-Caucasian region and the second one to Syria, due to the fact that they were grafted with other *Pistacia* species (*P. atlantica* and *P. palestina* in Syria; *Pistacia mutica* Fisch. & C.A. Mey., *Pistacia khinjuk* Stocks., and *P. vera* seedling rootstocks in Iran). For this reason, we may observe two separate clusters distinguished earlier by Hormaza and colleagues [21,38].

Zohary and Spiegel-Roy [35] argued that grafting was likely practiced by at least as early as three millennia ago. Although, other scholars have argued for earlier dates for the innovation; Harris et al. [39] suggested an origin date of almost four millennia ago in Mes-

opotamia. More conservative dates have also been proposed, suggesting that the innovation did not take hold until the late first millennium BC. Mudge et al. [33], reviewing Biblical texts (dated between 1400 and 400 BC) and ancient Greek and Persian written sources, claimed that grafting was well-known in the eastern Mediterranean by the second half of the first millennium BC. Whereas, Weiss [40] maintains that grafting was introduced from East Asia in the Roman period (27 BC–286 AD).

It is important to recognize that grafting would only lock desirable variants in place, as it would not have been essential for propagation. Pistachios can be dispersed and propagated from germinated seeds (Whitehouse 1950); however, it could have been an issue for early farmers to ensure a desirable number of female and male trees for sufficient pollination. Therefore, unlike in the case of parthenocarpic fruits, archaeological evidence for pistachio cultivation and dispersal cannot be directly linked to early grafting traditions. Many scholars have pointed out that rosaceous fruit trees required grafting for domestication, as they largely represent hybrids that are locked in place via clonal propagation [41]. As with the apple (*M. pumila*), the modern pistachio does not breed true. While a genomic analysis by Zeng et al. [8] identified multiple hybridization events between wild *Pistacia* species, it did not recognize any recent crop-to-wild introgression and verified the already well-accepted scenario of a single species progenitor. However, there is still a lack of evidence for when larger seeded varieties or robust foliage evolved under cultivation. Two genes, SAUR55 and CYCD7-1, have been linked to an increase in tree mass and seed size [8]. Given that pistachios can be sexually propagated, and their wild forms are not significantly different from their domesticated forms, it is probable that the landraces of pistachios observed around the world today were recently developed.

As noted above, the pistachio is dioecious and wind pollinated. Consequently, it is necessary to have enough male trees in close proximity to a female for sufficient pollination [42]. The complex pollination requirements may have been one of the reasons for the delayed dispersal of the crop along the Silk Road [43]. Additionally, the domestication of this species may not have fully unfolded until the past few hundred years, because cultivators would have needed a good understanding of grafting techniques as well as a realization that large dense populations were required for sufficient pollination. Suitable ratios of male and female trees, with appropriate distribution in an orchard, are important factors taken into consideration by farmers today [42].

Ancient farmers would have been well aware of the general process of pollination, as the first textual reference to the pollination process appeared in the 64th and 65th *Code of Hammurabi* (1750 BC) [44]. Depictions of artificial pollination are abundant in relief images from the Assyrian period, but they take the form of a mythical pollinating deity called Apkallu. As one example out of many, the Nimrud bas-reliefs, which adorned the royal palace of Ashur-Nasir-Pal, the Assyrian King from 885 to 860 BC, see photos and more details in [45]. It is clear that, by the period of ancient Greece, artificial pollination was a common practice; for example, Theophrastus [46] [[375 BC]: II, viii. 3–4] wrote “With dates it is helpful to bring the male to the female when the male palm is in flower, that at once cut off the spathe on which the flower is, just as it is, and shake the bloom with flower and the dust over the fruit of the female”. Four centuries later, Pliny the Elder in AD 79 [47] (XIII, vii. 35) also described artificial pollination of date palms, writing, “mankind has actually devised a method of impregnating them by means of the flower and down collected from the males, and indeed sometimes by merely sprinkling their pollen on the female”. In all of these cases, the artificially pollinated species was the date palm, and, as with the pistachio, it is anemophilous. If farmers in the eastern Mediterranean and across southwest Asia by at least two and a half millennia ago were artificially pollinating date palms, then it may have been easy to spread the pistachio into this region. There are no historical sources that specifically mention mechanical pollination for pistachios in Central Asia in the past; moreover, pistachio pollination is more complicated as most of the male trees bloom earlier than female ones [42].

The timing of the beginning of cultivation and eventual domestication for the pistachio require further archaeobotanical investigation. The lack of clarity is illustrated by a team of geneticists [8], who recently speculated that domestication could date back to around 8000 years ago; these scholars corroborate their surprisingly early date with genetic clock data and an obscure reference to pistachio consumption by 6750 BC. However, the reference, i.e., [48] that they appear to be citing is almost certainly mentioning *P. atlantica* secondarily from earlier sources, see [49]. Given that there is no good evidence for pistachios being cultivated at that early period and limited evidence for farming villages existing within the range of wild pistachios, the early genetic clock date is at present hard to defend.

2.2. Archaeobotanical and Historical Sources

Hormaza et al. [21] tracked genetic relatedness and geographic movements in *P. vera*. Their study distinguished two clusters among 13 studied pistachio varieties, the: (1) Mediterranean cluster consisted of cultivars originating in the Mediterranean, southwest Asia, and northern Africa; and (2) Iranian-Caspian cluster, with cultivars obtained from east of the Zagros Mountains. In their 1994 genetic study, the team speculated that the two distinct populations could represent separate centers of domestication. A few years later, Hormaza and colleagues [38] added 16 more cultivars, confirming the already well-accepted hypothesis that pistachios are monophyletic, as other scholars [8] would further confirm, and that they originated in or near southern Central Asia [38]. The lack of archaeobotanical evidence for pistachio seeds anywhere outside southern Central Asia, despite decades of research, further illustrates monophyly. Only *P. atlantica* and *P. palestina* remains have been reported from early Holocene sites in the territory of modern Syria [50–58]. Hormaza et al. [21] ultimately agreed that cultivated pistachios originated in southern Central Asia and eastern Iran and later expanded to Syria, where the Syrian population remained isolated long enough to develop a genetically distinct lineage. However, Strabo, describing Persia in AD 24 [59]: (book XV, 3, 18) and Syria [59]: (book XVI, 2, 41), based on the information recorded by historians of the fourth century BC, mentioned only *P. terebinthus*, possibly suggesting that pistachios reached Syria within the past two millennia.

2.3. Archaeobotany—Central Asian Data

The oldest archaeological remains of pistachios thus far recovered come from Toda Cave in Uzbekistan, dated to the eighth millennium BC (9200 years ago) (personal communication with Zhou). These carbonized shells were found in contexts that also contained pitted stones, which have been interpreted as hammer stones for cracking nuts—a necessity if the seeds did not dehisce upon ripeness. Other examples of pistachio shells from archaeological sites within the wild range have been reported—presumably representing wild foraged nuts. Recently published data from the Kaynar Kamar Rockshelter [60] illustrate continuous pistachio consumption in Uzbekistan starting as early as the tenth millennium BC. Some scholars have cited pistachio remains dating to the sixth millennium BC in northern Afghanistan, at the site of Shortughai [21,61]. Although, the original archaeological report for the Shortughai excavations [62] and the complementary archaeobotanical study [63], both specifically place the early settlement levels in the late third (not the sixth) millennium BC. Willcox [63] (p. 149) wrote that “*Pistacia vera* was common throughout the duration of the site and presumably was gathered from the wild as indeed it is today in the area”. Fragments of pistachio shells and wood were also recovered at the sedentary agropastoral village of Sarazm in Tajikistan. Three pistachio shells were recovered in excavation unit 4 [64]; taking into consideration that the first cultural layer, dating to the fourth millennium BC, is the necropolis [65], the seed fragments were recovered from the earliest occupation layers explored in that study, a building complex dated to the third millennium BC. The archaeobotanists working on the Sarazm material assumed

that this tree was not intentionally targeted as a wood source because only 4.5% of the recovered charcoal was from pistachio, despite a presumed ancient abundance of the tree in the nearby wild foothill forests [64]. Fragmented remains of pistachio shells were recovered in Kaptar Kamar Cave in southern Uzbekistan from a layer dated to the second millennium BC (personal communication with Giedre Motuzaitė Matuzėvičiūtė). Around 40 km to the south of Kaptar Kamar Cave, shells of 10 pistachio seeds (Minimum Estimated Number) were identified by Miller [19] at the early second millennium BC site of Djarkutan. Given the piecemeal finds of shell fragments from this period and the assumption that they would have grown across this region in abundance, there is no reason to believe that they were cultivated at any of these early sites. Nonetheless, these data illustrate a long-intertwined relationship between humans and the shrubby tree within its wild range.

Pistachio shells become slightly more prominent in the archaeobotanical record during the first millennium AD. While we still cannot say whether humans were cultivating the crop or more intensively foraging natural wild stands, the increasing number of finds suggests continuing interest in the seeds within the wild range of distribution. Pistachio kernels with the remains of other crops like wheat (*Triticum aestivum* L.), barley (*Hordeum vulgare* L.), broomcorn millet (*Panicum miliaceum* L.), cotton (*Gossypium* sp. L.), and peaches (*Prunus persica* (L.) Batsch) were recovered from small fireplaces dated to the fifth–sixth centuries AD at the Kanka archaeological site near Tashkent [66,67]. Shells were also recovered on a clay sufa with other fruit and nut remains at the Balalyk-Tepe castle from the fifth–seventh centuries AD in southern Uzbekistan [68]. Pistachio remains were found in rooms 3 and 10 of the Chil'khudzra castle in Tajikistan, dated to the fifth–eighth centuries AD [69]. Pulatov [69] assumed, despite the late period, that those pistachios were still gathered from the wild. A bracelet made with pistachio shells was unearthed from a tomb near early medieval Munchaktepa in the Fergana Valley. Natural raw materials like stones/kernels of apricot (*Prunus armeniaca* L.), cherry (*Prunus* sp. L.), pistachio, Russian olive (*E. angustifolia*), and animal bones (fish vertebrae and tubular bones) were also used for making a group of beads recovered at Munchaktepa. The beads and fruit stones were found in a tomb containing the burial of a woman and children; a detailed photo of the pistachio necklace after reconstruction is presented in the original publication [70].

By the later medieval period, a combination of sources seems to suggest that the pistachio at least was cultivated within its wild range, and maintained as an economic cash crop. The Tarikh-i-Bukhara, dating to AD 943, has mention of a specialized area of the early-medieval bazaars of Central Asia situated just outside of the city walls for the sale of pistachio nuts. Talking about the bazaar in Bukhara, this medieval source used the term “Pista-shikana”, which, translated from Persian, means “pistachio shellers” AD 943 [71]. Pistachio shells were one of the categories of hand-collected plant remains at the Bazar Dara site dated to the eleventh century AD in Tajikistan, at an elevation of 4000 masl [72]. Shell fragments were recovered at Tashbulak, another high-elevation (2200 masl) site in Uzbekistan, from the Qarakhanid period (AD 999–1220) [73]. Contemporaneous with Tashbulak, pistachio shell fragments were also found in samples from Afrasiab and Paykend [74]. Traveling in Khorasan, at Badghis city, located between the Hari River and the upper Murghab (modern northwestern Afghanistan), Ibn Battuta in AD 1354 [75] (p. 576) described the land, “Its herbage always remains green and serves as pasture for their cattle and horses; most of its trees are pistachios, which are exported from it to the land of al-'Iraq”.

3. Debated Early Evidence

Archaeological remains of pistachios are rare compared to other fruits and nuts in Eurasia. Recently, Rousou et al. [31] pointed out that many historians and archaeobotanists only identify *Pistacia* spp. to the genus level, complicating discussions of past biogeography. Imprecise identifications and confusion between different species (or the conflation of all wild species into the same category) has made many early published discussions

useless. Given the extreme morphological differences between the small-seeded Mediterranean pistachios and the cultivated pistachio, rectifying these issues is easy in the instances where images are published or descriptions are made. Even after accounting for the taxonomic uncertainty, there are many academic claims of early *P. vera* remains from the Neolithic onward in West Asia; for example, Beidha [48,79], WF16 [80], Tepe Abul Hosein [81], and Çatalhöyük [82]. However, all of these cases are secondary reports or parts of broader archaeological discussions and in each case, the original archaeobotanical study did not report the remains as being cultivated pistachios, but rather as *P. atlantica* (mastic), *P. palestina* (the old name for *P. terebinthus*) (terebinth) [49,83–85], and *P. khinjuk* [86]. Additionally, decades of detailed archaeobotanical research have failed to recover any clear remains of *P. vera* in Jordan [49,83,87], the Levant [52,88,89], or Turkey [84,85,90].

Debates over Archaeobotanical Identifications

Two endocarp fragments of *P. vera* were recovered from cultural sediments dating to the fifth–fourth millennia BC in Tepe-Yahya located in southeastern Iran [21,61,91]. These two seeds, reported in the 1980s, have spurred considerable discussion regarding long-distance crop exchange across the Iranian Plateau in the fifth–fourth millennia BC [92], despite the lack of further evidence for pistachios in the region from wood, pollen, or seed remains. Meadow [92] (p. 24) defended the Yahya fragments against claims by scholars that these two shell fragments should not be overemphasized by stating that: “this does not necessarily mean that pistachio and almond were absent from a region where both are found today, but only that they are not represented in the pollen record, a situation not impossible given their low production-dispersal characteristics”. Tosi [93] cited the pistachio as an imported product in that area at that time, and Miller [94] suggested that the pistachio remains represented interregional contacts, given their existence beyond the known wild range. In addition, she added that horticulture was only in its infancy during the sixth and fifth millennia BC.

Further fueling the debates over the role of pistachios in ancient exchange and commerce, pistachio remains were reported from Greece, at the Sesklo site dating to the fifth millennium BC [20]. While most references to finds of ancient plant remains lack photos, J. Renfrew had the foresight to provide a photograph, although, only with one view and it is difficult to identify with confidence. Given the small size of the seed in the photo and the narrow shape, it seems more plausible that the seed is actually a pine nut (*Pinus pinea* L.) rather than a pistachio. Other scholars have questioned the age of the Sesklo shells, and Zohary et al. [25] assumed it was a modern intrusion. Given the lack of direct dates and the questionable morphological features, the Sesklo pistachio remains an unreliable datum. However, a decade after Renfrew (1973) made her claim for early pistachios, Kroll [95] reported finding *P. vera* shells at Pefkakia-Magoula, also in Greece, from two layers dated to the fourth–third millennia BC and the second millennium BC. In this report, Kroll (1983) provided a detailed scientific illustration (recreated in Figure 1d); however, a comparison of the morphological features of modern comparative specimens of pistachios and pine nuts with the illustration from Kroll (1983), suggests that the archaeobotanical remains are more likely to have come from pine nuts. Moreover, in follow-up discussions with Kroll, he retracted his earlier identification, noting that the analysis was conducted a long time ago and with little previous work to build upon (personal communication).



Figure 1. (a)—modern cultivated pistachio nut; (b,c)—modern pine nuts; (d)—figure from Pefkakia-Magoula, Greece (recreated from [95]) formerly identified as true pistachio.

4. Dispersal

Whitehouse [6] wrote that the pistachio was likely introduced into the Mediterranean at the beginning of the common era. It might be that pistachio cultivation gradually expanded westward, reaching Syria by the end of the first millennium BC, and from there slowly spread westward over the following millennium (see Figure 2). There has been considerable debate over the importance of the commodity along the ancient trade routes, but much of this debate appears to be tied into a string of misidentifications (notably those from Greece), as noted above, along with two undated shell fragments from Iran; collectively, these data are spurious at best, and have received considerable attention from historians and archaeobotanists. It is also likely, given the importance of pistachios in markets across this region in the recent past, that scholars might have unconsciously projected their importance into the distant past. If we set aside the pursuit for the earliest evidence, and focus on the more reliable data points, we can start to piece together patterns in the data.

P. vera remains have been recovered from a ritual site in the Apollonian necropolis, dated to the fifth and fourth centuries BC, in Bulgaria [96,97]. Popova [96] suggested that the pistachios were exotic imports to the region and that they do not grow in the Bulgarian climate today. Hristova [98], reviewing archaeobotanical data from Bulgaria, mentioned that pistachio remains were one of the plants recovered from burials and ritual contexts (cremation pits) dating from the fourth century BC until the third century AD. Hristova [98] and Popova [96] stated that pistachios were a valuable import from the Mediterranean; although, clear evidence for pistachio cultivation in the Mediterranean from this period is still lacking. If the Bulgarian pistachios are proven to be from *P. vera*, then they might represent some of the earliest specimens outside their native range, but we do suggest caution, given the prominence of misidentifications at other sites.

Classical scholars, talking about plants that grew in West Asia, refer to pistachios, but do not specifically claim that the plants were growing in Mediterranean gardens. As one of the earliest examples, Theophrastus, retelling earlier accounts about an Asian plant with an unknown name, wrote “this sort of terebinth grows also in Bactria and bears nuts only as big as almonds, inasmuch as they are not large for the size of the tree; and they closely resemble almonds in appearance, except that the shell is not rough; and in palatableness and sweetness they are superior to almonds; wherefore the people of the country use them in preference to almonds” [46] ((325BC): IV, 7). Theophrastus was almost certainly referring to *P. vera*. Given his intimate knowledge of the flora of Greece and the broader Mediterranean region, his description of the tree as a foreign oddity seems to suggest that it was not present in eastern Europe during the fourth century BC. Theophrastus also used the words ‘pistachio’ and ‘terebinth’ separately. Two centuries later, Nicander of Colophon mentioned the pistachio in his poem, *Theriaca et Alexipharmaca*, comparing pistachio nuts also with almonds—likely following on Theophrastus’ description [99] ((2nd century BC): line 891). Nicander also defined India as the center for pistachio origin [100].

In *De Materia Medica*, Dioscorides compared pistachio nuts with pine nuts and defined their area of cultivation as being in Syria; moreover, it should be noted that Dioscorides clearly distinguished between the pistachio and terebinth trees, describing their different medical properties in AD 50 [101]. Pliny the Elder [47]: (book XII, chapter 13) mentioned Greek authors, who described terebinth fruit in Bactria as being similar to an almond and remarkably sweet. In his next book (XIII, chapter 10 and 12), he wrote about a pistachio that was grown in Syria in addition to terebinth. Likely Pliny’s notes in Book XIII, regarding pistachios and terebinths, were based on Dioscorides’ or Theophrastus’ records, but Pliny the Elder added a comment about pistachios being introduced to Rome from Syria. He specifically states: “This [pistachio] also was likewise brought into Italy by Vitellius at the same time, and it was simultaneously introduced to Spain by Pompeius Flaceus, Knight of Rome, who was serving with Vitellius” [47]: (book XV, chapter 91). Despite the historical data that pistachio was in Syria in the first century AD, the first archaeobotanical remains from this area come from the Bosra site, dated to the Byzantine period (fourth–fifth centuries AD) [102]. Although, the pistachio is mentioned by Pliny as a newly introduced plant to Italy, caution must be applied since most of Pliny’s works were based on second or third-hand observations, and, to the best of our knowledge, *P. vera* remains have never been recorded in archaeological contexts in Italy from that period. Moreover, there is no archaeobotanical evidence of pistachio cultivation in the rest of the Mediterranean, and Vargas et al. [43] wrote, specifically of Spain, that the pistachio was cultivated by Arabs in the Middle Ages, but it disappeared later, likely due to insufficient pollination.

Fuks and colleagues [103] recovered entire pistachio shell in the Negev Highlands, in Israel from the midden dated to the first–third centuries AD. The earliest pistachio remains from Egypt come from Ismant el-Kharab (Kellis), located in the central Bakhleh Oasis, from a layer dated to the Roman period, first half of the first millennium AD [104]. Thanheiser et al. [104] claimed that the pistachio was a newcomer to Egypt, due to its rare occurrence. There is no clear evidence for ancient cultivation of the pistachio in Egypt, and the pistachio has never played an important role in Egyptian arboriculture. Nearly 66 pistachio shells were recovered at the urban site of Quseir al-Qadim, a major Mamluk port, from a high-status residence dated between the eleventh and the thirteenth centuries AD, and one shell from the context of the late Islamic period, fourteenth to fifteenth centuries AD [78]. The authors observed that the arrival of pistachios in Islamic Egypt was paralleled by the disappearance of pine nuts from these sites. Additionally, many exotic plants have been identified at this and other ancient Red Sea ports. There is still a lack of solid evidence for pistachio cultivation in the Mediterranean, even from the first millennium

AD, because pistachio remains are less common or often not recorded in the archaeobotanical samples; consequently, it does not appear to have been cultivated until well after the Roman Period.

Bakels and Jacomet [105] reported one pistachio shell recovered at the Vindonissa site in modern Switzerland, a domestic site with a military component from the phase dated 10 BC–AD 1. According to the authors' interpretations, the pistachio was regarded as an imported product; and was more likely to be found in sites with a military influence, because exotic/rare foods would have been more readily consumed. Although, Vindonissa was not a real military camp, it was likely that high-ranking officers lived there. Another single seed of *P. vera* was recovered in the Prague Castle Vladislav Hall, dated to the sixteenth century [76,77,106]. The authors interpreted this finding as the result of the rich and varied nature of the royal trade.

The lack of mention of pistachios in accounts from explorers in neighboring regions may further indicate that the pistachio was not a prominent commercial crop outside its region of origin until the past few centuries, except for Syria (see discussion in the next paragraph). Ibn Fadlan, for example, discussed hazelnuts (*Corylus avellana* L.) and walnuts, but never mentions pistachios in northern Central Asia. Ibn Hawqal in AD 977 [107], who visited parts of Asia and Africa, also fails to mention pistachios. Al-Masudi in AD 956 [108], in his famous book *Meadows of Gold and Mines of Gems*, does appear to mention pistachios once, as one of the nuts that Adam took from Paradise, but not as one of the trees that he saw during his journey. Ahmad Ibn Majid in AD 1490 [109], making observations of flora, fauna, and commerce along his journey from Africa to the Indian subcontinent, did not mention pistachios. Although, describing his journey in India several decades earlier, Ibn Battuta in AD 1354 and 1355 [75,110] spoke briefly in two of his books about pistachios as an ingredient in dishes made in northern India.

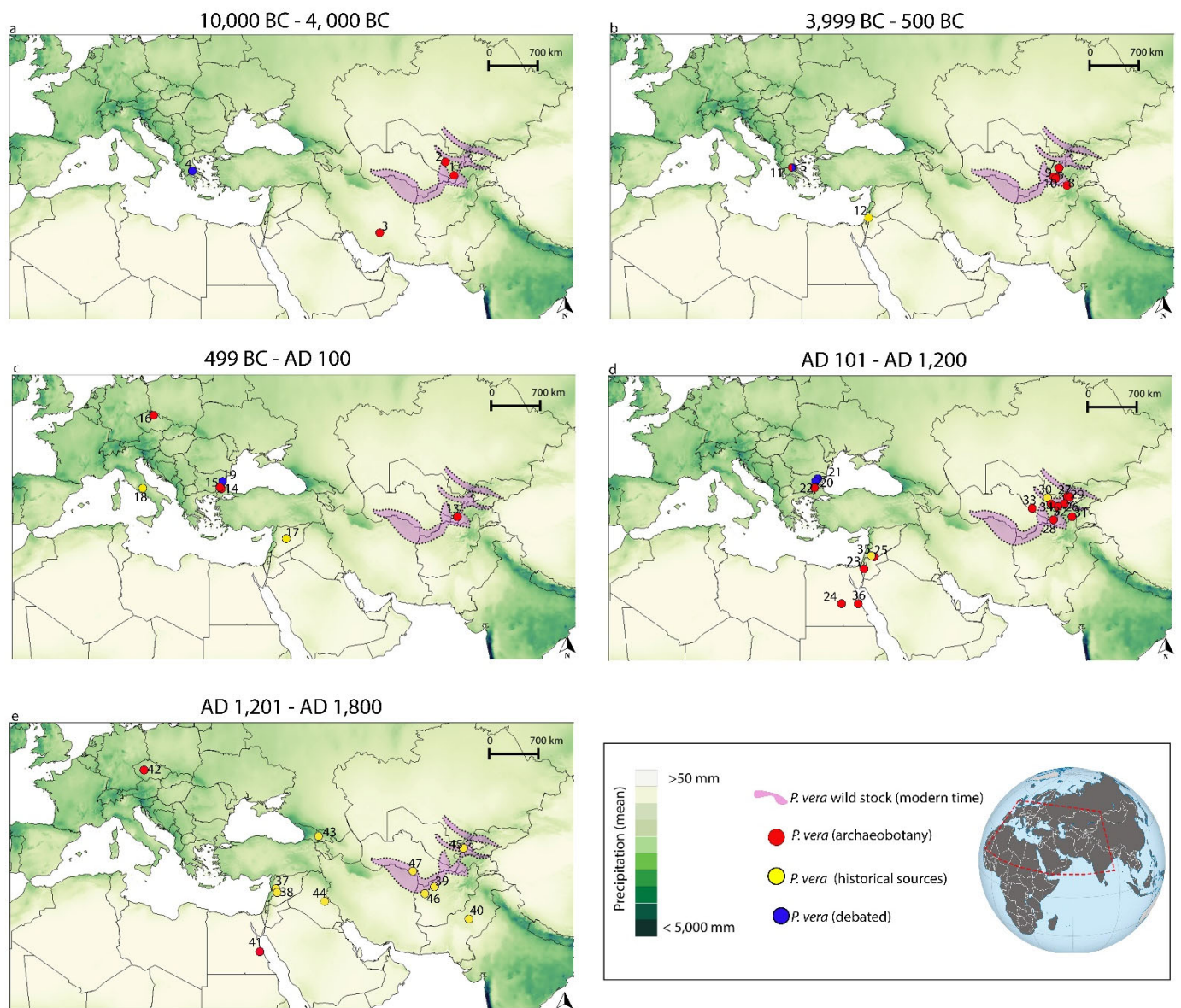
It seems likely that pistachios were cultivated in Syria well before their dispersal across the rest of the Mediterranean, either suggesting an earlier dispersal into the foothills of Syria or a separate wild population that no longer exists. As we already mentioned above, both Dioscorides and Pliny the Elder were already describing Syria as a center of pistachio cultivation by the first century AD. Moreover, archaeobotanical remains dated to the fourth–fifth centuries AD illustrate that Syria was likely the first area of pistachio cultivation outside its region of origin, starting from the first millennium AD. For example, Ibn Jubayr in AD 1185 [111], travelling around the Mediterranean and northern part of the Red Sea, mentioned pistachio trees in Syria, specifically while he was traveling from the towns of Tamanni to Hamah in 1184. According to his accounts, pistachio trees grew in accompaniment with olives, pomegranates, figs, and other fruits; he claims that the area was the most fertile and productive in the Islamic world. A few centuries later, Ibn Battuta [112] mentioned pistachio trees in the small town of Al-Ma'arra in Syria, which he noted were grown for export to Cairo and Damascus. In addition to export, pistachio nuts were one of the ingredients in candies (al-mulaban) produced in the small town of Ba'labakk, also in Syria [112]. In the late 1600s, Bembo in 1672 [27] also mentioned pistachio gardens in Aleppo, Syria, but his description of the tree and its fruit seems to suggest that the plant may still have been poorly known in his homeland of Italy. Moreover, Chitzanidis [113], reviewing works of botanists of the 18th and 19th centuries, pointed out that the pistachio was never mentioned by botanists who described Aegina flora; despite the fact that Aegina is the region where pistachio cultivation is said to have started in Greece. In addition, there is no solid evidence of *P. vera* cultivation in ancient Anatolia prior to the second half of second millennium AD as can be seen in Nesbitt's [114] time chart of major crops in Turkey.

P. vera is a minor crop in Georgia today. Bobokashvili and Maghradze [115] proposed that the cultivated pistachio was introduced to Georgia in Medieval times (between fifteenth–seventeenth centuries AD) but it is still not clear whether it was cultivated or just traded there. These authors specifically claim that it was mentioned by a Russian ambassador who visited Georgia in 1650. Cultivation of *P. vera* in the United States is relatively

recent, 1853 [116], the same can be said of many other regions, including Australia, Mexico [117], and South Africa [118]. The cultivation of pistachios historically started in Morocco only in the last century [119].

Based on genetic and archaeobotanical data, scholars have suggested that there were two independent dispersal routes of pistachios out of Central Asia: one to the Irano-Caucasian region and the second one to Syria, being grafted onto other *Pistacia* species (*P. atlantica* and *P. terebinthus* in Syria; *P. atlantica*, *P. khinjuk*, and *P. vera* seedling rootstocks in Iran).

The pistachio appears to have spread to China in the 10th century AD [21,116]. While Simoons [120] wrote that the pistachio was cultivated in Linghan by the mid-ninth century AD. The pistachio likely spread from the Iranian Plateau during the Tang Dynasty, when it was consumed as a food and also because there were beliefs that consumption of pistachio nuts was good for general wellbeing and sexual potency [120]. Within East Asia today, the pistachio is only cultivated in Xinjiang [121].



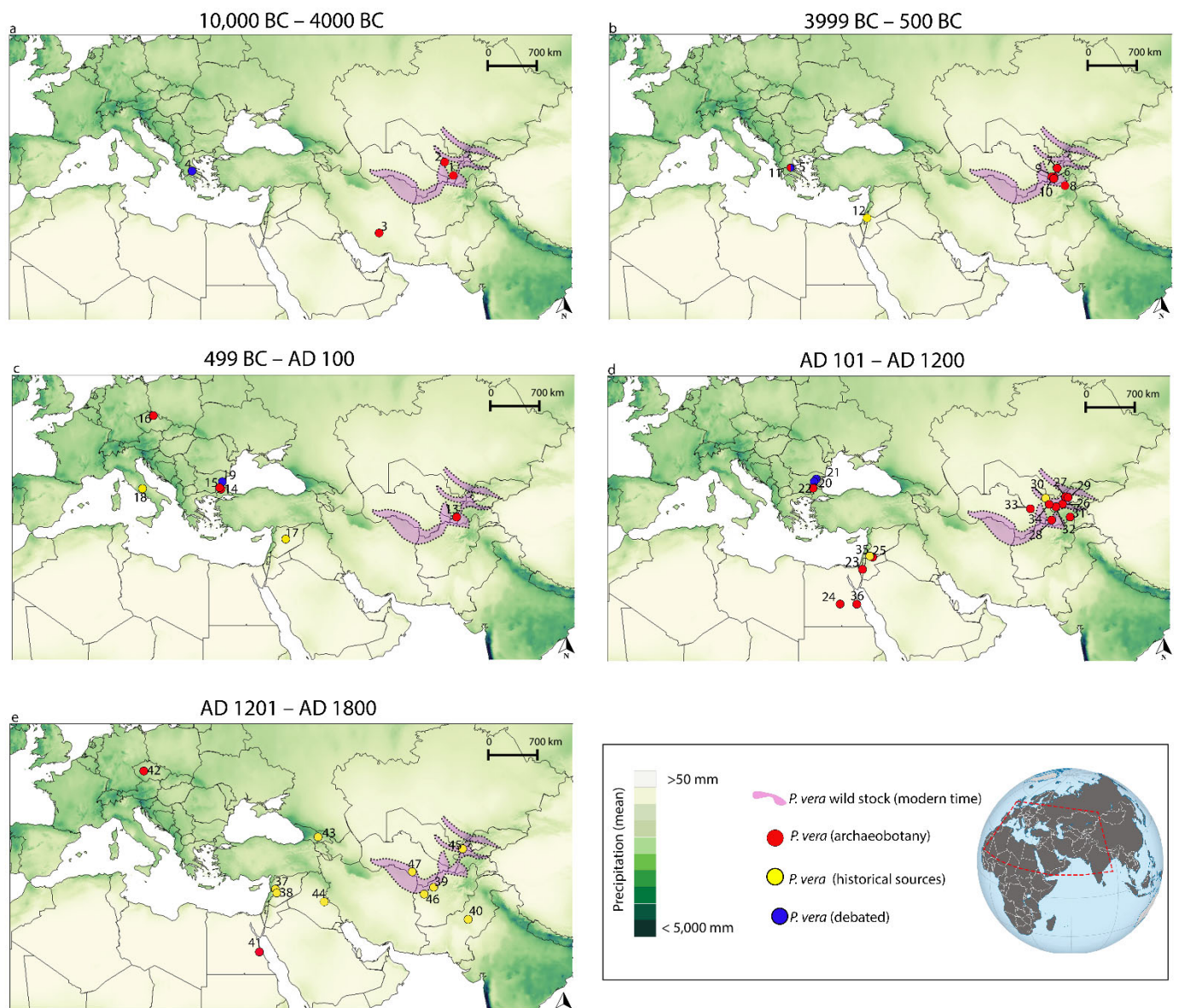


Figure 2. Modern geographical distribution of *P. vera* wild stock were estimated based on published information [6,7,10,11,16]. (a) 1—Kaymar Kamar Rockshelter, Uzbekistan [60]; 2—Toda cave site, Uzbekistan (personal communication Zhou); 3—Tepe-Yahya, Iran [21,61,91]; 4—Sesklo, Greece [20]; (b) 5—Pefkakia-Magoula, Greece [95]; 6—Kaymar Kamar Rockshelter [60]; 7—Sarazm, Tajikistan [64]; 8—Shortugai, Afghanistan [63]; 9—Djarkutan, Uzbekistan [19]; 10—Kaptar Kamar Cave, Uzbekistan; 11—Pefkakia-Magoula, Greece [95]; 12—approximate location of place in Genesis 43, Israel; (c) 13—Kaymar Kamar Rockshelter, Uzbekistan [60]; 14—Apolonia, Bulgaria [96,97]; 15—Sveshtry, Bulgaria [98]; 16—Vindonissa, Switzerland [105]; 17—Syria [101]; 18—Rome, Italy [47]; 19—Vetren, Bulgaria [98]; (d) 20—Karnobat, Bulgaria [98]; 21—Kabyle, Bulgaria [98]; 22—Malko-Tarnovo, Bulgaria [98]; 23—Negev Highlands, Israel [103]; 24—Ismant el-Kharab (Kellis), Egypt [104]; 25—Bosra, Syria [102]; 26—Chil’khudzra, Tajikistan [69]; 27—Kanka, Uzbekistan [66,67]; 28—Balalyk-Tepe, Uzbekistan [68]; 29—Munchaktepa, Uzbekistan [70]; 30—Pista-shikana, Uzbekistan [71] [AD 943]; 31—Bazar-Dara, Tadjikistan [72]; 32—Tashbulak, Uzbekistan [73]; 33—Paykend [74]; 34—Afrasiab, Uzbekistan (this study); 35—Mamanni, Syria [111]; 36—Quseir al-Qadim, Egypt [78]; (e) 37—Al’ma’ara, Syria [112]; 38—Ba’labakk, Syria [112]; 39—Badghis, Afghanistan [75]; 40—north-western India [75,110]; 41—Quseir al-Qadim, Egypt [78]; 42—Prague Castle Vladislav Hall, Czech Republic [76,77,106]; 43—Georgia [115]; 44—Bagdad, Iraq [27]; 45—Herat, Afghanistan [30]; 46—Tashkent, Uzbekistan [28]; 47—Hari River, Turkmenistan [29]. For more details, please check Table 1.

Table 1. *P. vera* remains mentioned in archaeobotanical, archaeological, and historic written sources.

Number on the Figure 2	Country	Archaeological Site	Source	Period	Sources
1	Uzbekistan	Kainar Kamar Cave	archaeobotany/archaeology	10th–5th millennia BC	[60]
2	Uzbekistan	Toda Cave	archaeobotany/archaeology	8th millennium BC	Personal communication with Zhou et al.
3	Iran	Tepe-Yahya	archaeobotany/archaeology	6th–5th millennia BC	[91]
4	Greece	Sesklo	archaeobotany/archaeology	5th millennium BC	[20]
5	Greece	Pefkakia-Magoula	archaeobotany/archaeology	4th–3rd millennia BC	[95]
6	Uzbekistan	Kainar Kamar Cave	archaeobotany/archaeology	4th–3rd millennia BC	[60]
7	Tajikistan	Sarazm	archaeobotany/archaeology	3500–2000 BC	[64]
8	Afghanistan	Shortugai	archaeobotany/archaeology	late 3rd and 2nd millennia BC	[63]
9	Uzbekistan	Djarkutan	archaeobotany/archaeology	Second half of the 2nd millennium BC	[19]
10	Uzbekistan	Kaptar Kamar Cave	archaeobotany/archaeology	2nd millennium BC	Personal communication with Dr. Motuzaitė Matuzevičiūtė
11	Greece	Pefkakia-Magoula	archaeobotany/archaeology	2nd millennium BC	[95]
12	Israel		written source	end of 2nd–1st millennia BC	Genesis 43:11
12	Uzbekistan	Kainar Kamar Cave	archaeobotany/archaeology	end of 2nd–1st millennia BC	[60]
14	Bulgaria	Apolonia	archaeobotany/archaeology	5th–4th centuries BC	[96,97]
15	Bulgaria	Sveshtry	Archaeology	4th–2nd centuries BC	[98]
16	Switzerland	Vindonissa	archaeobotany	10 BC–AD 1	[105]
17	Syria		written source	AD 50	[101]
18	Italy	Rome	written source	AD 79	[47]
19	Bulgaria	Vetren	Archaeology	1st century AD	[98]
20	Bulgaria	Karnobat	Archaeology	2nd century AD	[98]
21	Bulgaria	Kabyle	Archaeology	2nd–3rd centuries AD	[98]
22	Bulgaria	Malko-Tarnovo	Archaeology	2nd–3rd centuries AD	[98]
23	Israel	Negen Highlands	Archaeobotany/archaeology	1st–3rd centuries AD	[103]
24	Egypt	Ismant el-Kharab (Kellis)	archaeobotany/archaeology	1th–4th centuries AD	[104]
25	Syria	Bosra	archaeobotany/archaeology	5th century AD	[102]
26	Tajikistan	Chil'khudzra castle	Archaeology	5th–8th centuries AD	[69]
27	Uzbekistan	Kanka	Archaeology	5th–6th centuries AD	[66,67]

28	Uzbekistan	Balalyk-Tepe	Archaeology	5th–7th centuries AD	[68]
29	Uzbekistan	Munchaktepa	Archaeology	5th–7th centuries AD	[70]
30	Uzbekistan	Pista-shikana	written source	7th–8th centuries D	[71]
31	Tajikistan	Bazar Dara	Archaeology	10th century AD	[72]
32	Uzbekistan	Tashbulak	archaeobotany/archaeology	11th–12th centuries AD	[73]
33	Uzbekistan	Paykend	archaeobotany/archaeology	11th–12th centuries AD	[74]
34	Uzbekistan	Afrasiab	archaeobotany/archaeology	11th–12th centuries AD	New raw data
35	Syria	Tamanni	written source	AD 1185	[111]
36	Egypt	Quseir al-Qadim	archaeobotany/archaeology	11th–13th centuries AD	[78]
37	Syria	Al'Ma'ara	written source	AD 1354	[112]
38	Syria	Ba'labakk	written source	AD 1354	[112]
39	Afghanistan	Badghis	written source	AD 1354	[75]
40	India		written source	AD 1354	[75,110]
41	Egypt	Quseir al-Qadim	archaeobotany/archaeology	14th–15th centuries AD	[78]
42	Czech Republic	Prague Castle Vladislav Hall	archaeobotany/archaeology	16th century AD	[76,77,106]
43	Georgia		written source	1650	[115]
44	Iraq	Bagdad	Written source	1672	[27]
45	Afghanistan	Herat	Written source	1825	[30]
46	Uzbekistan	Tashkent	Written source	1877	[28]
47	Turkmenistan	Heri River	Written source	1881	[29]

5. Linguistics

Historical linguistics offers another perspective by identifying the cultural origins and dispersal of different species of pistachio. Close to being the exclusive source of all words for *P. vera*, early Persian pistaka is attested in the Middle Persian Bundahishn as pstk' [pistag], drawing on the Avestan tradition dating back to around 1000 BC [122,123]. Borrowings are readily recognizable in most modern languages; the European tradition began in the Classical period with cultural imports from the Persian Empire, appearing first in Greek pistákia and later in Latin pistacia, as well as in Russian fistashka, Hebrew fistuk, Arabic fustaq, Hindi pistah, Armenian fesdux, Turkish fistik [124], as well as in twelfth century AD Khakani Turkic as bitrik [125]. The word is held to derive from an inherited verb with the meaning "to break, crush" [126], presumably hinting at the easily detachable shell. It is noteworthy that the Persian word has become the primary word for the *P. vera* across the native range, where several other old and modern Iranian languages (e.g., Sogdian, Bactrian, and Parachi) must have had native words for the nut. It remains a possibility that the word belongs to a Central Asian substrate adopted by the immigrant Iranian community after 2000 BC, as the Indo-Iranian speakers presumably did not know any pistachio species in their native Steppe Zone [127,128]. Lubotsky [129,130], Witzel [131], and Palmér [132] have identified several loanwords in Indo-Iranian from the lost language of the Bactria-Margiana Archaeological Complex (BMAC), and it is possible that the word for pistachio originated there as well.

The Persian language distinguishes the pistak from other pistachio species that are generally covered under the term bana, van [122], which is secured for early Western Iranian through similar usage in Kurdish kez-wan and bêmk 'terebinth' [133] and Balochi gwan '(wild?) pistachio' [134]. Compounds containing this element first appear in Chinese records [122,124]. Persian bana is commonly held to be semantically narrowed from Proto-Indo-Iranian 'tree', cf. Vedic ván-'tree, wood' [135], and confirms the primacy of pistachio trees in Iran and Balochistan. There is no commonly accepted etymology for Proto-Indo-Iranian vana 'tree' [136]. Considering the early multipurpose employment of *Pistacia* spp. in Central Asia [137], it is not impossible, however, that the original meaning was "(wild) pistachio tree" and was borrowed from the Central Asian substrate; this would require the meaning to have been broadened or repurposed in the Indo branch and Iranian languages as they left the zone of wild pistachios.

Arabic botm "wild pistachio, terebinth" [138] represents the native Semitic tradition for naming *Pistacia* spp. The earliest attestation is Old Akkadian buṭnu 'terebinth'. It has been suggested that the feminine derivative buṭuttu was used for *P. vera* [139], but this is debated [140,141]. This echoes the difficulties in identifying the exact species also in Hebrew botnim, where one specific historical source has attracted considerable debates. In the Holy Bible, Jacob sent his brothers with gifts for the Egyptian leader and ordered them to "Put some of the best products of the land in your bags and take them down to the man as a gift—a little balm and a little honey, some spices, and myrrh, some pistachio nuts and almonds" [142]. If the nut mentioned in this text is, indeed, *P. vera* as opposed to a small-seeded species already prominent in the region, it may represent a rare commodity, being mentioned only once; but there is still debate around the exact meaning of Hebrew botnim. Considering both linguistic and archaeological data, Sorokin [143] concludes that botnim did not refer to *P. vera*, but was more likely to have referred to *P. terebinthus*. For example, in Abi'or Cave, archaeological remains dated to the period of the end of the Bar Kochba Revolt against the Romans in AD 135, only contain nutlets of *P. atlantica* [144]. Nonetheless, Zohary [145] and Moldenke [146] argued that pistachios could have been cultivated in Israel at the time when the Old Testament was written and later formalized; they highlight the location called Betonim [147] as an area suited to pistachio cultivation [145]. Today, in the Hebrew language, the word refers to peanuts (*Arachis hypogaea* L.). Other naturally occurring local *Pistacia* species, such as *P. atlantica*, are referred to as elah [145]—a word also mentioned many times in the Bible. Words cognate with Hebrew botnim are found in Arabic, Akkadian, Syriac, and Ugaritic, as well as a borrowing in the

Urfa dialect of Turkish *bittim*, all with the meaning ‘terebinth’. Three independent lines of evidence thus speak against the identification of *botnim* as *P. vera*: (1) there is no case where the meaning ‘terebinth’, ‘*khinjuk*’, or ‘mastic’ cannot be substituted; (2) although technically possible, the ubiquitous adoption of Persian **pistaka* across southwest Asia would be strange if a local tradition of *P. vera* already existed; and (3) the lack of archaeobotanical evidence in the region. It remains possible that local and highly prestigious adoptions could have arisen and been lost again using the word for the known ‘terebinth’ instead; but even here, it would be curious if a clear distinction from the terebinth was not employed. Therefore, the existing data support Sorokin’s hypothesis that *botnim* in Genesis 43:11 was not referring to *P. vera*.

The Semitic words have been sought reconstructed to Proto-Nostratic [148,149], a highly controversial superfamily comprising most language families of Eurasia and Northern Africa. This hypothesis is extremely doubtful, as the sole non-Semitic equivalent, Khakani Turkic *bitrik*, is considered borrowed from an Iranian language, and consequently there is no evidence for ancient heritage.

A final Western tradition for naming species of *Pistacia* can be found in Ancient Greek *terébinthos*, a later variant of original *términthos*, showing the common suffix-*inthos* associated with the Pre-Greek substrate [151]. Laufer suggested that the word may be related to a Kurdish *dar-i-ben* [124], but this fails to explain the Pre-Greek ending. Local familiarity with terebinth must, therefore, predate the Greek migration into southern Balkan and the Aegean that can be dated to the second half of the third millennium BC [151].

6. Conclusions

In this study, we compiled evidence for the domestication and dispersal of one of the most economically significant trees in the modern world. While there remains much to clarify regarding early dispersals and areas of domestication, there are now enough data to piece together much of the narrative. To this end, claims of West Asian pistachio cultivation and trade in the fifth–second millennia BC are currently hard to support and likely represent misidentifications. Given the immense phenotypic diversity among specimens, clear evidence for morphological change cannot be provided by archaeobotanical remains at present; therefore, further research, with more focus on the dehiscence trait, is necessary (see Figure S1—Supplementary Material). The domestication history of pistachios would have been tightly linked with an awareness about sufficient pollination conditions and grafting techniques; therefore, evidence from this study suggests that proposals for early domestication dates are rather unlikely. Given existing archaeobotanical, genetic, and historical evidence, we argue that: (1) the pistachio was brought under cultivation in southern Central Asia within the past three millennia, and there is no solid evidence for the dispersal of pistachios outside its natural range prior to the end of the first millennium BC (Figure 2—but there is need for reevaluation of the remains from Yahya Tepe in Iran and Apollonia in Bulgaria); (2) two modern distinct genetic populations likely suggest that there were at least two routes of plant dispersal and that the lineages have remained isolated; (3) the pistachio was known in the Mediterranean by the Classical period, but only Pliny the Elder hints to the possibility of local cultivation—other Classical authors see the shrubby tree as an oddity from West Asia; (4) it does not appear to have been widely cultivated anywhere until the medieval period, and even then, primarily in Central Asia and Syria, but may have been a commercial commodity in these regions as far back as the end of the first millennium AD; and (5) its intensification as a prominent cash crop outside southern Central Asia likely only unfolded at the end nineteenth century.

Supplementary Materials: The following supporting information can be downloaded at: www.mdpi.com/article/10.3390/agronomy12081758/s1, Figure S1. a – domesticated pistachios purchased in the market in Kant, Kyrgyzstan; b – feral pistachios collected from Chon-Aryk, Kyrgyzstan; and c – wild pistachios from Tash-Komur, Kyrgyzstan.

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