DETERMINATION OF RELATEDNESS AND GEOGRAPHICAL MOVEMENTS OF PISTACIA VERA (PISTACHIO; ANACARDIACEAE) GERMLASM BY RAPD ANALYSIS

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DETERMINATION OF RELATEDNESS AND GEOGRAPHICAL MOVEMENTS OF PISTACIA VERA L. (PISTACHIO; ANACARDIACEAE) GERMLASM BY RAPD ANALYSIS. Economic Botany 48(4):349-358. 1994. The pistachio tree (Pistacia vera) has long been cultivated in south-central Asia and throughout the Mediterranean region of southern Europe, north Africa and the Middle East. We examined genetic diversity and patterns of relatedness among fifteen P. vera cultivars, representing germplasm originating from throughout this range, by using Random Amplified Polymorphic DNA (RAPD) markers. The resulting data were used to construct a similarity matrix and to perform a UPGMA cluster analysis. These analyses revealed two major clusters of P. vera germplasm: a Mediterranean cluster, which includes cultivars originating from the Mediterranean region of Europe, north Africa and the Middle East; and an Iranian-Caspian cluster, comprising germplasm originating from locations east of the Zagros mountains plus 'Peters', a cultivar selected as a seedling of unknown origin in the U.S.A. The data presented here, in combination with historical and geographical records, support the hypothesis that pistachio cultivation originated in or near the present natural range of the species and was spread by cultivation to the Mediterranean region of the Middle East. This more limited pool was the germplasm source for subsequent spread of pistachio by cultivation throughout the Mediterranean region.

Determinaciòn del parentesco y movimiento geogràfico del germoplasma del pistacho (Pistacia vera L. Anacardiaceae) mediante anàlisis de “RAPD.” El pistacho (Pistacia vera) ha sido cultivado durante largo tiempo en el sur de Asia central y en las regiones mediterráneas del sur de Europa, norte de Africa y Oriente Medio. En el presente trabajo, se ha utilizado la técnica de RAPD (“Random Amplified Polymorphic DNA”) para examinar la diversidad genética y el grado de parentesco entre quince cultivares de P. vera, representativos del germoplasma presente en su área de cultivo. Con los datos obtenidos se construyó una matriz de siniplitud y un análisis de clusters usando la técnica de UPGMA. Los análisis diferenciaron dos grupos principales en el germoplasma de P. vera. El grupo mediterráneo, que incluye cultivares obtenidos en la cuenca mediterránea de Europa, norte de Africa y Oriente Medio, y un segundo grupo representativo de Irán y el Mar Caspio; este último grupo contiene germoplasma originario de lugares situados siempre al este de la cordillera del Zagros además de ‘Peters’, un cultivar seleccionado en Estados Unidos a partir de semilla de origen desconocido. Estos datos y registros históricos y arqueológicos confirman la hipótesis del comienzo del cultivo del pistacho cerca del área de distribución actual de poblaciones silvestres y la posterior difusión de germoplasma al Orient Medio. Las actuales variedades de la cuenca mediterránea tendrían su origen en el germoplasma que previamente había alcanzado el Oriente Medio.

Key Words: Tree crops; RAPDs; Pistachio; Pistacia vera.

The pistachio tree (Pistacia vera L.), a deciduous, dioecious, and wind-pollinated tree species, is a member of the Anacardiaceae, a family that also includes cashew, mango, poison ivy, poison oak, pepper tree, and sumac. The genus Pistacia includes at least 11 species (Zohary 1952). Although some of these produce seed that is eaten by local populations in their native ranges, P. vera is the only species that is cultivated commercially (Whitehouse 1957). The pistachio fruit is a drupe with a fleshy mesocarp and a bony
endocarp; pistachio nuts of commerce comprise the endocarp and the edible kernel. There are few cultivars of *P. vera* described, probably less than 100 worldwide (Maggs 1973).

Although pistachio is cultivated in various Mediterranean countries, its probable origin is central and southwestern Asia. The most complete surveys of the current range of wild pistachio trees were made by Whitehouse (1957), who traveled to southwestern Asia in the late 1920s, and by Zohary (1952, 1973). These two authors note that *P. vera* grows wild in the low mountains and foothills of the semi-desert zone of south-central Asia. The range extends from northern Iran (where only two small stands were found on the western end of the Koppeh-Dagh Mountains near the Caspian Sea) and northern Afghanistan through Turkmenistan, Uzbekistan, Tajikistan, Kyrgyzstan, western Tien-Shan and the mountains of Karatau. East of Karatau, in central Tien-Shan, wild pistachio trees exist in only a few, separate, small areas, and the species also grows in western Pakistan (Balochistan). It is not found in the deserts of the Aral-Caspian lowland. Historical records, however, tell of pistachio trees growing in places where none exists today, and the present distribution has been influenced by exploitation of the species by local populations, who used the trees as a source of fuel, and heavy pasturing of cattle, which prevented natural renewal (Whitehouse 1957).

The presence of pistachio nuts in archeological excavations provides evidence that pistachio has long been associated with human activities, although these reports do not always indicate if the nuts are *P. vera* or related *Pistacia* species. Such reports include the results of several archaeological excavations of Neolithic settlements west of the Zagros mountains dated from the eighth until the sixth millennium B.C.: Beidha near the Petra ruins in Jordan (Kirkbridge 1966a,b), Aswad, Ghoraiif, Ramad, Mureybit, and Shamra in Syria (Bender 1975; de Conteson 1983; Singh 1974), Çayönü and Çatal Hüyük in Turkey (Bender 1975; Singh 1974), Jarmo in northeastern Iraq (Bender 1975), and Sarab, Guran, and Ganj Darreh in western Iran (Kramer 1982). These findings would appear to be inconsistent with the view that central and southwestern Asia east of the Zagros mountains are the likely areas of origin for *P. vera*. It is not clear, however, if the nuts found in locations west of the Zagros mountains are true pistachio nuts (*P. vera*) or those of a close relative such as *P. palaestina* Boiss. or *P. atlantica* Desf. which are indigenous to those areas and whose seeds (which are smaller than the true pistachios) are eaten by local people (Hepper 1992). In at least two of these cases, Çayönü (Bender 1975) and Jarmo (Listitsina 1984), the nuts are referred to *P. atlantica*. An alternative possibility is that ancient pistachio forests occupied a larger area westward than the current wild pistachio stands.

In any case, it is clear that pistachio cultivation is very ancient and probably started in areas close to wild pistachio stands, likely from seedlings obtained from the best wild trees (Whitehouse 1957). Remnants of true pistachio nuts dated from the sixth millennium B.C. have been found in Shortughai, Afghanistan (Willcox 1991) and in Yahya in the Soghum valley of southeastern Iran (Prickett 1986), two places that were likely situated close to wild pistachio stands. From its presumed center of origin, *P. vera* was extended by cultivation within the ancient Persian Empire from where it gradually expanded westward. The name pistachio appears to derive from the Zend or Avestan (ancient Persian language) *pista-pis-tak* (Joret 1976). In Assyria, about the tenth century B.C., the Queen of Sheba monopolized the limited crop of nuts for her exclusive use and that of her guests (Whitehouse 1957). Pistachio trees were also planted in the gardens of the king Merodach-Baladan of Babylon around the eighth century B.C. (Brothwell and Brothwell 1969). Pistachio nuts (*botnim* in Hebrew) are mentioned in the Bible (Genesis 43:11) as precious fruits carried to Egypt by the sons of Jacob. In the second century B.C., Nicander found pistachios in Susa, a village in southwestern Iran close to the current border with Iraq (Joret 1976). In the first century B.C., Poseidonius finds cultivated pistachios in Syria which misled Greek and Roman writers to consider Syria as the site of origin for pistachio (Joret 1976), a misconception that persisted until recent times (Zohary 1973). Pliny wrote in his *Natural History* that pistachio was introduced into Italy from Syria by the Roman consul in Syria, Lucio Vitello, at the end of the reign of the emperor Tiberius early in the first century A.D. (Bonifacio 1942). From Italy it was introduced into Spain by Flavius Pompeius, and, probably at that time, to other Mediterranean regions of Southern Europe, North Africa, and