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GEOGRAPHICAL, MORPHOLOGICAL AND TAXONOMIC STATUS OF *PISTACIA KHINJUK* STOCKS EX STOCKS IN IRAN*

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Abstract – Geographical, morphological and taxonomic status of *Pistacia khinjuk* Stocks ex Stocks in Iran was revised. A total of 181 accessions (herbarium materials or specifically collected for this study) were examined geographically and morphologically. The chromosome number of 2n = 24, revealed among 15 accessions studied, was taken as evidence to lump the variability observed in *P. khinjuk* as one taxonomic species. However the states of the leaflet number, i.e. 1 (rarely 3) and 3-7 were taken as the key character in order to subdivide the *P. khinjuk* material in Iran into two varieties: *khinjuk* (the autonym variety) with 3-7 and *populifolia* Boiss. with 1 (rarely 3) leaflet in number. The relative illustrations are prepared and presented. Some nomenclatural corrections are also included.

Keywords – Iran, *Pistacia khinjuk*, Taxonomy, Geography, Morphology

1. INTRODUCTION

The genus *Pistacia* L. contains about ten species of dioecious, wind-pollinated shrubs or small trees. Zohary (1952) arranged them in four sections in his monograph [1], but these have been found to be largely inconsistent with a DNA sequence phylogeny of the genus [2] which indicates three major clades. Three species occur in Iran [3]. The focus of the work reported here is on *P.khinjuk* Stocks ex Stocks, a species very closely related to the cultivated pistacio, *P.vera*, and the two have been described as forming a complex [1]. The pattern of variation is further complicated by the polymorphic nature of *P.khinjuk*, in which the following variants have been introduced:

- var. *populifolia* Boiss. [4]: leaves unifoliolate

- var. *glabra* Schweinf. ex Engl. [5]: leaves three paired and leaf rachis glabrous = var. *glabrrima* Schweinf. ex Boiss. [6]

- var. *stocksii* Engl. [5]: leaves *lanceolate* 3 paired; it was regarded by Boissier (1888) [6] as a synonym of *P. integrrima* Stewart; Zohary (1952) [1] as a synonym *of P. chinensis* Bge. var. *integerrima*; and Rechinger (1969) [3] as a synonym of *P. chinensis* ssp.*integerrima* (J. L. Stewart; Rech. f.)

- var. *microphylla* Boiss.[6]: leaves 1-2 paired

- var. *heterophylla* Engl.[5]: leaves simple or with three to five leaflets

-var. *oblonga* Bornm. [7]: leaves 2-3 paired; Zohary (1952) [1] mentioned it with no reference

- var. *genuina* f. *heterophylla* Bornm. [7]: leaves one to two paired and leaflets late ovate; Zohary (1952) [1] referred it to: Bornm. (1906), Beih. Bot. Centralb. 19, 2: 224 [8]

- var. *macrocarpa* Zohary (1952) [1]: leaves up to 20 cm long and 3 paired

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The infra-specific subdivision of *P. khinjuk* is based mainly on foliage characters. Not all authors, however, have accepted all the named variants as recognisable taxa. Zohary (1952), in his monograph of the genus, accepted four varieties in addition to the nominate variety, viz. var. *populifolia*, var. *microphylla*, var. *glabra* (as var. *glaberrima* Schweinf. ex Boiss.) and var. *macrocarpa*; but he expressed doubts about the first two [1]. At the other extreme are botanists like Yaltrik (1967) [9], Jeffrey (1980) [10] and Nasir (1983) [11] who, in their respective accounts of *Pistacia* in the Flora of Turkey, Iraq and Pakistan, did not recognise any infraspecific taxa under *P.khinjuk*. In the most recent treatment of this species in the Flora Iranica area, Rechinger (1969) mentioned only var. *populifolia* [3], but otherwise likewise declined to recognise any infra-specific variants. The present study aims to review and re-evaluate the geographical, morphological and taxonomic status of *P.khinjuk* in Iran.

2. MATERIALS AND METHODS

A total of 181 accessions identified as *P. khinjuk* from all around Iran were used in this study; Table 1 shows a selected collection used for morphological studies and the accessions used for chromosomal studies. The specimens are preserved in the herbaria: HIUT = Herbarium of Isfahan University of Technology; HUI = Herbarium of the University of Isfahan; TARI = Herbarium of Research Institute of Forests and Rangelands, Tehran; TARIK = Herbarium of Research Centre of Natural Resources and Animal Affairs of Kermansha; HUT = Herbarium of the University of Tehran; IRAN = Phytomedicine Research Centre (Tehran, Evin).

Morphological data were derived from leaf and fruit characters. The characters scored were: number, shape and size of leaflets (recording terminal and lateral leaflets as separate characters); leaf rachis shape in cross-section; and fruit shape and size. Terminology follows Stearn (1983) [12].

Chromosome numbers were counted in plants from 15 populations (Table 1). Fruits were soaked in tap water for three days and, after removal of the fleshy exocarp, were sown in peat moss in a greenhouse; after about two weeks the roots were ready for sampling. Root tips were fixed, hydrolysed, squashed and stained with aceto-orcein following (Fukui and Nakayama1996) [13].

Table 1. A summarized list of the accessions belonging to *Pistacia khinjuk* used in this study

Locality and Herbarium address
27- Chaharmahal-Bakhtyari: between Lordegan & Semirom, Malkhalife, Alt. 2000 m, HUI 14765; Ch..
30- Chaharmahal-Bakhtyari: Shamsabad after Pole-Kale, Alt. 2000 m, HUI 14758.
31- Chaharmahal-Bakhtyari: after Guerdeh bisheh, 40 km to Lordegan, Alt. 1700-2000 m, HUI 14757.
40- Fars: Darab to Hajiabad, Alt. 1270 m, HUI 14766; Ch..
59- Hormozgan: Roodan, HUI 14773 Ch.
79- Isfahan: Near Abadeh, 25 km to Safa-shahr, Alt. 2000 m, HUI 14762
88- Kerman: 30 km to Sarcheshmeh from Rafsanjan, HUI 14751 Ch.
123- Kermanshah: Paveh road, Doabe Najar, Alt. 1200 m, TARIK1875
124- Kermanshah: Reejab, IRAN 812
139- Kuhkiluye- va- Bouyerahmad: Gachsaran, Kolak, HUI 14770 Ch.
145- Lorestan: Khoramabad, Sarabaleh, Bankool, Alt. 1100 m, HUI 14760
147- Lorestan: Oshtorankuh, Dorood, Alt. 1420 m, HUI 14761
148- Lorestan: Poldokhtar, Shoor-shoor village, Alt. 1300 m, HUI 14763; Ch..
153- Lorestan: Tange Tir, 40 km W. of Khoramabad, TARI 16537
171- Sistan-Baloochestan: Taftan, HUI 14771

The bold numbers to the left of each accession correspond to their order number in our main list of 181 accessions used in this study (the list is not presented here). Abbreviations are: Alt = altitude, Chr. = Chromosome counted, HUI = Herbarium of the University of Isfahan, TARI = Herbarium of Research Institute of Forests and Rangelands Tehran, TARIK = Herbarium of Research Centre of Natural Resources and Animal Affairs of Kermansha.

3. RESULTS

a) Geographical data

Following study of the available specimens of *P. khinjuk*, a map of the collection localities (Fig. 1) shows that the species has a disjunctive but wide distributional range from eastern to western parts of Iran through the Makran Zone, Zagros Mountains and the Sanandaj--Sirjan Zone, ranging from 50 to 3300 m in elevation; it is, however, almost absent from the Alborz Mountains (Fig. 1). This species occurs as sympatric with *P. atlantica* in many localities, although because of its rocky and steep slope habitats, differs from the latter.

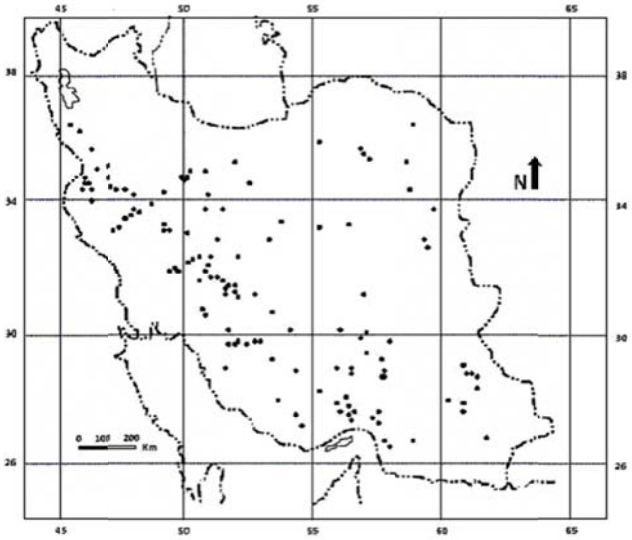

Fig. 1. Map shows the distributional pattern of *Pistacia khinjuk* in Iran

b) Morphological data

1) Leaf partition and the number of leaflets (Fig. 2). The results of this study showed that leaves in this species usually have a terminal leaflet (imparipinnate), although sometimes a number of leaves may also be present that do not (paripinnate) (Fig. 3A). The chief variable, however, is the number of lateral leaflets. The number present in each leaf on a particular plant varies from sometimes 0 (the leaf having only a terminal leaflet, i.e. unifoliolate), to usually 2 or 4 and rarely up to 6 (Fig. 3). There is no clear correlation between the number of lateral leaflets and geographical distribution.

2) Shape and size of leaflets. Leaflet shape is quite variable between and within populations and even on the same tree. The common leaflet shapes observed in this species are: ovate (narrow to broad), obovate, ovale, reniform, orbicular and cordiform (Fig. 3B). The leaflet apices show a series of shapes: emarginate, retuse, truncate, obtuse, acute, cuspidate and acuminate (Fig. 3C). Leaflet bases are similarly variable: truncate, attenuate, oblique and cordate (Fig. 3D), and leaflets vary greatly in size, 1.5--11.5 x 1--8 cm; usually the terminal leaflet is larger than the laterals. In unifoliolate leaves, the maximum length and width was 14.5 cm and 9.5 cm, respectively. Our field observations showed that the leaflets of male trees were consistently smaller than those of female trees. Neither leaflet shape nor size shows any relationship with the geographical distribution (Fig. 3B-D).

3) Rachis morphology. In cross-section, rachises are terete, angled, sometimes flattened, or, notably, winged in several populations, e.g. 79, 140, 142, 27 (Table 1).

4) Fruit morphology. The fruit is a drupe, usually dark brown in colour with a thin but fleshy mesocarp and a more or less bony endocarp. Its shape ranges from subglobose to sometimes longitudinally

elliptical (vertically elongated), similar to that of *P. vera*, but it is never transversely elliptical (horizontally elongated) as is usually the case in *P. atlantica*. The apex is apiculate and the base slightly oblique (Fig. 3E). Our measurements of size gave 5--9 x 4--7 mm.

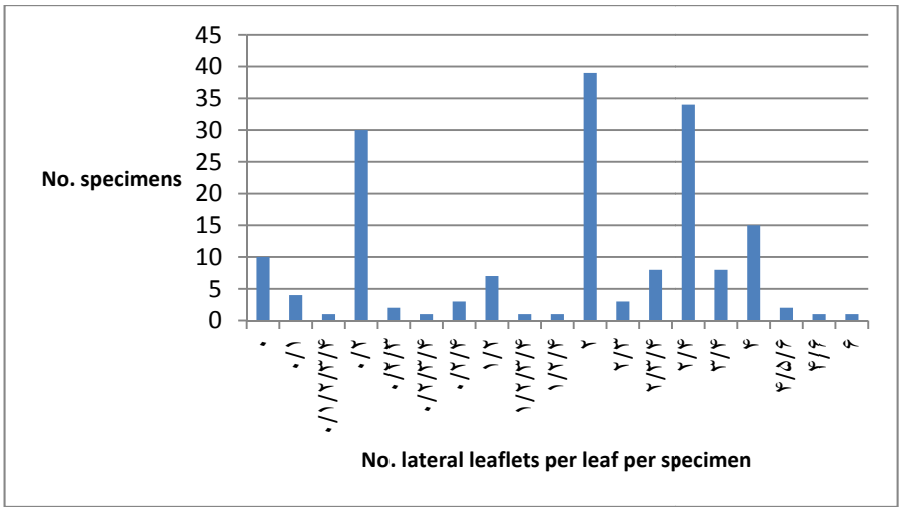

Fig. 2. Graph shows the frequency of the number of lateral leaflets among the specimens studied

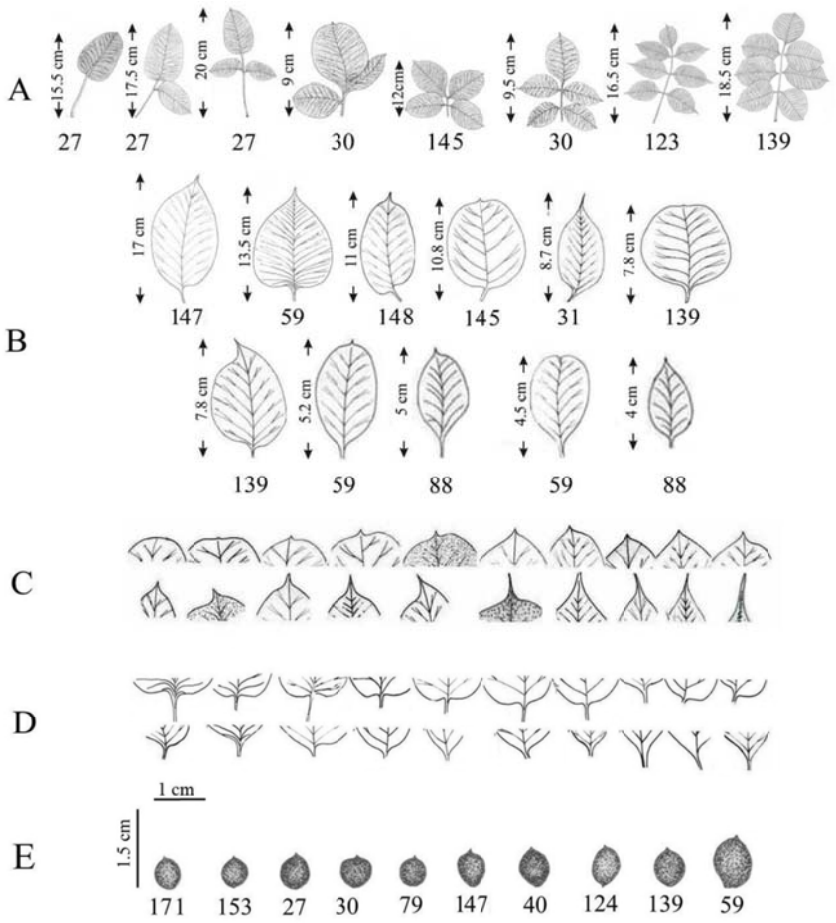

Fig. 3. Illustrations of leaf and fruit variation in *Pistacia khinjuk* in Iran. A: variation in leaf morphology. B: variation in leaflet shape. C: variation in leaflet apex shape. D: variation in leaflet base shape. E: variation in fruit shape. Numbers below the illustrations correspond to the accession number in Table 1

c) Chromosome number

All individuals from the 17 populations surveyed showed a sporophytic chromosome number of 2n = 24. The chromosomes are very small about 5 µm.

4. DISCUSSION

a) Geography

The widespread but disjunctive distribution pattern across Iran can be explained as the fragmentary remains of a formerly more widely distributed, continuous population [14]. The combination of dioecy and anemophily in *P. khinjuk* should promote outcrossing and geneflow between populations, depending on the local geographical isolating barriers and the distances involved. Studies into these aspects are currently underway.

b) Morphology

1) Leaflet number and shape. Our observations of the various foliage characters are largely consistent with previous reports [15, 4, 1, 3, 10, & 11]. The only difference is that we did not find as many as four pairs of lateral leaflets, the upper limit quoted by Stocks (1852) [15], Zohary (1952, 1972) [1 & 16], Rechinger (1969) [3] and Jeffrey (1980) [10]. Our maximum was three pairs. Combining our data with those in the literature, it is clear that the most common number of lateral leaflets in *P. khinjuk* is 3-7 (1-3 pairs); unifoliolate leaves or those with four pairs of lateral leaflets are rare. Boissier (1872) [4] described the unifoliolate plants as var. *populifolia*.

2) Rachis morphology. The discovery of a **winged rachis** in the leaves of a few populations (about five) of *P.khinjuk* was a surprise. Similarly we observed a winged rachis in some populations of *P.vera* and, conversely, a terete rachis in some plants of *P.atlantica* (unpublished data). Rachis morphology has hitherto been regarded as an important character, allowing the separation in keys of the usually winged *P.atlantica* from the usually unwinged *P.vera* and *P.khinjuk* (e.g. Zohary 1972) [16]. Further study is needed to determine whether this is a case of yet more infraspecific variation or whether hybridisation is involved.

3) Fruit morphology. Based on the results of this study it can be concluded that the fruit size of this species in Iran ranges wider than the limits found by Zohary (1952) [1] and Jeffrey (1980) [10], who quoted 4--7 x 4--5.5 mm. However, Zohary (1952) described his new var. macrocarpa as having fruits with 7-8 x 6-7 mm [1].

c) Chromosome number

Despite the extensive morphological variation seen in *P.khinjuk*, the chromosome number of 2n=24 appears to be constant. Our results from a survey of 20 populations are consistent with previously published data [1]. The finding serves to emphasize that although *P.khinjuk* is polymorphic it is evidently distinct from the two other Iranian species, *P. atlantica*, in which 2n = 28 (our unpublished data and Zohary 1952), and *P. vera*, in which 2n = 30 (our unpublished data and Zohary 1952) [1].

5. TAXONOMY

Zohary (1952) pointed out that "*P. khinjuk* is one of the best delimited, but also one of the least known species" [1]. Despite its extensive morphological variation, the species can be distinguished from its Iranian congeners (*P. vera, P. atlantica*, which is sympatric with *P. khinjuk*) based on the fruit form and leaflet apex character from the former and latter respectively. The chromosome number of 2n=24 and the

unicellular, conical trichomes on the leaves also serve to delimit the species. Nevertheless, the infra-specific subdivision has remained unsettled.

Based on all the literature corresponding with *P. khinjuk* through the area of its distribution, and examining hundreds of its scattered individuals or small local populations in many different localities, in this study it can be concluded that this species is highly polymorphic. Being a long lived dioecious tree and resistant to very harsh rocky and dry conditions of mountainous habitats of Iran have formed this species as a rich gene-pool in this country as a centre of diversity. As a result of this study, the following taxonomic treatment for *P. khinjuk* in Iran is suggested, based on the number of leaflets.

Pistacia khinjuk Stocks ex Stocks, in Hooker's J. Bot. Kew Gard. Misc. 4: 143 (1852) [15].

A dioecious, deciduous tree or sometimes shrub, up to 6 m high. Leaves are unifoliolate to usually imparipinnate or rarely paripinnate; 9-20 cm; the leaflets are opposite to sub-opposite, subsessile, 1, 3, 5 and 7 in number, rarely 2, 4 and 6, pubescent when young to glabrous when old, 1.5--11.5 cm x 1--8 cm, up to 14.5 x 9.5 cm for simple leaves; the leaflet shape is narrowly to broadly ovate, obovate, ovale, or reniform, apex orbicular and cordiformis, emarginate, retuse, truncate, obtuse, acute, cuspidate and acuminate, base truncate, attenuate, oblique or cordate; rachis terete, flattened or occasionally winged (as in *P.atlantica*). The fruits are subglobose or sometimes longitudinally, but never transversely, elliptical, apiculate distally, or slightly oblique at the base, 5--9 mm x 4--7 mm, usually dark brown, with a thin but fleshy mesocarp and a more or less bony endocarp.

Iranian material may be split into two varieties as follows:

var. *khinjuk*

Syn.: *P. acuminata* Boiss. et Buhse in Nouv. Mem. Soc. Nat. Mosc. 12: 53 (1860) [17].

P. khinjuk var. *heterophylla* Engl. in De Candolle, Monogra. Phanerog. 4:290 (1883) [5].

P.khinjuk var. *microphylla* Boiss. in Fl. Or. Suppl.: 154 (1888) [6].

P. khinjuk var. *oblonga* Bornm. in Beih. Bot. Centralbl. 57B: 247 (1937) [7].

P.khinjuk var. *genuina* f. *heterophylla* Bornm. in Beih. Bot. Centralbl. 57B: 247 (1937) [7].

P. khinjuk var. *macrocarpa* Zoh. in Palestine J. Bot., Jerusalem ser., 5: 212 (1952) [16].

Leaves compound, mostly imparipinnate, rarely paripinnate, leaflets 3-7.

var. *populifolia* Boiss.

Syn.: *P.khinjuk* var. *populifolia* f. *monophylla* Bornm. in Beih. Bot. Centrabl. 19, 2: 224 (1906) [8].

Leaves unifoliolate, rarely leaflets 1-3.

var. *glabra* Schweinf. ex Eng. in De Candolle, Monogra. Phanerog. 4: 291 (1883) [5].

Syn.: *P.khinjuk* var. *glaberrima* Schweinf. ex Boiss. in Fl. Or. Suppl.: 154 (1888) [6].

Leaf rachis glabrous.

This variety appears to be the sole representative of the species in the Flora Palestina area and southern Sinai [16].

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