



## Two new species of *Cotoneaster* (Rosaceae, subgen. *Chaenopetalum*) for the flora of Iran

NEMAT ALLAH RAEI NIAKI<sup>1</sup>, FARIDEH ATTAR<sup>1\*</sup>, MASOUD SHEIDAI<sup>2</sup>, HOSSEIN MAROOFI<sup>3</sup>, MOHAMMAD REZA JOHARCHI<sup>4</sup> & FAZAL ULLAH<sup>5,6</sup>

<sup>1</sup>Central Herbarium of Tehran University, School of Biology, College of Science, University of Tehran, Iran

<sup>2</sup>Faculty of Biological Sciences, Shahid Beheshti University, Evin, Tehran, Iran

<sup>3</sup>Research Center of Agriculture and Natural Resources, Kurdistan Province, PO Box 66169-36311-714, Sanandaj, Iran

<sup>4</sup>Research Center for Plant Sciences, Ferdowsi University of Mashhad, Mashhad, I. R. Iran

<sup>5</sup>CAS Key Laboratory of Mountain Ecological Restoration and Bioresource Utilization, Chengdu Institute of Biology, Chinese Academy of Sciences, Chengdu, China

<sup>6</sup>University of Chinese Academy of Sciences, Beijing 100049, China

\*Author for correspondence (e-mail: [fattar@khayam.ut.ac.ir](mailto:fattar@khayam.ut.ac.ir))

### Abstract

*Cotoneaster nima-yushiji* and *C. mazandaranicus* (sect. *Chaenopetalum*), two new species of the genus *Cotoneaster* (Rosaceae) from northern Iran, are described and illustrated. *Cotoneaster nima-yushiji* is closely related to *C. discolor* Pojark. (1954: 16) but differs by larger leaves, indumentum of leaves, number of flowers per inflorescence, longer inflorescence, dark red and succulent fruit (vs. light red and non-succulent). *C. mazandaranicus* is morphologically similar to *C. multiflorus* C. A. Mey. (1831: 171), but is distinguished by foliar lamina with base narrowly cuneate to cuneate, shape and size of leaves, indumentum of leaves, color of leaves and fruit.

**Keywords:** *Cotoneaster*, Iran, New species, Rosaceae

### Introduction

*Cotoneaster* belongs to the tribe Pyreae of the Rosaceae subfamily Spiraeoideae (Potter *et al.* 2007). The number of species in the genus differs according to the adopted species concept and ranges from about 50 to over 400 species. The most important reason for the wide range of taxa number consists of asexual seed production or apomixis, which is often associated with hybridization and polyploidy (Marshall and Brown, 1981; Nogler, 1984). This phenomenon has been reported in five Maloid genera e.g. *Amelanchier* (Campbell *et al.*, 1985) and *Cotoneaster* (Hjelmqvist, 1962). The majority of species are found in the Himalaya and southwestern China. *Cotoneaster* is a large genus in northern temperate regions of Europe, Asia (except Japan), and North Africa (Yü & Lu 1974, Brickell & Zuk 1997, Lu & Brach 2003, Mabberley 2008, Fryer & Hylmö 2009, Boer 2014). The natural habitats of *Cotoneaster* in China include mountain regions, forests, slopes, thickets, river valleys, river banks, and grassy sites, often on rocky or calcareous sites, at elevations of 800–4100 m (Lu & Brach 2003). Growth habits range from nearly prostrate to upright. Cold hardy types are more or less deciduous, whereas those of native to warmer regions are evergreen (Heriteau 1990). From the point of view of morphology, the habit is evergreen or deciduous shrubs, rarely small trees; branchlets mostly round in cross-section, rarely slightly angular; leaves alternate, simple, shortly petiolate; margin of leaf blade entire. Flowers are in cymes, small clusters, or solitary; sepals 5, persistent, short; petals 5, erect or spreading, imbricate in bud, white, pink, or red; stamens 10–20(–22); ovary inferior or semi-inferior, 2–5-loculed; 2 ovules per carpel; styles 2–5, free; stigmas dilated. Fruit a drupe-like pome, red, brownish red, or orange to black, with (1 or)2–5 bony seeds. (Fryer & Hylmö 2011, Lu & Brach 2003).

*Cotoneaster* includes numerous ornamentals that are widely grown in landscaping for their attractive flowers and fruit (Bailey & Bailey 1976). The earliest taxonomic treatment classified species into two subgenera on the basis of petal characters (Koehne 1893): (1) subgenus *Chaenopetalum*, in which the flowers within a cyme open simultaneously, the petals are spreading or rarely semi-spreading, pink in bud, and white when open; and (2) subgenus *Cotoneaster*,

in which the flowers open successively over an extended period and the petals are erect or suberect, white, red, pink, or green. According to ‘Flora Iranica’ (Riedl 1969), the genus has 14 species in Iran but according to ‘Flora of Iran’ it has 19 species (Khatamsaz 1992). In Iran, 19 species of the genus are mainly distributed in the Alborz Mountains, high elevations in NW (Azerbaijan province) and NE (Khorasan province) (Raei Niaki *et al.* 2009; Raei *et al.* 2018). Among these species, *C. assadii* Khat. (1988: 116), *C. esfandiarii* (1991: 2), and *C. persicus* Pojark. (1954: 118) are endemic to Iran (Riedl 1969, Khatamsaz 1985, 1992).

During our studies on *Cotoneaster* in Iran over 12 years, many specimens were investigated and some of them represent new species to science. In this paper, two new species from northern Iran are described.

## Materials and methods

This study is based on material collected from May to September 2016 in the vicinity of the Mazandaran, 50 km from Amol, near Yush village and Mazandaran, Firoozkooch road, ca. 30 km from Veresk village (Fig. 1). The plant material for this study was collected from different regions of Iran. The plants were studied more in detail as herbarium specimens. Holotypes of the new taxa are deposited in Tehran University Herbarium (TUH). Morphological characters were studied using stereo microscope and high-resolution macro photography. Plant specimens were identified using the Flora of USSR (Pojarkova 1971); Flora Iranica (Riedl 1969); Flora of Iran (Khatamsaz 1992), Flora of Turkey (Browicz 1972, Fryer & Hylmö 2009), and *Cotoneasters*: A comprehensive guide to shrubs for flowers, fruit, and foliage (Fryer & Hylmö 2009). After careful investigation of specimens, we deemed the potential new species to be most similar to *C. discolor* and *C. multiflorus*, which guided us in further morphological comparisons.

**Leaf epidermis:**—The materials for LM study were boiled in water before being macerated in Jeffrey’s solution (Stace 1965). Pieces of leaf epidermis were stained in a solution of 1% safranin (in 50% alcohol) before being mounted in glycerin jelly. To check the constancy of epidermal structure, at least four slides were made from different parts of a single leaf or from different leaves of the same species. Descriptive terminology of leaf epidermis follows mainly the terminology of types of stomata, shape, and pattern of epidermal cells follows mainly that of Dilcher (1974), Baranova (1987, 1992) and Carpenter (2005).

**Pollen:**—For SEM observations, pollen grains obtained from each specimen were transferred onto stubs and coated with platinum. The SEM micrographs were taken with Tescan model Vega and Zeiss model DSM960A at an accelerating voltage of 15 KV. In this study, nomenclature for pollen morphology was used in accordance with Erdtman (1952). For detailed examination of sculpturing, the classification presented in Ueda & Tomita (1989) was used.



FIGURE 1. Map showing location of *Cotoneaster mazandaranicus* sp. nov. and *C. nima-yushiji* sp. nov. in Iran.

## Results and Discussion

*Cotoneaster nima-yushiji* R. Niaki & Attar, sp. nov. (Fig. 2a)

**Type:**—IRAN. Mazandaran: 50 km after Amol, near Yush village, N: 36° 11' 02", E: 51° 43' 39", 1810 m, 15 September 2016, R. Niaki & Mahdigholi, 46879 (holotype:TUH!).



**FIGURE 2.** a) Holotype of *Cotoneaster nima-yushiji* sp. nov. deposited in the TUH Herbarium (R. Niaki & Attar 46879); b) *Cotoneaster discolor* (holotypus, 2546-LE)

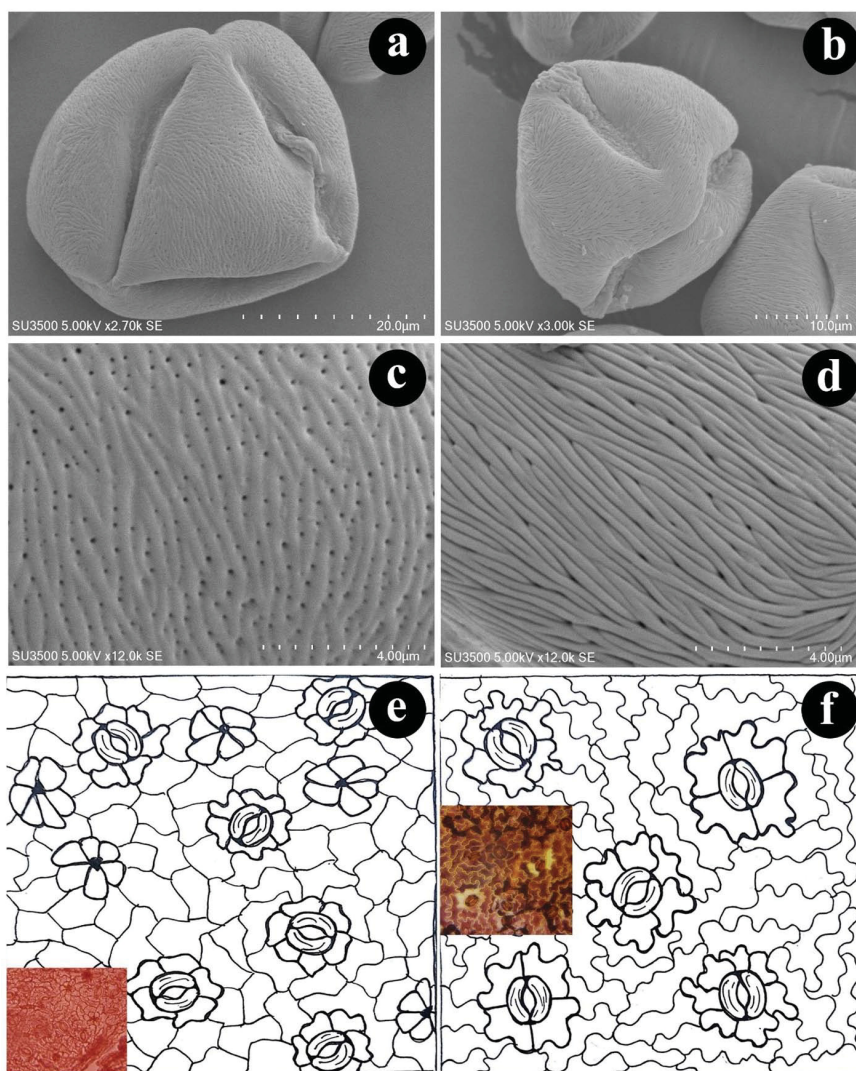
Shrubs deciduous, 3–4 m tall. Branchlets reddish brown to brown, slender, initially greenish gray pubescent, soon glabrescent. Leaves deciduous, chartaceous, narrowly ovate to lanceolate, 15–38 × 10–24 cm, thin, lower surface pale green, thinly gray tomentose, at fruiting time slightly pilose to subglabrous or glabrous, upper surface dark green, glabrous or slightly appressed pubescent in flowering time, base broadly cuneate to cuneate, apex acute or seldom obtuse, often mucronate. Petiole 4–6 mm, thinly tomentose, often pale green to pale red. Corymbs semi-lax, 5–13-flowered; peduncles and pedicels thinly pubescent; in the fruiting season subglabrous or glabrous, peduncles 9–12 mm. Pedicel 2–7 mm. Flowers 9–10 mm in diam. Hypanthium infundibulate, thinly pilose. Sepals triangular, ca. 2 × 1.5 mm, apex acute, pilose. Petals spreading, white, suborbicular, 3–3.5 mm in diam., adaxially white pubescent near base, base shortly clawed, apex emarginate. Stamens 16–20, somewhat longer than petals, filaments white, anthers yellow. Fruit dark red to maroon, subglobose, 8–10 mm in diam, succulent, pruinose, calyx lobes flat, novel (the position of sepals at mature fruit time) open. Pyrenes 2, sometimes united into 1.

**Leaves epidermal cells:**—The epidermal cells on both surfaces of *Cotoneaster nima-yushiji* leaves are irregular. The anticlinal walls of the epidermis cells are curved to repand. Stomatal type is stephanocytic: type of stomata surrounded by a wider and weakly differentiated ring of 4 or more (usually 5–7) subsidiary cells, forming a more or less distinct rosette (Fig. 3e).

**Pollen:**—View of symmetry, iso- and heteropolar types are observed in the species. The aperture is tricolpate (Fig. 3a). The surface is mainly striate ornamentation. This type of ornamentation is recognized by having perforations between ridges (Fig. 3c).

**Taxonomical remarks:**—*Cotoneaster nima-yushiji* is one of the species of subgenus *Chaenopetalum* by its petals spreading at anthesis, suborbicular or broadly spathulate, white or rarely pale pink. This species includes section *Racemiflori* by inflorescence mostly lax, < 30 flowered, pedicels less than 20 mm; nutlets (1)1 plus 1 coadunate (fused) (or 2). The species is close to *C. discolor* Pojark. (Fig. 2b) but differs from the latter by its larger leaves, indumentum of leaves (Fig. 4a, 4b), number of flowers per inflorescence, longer inflorescence (Fig. 4c, 4d), dark red and succulent fruit (vs. light red and non-succulent) (4e, 4f) (Table 1). The shape of leaves and habit of *C. nima-yushiji* and *C. discolor* are similar to each other (Fig. 2). Detailed comparisons of these species are listed in Table 1.





**FIGURE 3.** *Cotoneaster nima-yushiji* sp. nov. (a, c, e) and *Cotoneaster mazandaranicus* sp. nov. (b, d, f): a, b) SEM-micrographs of pollen grain; c, d) Ornamentation on the equatorial view; e, f) SEM-micrographs of abaxial surface of leaf epidermis.

**TABLE 1.** Morphological differences of *Cotoneaster nima-yushiji* and *C. discolor*

Characters	<i>C. nima-yushiji</i>	<i>C. discolor</i>
<b>Leaves</b>		
Apex of leaves	often acute	obtuse to acute
length of leaves (mm)	15–38	9–22
Wide of leaves (mm)	10–24	6–12
Lower surface indumentum in fruit period	slightly pilose to subglabrous	densely pilose-strigose
Petiole length (mm)	4–6	2–3
Petiole color	often pale green to pale red	often reddish purple
<b>Inflorescences</b>		
Length of peduncle (mm)	9–12	3–6
Length of pedicle (mm)	2–7	1–3
Number of flower	5–13	5–9
Inflorescence type	lax to compact	compact

...Continued on next page

TABLE 1. (Continued)

Characters	<i>C. nima-yushiji</i>	<i>C. discolor</i>
<b>Flower</b>		
Hypanthium shape	infundibulate	narrowly cupulate
Hypanthium indumentum	pilose	tomentose
Diameter of corolla (mm)	8–10	6–7
Diameter of petal (mm)	3–3.5	2–2.5
Length of anther (mm)	3–3.5	2.5
Color of anther	yellow to brown	white to green
<b>Fruit</b>		
Color of fresh fruit	dark red to maroon	red to brownish red
Shape of fruit	globose	obovoid to globose
Diameter of fruit (mm)	8–10	5–7
Fruit indumentum	glabrous	sparsely pilose
Calyx lobes	depressed	suberect
Calyx indumentum in fruit	glabrous	villous

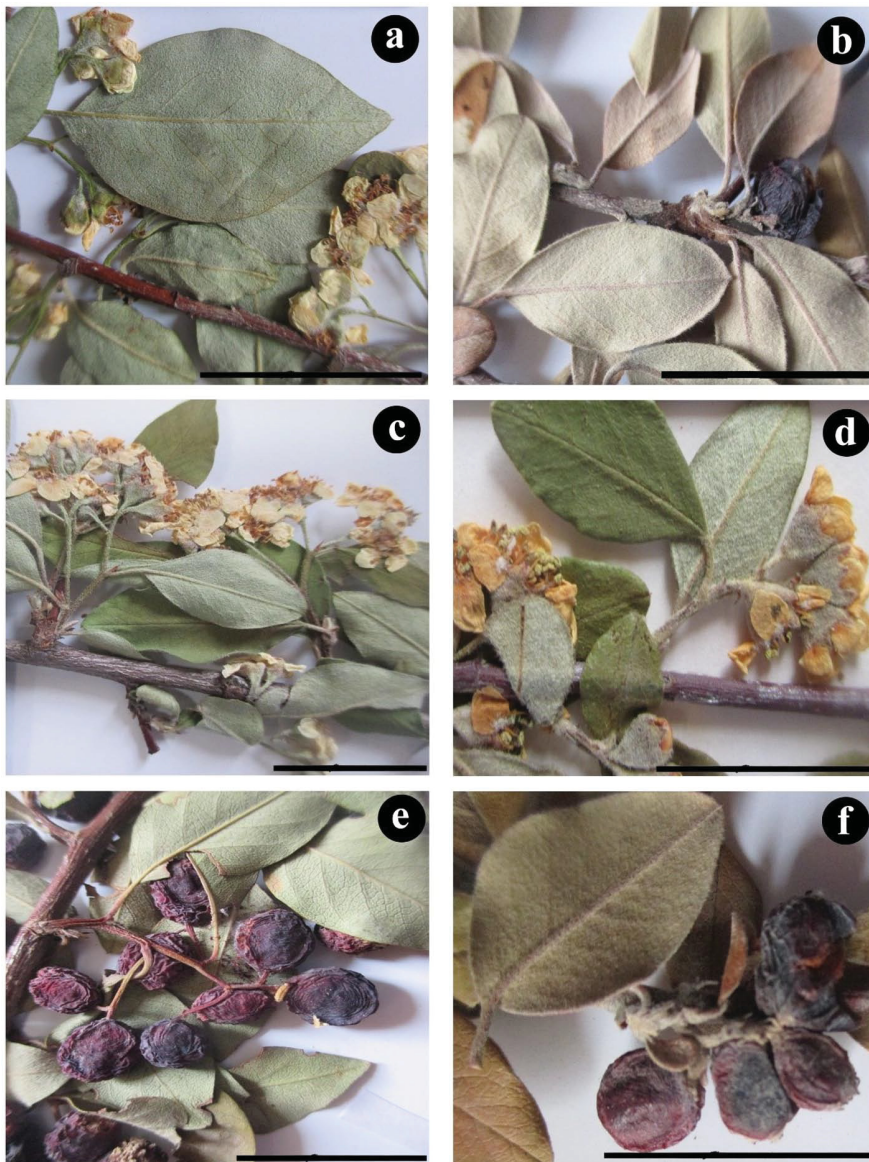


FIGURE 4. a, c, e) *Cotoneaster nima-yushiji*, sp. nov. b, d, f) *Cotoneaster discolor*; a, b) Indumentum of leaves; c, d) Flower; e, f) Fruit. Scale bars= 2 cm

**Etymology:**—The specific epithet refers to Nima Yushij (1897–1960), one of the most famous contemporary poets in Iran, born in Yush village.

**Phytochoria:**—Irano-Turanian (Zohary 1973, Takhtajan 1986).

**Phenology:**—Flowering, May–July; Fruiting, August–September.

**Distribution:**—Endemic to Iran. *Cotoneaster nima-yushiji* is currently only known from Yush village, Amol County, Mazandaran Province, in northern Iran. Based on the information from our own collections, a distribution map of *Cotoneaster nima-yushiji* is shown in (Fig. 1). *Cotoneaster nima-yushiji* is found in vegetation mainly composed of trees and shrubs such as *Prunus*, *Rosa*, *Rubus*, etc.

**TABLE 2.** The main separating characters of *C. mazandaranicus* and *C. multiflorus*.

Characters	<i>Cotoneaster mazandaranicus</i>	<i>C. multiflorus</i>
<b>Leaves</b>		
Length of leaves	35–58	30–46
Wide of leaves	10–25	21–40
Base of leaves	narrowly cuneate to cuneate	obtuse
Apex of leaves	acute, seldom obtuse	obtuse or rounded
Shape of leaves	narrowly ovate to elliptic-lanceolate	broadly ovate to suborbicular
Upper surface color	dark green	pale green
Upper surface luster	shiny	dull
Lower surface indumentum in flowering time	semi-glabrous	semi-pilose
lower surface indumentum in fruiting time	glabrous	subglabrous
Leaves number of fertile shoot	3–6	3–4
<b>Flower</b>		
Hypanthium shape	Infundibulate	Cupulate
Sepal	acute or acuminate	obtuse or acute
<b>Fruit</b>		
Color of fruit	maroon to black	light red to red
Mesocarp	succulent	non succulent

**Additional specimens examined:**—*Cotoneaster nima-yushiji*:—IRAN. Mazandaran: 50 km after Amol, near Yush village, N: 36° 11' 02", E: 51° 43' 39", 1810 m, 24 May 2016, Raei Niaki & Mahdigholi 46880 (TUH). 50 km after Amol, near Yush village, 24 September 2016, Raei Niaki & Mahdigholi, 46879 (TUH). *Cotoneaster discolor*:—Mazandaran: Firoozkuh, after Dogol station to Qaemshahr, Attar, Raei Niaki, Zamani, 37702 (TUH). Firoozkuh, near Veresk village, Attar, Raei Niaki, Zamani, 37648 (TUH). Firoozkuh, 75 km to Qaemshahr from Firoozkuh, Attar, Raei Niaki, Zamani, 37646 (TUH). IRAN. 65 km from Gachsar to Chalus, Attar, Raei Niaki, Zamani, 37638 (TUH). 78 km to Qaemshahr from Firoozkuh road, Attar, Raei Niaki, Zamani, 37642 (TUH). Northern Khorasan: Darkesh to Haver village, Attar, Raei Niaki, Zamani, 37667 (TUH).

***Cotoneaster mazandaranicus* R. Niaki & Attar, sp. nov.** (Fig. 5a)

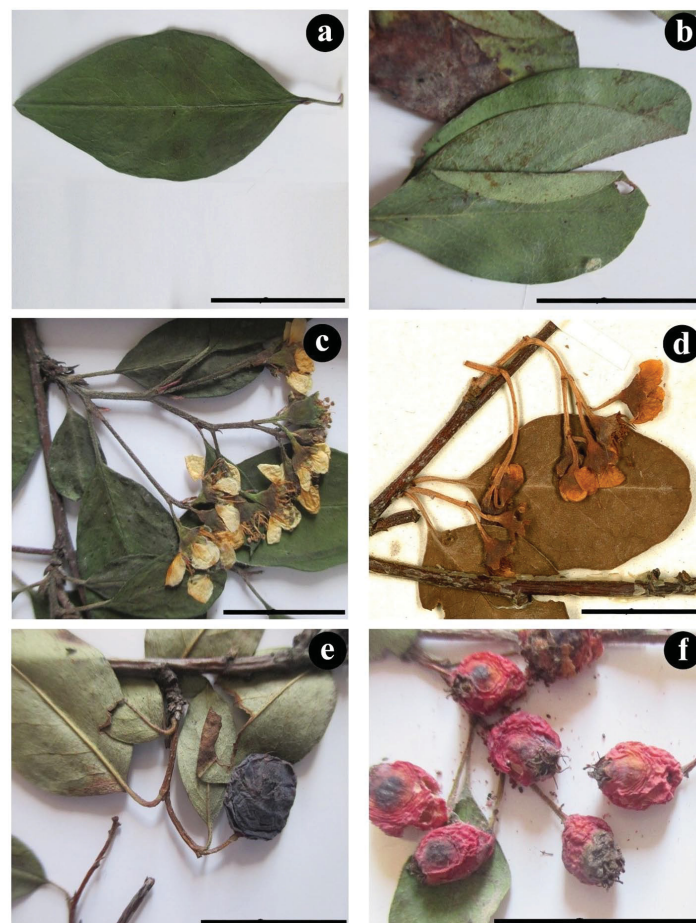
**Type:**—IRAN. Mazandaran: Firoozkooh road, Ca. 30 km after Veresk village, N: 35° 52' 43", E: 52° 57' 31", 1802 m, 24 May 2016, Raei Niaki & Mahdigholi, 46877 (holotype: TUH).

Shrubs deciduous, 3–4 m tall. Branchlets reddish brown to brown, slender, initially greenish gray pubescent, soon glabrescent. leaves deciduous, chartaceous, narrowly ovate to elliptic-lanceolate, 35–58 × 10–25 cm, thin, lower surface pale green, at flowering time subglabrous or glabrous, upper surface dark green, glabrous, base narrowly cuneate to cuneate, apex acute or seldom obtuse, often mucronate. Petiole 6–10 mm, glabrous or subglabrous, light green. Corymbs lax, 10 to 20-flowered; peduncles 9–16 mm, subpilose to glabrous; pedicel 3–7 mm, glabrous. Flowers 9–10 mm in diam. Hypanthium infundibulate, glabrous, margin seldom semi-pilose. Sepals triangular, ca. 2 × 1.5 mm, apex acute, pilose. Petals spreading, white, suborbicular, 3–3.5 mm in diam., adaxially white pubescent near base, base shortly clawed, apex emarginate. Stamens 20, filaments white, anthers white. Fruit to maroon to black, subglobose, 8–10 mm in diam, succulent, pruinose, calyx lobes flat, novel close. Pyrenes 2.





**FIGURE 5.** a) Holotype of *Cotoneaster mazandaranicus* sp. nov. deposited in the TUH Herbarium (R. Niaki & Attar 46877) ; b) *Cotoneaster multiflorus* (type specimen, LE, without number)



**FIGURE 6.** a, c, e) *Cotoneaster mazandaranicus* sp. nov. general shape; b, d, f) *Cotoneaster multiflorus*; a, b) Indumentum of leaves; c, d) Flower; e, f) Fruit. Scale bars= 2 cm

**Leaves epidermal cells:**—The epidermal cells on and abaxial surfaces of *Cotoneaster mazandaranicus* are irregular. The anticlinal walls of the epidermis cells are sinuous. Stomatal type is stephanocytic or staurocytic (4 cells,

more or less equal in size, with the anticlinal walls of the subsidiary cells extending at right angles from the poles and middle of the guard cells (Fig. 3 f).

**Pollen:**—View of symmetry, iso- and heteropolar types are observed in the species (Fig. 3b). The aperture is tricolpate (Fig. 3b). The surface is mainly striate ornamentation (Fig. 3d).

**Etymology:**—The specific epithet is derived from the name of Mazandaran province where the new species grows.

**Phytochoria:**—Irano-Turanian (Zohary 1973, Takhtajan 1986).

**Phenology:**—Flowering, May–July; Fruiting, August–September.

**Additional specimens examined:**—*Cotoneaster multiflorus* (Fig. 5b):—IRAN. Khorassan: W Bojnord, Zuhaver, 27 June 2000, Zangoie, 32994 (FUMH). SW Dargaz, Songhoz, Ghareghat valley, Rafei & Zangoie, 27655 (FUMH).

**Taxonomical remarks:**—*C. mazandaranicus* belongs to subgenus *Chaenopetalum* by erect petals and flowering of inflorescence extended; section *Multiflora* by deciduous and ovate leaves; series *multiflora* by chartaceous and dark green leaves, inflorescence lax with 1- to 20-flowered and corolla mostly open. *Cotoneaster mazandaranicus* originates from eastern Siberia (Szweykowsky 1993). This study showed that the new species differ from similar species in gross morphology for several diagnostic traits. This species is morphologically similar to *C. multiflorus*, but is distinguished by leaf blade with base narrowly cuneate to cuneate, shape and size of leaves, indumentum of leaves, color of leaves and fruit (Fig. 6 a–f) (Table 2).

## Reference

- Bailey, L.H. & Bailey, E.Z. (1976) *Hortus: A concise dictionary of plants cultivated in the United States and Canada*. third edition. Macmillan General Reference, NY.
- Baranova, M.A. (1987) Historical development of the present classification of morphological types of stomates. *Botanical Reviews* 53: 53–79.  
<https://doi.org/10.1007/BF02858182>
- Baranova, M.A. (1992) Principles of comparative stomatographic studies of flowering plants. *Botanical Reviews* 58: 49–99.  
<https://doi.org/10.1007/BF02858543>
- Boer, E. (2014) Risk Assessment *Cotoneaster*. Naturalis Biodiversity Center.
- Brickell, C. & Zuk, J.D. (1997) *The American Horticultural Society A-Z Encyclopedia of Garden Plants*. DK Publishing, Inc., NY.
- Browicz, K. (1972) *Cotoneaster* Medik. In: Davis, P.H. (Ed.) *Flora of Turkey*. Vol. 4. Edinburgh, pp. L2g–L32.
- Campbell, C.S., Greene, C.W., Neubauer, B.F. & Higgins, J.M. (1985) Apomixis in *Amelanchier laevis*, shadbush (Rosaceae, Maloideae). *American Journal of Botany* 72: 1397–1403.  
<https://doi.org/10.1002/j.1537-2197.1985.tb08397.x>
- Carpenter, K.J. (2005) Stomatal architecture and evolution in basal angiosperms. *American Journal of Botany* 92 (10): 1595–1615.  
<https://doi.org/10.3732/ajb.92.10.1595>
- Dilcher, D.L. (1974) Approaches to the identification of angiosperm leaf remains. *Botanical Reviews* 40: 1–157.  
<https://doi.org/10.1007/BF02860067>
- Erdtman, G. (1952) *Pollen Morphology and Plant Taxonomy: Angiosperms, An introduction to Palynology*. Stockholm: Almqvist & Wiksell/Waltham, Chron. Bot. Hafner, 553 pp.
- Fryer, J. & Hylmö, B. (2009) *Cotoneasters: A comprehensive guide to shrubs for flowers, fruit, and foliage*. Timber Press, Portland-London, 344 pp.
- Fryer, J. & Hylmö, B. (2011) *Cotoneaster* Medik. In: Cullen, J., Knees, S.G. & Cubey, H.S. (Eds.) *The European garden flora, flowering plants: a manual for the identification of plants cultivated in Europe, both out-of-doors and under glass*. Volume 3. Rosaceae to Cyrtaceae, pp. 286–297.
- Heriteau, J. (1990) *The National Arboretum book of outstanding garden plants*. Simon and Schuster, New York, 292 pp.
- Hjelmqvist, H. (1962) *The embryo sac development of some Cotoneaster species*. C. Bloms publications.
- Khatamsaz, M. (1985) Studies on the genus *Cotoneaster* Medik. in Iran, new records and key. *Iranian Journal of Botany* 3: 55–62.
- Khatamsaz, M. (1988) Studies on the Rosaceae family in Iran, new taxa and new records. *Iranian Journal of Botany* 4 (1): 111–125.
- Khatamsaz, M. (1991) Two new species of Rosaceae from Iran. *Iranian Journal of Botany* 5: 1–5.
- Khatamsaz, M. (1992) *Cotoneaster* Medik. In: Assadi M (ed.) *Flora of Iran*, no. 6. Research institute of forests and rangelands. [in Persian]



- Koehne, E. (1893) *Deutsch. Dendrology*, 224 pp.
- Lu, L.D. & Brach, A.R. (2003) *Cotoneaster*. In: Wu, Z.Y. & Raven, P.H. (Eds.) *Flora of China*, Vol. 9. Science Press, Beijing & Missouri Botanical Garden Press, St. Louis. pp. 85–108.
- Mabberley, D.J. (2008) *Mabberley's Plant-Book. A portable dictionary of plants, their classification and uses*. Third Edition. Cambridge Univ. Press, Cambridge, U.K., 1021 pp.
- Marshall, D.R. & Brown, A.H.D. (1981) The evolution of apomixis. *Heredity* 47: 1–15.  
<https://doi.org/10.1038/hdy.1981.54>
- Meyer, C.A. (1831) *Verzeichniss der Pflanzen, welche wahrend der in den jahren 1829 und 1830 Unternommenen reise im Caucasus und in den provinzen am westlichen ufer des Caspischen Meeres gefunden und eingesammelt worden sind*. St. Petersburg. Kaiserl. Akademie der Wissenschaften, S. Petersburg, 241 pp.
- Nogler, G.A. (1984) Gametophytic apomixis. In: Johri, B.M. (Ed.) *Embryology of angiosperms*. Springer-Verlag, Berlin, pp. 475–518.  
[https://doi.org/10.1007/978-3-642-69302-1\\_10](https://doi.org/10.1007/978-3-642-69302-1_10)
- Pojarkova, A.I. (1954) *Botanicheskie Materialy Gerbariya Botanicheskogo Instituta Imeni V. L. Komarova Akademii Nauk SSSR*. Leningrad. Leningrad [St. Petersburg].
- Pojarkova, A.I. (1971) *Cotoneaster* Medik. In: Komarov, V.L. (Ed.) *Flora of USSR* 9. Academy of Science of the U.S.S.R, pp. 259–274.
- Potter, D., Eriksson, T., Evans, R.C., Oh, S.H., Smedmark, J.E.E., Morgan, D.R., Kerr, M., Robertson, K.R., Arsenault, M.P., Dickinson, T.A. & Campbell, C.S. (2007) Phylogeny and classification of Rosaceae. *Plant Systematics and Evolution* 266: 5–43.  
<https://doi.org/10.1007/s00606-007-0539-9>
- Raei Niaki, N., Attar, F. & Maroofi, H. (2009) Anatomical studies on fourteen species of the genus *Cotoneaster* Medik. (Rosaceae) in Iran. *Iranian Journal of Botany* 15: 96–104.
- Raei Niaki, N., Attar, F., Mirtadzadini, M., Mahdigholi, K. & Sheidai, M. (2019) Micromorphological studies of leaf epidermis on the genus *Cotoneaster* Medik in Iran and its implication. *Nordic Journal of Botany* 37 (2). [Published Online]  
<https://doi.org/10.1111/njb.02074>
- Riedl, H. (1969) *Cotoneaster* Medik. In: Rechinger, K.H. (Ed.) *Flora Iranica*, no. 66. Graz, pp. 13–26.
- Stace, C.A. (1965) *Cuticular studies as an aid to plant taxonomy*. *Bulletin of British Museum* 4: 1–78.
- Takhtajan, A.L. (1986) *Floristic Regions of the World*. (translated by T.J. Crovello & A. Cronquist). University of California Press, Berkeley.
- Ueda, Y. & Tomita, H. (1989) Morphometric analysis of pollen exine patterns in Roses. *Journal of the Japanese Society of Horticultural Science* 58: 211–220.  
<https://doi.org/10.2503/jjshs.58.211>
- Yü, T.T. & Lu, L.T. (1974) *Cotoneaster* Medik. In: Yü, T.T. (Ed.) *Flora Reipublicae Popularis Sinicae*, 36. Beijing, pp. 107–178. [in Chinese]
- Zohary, M. (1973) *Geobotanical foundations of the Middle East*, vol. 2. Fischer, Stuttgart, 738 pp.