Taxonomy of the wild species of genus *Crataegus* (Rosaceae): An updated review for the flora of Nakhchivan Autonomous Republic (Azerbaijan)

A. M. Ibrahimov*, A. V. Matsyura**, K. Junkowski***

*Institute of Bioresources of Nakhchivan Section of Azerbaijan National Academy of Sciences, Nakhchivan, Azerbaijan
**Altai State University, Barnaul, Russian Federation
***Siedlce University on Natural Science and Humanities, Siedlce, Poland

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Introduction

Nakhchivan Autonomous Republic (AR) is a part of the Azerbaijani Republic, situated in the southwestern region of the Lesser Caucasus Mountains. The overall length of the republic’s boundaries is 598 km. The region occupies 5,363 km² and borders Armenia in the east and north (221 km), Iran in the south and west (179 km), and Turkey in the northwest (15 km). Its highest point is the Gapazhdak peak (3,906 m), and the lowest point of the autonomous republic (600 m) is located on the left bank of the Aras River, at the foot of the steep Soyugdag ridge (Fig. 1).

The Republic of Nakhchivan is considered a distinct climate and physical-geographical area of Azerbaijan (Mirzeyev, 1952). It has a continental climate with cold winters and dry summers. The mean annual temperature is about 10–14 °C. Areas above 2,300–2,400 m have a mean annual air temperature of less than 4 °C. In the lower part of the Republic, the mean air temperature is 18 °C in January and 41–43 °C in July–August. Relative humidity ranges significantly, accounting for 74–76% in the city of Nakhchivan in December–February and 39–40% in July–August. In the middle mountain zone in December–February and July–August, it equals 69–78% and 52–55% respectively, which is similar to the Lesser Caucasus foothills area. The greatest share of precipitation is registered in spring (March–May), while July–August is the minimum precipitation period. The annual precipitation volume is 210–310 mm in the lowland region, 365–550 mm in the mid-mountainous area, and 660 mm in the alpine region.

Nakhchivan Autonomous Republic territory has abundant flora and plant diversity. Initially that is due to the territory’s environmental and highly dynamic geological and geomorphological composition. The territory, which forms the boundary of the Caucasian, Central Asian and Iranian migration flora, contains several botanical-geographical areas. A total of 2,963 species of higher plants have been found in the territory, identified to 880 genera and 168 families (Talibov & Ibrahimov, 2008).

Some of the oldest representatives of the Rosaceae family are the species included in the genus *Crataegus*. Research conducted in the field of paleobotany has confirmed the antiquity of the genus *Crataegus*. According to Krzyżtopf (1957), *Crataegus* representatives initially appeared during the Cretaceous period in the Mesozoic Era, and were widespread in the Tertiary Period. The traces found in the former USSR, in the Upper Oligocene, Miocene, and Pliocene sediments, may also confirm this. In modern times the genus *Crataegus* is distributed in hot and subtropical and temperate provinces located at latitudes from 30° to 60° (Talishnaj, 1978). While in temperate Europe there are fewer *Crataegus* species compared with North America, those few species are very widespread and common in grassland and forest ecosystems. They are found mostly in the American flora, while the genetic diversity center of the section *Crataegus* ranges from Turkey to Iran (Albarouki & Peterson, 2007; Dönmez, 2014; Dönmez & Özderin, 2019).

We considered a few taxonomic studies on the Turkish *Crataegus* species, while some new taxa have been described from Asia and Europe (Dönmez, 2007, 2014; Dönmez & Özderin, 2019). Many new species have been described from North America (Christensen, 1992). Nowadays, the *Crataegus* species number is estimated by some authorities to be as high as 1,200. Nevertheless, the widely accepted species number is almost 200, some species being considered to be synonyms (Fineschi et al., 2005; Talent & Dickinson, 2005; Lo et al., 2007, 2009).

Studies related to wild species of the *Crataegus* genus were also performed by Riedl (1959), Cinvoskis (1971), Browics (1972), Dönmez

Key words: flora; Azerbaijan Republic; systematic; rare species; distribution.
Grosheim (1952) described the distribution of 14 hawthorn species in the Caucasus and grouped them (at section level) as follows: pentagyna, C. pentagyna Zbl. (C. pentagyna, C. colchica Grosch.), azarol, Loud. (C. orientalis, C. svovitish, C. pontica, ovacanth Zbl. (C. meyeri, C. eriantha, C. caucasica, C. atrosanguinea, C. kyrtoysta, C. pallasia, C. monogyna, C. pseudoheterophylla, C. lagenaria). Besides, the author reported new species of hybridogenic origin and mentioned regular hybridization between the species of Crataegus genus. Among them were C. zangezura (C. pentagyna x), C. armena (C. kyrtoysta x C. meyeri) and C. schraderiana (C. orientalis x C. pentagyna) that were described as hybridogenic species.

Poletiko (1954) changed the systematic composition of the Crataegus genus on the basis of available herbarium specimens and his data, confirming that 15 species – C. pentagyna, C. zangezura, C. orientalis, C. svovitish, C. pontica, C. meyeri, C. eriantha, C. caucasica, C. atrosanguinea, C. kyrtoysta, C. pseudoheterophylla, C. armena, C. pallasia, C. monogyna, and C. microphylla, were distributed in the Caucasus. The author also mentioned that C. zangezura and C. armena were not found in cultivation. He classified C. schraderiana (C. orientalis x C. pentagyna) as a hybrid C. tournefortii Griseb. and suggested that it was distributed only in Minsk and Crimea as a cultural species.


Prilipko (1939, 1954, 1965) reported the distribution of C. orientalis, C. pentagyna, C. pectinata, C. monogyna, C. svovitish, C. meyeri, C. caucasica, C. pseudoheterophylla, and C. kyrtoysta for the area of Nakhchivan AR. K. S. Asadov et al. (2008, 2014) have also substantiated this information. Prilipko (1954) showed that nine species of hawthorn – C. pentagyna, C. orientalis, C. svovitish, C. meyeri, C. eriantha, C. caucasica, C. kyrtoysta, C. pseudoheterophylla, and C. lagenaria are distributed in the territory of Azerbaijan. C. zangezura (C. pentagyna x), C. armena (C. kyrtoysta x C. meyeri), and C. schraderiana (C. orientalis x C. pentagyna) were described as species of hybridogenic origin.


Askero (2006) confirmed the presence of 17 hawthorn species for the territory of Azerbaijan and showed the problematic independent status of C. atrofusca in relation to C. pentagyna, which was suggested by Kasumova. According to Askero, C. atrofusca differs from C. pentagyna mainly by leaves, sepal and fruit, which, in our opinion, is not sufficient for species status. Thus, Askero (2006) suggested the hawthorn species list for the territory of Azerbaijan including C. pentagyna (incl. C. atrofusca), C. orientalis (C. luciniate), C. svovitish, C. meyeri, C. eriantha, C. caucasica, C. curvisepala (C. kyrtoysta), C. microphylla (C. lagenaria), C. pseudoheterophylla, C. atrosanguinea, C. armena, C. zangezura, C. pallasia, C. pontica, C. monogyna, C. pojarjovae, and C. tournefortii. Further research on hawthorns has been continued by Ufimov (2011), and initially Crataegus tayshensis Pojark. ex Ufimov was added to the Cauca- casian flora and later Ufimov (2013) reported 30 species of Crataegus for the Caucasus.

Talibov & Ibrahimov (2008) determined the latest systematic composition of species belonging to the Crataegus genus. The authors reported 20 species of hawthorn for Nakhchivan AR, among them 15 species – C. armena, C. caucasica, C. cinovskisii, C. curvisepala, C. eriantha, C. meyeri, C. monogyna, C. orientalis, C. pallasia, C. pentagyna, C. pojarjovae, C. pontica, C. pseudoheterophylla, C. svovitish, and C. zangezura were found in the wild, while five species – C. chlorocarpa, C. ferganensis, C. sangiuina, C. songaria, and C. turkestanica were cultivated. However, Kasumova (1985) did not include C. atrosanguinea and C. tournefortii for this area due to the problematic taxonomy. Later, Talibov & Ibrahimov (2013) presented detailed information about distributions of these species in the Nakhchivan Autonomous Republic. Sargsyan (2011) also indicated the presence of C. tournefortii in the Nakhchivan Autonomous Republic.

Thus, though there is some research concerning the distribution of Crataegus throughout the Autonomous Republic, the species structure of the genus is still unclear.

Material and methods

We analyzed the specimens from the Herbarium Fund of the Botany Institute of the Azerbaijan National Academy of Sciences, Bioresources Institute of the Nakhchivan Section of the Azerbaijan National Academy of Sciences, Nakhchivan State University. We performed the field research during 2004–2018, partially reported in Ibrahimov et al. (2018) and...
Ibragimov (2005) within the Nakhchivan Autonomous Republic. We applied standard methods for collecting and storing the plants, particularly the methods according to Baranec (1986), and Metsger & Byers (1999). We used the GPS Garmin to determine the locality coordinates and altitudes during the field trips.

The species were identified according to Christensen (1992), Kasumova & Akhundov (2004), Askero (2006), Christensen & Zielinski (2008), Ufimov (2011, 2013). We used data from Gladkova (1968) and Byatt & Murray (1977) for chromosome analysis to detect the parentage of some hybrids. Since there is some interspecies variation in chromosome numbers we also used data from Gladkova (1967, 1968), Magulayev (1976), Byatt & Murray (1977), Baranec (1983, 1986), and Donmez (2007, 2014) for the identification of Crataegus species karyotypes. We enhanced our previous research data (Ibragimov, 2017; Ibragimov et al., 2018) with more detailed chromosome analysis, which resulted in inter- and intersection hybrids status clarification.

To collect the flowering and fruiting materials, we visited most of the localities two or three times. We also performed observations on habitat, lifeform, phenology and some morphological features with notation and photographs. We presented the taxa, families, and author citations in accordance with Christensen (1992) and Pipps et al. (2003); we also arranged alphabetically the family and species names in our article. All collected herbarium materials were deposited in the Herbarium of the Bioresources Institute of the Nakhchivan Section of the Azerbaijan National Academy of Sciences.

Results

We reported 17 wild species of Crataegus L. for the flora of Nakhchivan Autonomous Republic. The identified species are listed in alphabetical order of family names.

Type: C. pentaphylla Gandoger (C. oxyacantha L., nom.rejic.)
Subgen. 1, Crataegus
Type: Crataegus L.


C. pentagyna species are shrubs or small trees, mostly growing to 5–15 m tall, with small pome fruits and usually thorny branches. The most common type of bark is smooth grey in young individuals, developing shallow longitudinal fissures with narrow ridges in older trees. The thorns are small sharp-tipped branches that arise either from other branches or from the trunk, and are typically 1–3 cm long (once recorded as up to 11.5 cm). The leaves grow spirally arranged on long shoots, and in clusters on spur shoots on the branches or twigs. The leaves of most species have lobed or serrate margins and are somewhat variable in shape. The fruit, sometimes known as a “haw”, is berry-like but structurally like a pome, containing 1–5 pyrenes that resemble the “stones” of plums or pea-shrubs, which are drupaceous fruits in the same subfamily.

Type: C. pentaphylla Gand.


Type: C. pentagyna Waldst. et Kit. ex Willd.

The branches of the trees are covered with short thorns. The leaves are egg-shaped or ovate-oblanceolate; the lower surface is clean or fuzzy. The flower group is bare or hairy. Blackish fruits pulp are slightly red. Seeds 2–5, flank side is smoother; the backside is scarce furrow. The fruits are in a spherical shape and black coloured, with blue spots on them and 3–5 pyrenes.

Ser. 1, pentagynae (C. K. Schneider) Russanov


Flowering from May–June, fruiting from September.

 Chromosome number: 2n (2x) = 34 (Gladkova, 1968; Byatt & Murray, 1977; Donmez, 2004); 2n (3x) = 51 (Gladkova, 1967), as C. atrofuscua (K. Koch) T. A. Kasumova.

Type: “Hungary/Yugoslavia. In Durato et Simyio (Dunabe and Serbia), kitaibel s.n.”, holotype: B-W 9718.

Distribution and habitat: From Hungary and Yugoslavia through Romania and Bulgaria to Ukraine, Crimea, Moldavia, Northeastern Greece, Turkey, Caucasus, Iran, Kopet Dagh, and Northeastern Iraq; on limestone, serpentine, rocky mountain slopes, in woods with Rosu and Quercus along rivers.

Locality: The species is found in adjacent forests and mountain slopes of Bichanak village of Shahbaz region (1,836 m a.s.l., 39°31′01″ N, 45°46′16″ E) village of Ordubad (1,956 m a.s.l., 39°09′55″ N, 45°55′34″ E) village of Ordubad district, in low and middle mountain zones at the height of 1,400–2,200 m a.s.l., and in the brushwoods, forest glades, rarely in oak forests and well lit places in mixed forests (Fig. 2a).


Ser. 2. digyna Ufimov, Novitates Systematicae Plantarum Vascularium, 2013, 44: 117


Flowering from May, fruiting from September–October.

 Chromosome number: 2n (4x) = 68 (Christensen, 1992).

Type: U.S.S.R., Armenia, Zangezur, prope opp. Goris (Genjuri), in Nasirvaz (1,956 m a.s.l., 39°09′55″ N, 45°55′34″ E) village of Ordubad district, in low and middle mountain zones at the height of 1,400–2,200 m a.s.l., and in the brushwoods, forest glades, rarely in oak forests and well lit places in mixed forests (Fig. 2a).

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Distribution and habitat: Kopet-Dag in Turkmenistan, Iran, and Caucasus; on rocky mountain slopes and in scrub.

Locality: It was found on stony slopes and sparse forests of the surrounding areas of Nusnus village (1,409 m a.s.l., 38°58′02″ N, 46°01′48″ E), Ordubad district and Chakhchgala village (1,793 m a.s.l., 39°29′06″ N, 45°17′40″ E), Babak region. We collected it around the Bichanek village (1,388 m a.s.l., 39°30′52″ N, 45°40′22″ E), Shahbud region and in Havsh village (1,957 m a.s.l., 39°35′59″ N, 45°14′44″ E), at the altitudes of 1,200–2,000 m a.s.l. on the rocks, in sparse forests, in the bushes, and in valleys (Fig. 2a).


Small tree or shrubs. The thorns are usually short. The leaves are oblong-egg shaped, hairy and fragmentary. The flower buds are felled. Anthers are white. Large fruits are yellowish, pink, red-pink, round, smooth and hairy.

Type: C. orientalis Pall. ex M. Bieb.

Ser. 1. orientales (C. K. Schneid.) Pojark.


Flowering from June, fruiting from September–October.

Chromosome number: 2n (4x) = 68 (Gladkova, 1968; Donmez, 2007).

Distribution and habitat: Europe, Caucasus, Sicily (Nebrodi Mts), Albania, Southern Yugoslavia, Greece, Bulgaria, Turkey, Ukraine (near Odessa), and the Crimea.

Locality: T. A. Kasumova collected the specimens from Chakhanga village of Kengerli region and Bichanek forest of Shahbuz region. The species is distributed in Khanbaliag areas of Sharur region, in the middle and upper mountain zones at 1,300–1,400 m above sea level, at the edges of the forests, on stony slopes or individually or in groups. During our research samples of C. tournefortii were collected from Kuku village (1,888 m a.s.l., 39°32′02″ N, 45°36′35″ N), Ayrinj village (1,320 m a.s.l., 39°26′08″ N, 45°35′33″ E) of Shahbuz region, Chakhangala village (1,678 m a.s.l., 39°25′55″ N, 45°20′44″ E) of Kangari region, Khazine dere village (2,121 m a.s.l., 39°20′39″ N, 45°46′36″ E) of Julfa region (Fig. 2b).


Flowering from June, fruiting from September–October.

Chromosome number: Unknown.


Distribution and habitat: Caucasus, European and Asian Turkey, western Iran.

Locality: According to Isaev & Kasumova, this species is present on the dry stony slopes between the Payiz and Bugovz villages of Babek region and Kolani village of Shahbud region. We collected specimens around the Payiz and Ashagi Bugovz villages (1,289 m a.s.l., 39°27′36″ N, 45°22′59″ E) of Babek region, Aramis village (2,182 m a.s.l., 39°22′22″ N, 45°46′45″ E) of the Julfa region, Kuku village (1,762 m, 39°31′08″ N, 45°37′33″ E), Kolani village (1,399 m a.s.l., 39°26′47″ N, 45°40′32″ E) and Ayrinj village (1,318 m a.s.l., 39°26′27″ N, 45°35′06″ E) in Shahbud region, in the middle mountain zones, at 1,300–2,200 m a.s.l., from


Flowering from June, fruiting from September.

Chromosome number: 2n (3x) = 51 (Gladkova, 1968).

Type: U.S.S.R., the Crimea, Kakudag, in parte inferiori declivitatis austriales jugi Stur'ko-Kaja, 14.06.1960, Kossych s.n. (holotype: YALT; isotype: LE).

Distribution and habitat: Caucasian, Crimea.

Locality: It was found in stony-gravel slopes of Yukhari Gishlag village (1,745 m a.s.l., 39°29′49″ N, 45°14′40″ E) and Gizil Gishlag village (1,546 m a.s.l., 39°29′35″ N, 45°36′32″ E), Shahbud region, in the middle and high mountain zones at 1,300–2,000 m a.s.l in sparse and forests (Fig. 2b).
story slopes of mountains, rocks, brushwoods, and arid sparse forests and edges of forests (Fig. 2c).


Flowering from May–June; fruiting from September–October.

Chromosome number: 2n (4x) = 68 (Glädka, 1967, 1968; Donmez, 2004).


Neotype, here designated: drawing of holotype, according to Pojarkova’s classification (1939).

Distribution and habitat: Israel, Jordan, Turkey, Caucasus, Georgia, Iraq, Iran, Turkmenia (Koptet-Dagh), Southern Kazakhstan, Uzbekistan, Tadzhikistan, and Kirgizistan.

Locality: According to Kasamova (1981, 1983, 1985, 1991), the species is distributed around Yulhary Gishlag in Shahbuz region. We collected samples around Chalkhanqala village (1,626 m a.s.l., 39°25′52″ N, 45°20′56″ E) of Kangarli region, around Ashagi Gishlag village (1,533 m a.s.l., 39°26′59″ N, 45°41′26″ E), Nusruni village (1,737 m a.s.l., 39°28′48″ N, 45°41′06″ E), Kulu village (1,421 m a.s.l., 39°27′11″ N, 45°41′58″ E), Nasirvaz village (1,483 m a.s.l., 39°26′29″ N, 45°35′07″ E), and around Ashagi Gishlag village (1,870 m a.s.l., 39°30′52″ N, 45°40′50″ E). We also registered this species in Nursu and Agbulag villages of Shahbuz region, in the low and middle mountain zones, at heights of 1,300–1,800 m a.s.l., on dry banks of mountain rivers and in arid forests (Talibov & Ibrahimov, 2013).

Chromosome number: 2n(3x) = 51; 2n(4x) = 68 (Gladkova, 1967, 1968).


Distribution and habitat: South Caucasus, Eastern Turkey, Central and Northern Iran.

Locality: This plant is distributed in the surroundings of Chakhchanga village (1,763 m a.s.l., 39°29′08″N, 45°55′02″E) of Khanagur region in the areas between vineyards, in Jahr village (1,057 m a.s.l., 39°20′50″N, 45°31′12″E). The herb of Habak region, in low and middle zones at the height of 1,300–1,800 m a.s.l., on the slopes of the mountains, at the edges of the rivers and in the valleys, among shrubs (Fig. 3a).


Flowering from May, fruiting from September–October.

Chromosome number: 2n (3x) = 51 (Gladkova, 1968; Donmez, 2004).


Flowering from May, fruiting from September–October.

Chromosome number: 2n (3x) = 51; 2n (4x) = 68 (Gladkova, 1967, 1968; Donmez, 2004).


Distribution and habitat: Southeastern Europe, Caucasus, Turkey, Checheno-Ingushskaya ASSR, Dagestan, mouth of the Kuban River, and near Volgograd (Krasnoarmeiski Gorod); on mountain slopes, along rivers, and in scrub.

Locality: The plant grows on rocky slopes and sparse woods in Akhurra village (1,141 m a.s.l., 39° N, 45°08′36″E) and Harvus village (1,429 m a.s.l., 39°36′01″N, 45°14′39″E) of Shanur region. During our investigations, we found the species around Bihekan village (1,913 m a.s.l., 39°30′25″N, 45°46′26″E) and Kuku village (1,910 m a.s.l., 39°32′14″N, 45°54′23″E) of Ordubad district, in Kuku village (1,910 m a.s.l., 39°32′14″N, 45°54′23″E) of Ordubad region, at the height of 1,400–2,200 m above sea level, growing individually or in small groups, in forests, glades, well lit oak forests and sparse arid woods. Sometimes, along with other species of hawthorns, they form brushwood on riverbeds and on dry slopes of the mountains (Fig. 3c).


Flowering from May, fruiting from September–October.

Chromosome number: Unknown.

Type: U.S.S.R., Sarapi [Krasnoarmeiski Gorod], Pallas s.n. (holotype: LE?).

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Flowering from May, fruiting from September.

Chromosome number: 2n (3x) = 51; 2n (4x) = 68 (Gladkova, 1967, 1968; Donmez, 2004).


Distribution and habitat: Eastern Europe, Caucasus, Asian Turkey, Caucasus, Crimea, Dagestan, Iran, Turkomania, Uzbekistan, Kazakhstan, Kirgistan, Tadzhikistan, Afghanistan, Pakistan, Northern India, and Tibet; in scrub, rocky mountainous terrains, gorges, along rivers, and at field edges (Christensen, 1992).

Locality: It is one of the rare species in the autonomous republic. It is distributed in Ayriyan, Bichenech, South Gishgal Gishgal, and Gold Gishgal Gishgal of Shabazh region, in Chakhchanga villages of Karangiri region and foothills near Ordubad city (Kasumova & Akhandov, 2004). We collected samples in Bichenech village (1,788 m a.s.l., 39°29′47″N, 45°40′03″E)
of Shahbuz region, in Akdura village (1,204 m a.s.l., 39°32′40″ N, 45°16′17″ E) and Nasirvaz village (1,904 m a.s.l., 39°32′40″, and 45°45′29″ E) of Shahbuz region, in Akhura village (1,204 m a.s.l., 39°33′29″, and 45°44′47″, and 45°14′36″ N, 44°54′31″ E) of Ordubad district (Fig. 3c).

Locality: it was found in arid sparse forests, on stony slopes and in forest fronts at 1,500–2,000 m a.s.l. in middle and high mountainous hedges, and on road sides.

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C. tournefortii by C. schraderiana and proved its presence in the Nakhchivan Autonomous Republic. Christensen (1992) adopted C. tournefortii as a synonym of C. orientalis identifying it to the C. orientalis subsp. orientalis. However, we discovered that both species differ from each other significantly by the flowers, shapes of leaves, fuzzyness, size, shape, and colour of fruits and by number of seeds (Table 1). It is possible to assume that C. tournefortii is a completely different species from C. orientalis, and this should be further clarified.

Letukhova & Potapenko (2011) reported that C. tournefortii was of hybridogenic origin and resulted from the hybridization of C. orientalis and C. pentagyna.

C. szovitsii Pojark. was added to the Nakhchivan Autonomous Republic flora as a new species during the analysis of materials collected from Kolani village (dry-stony slopes) of Shahbuz region, Payiz and Buzgov villages of Babek region in 1976 by Bayev and Kasumova (1976). According to the authors, the collected herbariums differed from the typical examples and had 3–5 seeds (not 2–4). C. szovitsii has been regarded as C. orientalis subsp. szovitsii (Pojark.) Christensen by A. Christensen (1992). However, we determined that C. szovitsii differs from C. orientalis by more fragmented leaves, reddish-yellow fruits and number of seeds 3 (2) to 4 (5). Generally, C. szovitsii is considered an independent species, given its obvious distinction from other hawthorn species by many features (Table 2).

| Table 2 |
|------------------|------------------|------------------|
| **Key morphological features of Crataegus szovitsii, C. eriantha and C. meyeri** |
| **Characteristic** | **C. szovitsii** | **C. eriantha** | **C. meyeri** |
| Life form | shrub, small tree | shrub, small tree | shrub, small tree |
| Height, m | 2–3 | 3–5 | 2–4(6) |
| Flowering time | May | May–June | May–June |
| Flower number per inflorescence | 10–12 | 5–15 | 9–20 |
| Leaf size (on short shoot) | 3–5 × 2.0–4.5 | 25.40 × 25.40 | 20–40 × 20–40 |
| Leaf indumentum (beneath) | cuneate | almost truncate | long villosa |
| Leaf base | glaucous | pubescent | cuneate |
| (on short shoot) | or attenuate | or attenuate | or attenuate |
| Stamens | 20 | 18–20 | 18–20 |
| Pyrenes | 3–4, rarely 2 | 2, rarely 1 | 2, rarely 1 |
| Fruit colour | dark red | dark red | red, more |
| Fruit size, mm | 12–14 × 10–12 | 10–12 × 6–8 | 12–15 × 8–10 |
| Thorn length, mm | 5–15 | 5–15 | 10–15 |
| Thorn shape | more or less stout | thin | stout |

C. pontica C. Koch as a new species was included to the flora of Azerbaijan by Kasumova (1981) with the samples collected from the territory of Nakhchivan Autonomous Republic.

C. meyeri Pojark. was broadly distributed in the South Caucasus and was described as C. pentanthera C. A. Mey. by Grossheim (1952). According to Pojarkova (1939), some authors incorrectly identified C. meyeri with 2–3 seeded fruits as C. caucasica, and some of them misidentified it as C. orientalis confused by the densely fuzzy character of both sides of the leaves.

C. eriantha Pojark. is closer to C. meyeri, and differs by fewer fragmented, rarely fuzzy leaves, relatively large, sparse, densely fuzzy flowering groups. We also presented a comprehensive description of these species (Table 2).

Christensen (1992) considered C. atrosanguinea as a synonym of C. ambigua subsp. ambigua Meyer ex Becker. However, we discovered that they are different species and differ from each other by key features. Thus, their leaves are large, greenish, and have smooth edges, but there are slightly larger serrated plaques on the top of the leaves of C. atrosanguinea. The leaves are dark green colored, serrated plaques and the serration continue from the middle of the leaf to the apex of the C. ambigua. Two seeds per fruit. The C. ambigua are herbarium samples stored in Saint Petersburg has fruits with 1–2 (3) seeds (Christensen, 1992) (Table 3).

C. pseudoheterophylla Gend. (C. curvisepala Lindm., C. krytostyla Pojark.) in contemporary literature (Donmez, 2004; Tzvelev, 2006; Christensen & Zielinski, 2008) is called C. riphiphylly, which does not take into account C. curvisepala (C. krytostyla). It was not mentioned by Cherepanov (1995) and in the study by Sargsyan (2011) C. curvisepala (C. krytostyla) was accepted as C. riphiphylly. As was mentioned in Pojarkova (1939) and Poletico (1954), C. pseudoheterophylla sometimes is mistakenly applied to C. monogyna or C. heterophylla. However, C. heterophylla is distributed in Spain as a wild species and was not found in the former Soviet Union. Pojarkova reported that both C. krytostyla and C. pseudoheterophylla were presented as C. monogyna. Further C. pseudoheterophylla was found in Tuapse and in Krasnodar region (Fedorov, 1958).

| Table 3 |
|------------------|------------------|------------------|
| **Key morphological features of C. atrosanguinea, C. ambigua, C. monogyna and C. riphiphylly** |
| **Characteristic** | **C. atrosanguinea** | **C. ambigua** | **C. monogyna** | **C. riphiphylly** |
| Life form | shrub | shrub, small tree | shrub, small tree | shrub, small tree |
| Height, m | 4–6(10) | 12 | 3–6(8) | June |
| Flowering time | May–June | May–June | May–June | June |
| Flower number per inflorescence | 6–12 | 5–12 | 10–18 | 5–15 |
| Leaf size (on short shoot) | 1.8–5.0 × 2.3–5.8 | 1.9–6.6 | 1.5–5.7 × 1.1–5.8 | 0.5–5.4 |
| Leaf indumentum (beneath) | glabrous or more or less | villosa | coriaceous, more or less | villosa |
| | coriaceous or | or | coriaceous, or | or |
| | villosa | villosa | villosa | villosa |
| Stamens | 20 | 18–20 | 18–20 | 18–20 |
| Pyrenes | 2(3) | 1–2(3) | bright or dark red | 1–2(2) |
| Fruit colour | dark, blood red | dark red to blackish purple | bright or dark red | bright or dark red |
| Fruit size, mm | 14–18 × 15–18 | 8–14 × 7–13 | 6–11 × 5–10 | 8–15 × 6–12 |
| Thorn length, mm | 5–15 | 5–15 | 10–15 | 10–12 |
| Thorn shape | more or less | more | more | less |
| more | less | or | or | or |
| or | or | less | less | less |
| or | or | less | less | less |
| or | or | less | less | less |

According to Sargsyan (2011), the hawthorn was hybridized by C. pseudoheterophylla x C. atrosanguinea = C. x ruzanica; C. pentanthera x C. pseudoheterophylla = C. x c. zaragetsara.

C. monogyna Jacq. is polymorph. According to Pojarkova (1939), the Russian and European authors did not differentiate between C. krytostyla and C. monogyna Jacq., but C. krytostyla is currently considered a hybrid between C. monogyna and C. riphiphylly, as evidenced by stipule sarration, leaf serration and fruit characters (Christensen, 1992).

However, C. krytostyla differs significantly from C. monogyna by the fragmentation of the smallest, wide, and darker green leaves, and shape of the sepal (Table 3). Pojarkova (1939) reported that C. monogyna has a narrow range, adapted to the European part of the former Soviet Union (southern and especially eastern regions), and cannot be distributed in the South Caucasus in comparison to C. krytostyla. Sargsyan (2011) has shown that C. monogyna is not distributed in Nakhchivan Autonomous Republic. However, there are species formed by hybridization of C. krytostyla x C. monogyna in the South Caucasus. Despite the fact that range of C. monogyna includes Ganja, Lankaran and Garabagh (Grossheim, 1934), the herbarium samples collected later were designated as C. curvisepala (C. krytostyla).

C. x armena Pojark. was added to the flora of Azerbaijan by Kasumova according to the samples collected from the Bicheneck forest (20.X.1980) and Gəzil Gishlag village (10.X.1980, stony-gravel slopes) of Shahbuz region. According to Pojarkova (1939), crossbreeding of C. krytostyla and C. meyeri created this species. Grossheim (1952) also did not regard C. armena as an independent species and considered it hybrid species. Fedorov (1958) did not agree with Grossheim’s ideas, stating “the C. armena has not been fully proven to be hybrid”, therefore it was more acceptable to consider this species independent. Christensen (1992) also believed that this species derived from the hybridization of C. cirticus and C. monogyna. Thus, the lower slices of leaves of the flowering twig of C. armena have 1–5 teeth, as in C. monogyna. The number of teeth of C. monogyna varies between 6 and 16. Besides, there are also many similarities of the perianths in the C. armena, C. monogyna and...
C. meyeri. For instance, fruiting perianth of C. armena is pyrene, resembles of the C. meyeri perianths.

Sargsyan (2011) noted that there were no records of C. monogyna in Armenia and that so far no individuals have been introduced to the area. The author was also skeptical about the distribution of C. monogyna in the Nakhchivan Autonomous Republic and Iran, so C. monogyna could not have hybridised with C. meyeri. Considering the number of leaf slice teeth and similarity of features of perianths, and taking into account the hybrid origin of C. armena, this suggestion should be definitely accepted. Sargsyan agreed with Pojarkova that C. meyeri and C. rhipidophylla (C. kyrtostyla) are hybrids, whereas Byatt & Murray (1977) and Christensen (1992) suggested that C. rhipidophylla is a separate species. Moreover, C. x kyrtostyla is the hybrid between C. rhipidophylla and C. monogyna, which was also confirmed by a number of evidences.

Table 4

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>C. armena</th>
<th>C. cinovskisii</th>
<th>C. pontica</th>
</tr>
</thead>
<tbody>
<tr>
<td>Life form</td>
<td>shrub</td>
<td>shrub, small tree</td>
<td>shrub, small tree</td>
</tr>
<tr>
<td>Height, m</td>
<td>2.0–2.5</td>
<td>5–6</td>
<td>4.5–(8)</td>
</tr>
<tr>
<td>Flowering time</td>
<td>May–June</td>
<td>May</td>
<td>May–June</td>
</tr>
<tr>
<td>Flower number per inflorescence</td>
<td>8–15</td>
<td>5–15</td>
<td></td>
</tr>
<tr>
<td>Leaf size (on short shoot)</td>
<td>3.8–4.2</td>
<td>3.4–3.6</td>
<td>4.1–5.1–3.2–4.9</td>
</tr>
<tr>
<td>Leaf indumentum (beneath)</td>
<td>villosus</td>
<td>villos to appressed-pubescent</td>
<td>villos to appressed-pubescent</td>
</tr>
<tr>
<td>Leaf base (on short shoot)</td>
<td>cuneate or truncate</td>
<td>cuneate or attenuate</td>
<td>cuneate-attenuate</td>
</tr>
<tr>
<td>Stems</td>
<td>18–20</td>
<td>16–20</td>
<td>20</td>
</tr>
<tr>
<td>Pyraxes</td>
<td>1, rarely 2</td>
<td>4–5</td>
<td>2–3</td>
</tr>
<tr>
<td>Fruit colour</td>
<td>red, more</td>
<td>chery-dark</td>
<td>yellowish</td>
</tr>
<tr>
<td>Fruit size, mm</td>
<td>7–12 × 6–9</td>
<td>10–15 × 12–18</td>
<td>14–18 × 15–21</td>
</tr>
<tr>
<td>Thorn length, mm</td>
<td>7–15</td>
<td>up to 13 mm</td>
<td>up to 10 mm</td>
</tr>
<tr>
<td>Thorn shape</td>
<td>stout</td>
<td>more or less stout</td>
<td>small</td>
</tr>
</tbody>
</table>

According to Kasanova (1981, 1983), C. cinovskisii Kasanova is close to C. pontica and differs from it by dark-coloured fruits (vs. yellowish) and by 4–5 (vs. 2–3) seeds (Table 4). It is a Nakhchivan endemic species and its further research is needed.

Conclusions

Thus, we reported 17 species of the Crataegus genus in the Nakhchivan Autonomous Republic found as wild species, namely C. pentagy- фис Pall. ex Bieb., et Kt. ex Willd., 1800, C. sanguinea Pall., 1809, C. cotoneaster Griseb., 1843, C. meyeri Pojark., 1939, C. cinovskisii Kasanova, 1939, and C. x cinovskisii Kasanova. In addition, five species – C. chlorocarpa, C. ferganensis, C. sanguinea, C. songarica, and C. tur- kestanica were introduced and used in greening for parks and gardens. Of these, C. pojarkoviae and C. tanevferoti were included in “Red Data Book of USSR”, C. pontica was included in “Plants and plant formations recommended for the “Red” and “Green” Books of Azerbaijan”, Talibov & Bragimov (2013) included C. orientalis Pall. ex Bieb. (NT) and C. pontica C. Koch (NT) into the “Red Book” of the Nakhchivan Autonomous Republic. Later, Mammadov et al. (2016) included C. cinovskisii C. Koch (category CR A2abc; C1), C. cinovskisii A. Pojark. (VU D2), C. orientalis Pall. ex Bieb. (NT), C. pontica C. Koch (NT), C. tanevferoti Griseb. (EN A1bc; BB (i, ii)) into “Rare trees and shrubs of Azerbaijan”.

We confirmed that the Nakhchivan Autonomous Republic has high endemic species diversity of the Crataegus L. genus, while C. cinovskisii Kasanova and C. armena Pojark. are Caucasus endemics and C. cinovskisii Kasanova is endemic to Azerbaijan.

According to Gladkova (1968, 1969), some species of C. tanevferoti were introduced and used in greening for parks and gardens. Of these, C. pojarkoviae and C. tanevferoti were included in “Red Data Book of USSR”, C. pontica was included in “Plants and plant formations recommended for the "Red" and "Green" Books of Azerbaijan”, Talibov & Bragimov (2013) included C. orientalis Pall. ex Bieb. (NT), C. pontica C. Koch (NT), C. tanevferoti Griseb. (EN A1bc; BB (i, ii)) into “Rare trees and shrubs of Azerbaijan”.

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