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Ecological, morphological, and anatomical investigation of Sorbus L. (Rosaceae) taxa distribution in Rize province (Türkiye)

Rize ilinde (Türkiye) yayılış gösteren Sorbus L. (Rosaceae) taksonlarının ekolojik, morfolojik ve anatomik yönden incelenmesi

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Abstract

This research was carried out to determine the *Sorbus* L. species distributed within the borders of Rize province between 2011-2013 and to reveal the differences (morphological, anatomical, and ecological) between them. It was determined that four taxa belong to the genus *Sorbus* L. in the research area, which is located in the A8 square according to the grid system. Identified taxa, *Sorbus aucuparia* L., *Sorbus subfusca* (Ledeb) Boiss, *Sorbus caucasica* (Zinserl) var. *Yaltırikii*, Gökşin and *Sorbus umbellata*. var. *cretica* (Lindl) Schneidear. The morphological, anatomical, and ecological characteristics of these taxa, which are naturally distributed in the flora of the research area, were comparatively examined. Localities of *Sorbus* L. taxa distributed in the region, habitat characteristics, and species identification keys were identified. The localities of the taxa that naturally spread in the region were determined, and their maps were processed according to the GPS coordinate data.

Özet

Bu araştırma, 2011-2013 yılları arasında Rize ili sınırları içerisinde yayılış gösteren *Sorbus* L. türlerini belirlemek ve aralarındaki farklılıkları (morfolojik, anatomik ve ekolojik) ortaya koymak amacıyla gerçekleştirildi. Grid sistemine göre A8 karesinde yer alan araştırma alanında *Sorbus* L. cinsine ait dört takson tespit edildi. Belirlenen taksonlar, *Sorbus aucuparia* L., *Sorbus subfusca* (Ledeb) Boiss, *Sorbus caucasica* (Zinserl) var. yaltırikii Gökşin ve *Sorbus umbellata*. var. cretica (Lindl) Schneidear'dır. Araştırma alanı florasında doğal yayılış gösteren bu taksonların morfolojik, anatomik ve ekolojik özellikleri karşılaştırmalı olarak incelendi. Bölgede yayılış gösteren *Sorbus* L. taksonlarının lokaliteleri, habitat özellikleri ve tür teşhis anahtarları belirlendi. Bölgede doğal yayılış gösteren taksonların lokaliteleri belirlendi ve GPS koordinat verilerine göre haritaları işlendi.

INTRODUCTION

The province of Rize, chosen as the research area, is located in the Eastern Black Sea region, in the A8 square (Davis 1972) with a mountainous and rugged topography in terms of its topography (URL 1, Figure 1).

In Rize, the province that receives the most precipitation in Türkiye, the annual total precipitation is over 2300 mm, and precipitation is evenly distributed throughout all seasons. Therefore, there is no dry season in Rize. The total precipitation in the spring with the least precipitation is well above the drought limit (367.9 mm). Rize, which receives abundant rainfall and has a balanced temperature regime, has a dense and lush vegetation. *Sorbus* species were observed only at 800-2300 m and not at lower altitudes. They are mostly observed singly or rarely in sparse groups on hard rocky slopes. The distribution of *Sorbus* taxa in the Eastern Black Sea region has been included in many studies conducted in the region in recent years (Anşin 1983, Anşin et al. 2000, Eminağaoğlu 2015, Baykal 2015, Baykal and Atamov 2017, Atamov and Çobanoğlu 2019, Demir and Atamov 2019, Atamov 2021, Süzen and Atamov 2022).

There are many studies on the genus *Sorbus* carried out for various purposes in the world and in Türkiye. Some of these are highlighted below.

Gültekin (2007) carried out this study aiming the effects of doubling times on the germination of *Sorbus* L. seeds on *S. domestica* L., *S. torminalis* L. (Crantz) and *S. umbellata* (Lindl) Schneidear taxa.

Koçak (2006) revealed the effect of phytohormones on the germination and seedling development of *Sorbus* domestica L. *Sorbus torminalis* L. (Crantz), *Sorbus aucuparia* L. taxa in the study on the effect of hormonal treatment on the germination and seedling development of some *Sorbus* L. species seeds.

Başgül (2007) investigated the introduction and developmental characteristics of species *Sorbus domestica* L., *S. torminalis* L. (Crantz), *S. americana* Marsh, *S. graeca* (Spach), Kotschy and *S. aria* L. (Crantz). As a result of the study, it was determined that *S. domestica* species gave the best values in germination (89%) and S. t*orminalis* height increase (204 cm). As a result, he emphasized that *S. domestica* and *S. torminalis* species were suitable for use in recreational areas.

Erbaş (2010) stated that deer apple *Sorbus umbellata* var. *umbellata* (Desf.) Fritsch. have significant effects on the essential oil content and essential oil components different collection times, altitudes, and elevations.

Ertürk (2011) investigated some technological properties of ash-leaved rowan ash (*Sorbus aucuparia* L.) wood impregnated with various chemicals, especially boron compounds (Borax, Boric acid).

Gültekin and Alan (2007) conducted a research on Rowan species and sapling production techniques in Türkiye.

Ketenoğlu et al. (1983), Atamov and Çobanoğlu (2019), Atamov (2021) stated that some taxa of *Sorbus* participated in the phytosociological structure of the maquis formation of the Eastern Black Sea region.

In a study on the seed morphology of *Sorbus* L. species in Slovakia, a hybridization study was made between *Sorbus torminalis* and *Sorbus donubilis*, and the hybrid type was named *Sorbus dolomiticola* Micolas (Mikolas 1996).

Kovanda (1996) conducted a study on the holotypes of ten different *Sorbus* L. species. *Sorbus* L. species are close to *Pyrus* L. species in terms of genetic relatedness. Although mostly 2n=34, some *Sorbus* L. species are polyploid and carry 51-68 chromosomes (Darlington and Wylie 1955, Wright 1963).

In the study of Kartal and Gür (2010), *Sorbus domestica* L. fruit pomological characteristics were determined, while Yılmaz (2010) investigated the effects of different applications on the germination of seeds of some *Sorbus domestica* L. types grown in the Tokat region.

Most *Sorbus* species carry their fruit on them until the first leaves in the spring, without falling during the winter months. This situation provides a plus advantage in terms of decoration. They form the food of birds, especially in forests. It improves the physical structure of the forest soil where it is found with its leaves falling in autumn (Anşin et al. 2000). They grow in fertile, well-drained and moist soils, and they cannot develop in sunny dry soils, they are resistant to light shade. Normally by seed, however, selected forms can be propagated vegetatively through vaccination or immersion.

Various organs of the *Sorbus* L. taxa are used in modern medicine and alternative medicine for multiple purposes. Rowan fruit (fructose sorbidomesticae) and leaves (folium sorbi) are used internally as infusions (5%) due to their constipating effects. Its leaves are used in the form of infusion (5%) among people against diabetes, and laboratory experiments have shown that it has a blood sugar-lowering effect, and it is a harmless drug. Again, its leaves have a mild mucilage and breast softening effect (Gultekin 2007).

There are 80 tachonas species belonging to the genus *Sorbus* L. worldwide, 39 of which are distributed in Central Asia.

Sorbus L. genus is represented by 18 taxa in Türkiye (Güner et al. 2000, Güner 2012, Dönmez and Aydın 2017).

Gabrielian (1958, 1972) deals with the systematic features and description of taxa belonging to the genus *Sorbus*, which are distributed in Kafkas and the flora of Türkiye.

Kamarow (1971) gave the systematic features and identification key of taxa belonging to the genus *Sorbus* in the flora of the former Soviet Union.

In the Red Book of Plants of Türkiye, 5 endemic and non-endemic species belonging to the *Sorbus* genus are endangered and need to be protected (Ekim et al. 2000).

Güner et al. (1987) showed that there are 3 taxa belonging to the genus *Sorbus* in the flora of Rize.

According to Eminağaoğlu (2012), there is *Sorbus caucasica* var. *caucasica* a new record for the Flora of Türkiye, distributed in and around the Artvin region has been described.

Sorbus buschiana Zinserl. the species was collected from Çankırı and Rize provinces and declared to be a new record for the Flora of Türkiye by Dönmez and Aydın (2017). Detailed description, distribution image and phenological observations of this species are given. The new registration is placed in the VU hazard category according to IUCN standards. According to the most accepted and recent literature information, it is stated that *Sorbus luristanica* grows naturally in Türkiye and this information is still accepted. Contrary to what is known, it has been determined that this species does not grow in Türkiye, both in herbariums and in the field.

According to the Grid system used in the flora of Türkiye, the research area is located in the A8 square (Figure 1).

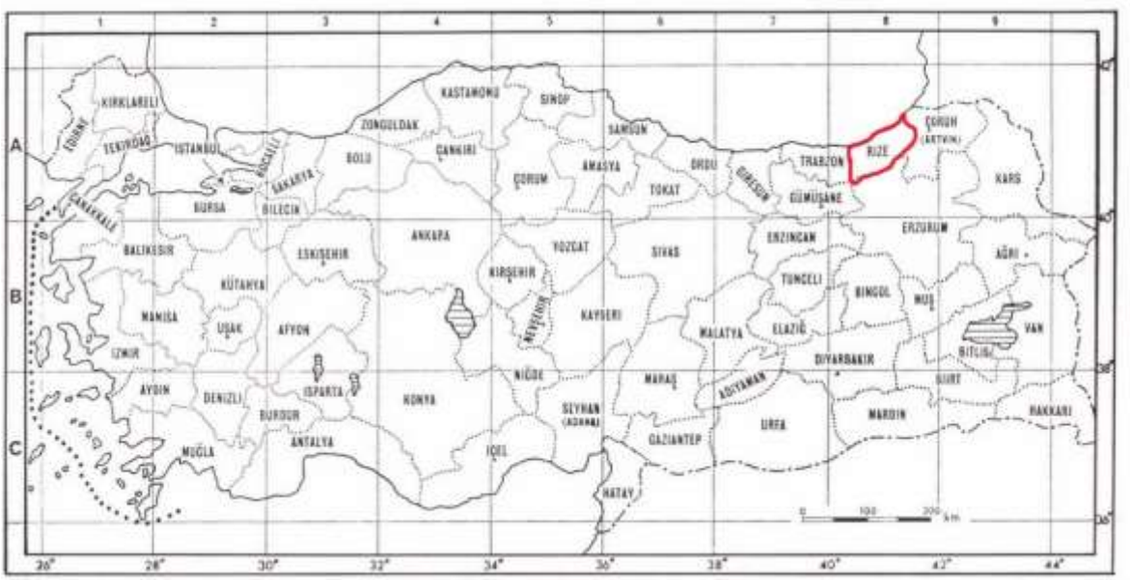

Figure 1. The place of Rize in the Grid system

The region has a very rich hydrographic structure thanks to its rainy climate and numerous under ground water resources. The characteristics of rivers in Rize are determined by rain, snow and abundant springs.

Sorbus taxa are generally distributed in the forest belt of the region, but there are also taxa that are sometimes found in the subalpine belt.

MATERIAL AND METHODS

Material

Sorbus taxa distributed within the provincial borders of Rize were chosen as research material. Field studies were collected from different localities and habitats between the years of 2011-2013, including flowering and fruit ripening phenophases. The collected samples were herbarized according to herbarium construction rules and are currently kept in the herbarium of the RTEU Biology Department (RTEUH).

In the identification of plants, 'The Flora of Türkiye and East Aegean Island's Vol:4-11 (Davis 1972) was used. In these studies, samples were taken from different organs (stem, leaf, flower and fruit) and different phenophases (flowering and fruiting) from March to August. Field studies were organized once a month, on the condition that they also covered the districts. Soil samples were collected from each locality to determine their ecological characteristics, and their elevations were determined using GPS. Ten samples were collected from the flowers, fruits, leaves and stems of each taxon. After the samples were numbered and pressed.

Methods

In the morphological examinations, features such as stem, leaf and fruit length and width, which are distinctive characteristics of taxa, were examined. Soil samples taken as 1-2 kg from 0-30 cm depth from the areas where *Sorbus* L. species are distributed were analysed in Rize/Pazar Village Services Directorate Water and Soil Research Institute. In these analyses, Isba (soil saturation ratio of soil to water), total salt amount, pH level, phosphorus, potassium, organic matter ratios of soil samples were determined.

After some of the diagnosed specimens were turned into herbarium material, the remaining specimens were placed in 70% alcohol for anatomical examination. The paraffin method was used for anatomical examinations. Sections were taken from the stem, leaf, and petiole with the help of a shandon brand freezer microtome and a razor blade.

The preparations were photographed with the BAP 2000 PRO program on an Olympus BX51TF model microscope using 4x-40x objectives.

Photographs reflecting the morphological features of the *Sorbus* L. specimens examined were taken under a LEICA S6D stereo microscope.

RESULTS

In this study, 4 taxa belonging to the genus *Sorbus* were distributed within the borders of Rize Province, including different districts (Table 1, Figure 2).

These taxa are *Sorbus aucuparia* L, *Sorbus subfusca* (Ledeb.) Boiss, *Sorbus umbellata* var. *cretica* (Lindl) Schneidear and *Sorbus caucasica* Zinserl var. *yaltırikii* Gökşin (Table1, Figure 2).

12 districts, including the central district, were considered in the research area. *Sorbus aucuparia* spread in 6 districts and the population was seen as the most dense species, *Sorbus umbellata* is found in 3 districts. cretica, in 1 district there is *Sorbus subfusca* and *Sorbus caucasica.* It has been observed that there are yaltirikii taxa. *Sorbus aucuparia* and *Sorbus umbellata* var. *cretica* is the new record for Rize province (URL 2, URL 3, URL 4).

Figure 2. Location map of Sorbus L. taxa distributed in Rize province

Table 1. Location of taxa belonging to the genus *Sorbus* L. distributed in different regions of Rize

Taxon	Collected date	Collected field	Coordinates	Altitude (m)
Sorbus umbellata var. *cretica*	26.10.2013	Elevit plateau	N06°69'123" E45°25'149"	1851 m
Sorbus aucoparia	28.09.2013	Camlihemsin, Meydan village	N06°62'551" E45°27'283"	1053 m
Sorbus umbellata var. *cretica*	28.09.2013	Camlihemsin, Kale village	N06°63'423"E45°25'3012"	1650 m
S. caucasica var. *yaltırıkii*	28.09.2013	Camlihemsin, Kale village	N06°63'423" E45°25'301"	1650 m
S. umbellata var. *cretica*	28.09.2013	Camlihemsin, Kale village	N06°63'529 E45°18'669"	1880 m
S. aucuparia	28.09.2013	Opposite the middle plateau	N06°60'795" E45°13'353"	1981 m
S. aucuparia	06.06.2014	Gito Plateau	N06°64'916" E45°29'993"	1020 m
S. aucuparia	06.06.2014	Gito Plateau	N06°69'829" E45°30'098"	1977 m
S. aucuparia	06.06.2014	Gito Plateau	N06°60'712" E45°31'129"	1750 m
S. aucuparia	13.06.2014	Ciha castle	N06°59'565" E45°52'041"	364 m
S. subfusca	21.06.2014	Ambarlik plateau	N06°58'493" E45°27'551"	2368 m
S. aucuparia	23.06.2014	Ambarlik plateau	N06°60'760" E45°29'560"	2118 m
S. aucuparia	27.06.2014	Tunca, Neknari village	N06°88'001" E45°49'630"	1253 m
S. aucuparia	27.07.2014	Hemsin, Topcular village	N06°75'188" E45°47'427"	1340 m
S. aucuparia	27.07.2014	Komati plateau	N06°87'792" E45°44'202"	1705 m
S. aucuparia	21.07.2014	Handuzu plateau	N06°33'7490"E45°24'546"	732 m
S. aucuparia	21.07.2014	Handuzu plateau	N06°38'8140"E45°29'444"	1335 m
S. aucuparia	21.07.2014	Cagirankaya plateau	N06°41'2660"E45°74'879"	1998 m
S. aucuparia	01.08.2014	Near Ridos hotel	N06°40'037" E45°16'598"	1144 m
S.aucuparia	04.08.2014	Pointed rock	N06°44'421" E45°04'435"	867m
S.aucuparia	08.08 2014	Avasor plateau	N06°78'843" E45°36'244"	1497 m
S.aucuparia	08.08 2014	Avasor plateau	N06°79'952" E45°36'448"	1703 m
S.aucuparia	08.08 2014	Avasor plateau	N06°80'508" E45°36'605"	1800 m
S.subfusca	03.09.2014	Ardesen, Asagi durak village	N06°76'539" E45°51'964"	621 m
S.aucuparia	03.09.2014	Ardesen, Asagi durak village	N06°78'101" E45°52'039"	1108 m
S.aucuparia	03.09.2014	Ardesen, Kubaroglu plateau	N06°83'629" E45°52'039"	1746 m

Ecological, Morphological, and Anatomical Characteristics of *Sorbus* L. taxa

Sorbus L. taxa are generally deciduous trees and/or shrubs with no thorns in their shoots. The buds are covered with scales arranged like tiles. The leaves are simple or compound (single pubescent), arranged on the shoots, and having toothed and lobed edges. The flowers are white, rarely pink in color and form composite pseudo-umbrella-shaped boards. The crown and sepals are 5-part, and the number of male organs is 15-20. The ovary has 2-5 carpels and carries 2 ovules. The fruit is a pseudo-juicy fruit type with 2-5 eyes. When it matures, it turns yellow, red or orange (Rehder 1962, Gabrelian 1972, Kayacık 1975).

Soil analysis results of *Sorbus* L. species grown in Rize province are given in Table 2.

Table 2. Soil analysis results of *Sorbus* L. species distributed in Rize province borders

Species name	Isba (%)	pH	Total salt (%)	Phosphorus (kg/da)	Potassium (kg/da)	Organic matter(kg/da)	Altitude (m)
S.aucuparia	40	6.89	0.010	13.66	133	1.91	1820
S.aucuparia	59	4.86	0.080	0.18	27.4	0.29	1000
S.aucuparia	72	4.49	0.030	0.72	93.9	4.70	786
S.aucuparia	40	5.35	0.060	5.27	17.9	4.18	1525
S.aucuparia	39	5.67	0.045	2.24	63.3	1.74	1968
S.subfusca	88	4.83	0.035	3.24	310.3	2.84	1995
S.caucasica var.*yaltırıkii*	94	6.22	0.010	1.30	190	4.18	1900
S.umbellata var.*cretica*	66	4.87	0.060	1.80	102.4	1.27	2239
S.umbellata var.*cretica*	-	-	0.020	1.38	195	0.85	1790

Ecological, Morphological, and Anatomical Characteristics of *Sorbus aucuparia*

Ecological Characteristics of Sorbus Aucuparia

This taxon is distributed in İkizdere, Çayeli, Güneysu, Çamlıhemşin, Hemşin, and Fındıklı districts (Table 1).

It usually grows on hard, steep, rocky slopes. It is a member of the Euro-Siberian phytogeographic region. The height they can grow is up 800-2300 m. According to Browicz (1978), who takes into account the general distribution of the species, it can grow in leafy and coniferous forests in very arid, acidic, clayey and clayey-sandy soils and shady places, as well as in humid meadows and even peatlands (Figure 3). Considering the soil properties, soil saturation (isba) is 39-72%.

Morphological Features of Sorbus aucuparia

It is a small tree with a round, rather loose canopy, and its trunk can be between 4-15 (-20) m. According to these findings, the trunk bark is light gray, shiny, flat and smooth in youth. In advanced ages, longitudinal cracks appear on the bark and the color darkens. In the last year, the shoots are gray-brown or reddish-brown, with a pubescent cover that sparsely and quickly spills, and later becomes bare. The apical and lateral buds are 9-18 mm long, conical with a pointed tip, and are externally covered with 3 very dark blackish-brown scales.

Figure 3. Flowering (a) and fruit ripening phenophyte (b) of *Sorbus aucuparia* taxon

The leaf petiole is mostly reddish-brown and the length of the stems is 1.5-6.7 cm. They vary between sparse hairs or are completely bare. The leaf blade is single a hairy imparipinnate (Figures 3a and 15d). According to the research, the leaves are 20-6×14-2.1 cm in size, the number of leaflets is 11-17 pairs, excluding the apical leaflet. The base is asymmetric, the veining is reticulate and glabrous.

Its fruits are drupe-type, flattened spherical, 09-0.5×1-0.7 cm in size, generally reddish, rarely yellowish-orange, with sparse small lenticels and glabrous (Figure 3b).

Compound pseudoumbrella type flower boards are 8-15 cm in size and stand upright. Among the Sorbus taxa, it bears the most flowers (75-100). Sepal pubescent, petal glabrous, stamen and pistil glabrous, peduncle dense pubescent shape (16,17) (Figure 4c and 4d). The number of stamens is 19-20 (Figure 4b), the number of pistils is 1 (Figure 4a), the number of carpels is 2-3, the number of sepals and petals is 5, the average sepal length is 0.6 mm, the average sepal width is 1 mm, the average petal length is 4.5 mm, the average petal width is 3.5 mm (Figure 4c).

Figure 4. Morphological structure of *Sorbus aucuparia* flower pistil (a), stamen (b), petal (c), and sepal (d)

It blooms in May-June. They grow alone or in small groups on hard rocky slopes up to 800-2300 m.

Anatomical Features of Sorbus aucuparia

In the cross-section taken from the leaf, epidermis in the upper part of the leaf, double-rowed palisade parenchyma just below, sponge parenchyma, as it approaches the lower part of the leaf, air spaces and dense chloroplasts spread over the parenchymatic tissues are seen. Since this taxon has a hypostomatic stomatal structure, stomatal spaces can be seen on the lower surface section of the leaf. In this species, stomata are anomocytic compared to neighboring cells and amaryllis type according to wall thickness (Figure 5a, 5b, 5c, and 5d).

Looking at the cross-section of the petiole, the outermost epidermis layer is followed by the inward collenchyma, just below the parenchymatous cells covering most of the petiole. In the center is the main transmission bundle. In this vascular bundle, there is the outer phloem and just above the sclerenchyma layer. Just below the phloem, it is covered by the xylem layer and in the center by parenchymatic cells. Apart from the main vascular bundles, there are 2 small vascular bundles (Figure 5a).

Judging by the trunk cross-section, the samples are taken from the youngest shoots, so the epidermis is on the outside, and the phloem and phloem sclerenchyma, secondary and primary xylem are located underneath. At the center, there is the pith region consist of parenchymatic tissues. The rays are heterocellular and radial (Figure 5b).

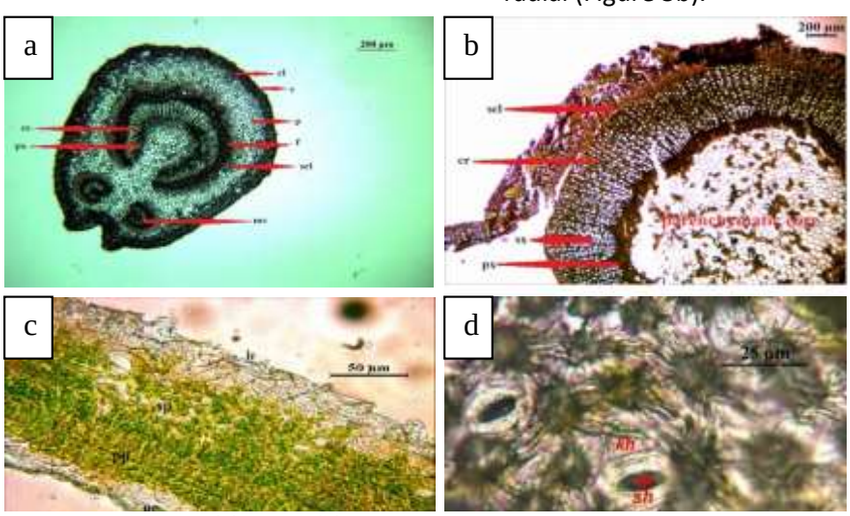

Figure 5. *Sorbus aucuparia* taxon has stem(a), petiole(b), sc: sclerenchyma, px: primary xylem, sx: secondary xylem, I: ray), upper leaf (c) (ae: lower epidermis, sp: sponge parenchyma, pp: palisade parenchyma, ure: upper epidermis) and anatomical view of the lower leaf (d) (kh: adjacent cells, sp: stoma pore, sh: stomatal cell) section

Ecological, Morphological, and Anatomical Features of *Sorbus subfusca*

Ecological Characteristics of Sorbus subfusca

This taxon is distributed in the Çamlıhemşin district of Rize province. This species is one of the Euxine-Colchis members belonging to the Eastern Black Sea region. It is mostly seen in high mountain regions at 1900-2300 m, it has not been found in lower elevations. This taxon is *Picea orientalis* (L.) Link. It is mostly found singly and sometimes in small groups on perhurmite and slightly acid-reactive soils with high relative humidity and in forest clearings in the growing part of Türkiye. Its soil saturation (isba) is 88%, total salt content is 0.035%, pH value is 4.83%, phosphorus is 3.24 kg/da, potassium is 310.3 kg/da, and organic matter amount is 2.84% (Table 2).

Morphological Features of Sorbus subfusca

It is found in the form of densely branched, rounded-topped small trees or mostly bushes, which can grow up to 1-6 m. The bark is thin, shiny brownish-ash colored with light colored large lozenge-shaped lenticels (Figure 6b). The shoots of gray-brown or reddish color are slightly tomentose and then disappear. The buds are 5-10 mm long, pointed, ovoid, covered externally with 3 yellowish brown bare scales. However, the margins of the scales are slightly cottony and hairy.

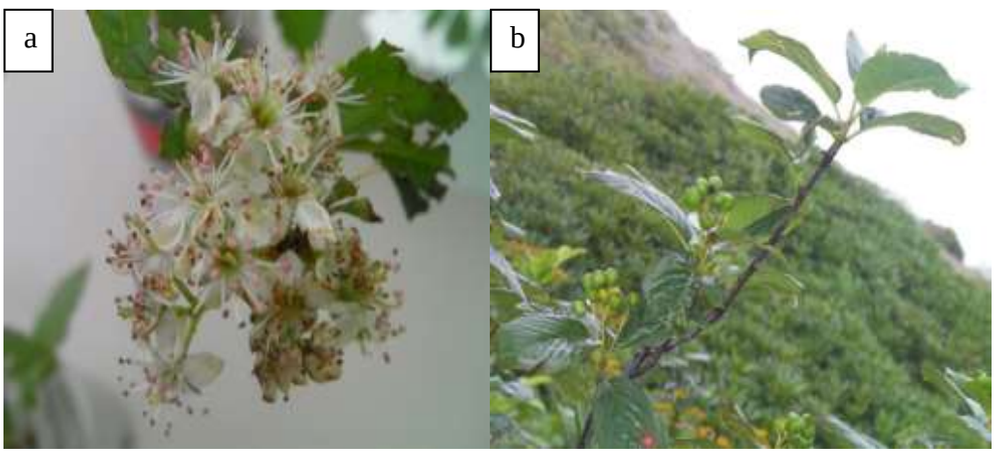

Figure 6. Morphological image of flower (a) and fruit ripening phenophases (b) of *Sorbus subfusca* taxon

The petiole is 0.5-2.0 cm long, the petiole is yellowish green, tomentose or bare. In this species, the leaves are toothed, not lobed. It is almost broad-elliptical (circular) on obovate or sterile shoots in shape, and measures 9.6-3×6-1.6 cm in size (Figures 6b and 15a). The tip of the leaf is acuminate, the margin is biserrate, the base is asymmetrical, the veining is reticulate, and the lower and upper surfaces of the young leaves are tomentose near the petiole, the other parts are bare. In the following periods, these hairs disappear complete.

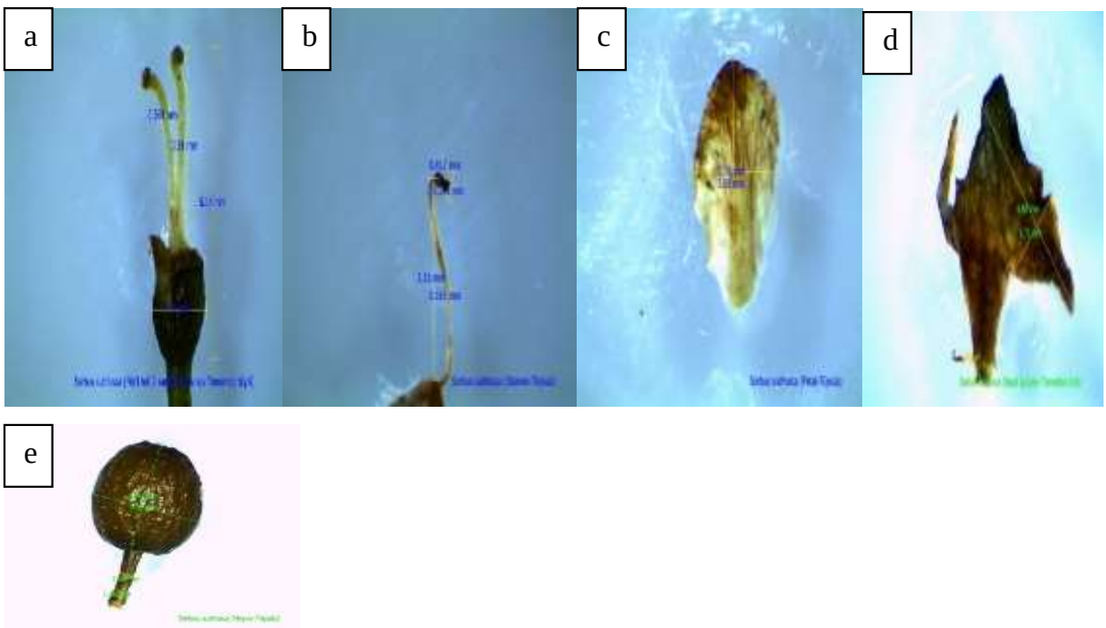

Figure 7. Flower pistil (a), stamen (b), petal (c) sepal (d) structure and fruit (e) morphological features of *Sorbus subfusca* taxon

At 2200-2275 m, this taxon is mostly found singly and sometimes in small groups in the growth zone of *Picea orientalis* L., on soils with very high relative humidity and mild acid reaction, and in forest clearings.

Its fruit is drupa type, dark red colored ripe fruits, abundant lenticelli, ellipsoidal (baseline) or inverted egg-shaped, 1.2-0.9×1-0.5 mm in size and hairless (Figure 7e).

Inflorescence and flower, false umbrella-type flower boards, which bear 20-50 flowers and stand upright, are approximately 3-11 cm in size. The flower axes are densely tomentose. This species is the youngest bloomer among other taxa of the genus. This type, which blooms in late June and early July, has yellowish-white flowers, mostly 16 mm diameter, sepal tomentose, pistil tomentose at the base, other flower parts are hairless. The sepal-petal number is 5, the stamen number is 19-20, the pistil number is 1, carpel number is 2 (Figure 7a, 7b, 7c, and 7d).

Anatomical Features of Sorbus subfusca

According to the cross-sectional image taken from the leaf of *Sorbus* subfusca, starting from the top, a single layer of epidermis at the top, a double layer of palisade parenchyma, a sponge parenchyma below, and vascular bundles in the middle are seen. In the vascular bundles, the phloem is located towards the lower surface of the leaf, and the primary and secondary xylem are located in the center. It is surrounded by dense parenchymatic tissue. The stoma of this taxon are hypostomatic, anomocytic according to the state of the neighboring cells, and amaryllis type according to the wall thickness (Figure 8).

In the cross-section taken from the petiole; there is the outermost epidermis, 5-6 rows of collenchyma below, parenchyma cells up to the center and surrounding the entire petiole. There is a single main conduction bundle in the center. This vascular bundle consists of primary xylem, secondary xylem, phloem and sclerenchymatic cell plate just above the phloem from the inside out. In addition to, the main vascular bundles, there are 4 auxiliary edge vascular bundles in this taxon (Figure 8a, 8b, 8c, and 8d).

Judging by the body section of *Sorbus subfusca*; in the center, there is a large pith region composed of parenchymatic cells. From the center outward, there are primary xylem, secondary xylem, phloem, phloem sclerenchyma, cortex parenchyma, 5-6 rows of

collenchyma cells and epidermis. Rays of this type are heterocellular (Figure 8a).

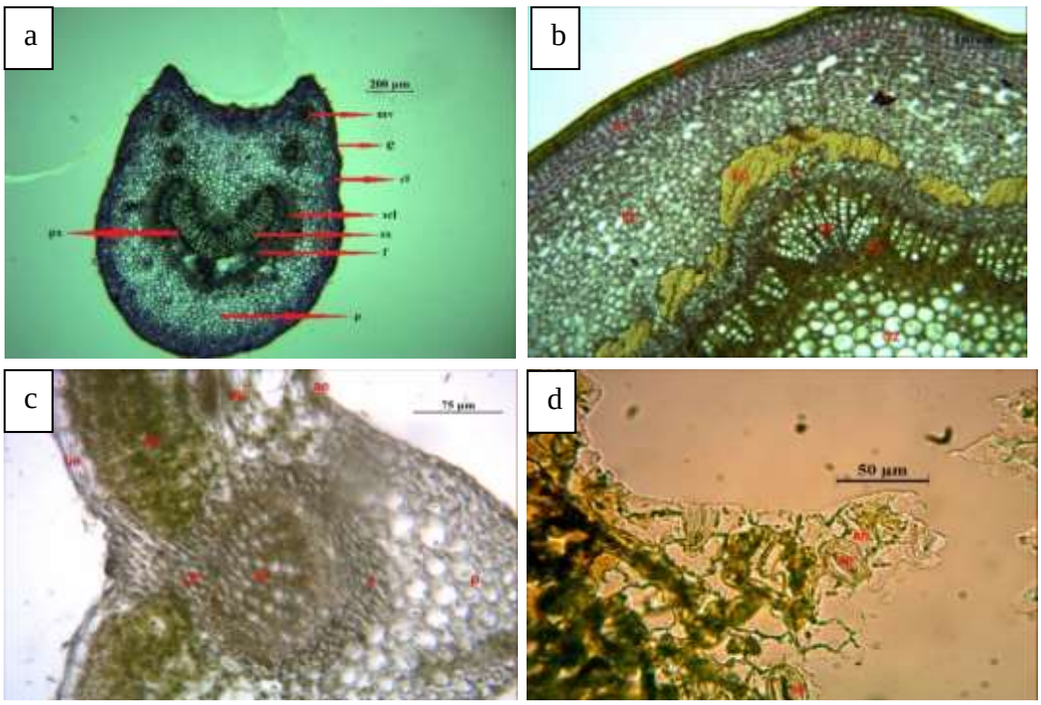

Figure 8. Stem (a) (e: epidermis, cl: collenchyma, scl: sclerenchyma, kp: cortex parenchyma, pk: primary xylem, f: phloem), petiole (b) (e: epidermis, cl: collenchyma, sclenchyma of the *Sorbus subfusca* taxon: , f: phloem, sc: secondary xylem, pk: primary xylem, p: parenchyma, kd: marginal veining), upper leaf (c) (ue: upper epidermis, ae: lower epidermis, pp: palisade parenchyma, sp: sponge parenchyma, pk: primary xylem, sc: secondary xylem, f: phloem, p: parenchyma), lower leaf surface (d) (kh: neighboring cells, sp: stoma pore, sh: stomatal cell) anatomical features.

Ecological, Morphological, and Anatomical Characteristics of *Sorbus caucasica* var. *yaltrikii*

Ecological Characteristics of Sorbus caucasica var. yaltırikii

This taxon was observed within the borders of Çamlıhemşin district of Rize province. *Sorbus caucasica* Zinserl. var. *yaltirikii* there is. grows in the middle and high mountainous region (1650-2000 m) in its natural habitat, among the rocks whose main stone is lime (Figure 9). *Rhododendron luteum* Sweet, *R. caucasicum* Pall. and *R. ponticum* L., *Populus tremula* L. *Sorbus subfusca* (Ledeb.) Boiss., *S. umbellata* (Desf.) Fritsch. var. *cretica* (Lindl.) Schneidear. It is found with *Corylus avellana* L. It has also been observed individually in mountain meadows above the forest border (Gökşin 1982).

According to Table 2, soil saturation (isba) is 94%, total salt content is 0.010%, pH value is 6.22, phosphorus amount is 1.30 kg/da, organic matter amount is 4.18% and potassium amount is 190 kg/da.

Morphological Features of Sorbus caucasica var. yaltırikii

It is a small tree up to 7 m in height, with a wide crown and many branches. Its bark is reddish-dark gray in youth and has a very thin and smooth surface. Young shoots are chestnut-red, lenticelli, shiny as if they are polished (Figure 9b). However, at advanced ages, the shoots turn grayish-brown (Figure 9b). 6-12 mm long buds are cone-shaped and covered with 3-4 yellowish-brown bare scales.

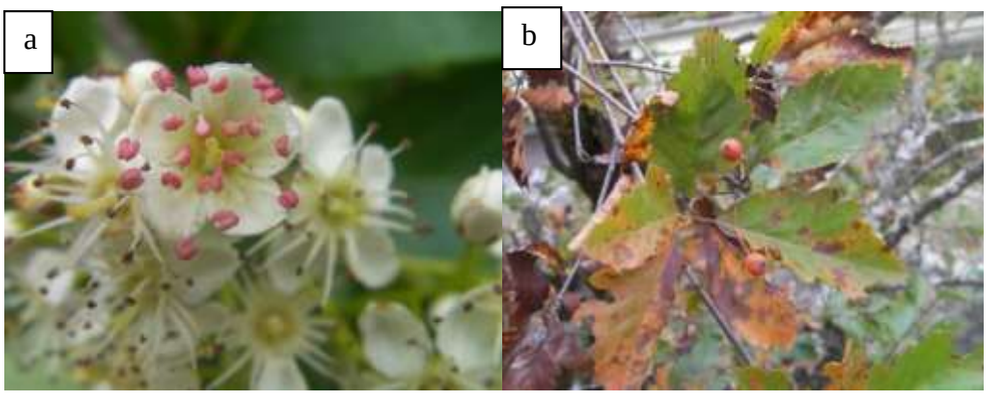

Figure 9. Morphological image of flower (a) and fruit ripening phenophases (b) of *caucasica* var. *yaltırikii* taxa

Leaf petiole, 1-2.2 cm. The leaf stalks are yellowish-green in color and the stems are covered with sparse tomentose or bare, which are later shed. The leaves are 12-5.5×8-20.5 cm in size and broadly elliptical or egg-shaped. The leaves are lanceolate, leaf tip acute, leaf margin biserrate, leaf base asymmetric, leaf veining reticulate (reticulate) and glabrous (Figures 9b and 15b).

Its fruit is drupe, spherical or ovoidal in shape, 1.4-1×1-0.5 in size, bright orange yellow, or brick red when ripe, lenticelli and glabrous (Figure 9).

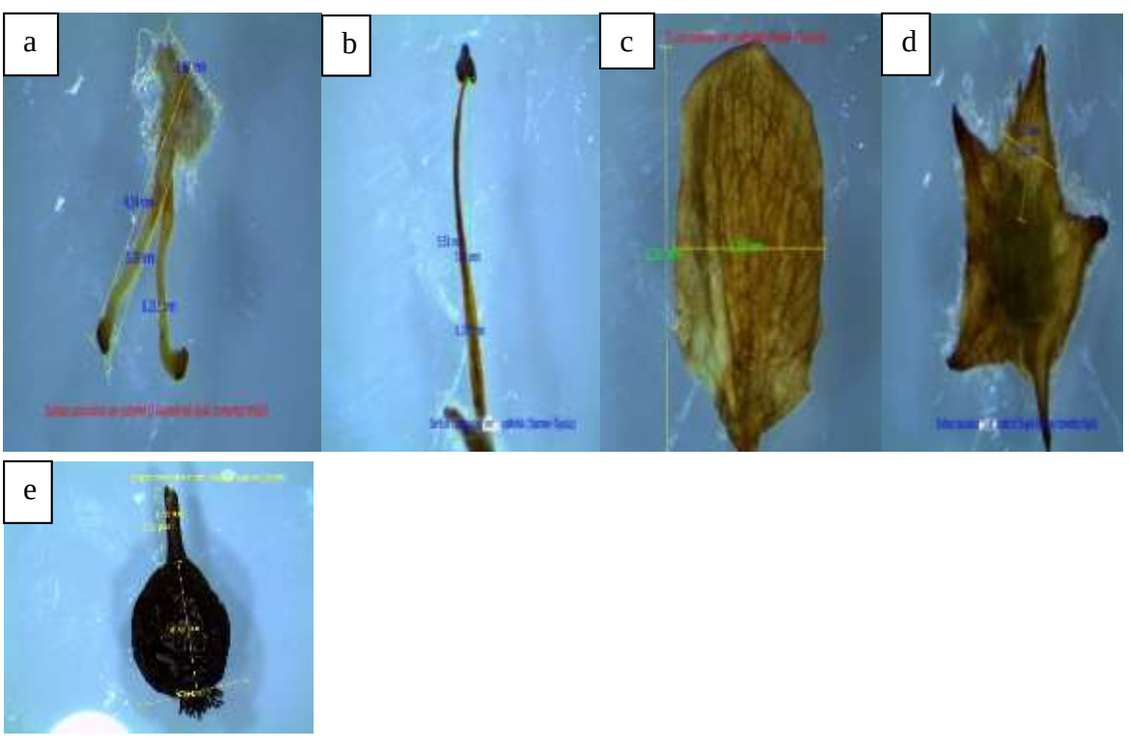

Figure 10. *Sorbus caucasica* var. *yaltirikii* Morphological image of flower pistil (a), stamen (b), petal (c), sepal (d) and fruit (e).

Flowers, upright compound pseudo-umbrella type flower boards bearing 40-50 (-70) flowers, are approximately 8-10 cm in size. The flower axes are bare or very slightly hairy, and the hairs are shed prematurely. Flower, 15-16 mm diameter and the petals are yellowish-white in color (Figure 10). Flowering immediately after foliation May-June with confluent state, petal glabrous, sepal tomentose, stamen glabrous, pistil tomentose, stamen number 19-20, pistil number 1, carpel number 2-3, stamen length 5.5 mm, pistil length 4 mm, number of

sepals and petals is 5, sepal dimensions are 2.5 × 2 mm, petal dimensions are 5.4 × 3.4 mm (Figure10a, 10b). It is stated that this taxon grows in the vicinity of Yaylaköy in Çamlıhemşin district at 1600-2000 m between rocks whose main stone is lime. It has been emphasized by researchers that.

This taxon is distributed in the Caucasus region under similar ecological and habitat conditions (Gabrielian 1958).

Anatomical Features of Sorbus caucasica var. yaltırikii

Sorbus caucasica var. *yaltirikii* taxon in the cross-section taken from the leaf of epidermis at the top, palisade parenchyma below with abundant chloroplasts, sponge parenchyma at the bottom of ten, air spaces, lower epidermis and stomatal openings at the bottom. The transmission bundles cover the leaf from end to end. The stoma type is hypostomatic according to the position of this taxon on the leaf, anomocytic type according to the state of the neighboring cells, and amarillis type according to the wall thickness (Figure 11c and 11d).

Sorbus caucasica var. *yaltirikii* in the section taken from the of petiole, the outermost: epidermis cells, collenchyma cells, parenchyma cells surrounding the entire stem up to the center, and the main vascular bundle in the center. In the main vascular bundle, the sclerenchymatic cell layer is located above the phloem layer. In this type, besides the main transmission beam, there are 4 auxiliary transmission beams (Figure 11a).

Sorbus caucasica var. *yaltirikii* when looking of at the trunk cross-section (Figure 11a), the pith region is located in the center. It consists of parenchymatic cells with varying diameters. The core rays are radial and heterocellular. From the center outward, there are primary xylem, secondary xylem, phloem, phloem sclerenchyma, parenchymatic tissues. In this taxon, the rays are heteroceles.

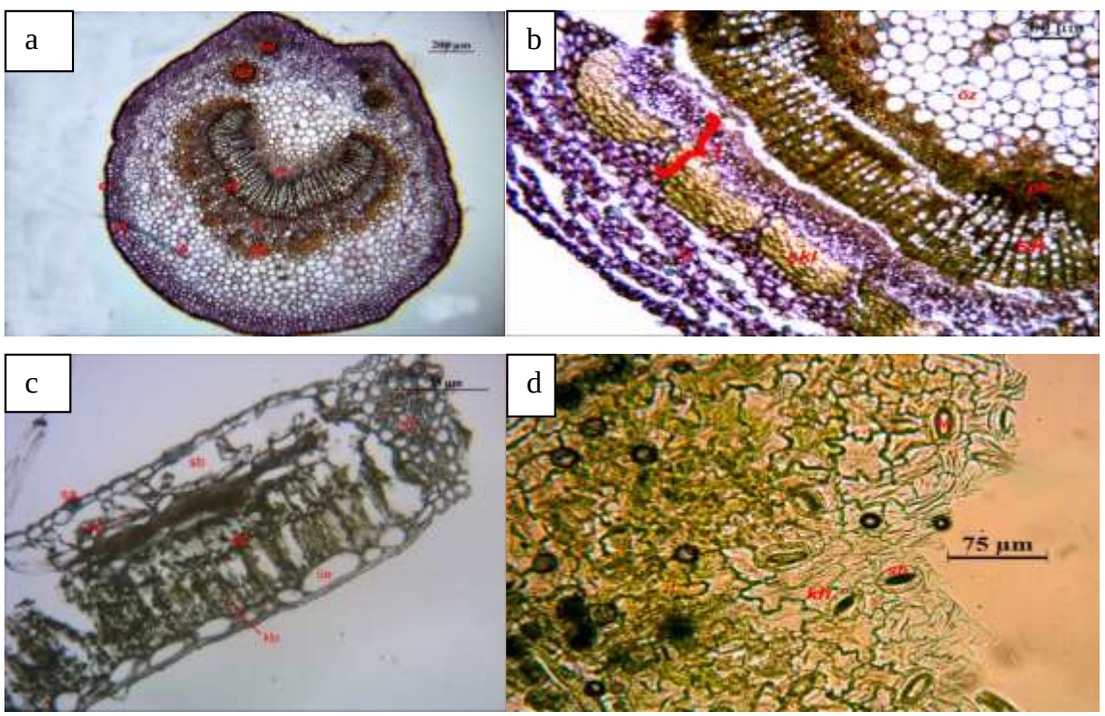

Figure 11. *Sorbus caucasica* var. *yaltrıkii* stem (a) (p: parenchyma, sc: sclerenchyma, f: phloem, sc: secondary xylem, pk: primex xylem core), petiole (b) (e: epiderma, cl: collenchyma, p: parenchyma, scl: sclerenchyma, f: phloem, sc: secondary xylem, pk: primary xylem, kd: lateral veining) upper leaf (c) (üe: est epidermis, clp: chloroplast, pp: palisade parenchyma, sp: spongy parenchyma, sb: stomatal cavity, hr: stomatal opening, id: vascular bundle), and the section taken from the lower surface of the leaf (d) (kh: neighboring cells, sp: stomatal pore, sh: stomatal cell)

Ecological, Morphological, and Anatomical Features of *Sorbus* umbellata var. cretica

Sorbus umbellata var. cretica of Ecological Characteristics

This taxon was observed in Çamlıhemşin, Ardeşen and Güneysu districts in Rize (Table 1). *Sorbus umbellata* var. *cretica* has the widest distribution in Türkiye. It spreads at 1200-1800 m in Rize province. They are found individually or in small groups on warm, well-lit, shallow and stony slopes.

According to Table 2, soil saturation (isba) is 66%, total salt content is 0.020-0.060%, pH value is 4.87, phosphorus amount is 1.38-1.80 kg/da, potassium amount is 102.4-195 kg/da, organic matter amount is 0.85-1.27%.

Sorbus umbellata var. cretica of Morphological Features

It can be up to 6 m in height, mostly with a forked body, scattered-topped bush, but sometimes in the form of a tree. The trunk bark of the trees is smooth and uncracked, 0.2 - 0.4 cm thickness. It is brownish-gray in color. Young shoots are rather thick, reddish-brown, slightly tomentose and later bare. The old shoots are dark gray-brown in color and wax layers and lenticels are seen on them. Peduncles are covered with dense tomentose and then become bare. The pointed egg-shaped buds are covered with 3-4 scales from the outside and are 4-6 mm in diameter. Long and slightly sticky (Figure 12).

The length of the petioles is between 1-2.5 cm. Yellowish-green stems, upper surfaces of leaves are hairless, lower surfaces are dense tomentose. The leaf margins are 20-35, with double rows of teeth, and these teeth are small and pointed. The leaves are obavate-orbicular type, the tip is acute, the margin is biserrate, the base is asymmetrical, the veining is reticulate (reticulate) and the undersides of the leaves are dense tomentose (Figures12b and 15c). The fruits are mostly 1.6-1.2 x 1-1.5cm in size, spherical and dark red.

The flower boards of this taxon are 3.5-7.0 x 4.5-9.0 cm length and diameter. The number of flowers on the boards (6-) is between 10-45 (-60), the axis of the flower boards is densely tomentous, the number of sepals and petals is 5, the number of stamens is 19-20, the number of pistils is 1, the number of carpels is 2, sepal sizes 5×2.3mm, petal dimensions 8×3.3 mm, stamen dimensions 5.3 x 1.9 mm, pistil dimensions are on average 7.4 x 3.2 mm (Figure 13a). They grow on rocky hard slopes at 1300-2250 m They bloom in May-June.

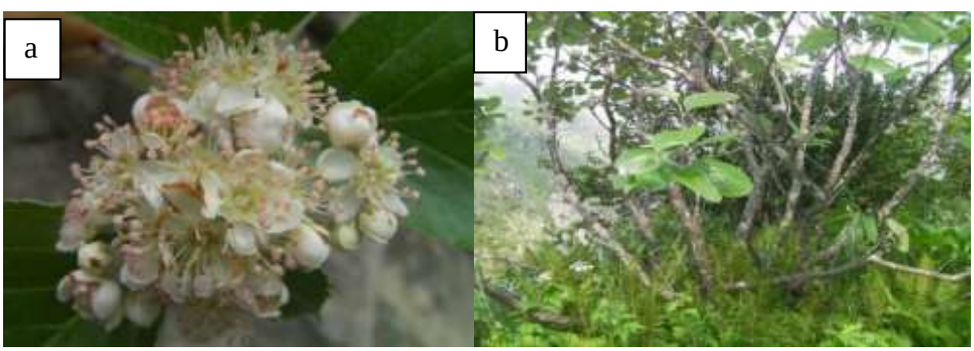

Figure 12. Morphological image of flower (a) and general images (b) of *S. umbellata* var. *cretica*

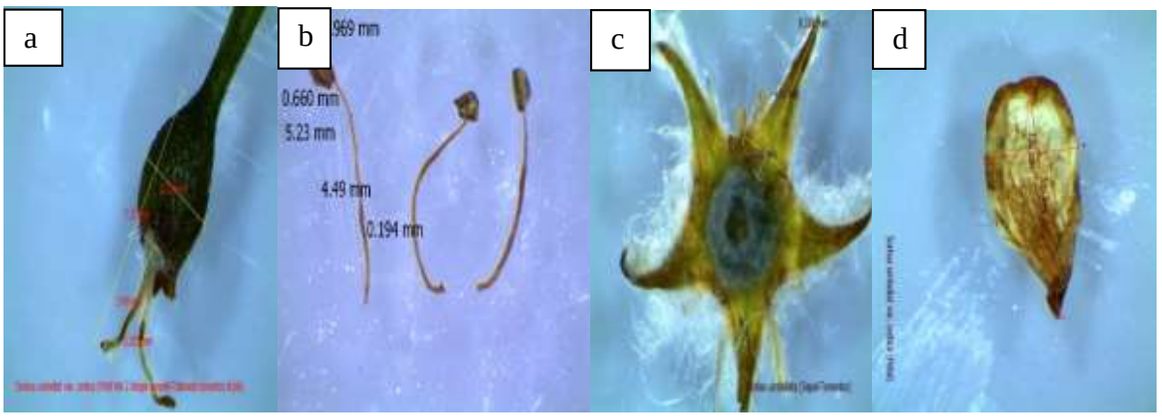

Figure 13. *Sorbus umbellata* var. *cretica* morphological features of flower pistil (a), stamen (b), petal (c), and sepal (d).

Sorbus umbellata var. cretica of Anatomical Features

S. umbellata var. *cretica* looking at the cross-section of the leaf (Figure 14c) the outermost single layer of epidermis, the double layer of palisade parenchyma below, and the sponge parenchyma extending to the lower epidermis below it. Conduction bundles are located as phloem on the outside and xylem on the inside. In this taxon, stomata are hypostomatic according to their position, anomocytic according to the status of neighboring cells, and amaryllis type according to the wall thickness (Figure 14d).

S. umbellata var. *cretica* of when looking at the petiole cross-section (Figure 14a), from outside to inside, epidermis, 7-8 rows of collenchyma cells, a dense layer of parenchymatous cells surrounding the entire surface. In the center, there is the main transmission bundle and 2 accompanying auxiliary transmission bundles. In the main vascular bundles, there is the outermost phloem and the sclerenchyma layer above it. The primary xylem is located in the innermost part of the main vascular bundle, and the secondary xylem is located above it.

S. umbellata var. *cretica* looking at the transverse body section (Figure 13 b). It can be said that the pith region is located in the center and these cells are parenchymatic. The primary xylem developed just above the core and the secondary xylem developed above it. The phloem is located on the xylem layers. The beams are radial and homocellular.

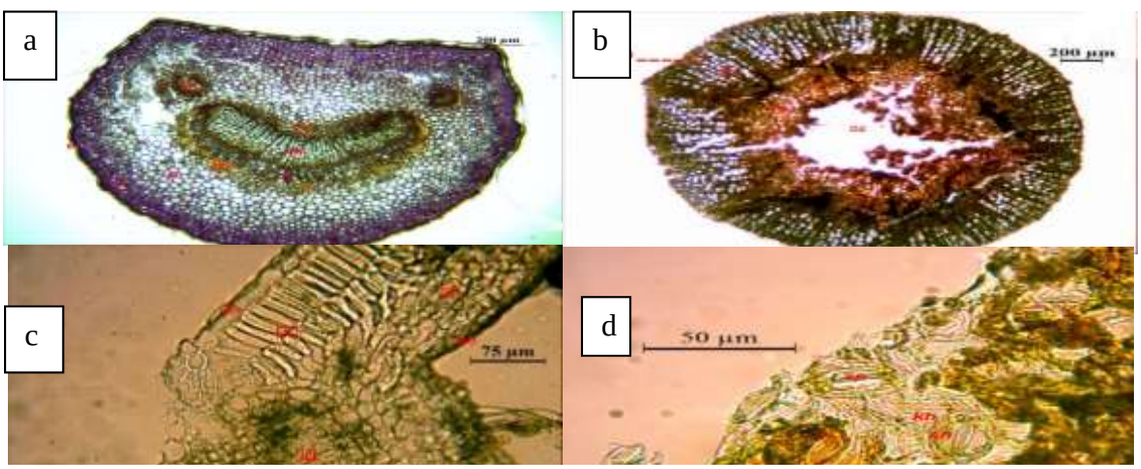

Figure 14. *Sorbus umbellata* var. *cretica* transverse of from stem (a) (sk. secondary xylem, pk: primary xylem, ı: ray, core), transverse from petiole (b) (e: epidermis, kl: collenchyma, p: parenchyma, sc: sclerenchyma, f: phloem, sc: secondary xylem , pk: primary xylem, kd: marginal veins), the upper part of the leaf (c) (e: upper epidermis, pp: palisade parenchyma, sp: sponge parenchyma, ae: lower epidermis, id: vascular bundle), and the section taken from the lower surface of the leaf (d) (kh: adjacent cells, sh: stomatal cells)

DISCUSSION

The parameters analyzed in Table 2 are divided into physical and chemical properties. Of these, pH, total salt, depleted physical properties, potassium and phosphorus amounts and organic matter ratios are classified as chemical properties.

If the parameters in Table 2 are evaluated in general, it can be said that the total salt ratios are within the limits that the plants can grow.

Considering the water saturation (Isba) rates, *Sorbus aucuparia* has *Sorbus umbellata* in both loamy and clay loam soils. *Sorbus umbellata* var. *cretica* has clay loam, *Sorbus subfusca* and *Sorbus caucasica* var. *yaltrikii* can be said to grow in clay soils.

When evaluated in terms of soil pH, *Sorbus aucuparia* has *Sorbus subfusca* and *Sorbus umbellata* in soil with a wide tolerance from strongly acidic to neutral soil. *Sorbus umbellata* var. *cretica* in moderately acidic soil, *Sorbus* caucasica var. *yaltırıkii* grows in slightly acidic soil.

When evaluated in terms of usable phosphorus amounts, *Sorbus aucuparia* has a wide tolerance that can grow from very little to very high usable phosphorus values, *Sorbus caucasica* var. *yaltirikii* and *Sorbus umbellata* var. *cretica*. It can be said that cretica can grow in soil containing very little phosphorus, while *Sorbus* subfusca can grow in soils with low phosphorus levels.

From the perspective of potassium, it can be said that *Sorbus aucuparia* can grow from soil with low potassium to soil with very high potassium levels, while other *Sorbus* L. taxa can grow in soil with a very high potassium level.

In terms of organic matter, *Sorbus aucuparia* can grow in soil with very little organic matter in the soil to very high organic matter, *Sorbus umbellata* var. *cretica* has soil with very low to low organic matter content, *Sorbus subfusca* has medium, *Sorbus caucasica* var. *yaltırıkii* which grows in soil with high organic matter content.

The data in Table 3 is the arithmetic mean of the measurements (5 replicates) taken from the leaves of the taxa shown in Figure 14. During the flowering and fruit ripening period, *Sorbus aucuparia* has the largest leaf with a leaf length of 11.7-13.8 cm and a width of 9.45-9.86 cm (Table 3). As leaf type, *Sorbus aucuparia* imparipinnat, *Sorbus subfusca* obavate-elliptic*, Sorbus caucasica* var*. yaltirikii* has lanceolate, *Sorbus umbellata* var. *cretica* has an obovate-orbicular type leaf. Looking at the leaf veining, it was observed that all taxa had reticulate type.

Sorbus aucuparia, *Sorbus caucasica* var *yaltirikii* as leaf tip and *Sorbus umbellata* var. *cretica* have acute and *Sorbus subfusca* has acuminate type leaf tips.

When looking at the leaf margins, it was observed that *Sorbus subfuca, Sorbus caucasica* var. *yaltırıkii* and *Sorbus umbellata* var. *cretica* had biserrate margins and *Sorbus aucuparia* had serrate type margins.

When examined as leaf base, it was observed that these four taxa had an asymmetric base.

Table 3. Leaf morphological characteristics of *Sorbus* L. taxa in the study area

Species name	Flowering period		Maturation period		Leaf type	Leaf veining shape	Leaf tip shape	Leaf edge shape	Leaf base shape
	Leaf length aver. (cm)	Leaf width aver. (cm)	Leaf length aver. (cm)	Leaf width aver. (cm)					
Sorbus aucuparia	11.7	9.45	13.8	9.86	Imparipinnate	Reticulate	Acute	Serrate	Asymetric
Sorbus subfusca	-	-	7.26	4.69	Obovate- Eliptic	Reticulate	Acuminate	Biserrate	Asymetric
Sorbus caucasica var.*yaltrikii*	8.55	5.65	9.35	5.97	Lanceolate	Reticulate	Acute	Biserrate	Asymetric
Sorbus umbellata var.*cretica*	8.75	6.53	9.1	6.95	Obavate-Orbicular	Reticulate	Acute	Biserrate	Asymetric

The leaf of *Sorbus aucuparia* is elliptical, single hairy (compound). According to the measurement results, the size of the leaves varies between 20-6×14-2.1 cm. The number of leaflets is 11-17 pairs, excluding the apical leaflet. When looking at the petiole, it is mostly reddish-brown and the length of the stems varies between 1.5-6.7 cm. Leaflets have sparse hairs on them or are completely bare. The margin of the leaflets is serrate, the tip is acute, the base is asymmetrical, the veining is reticulate, and the leaf type is imparipinnate. It is distinguished from the other three taxa by leaf type and margin.

The leaf of *Sorbus subfusca* is broadly obovate or on sterile shoots, almost broad-elliptical (circular), 9.6-3×6-1.6 cm. The base of the leaf is wedge-shaped or rounded, the tip is blunt or rarely slightly pointed. Its veining is reticulate and its margin is biserrate. Petiole has a length of 0.5-2.0 cm, is yellowish-green and has a cottony hairy or bare surface. This species can be distinguished from other taxa by the difference in leaf lamina and leaf tip, and by the frequent and over-toothed edges of the lamina.

Sorbus caucasica var. *yaltırikii* of the leaf is 12-5.5×8-2.5 cm in size and in the form of a wide elliptical or wide egg. The base of the leaves in question is asymmetrical, the tip is acute, the veining is reticulate, the leaf margin is biserrate. Leaf petiolate, has a length varying between 1.2-2.2 cm. This species differs from other taxa with its lanceolate leaf type and lobed leaf structure.

Sorbus umbellata var. *cretica* of the leaf is obovate-orbicular, its veining is reticulate, the leaf tip is acute, the margin is biserrate, the base is asymmetrical, and its dimensions are 12-5.5×9.5-3 cm. The number of leaf margin teeth is between 20-35, bilateral and the top of the leaf is hairless, and the bottom is dense tomentose. The length of the petiole varies between 0.5-2 cm. It is covered with yellowish-green petiolate tomentose. It differs from other taxa with its leaf type and especially the dense tomentose structure in the lower part of the leaf lamina.

Table 4. Stem, leaf, and fruit hairiness characteristics of *Sorbus* L. taxa found in the study area

Species name	Leaf bottom surface	Leaf upper surface	Body hairiness status	Fruit hairiness	Neighbour your cells stoma type according to condition	Type according to the location of the stoma in the leaf	Stoma type according to wall thickness
Sorbus aucuparia	Hairless	Hairless	Hairless	Hairless	Anomocytic	Hipostomatic	Amaryllis
Sorbus subfusca	Hairless	Hairless	Hairless	Hairless	Anomocytic	Hipostomatic	Amaryllis
Sorbus caucasica var. yaltırıkii	Hairless	Hairless	Hairless	Hairless	Anomocytic	Hipostomatic	Amaryllis
Sorbus umbellata var. *cretica*	Hairy	Tomentoz	Hairless	Hairless	Anomocytic	Hipostomatic	Amaryllis

Table 4 contains information on the hairiness of the leaves, stems, fruits, and stoma types of the taxa found in the study area. In the light of the information in the table, there are *Sorbus aucuparia* and *Sorbus caucasica* var. *yaltırıkii*. The upper and lower leaf surfaces of are hairless. The leaves of *Sorbus subfusca* are hairless, but in the early stages of leaf development of this taxon, on the lower and upper surfaces of the leaves close to the leaf petiole, the later shed hairs have a tomentose structure. Among the taxa is in the study area *Sorbus umbellata* var. *certica*. The upper leaf surface of this taxon glabrous, and the lower surface is densely tomentose hairy. No feather structure was found on the stems of 4 taxa in the study area. The fruits of these taxa are hairless. There is only *Sorbus umbellata* var. *cretica*, tomentose cover is seen on the fruits in the early stages of fruit formation. This cover disappears towards fruit ripening. All taxa show anomocytic stomatal structure according to the state of the neighboring cells, amaryllis according to the wall thickness, and hypostomatic according to the location of the stoma in the leaf.

When these taxa are evaluated according to the shape of the leaf lamina, leaf tip, leaf base and leaf margin shape: A. *Sorbus subfusca* oblanseolate, steady edge, blunt tip, sharp base, B. *S.caucasica* elliptic, sawtooth, sharp ucluv,

sharp base, C. *S. umbellulata* var. *cretica* ovate, saw-toothed, sharp-edged and blunt-based, D. *S. aucuparia* compound imparipinnate, leaflets differ morphologically from being oblong, full-edged, sharp-edged and blunt-based (Figure 14).

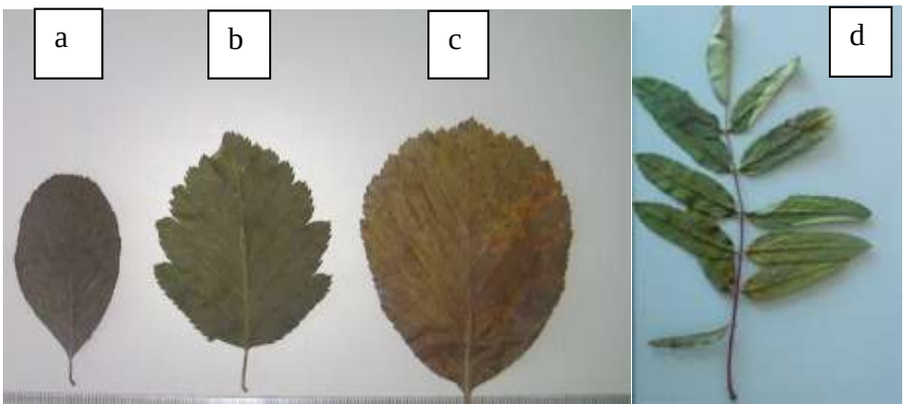

Figure 15. Comparison of leaf morphological features of Sorbus L. taxa *Sorbus subfusca* (a), *Sorbus caucasica* var. yaltirikii (b), *Sorbus umbellata* var. C cretica (c), *Sorbus aucuparia* L. (d)

Table 5 gives information about the morphological features of the reproductive organs of taxa. The number of stamens of all taxa found in the study area is 19-20. Stamens of all taxa are hairless. *Sorbus caucasica* var, *yaltirikii* with the longest stamen at 5.5 mm. It has a sliver. All taxa found in the study area have a single pistil. In general, the number of carpels is 2-3. The longest pistil average is *S. umbellata* var. *cretica*, and the shortest pistil is *S.caucasica* var. *yaltirikii* which has a sliver. Considering the pistil hairiness, *S.aucuparia* has pubescent cover and other taxa have a tomentose cover.

Table 5. Stamen and pistil characteristics of *Sorbus* L. taxa found in the study area

Species name	Average stamen number	Stamens length-width avg. (mm)	Stamens hairiness	Anther length-width avg. (mm)	Flament length avg. (mm)	Pistil count approx.	Pistil length-width avg. (mm)	Pistil hairiness	Number of carpels
Sorbus aucuparia	19-20	2.6-0.2	Glabrous	0.3-0.3	2.35	1	4.98-2.02	Pubescent	2-3
Sorbus subfusca	19-20	3.5-1.5	Glabrous	0.5-0.3	3.10	1	6.1-2.1	Tomentose	2
Sorbus caucasica var. yaltırıkii	19-20	5.5-0.4	Glabrous	0.6-0.5	5.10	1	4.15-1.65	Tomentose	2-3
Sorbus umbellata var. cretica	19-20	5.3-1.9	Glabrous	0.9-0.6	4.50	1	7.4-3.2	Tomentose	2

In Table 6, data on the sepals and petals of the taxa found in the research area are given. The sepal and petal numbers of all taxa are 5. The longest sepale is *Sorbus umbellata* with 5×2.3mm. cretica, *Sorbus aucuparia* with the shortest sepal 0.6×1mm. When we look at the sepal hairiness, *Sorbus aucuparia* has pubescent, the other 3 taxa have tomentose cover. Looking at the petal dimensions, *Sorbus umbellata* has the longest petal cretica has the shortest petal, *Sorbus subfusca*. The petals of all the taxa in the study area are hairless.

Table 6. Morphological features of flowers (sepals and petals) of taxa belonging to *Sorbus* L. genus

Species name	Sepal length avg. (mm)	Sepal width avg. (mm)	Sepal hairiness status	Petal length avg. (mm)	Petal width avg. (mm)	Petal hairiness	Number of sepals	Number of petals
Sorbus aucuparia	0.6	1	Pubescent	4.5	3.5	Glabrous	5	5
Sorbus subfusca	4.3	1.5	Tomentose	3.8	2.3	Glabrous	5	5
Sorbus caucasica var. *yaltırıkii*	2.5	2	Tomentose	5.4	3.4	Glabrous	5	5
Sorbus umbellata var. cretica	5	2.3	Tomentose	8	3.3	Glabrous	5	5

Considering the standard deviation error values, *Sorbus caucasica* var. *yaltırıkii* had the highest reliability values at leaf length with 0.3896, leaf width with 0.3604, and the lowest reliability values with *Sorbus aucuparia* at leaf length at 1.1970 and leaf width with 0.5756. Considering the maturation period, it can be said that *Sorbus caucasica* var. *yaltirikii* has the highest reliability values with 0.5095 leaf length and 0.4596 leaf width, while *Sorbus aucuparia* has the lowest reliability values with 1.4670 leaf length and 1.0401 leaf width.

Some characteristics of the fruits of the *Sorbus* L. taxa are listed in Table 7. The fruit type of all the taxa is drupa. That is, it has a leathery shell on the outside, the mesocarp is soft and the endocarp is hard. They have false fruit structures. While the fruit sizes of *Sorbus aucuparia* are slightly different from the others, fruit sizes are similar in the other three taxa.

Table 7. Fruit sizes and hairiness of *Sorbus* L. taxa found in the study area

Species name	Length avg. (mm)	Width avg. (mm)	Hairiness condition
S. aucuparia	7.5	8.6	Glabrous
S. subfusca	10.6	8.6	Glabrous
S. caucasica var. *yaltırıkii*	13.6	11.5	Glabrous
S. umbellata var. *cretica*	10.6	7.5	Glabrous

In the flora of Rize, 4 taxa (2 species and 2 varieties) belonging to *Sorbus* L. species were identified. These *Sorbus aucuparia* L., *S. subfusca* (Ledeb.) Boiss, *S. caucasica* Zinserl var. *yaltırikii* Gökşin, *S. umbellata* var. *cretica* (Lindl.) Schneidear.

The most widespread *S. aucuparia* in 6 districts, *S. umbellata* var. *cretica* in 3 districts, *S. subfusca* and *S. caucasica* var. *yaltirikii* are distributed in 1 district. *S. aucuparia* and *S. umbellata* var. *cretica* are the new record for Rize province. While no taxa were observed in 5 districts including the central district on a district basis, all taxa were found in Çamlıhemşin district.

In the soil analysis, Isba (water saturation ratio) *S. ucuparia* in both loam and clay-loam soils, *S. umbellata* var. *cretica* has clay loam, the other two taxa are *S. subfusca* and *S. caucasica* var. *yaltrikii*, on the other hand, was determined to grow in clayey carbonate soil.

Considering the total salt content in the soils where *Sorbus* L. taxa can grow in Rize province, it was determined that the salt contents were within the limits of plants and without salt.

When evaluated in terms of soil pH, *S. aucuparia* can grow in a wide tolerance range from strongly acidic to neutral soil, and *S. subfusca* and *S. umbellata* var. *cretica* fruit width have the lowest reliability values in moderately acidic soil, *S. caucasica* var. *yaltırıkii* was determined to grow in slightly acidic soil.

When evaluated in terms of usable phosphorus amounts, *S. aucuparia* has a wide tolerance to grow from very low to very high usable phosphorus values, *S. caucasica* var. *yaltirikii* and *S. umbellata* var. *cretica* grow in soils containing very little phosphorus, and *S. subfusca* grows in soils with low phosphorus level.

From the perspective of potassium, it has been determined that *Sorbus aucuparia* can grow in soils with low potassium to very high levels, where as the other three *Sorbus* L. taxa can grow in soils with very high potassium levels.

In terms of organic matter, *S. aucuparia* and *S. umbellata* var. *cretica* grow in soils with very low to very high organic matter content, *S. subfusca* is medium, *S. caucasica* var. *yaltırıkii* grows in soils with high organic matter content.

S.aucuparia Euro-Siberian element*, S. subfusca* Euxine-colchis element, *S. umbellata* var. *cretica* is generally distributed in Central and Southern Europe, as well as in Southwest Asia, but it is not known to which phytogeographic element type it belongs to.

S. caucasica var. *yaltırıkii* although is an endemic taxon, it was determined that it only spreads within the borders of the colchic subregion of the Euro-Siberian phytogeographical region.

As a result of the research, the samples taken from the fruits and leaves during the flowering and fruit ripening periods were measured and statistical data were determined in 4 taxa that we identified. *S. aucuparia* in leaves had the highest values in all statistical averages, while *S. umbellata* var *cretica* in fruit had the highest value in averages has the highest variability in fruit size *S. aucuparia, S. caucasica* var*. yaltirikii* and *S.umbellata* var. *cretica* has the highest variability in fruit width, *S. caucasica* var. *yaltirikii* and *S. umbellata* var. *cretica* have been observed.

It was determined that all taxa were anomocytic according to the state of neighboring cells, hypostomatic according to the location of the stoma in the leaf, and amarillis type according to the wall thickness. While some structures have pubescent cover, other taxa have tomentose cover in some structures.

In addition, stamen, filament, pistil, anther, sepal and petal number measurements, which are not included in the literature, were recorded for the first time in the study.

In all taxa, the number of stamens is 19-20, the number of pistils is 1, and the number of sepals and petals is 5. *S.aucuparia* and *S. caucasica* var. *yaltırıkii* have 2-3 carpels, while *S.umbellata* var. *cretica* and *S. subfusca* each have 2 carpels. The longest stamen is *S.caucasica* var. *yaltırıkii* with an average of 5.5 mm while the longest pistil is *S.umbellata* var. *cretica* with an average of 6.1 mm. It has *S. subfusca* has the longest sepal with an average of 4.3 mm, while *S. umbellata* var. *cretica* has the longest petal with an average of 8 mm.

In this study, in addition to the characters given in the flora of Türkiye, new characters were extracted. These characters are the key morphological characters that can be used to determine the systematics of the species and the taxonomic relations between the species.

S. aucuparia: Its leaves are large compared to the leaves of imparipinnate and other taxa, the leaflet margins are serrate and petiolate, the fruit is spherical, the number of flowers in the inflorescence is high, which should be considered as a key character in distinguishing it from other taxa.

S. subfusca: obavate- elliptical leaf type, dense and densely toothed leaves, generally less sorting structure, ellipsoidal fruits make it different from other taxa.

S.caucasica var*. yaltirikii*: lanceolate leaf type, lobed leaves, brick red and orange-yellow lenticel fruits distinguish it from other taxa.

S. umbellata var. *cretica*: obavate-orbicular type leaves, toothed leaf margins, broad leaf blades, dense tomentose cover under the leaves, dark red, lenticel and larger fruits from other taxa are distinctive.

Considering the statistical values of the leaf, petiole and stem sections of the taxa, *S. subfusca* has the widest palisade parenchyma mean with 97.62 µm and *S. subfusca* has the highest standard deviation mean with 12.45 µm in this criterion. While *S. subfusca* has the widest sponge parenchyma with an average of 133.20 µm, *S. caucasica* has the highest standard deviation mean of 7.22 µm in this criterion. It has a sliver. The radius of

the main vascular bundles of the petiole is *S. caucasica var. yaltirikii*, with the highest average of 475.14µ. *S. caucasica* var. *yaltirikii* has the highest standard deviation mean of 7.22. It has a sliver. S.caucasica var. *yaltirikii* has the highest average petiole cortex width of 126.24µ. *S.subfusca* has the highest standard deviation mean value with 16.63. *S. caucasica* var. *yaltirikii* with the highest average petiole diameter of 1002.6 µm. The highest standard deviation is *S.umbellata* var. *cretica* with 112.75 µm. Stem pith radius has the highest *S. aucuparia* with an average of 716.27µ, and *S. aucuparia* has the highest standard deviation average of 78.06. The highest average length of stem vascular bundles is *S. caucasica* var. *yaltirikii* with 2131.1 µ. *S. umbellata* var. *cretica*, with a mean value of 71.27 in standard deviation. By taking advantage of the ability of *Sorbus* L. taxa to achieve a very high level of CO_2 tolerance, it may play a role in reducing global warming by providing ecological benefits to reduce greenhouse gas emissions.

CONCLUSIONS

S. subfusca, one of the *Sorbus* L. taxa in the research area, should be given the 'VU' status in the Red Book, and *S. caucasica* var. *yaltirikii* it may be suggested that be taken to the 'CR' status. *S. caucasica* var. *yaltirikii* which is endemic to these taxa. Considering that and *S. subfusca*, which has a very narrow distribution in Türkiye, are considered by the local people as a tree with no economic value and only intended for fuel. The above-mentioned dangers are realistic and for these reasons, these taxa should be immediately protected.

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REFERENCES

Anşin R (1983) The floristic regions and the major vegetation types of Türkiye. Karadeniz Teknik üniversitesi Orman Fakültesi Dergisi, 6 (2): 318-339.

Anşin R, Özkan ZC, Eminağaoğlu Ö (2000) A research on structure of vegetatıon of Artvin-Atila (Hatilla) Valley National Park. Journal of Artvin Forestry Faculty of Kafkas University, 1 (1): 59-71.

Atamov V, Çobanoğlu M (2019) Floristic diversity of Handüzü Natural Park and Environs, Türkiye. KSU J. Agric Nat, 22(Suppl 1): 84-90.

Atamov V (2021) Plant Diversity of Rize. ISBN:978-625-7502-20-7, Duvar Yayınları, 315 s.

Başgül Ş (2007) Gaziantep Üniversitesi botanik bahçesine introduksiyonu yapılan *Sorbus* l. türlerinin gelişim özellikleri. Gaziantep Üniversitesi Fen Bilimleri Enstitüsü Yüksek Lisans Tezi, Gaziantep.

Baykal H (2015) Başhemşin (Çamlıhemşin/Rize)'in florası, fitososyolojisi ve etnobotanik özellikleri. Recep Tayyip Erdoğan Üniversitesi Fen Bilimleri Enstitüsü Doktora Tezi, Rize.

Baykal H, Atamov V (2017) Ethnobotanical documentation of plants of Bashemsin Valley, Kackar Mountains National Park, Rize, Türkiye. Bangladesh J. Bot, 46: 767-773.

Darlington CD, Wylie AP (1955) Chromosome atlas of flovering plants. George Alien and Unwin Ltd. p. 147, London.

Davis PH (1972) Flora of Türkiye and the east aegean island, Edinburgh University, Press Edinburgh, 4: 147-154

Demir E, Atamov V (2019) Flora of the region between Galerdüzü-Ceymakçur Highlands (Çamlıhemşin/Rize). Anadolu Çev. ve Hay. Dergisi, 4 (2): 201-210.

Dönmez A, Aydın ZA (2017) Biogeographic and taxonomic contributions to the genus Sorbus l. (rosaceae) in Türkiye: Sorbus *buschiana* and Sorbus *luristanica.* Hacettepe Journal of Biology and Chemistry, 45 (3):337-341.

Ekim T, Koyuncu M, Vural M, Duman H, Aytaç Z, Adıgüzel N (2000) Türkiye bitkileri kırmızı kitabı. Türkiye Tabiatını Koruma Derneği, Ankara.

Eminağaoğlu Ö, Özkaya SM, Akpulat HA (2012) A new record for the flora of Türkiye: Sorbus. Turkish J. Bot., 36 (4): 426.

Eminağaoğlu Ö (2015) Artvin'in doğal bitkileri. Promat Basın Yayın San. ve Tic. A Ş., ISBN: 978-605-030-854-9, Istanbul, 456.

Erbaş S (2010) The effect of different harvesting times, altitude and aspect on essential oil content and essential oil components of deer apple (Sorbus umbellata (Desf.) Fritsch. var. umbellata). SDU Graduate School of Natural and Applied Sciences, Graduate Thesis.

Ertürk NS (2011) Some technological properties of Ash Leaf Rowan (*Sorbus* aucuparia lipsky) wood impregnated with various chemicals. Gazi University Institute of Science and Technology Master Thesis, Ankara.

Gabrielian ET (1958) Kavkazskiye predstaviteli roda *Sorbus* L. [Caucasian representatives of genus Sorbus L.] Acta Inst. Bot. Acad. Sci. SSR Armeniae., 11: 73–141.

Gabrielian ET (1972) Sorbus L. in Türkiye from flora of Türkiye. 4:147-156.

Gökşin A (1982) Türkiye'de doğal olarak yetişen Üvez (Sorbus L.) taksonlarının yayılışları ile önemli bazı morfolojik ve anatomik özellikleri üzerinde araştırmalar. Ormancılık Araştırma Enstitüsü Yayınları, Teknik Bülten Serisi, No: 120, Ankara.

Gültekin C (2007) Rowan (Sorbus L.) species and seedling production techniques. Ministry of Environment and Forestry, General Directorate of Afforestation and Erosion Control, Department of Nursery and Seed Affairs Publication, Ankara, ISBN 978-605-393-001-3.

Gültekin C, Alan M (2007) Türkiye'nin üvezleri. Flaraplus Dergisi, 12: 76-82.

Güner A, Vural M, Sorkun K (1987) Rize flora, vegetation and pollen analysis of local honey. TUBITAK Mathematics, Physics and Biological Sciences Research Group, Project No: TBAG-650.

Güner A, Özhatay N, Ekim T, Başer HC (2000) Flora of Türkiye and East Aegean Islands, Volume. 11, Edinburg University Press, Edinburg, 114-115.

Güner A (2012) Türkiye bitkileri listesi (damarlı bitkiler). ISBN 978-605-60425-7-7, ANG Vakfı Nebahat Gökyiğit Botanik Bahçesi, Namaş Nurtan Amb. Matb. San. Tic. A.Ş., İstanbul.

Kamarow VL (1971) Flora of the U.S.S.R. Vol. IX, P. 286-310 .(Translated from Russian, Israel Program from scientifio, Translations).

Kartal T, Gür E (2010) Determination of pomological characteristics of rowan (Sorbus domestica l) fruit. Comuljar, 1(1): 24-30.

Kayacık H (1975) Orman ve park ağaçlarının özel sistematiği. III. Cilt Angiospermae, İstanbul Üniversitesi Yayınları No: 3013, Or. Fak. Yayın No: 321, İstanbul.

Ketenoğlu O, Akman Y, Aydoğdu H (1983) A phytosociological research on the maquis formation in the black sea region. Comm. Fac. Sci. D., Ankara, 1 (C): 11-19.

Koçak M (2006) Effects of the hormonal application on seed germination and seedling growth of the some *Sorbu*s L. (mountain ash) species. Gazi Üniversitesi Fen Bilimleri Enstitüsü Orman Mühendisliği Ana Bilim Dalı Yüksek Lisans Tezi, Ankara.

Kovanda (1996) Endangerad names in Sorbus. Thaizsia J.of Bot., 13-14.

Mikolas (1996) Sorbus dolomiticola Micolas anev hibridogenous species of the genus Sorbus. L. from Eastern Slovakia. Thaizsia J.of Bot. Kpsice, 6 (2): 2-12.

Rehder A (1962) Manual of cultivated trees and shrubs. New York.

Süzen A, Atamov V (2022) Endemic and rare plant diversity of Ambarlik highland- case study from Çamlihemşin, Türkiye. PFR, 5(1): 51-55.

URL 1. http://http://www.rize.gov.tr, Accessed: 13.06.2023.

URL 2. earth.google.com, Accessed: 12.05.2023.

URL 3. http://www.mgm.gov.tr, Accessed: 10.05.2023.

URL 4. http://www.belgeler.com, Accessed: 01.04.2023.

Yılmaz C (2010) The Effects of different applications on the germination of some rowan (*Sorbus domestica* L.) types growing in the Tokat Region. Gaziosmanpaşa University Graduate School of Sciences Department of Horticulture Master's Thesis, Tokat.

Wright JW (1963) Aspects genetiques de l'Amelioration des arbres forestiers. F.A.O. Rome.