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THE GENUS *SORBUS* L. IN TURKEY

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Due to the kindness of Dr. P. H. Davis, we have had the opportunity of examining the material of *Sorbus* collected during his numerous journeys in Turkey and kept in the herbarium of the Royal Botanic Garden, Edinburgh. Besides this, the Edinburgh material collected by other botanists has been thoroughly looked through. In addition, all the material of Turkish *Sorbus* kept in the Herbarium of the Botanical Institutes in Leningrad and Tbilisi, as well as the material in the Georgian State Museum, has also been examined and is included in this account.

While studying the representatives of such a difficult genus as *Sorbus*, previous authors mainly based their work on the shape of the leaves without taking into consideration the amplitude of their variation. The form of the leaf in *Sorbus* varies according to ecological conditions, the phases of vegetation, or after abundant snowfall and freezing of the shoots. The habit of shrubs or shape of leaves is also entirely changed after being eaten by animals or after other accidents. In order to have an idea of every species of the genus *Sorbus* it is not sufficient to study the shape and size of the leaves but their pubescence too. These characteristics, being very variable, give rise to a great variety of forms, so that botanists have been tempted to describe such variants as independent species. The study of those occurring in the same region revealed a smooth intergradation between them; they are therefore most reasonably considered as not more than local deviations of the same species. While studying the genus *Sorbus* it is therefore necessary to use, besides the leaves, some more constant characteristics such as the morphological-anatomical structure of flowers, fruit and wood.

Sorbus is represented by 9 species in Turkey disposed in 4 different sections. These are keyed out and annotated below. All specimens cited have been examined by the author, except for additional material in the Kew Herbarium determined by Dr. Davis.

1. Leaves pinnate, pinnately cut or with 1-3 pairs of leaflets at base, slightly lobed or dentate above 2
- Leaves simple 4
2. Styles 5, fruit 15-30 mm. across, usually pear-shaped, yellowish with big stone-cells 1. *domestica*
- Styles 2-3, fruit smaller, 4-10 mm. across, usually apple-shaped, red, rarely yellowish orange, stone-cells inconspicuous 3
3. Leaves odd-pinnate, styles 3-4, stone-cells (*sub lente*) in endocarp as well as mesocarp; epidermis of the lower leaf surface papillate 2. *aucuparia*
- Leaves pinnate only towards the base, with 1-3 pairs of leaflets, or pinnately cut, the upper part lobed and dentate, dark lustrous green above, glaucous-pubescent beneath; styles 2-4, stone-cells only in endocarp; epidermis of the lower leaf surface without papillae 8. *roopiana*
4. Ovary inferior; fruit brown; numerous stone-cells forming an entire firm ring; leaves glabrous beneath, usually with 3-5 pairs of triangular-ovate, often acuminate lobes 9. *torminalis*
- Ovary half-inferior; fruit red, rarely yellowish-orange; stone-cells not forming an entire ring in the endocarp and conspicuous only *sub lente*; leaves more or less pubescent beneath 5
5. Fruit with deciduous calyx; stamens with red anthers; leaves obovate, doubly serrate with small teeth, glabrous beneath to more or less glaucous-pubescent 3. *subfusca*
- Fruit with persistent calyx; stamens with yellow anthers; leaves lobed, dentate or doubly serrate, forming a slight crenation, white or greyish tomentose beneath 6
6. Leaves lobed 7
- Leaves not lobed 8
7. Leaves ovate-elliptical with 9-10 pairs of glandular veins; fruit red with erect sepals 4. *armenica*
- Leaves broadly elliptical, broadest below the middle or slightly rhombic, with 4-7 pairs of glandular veins; fruit orange-yellow, with sepals bent back 5. *persica*
8. Leaves oblong-obovate, serrate, the serration superimposed on larger clear crenations, greenish pubescent beneath; fruit with tightly closed sepals, dark red, densely puncticulate (at maturity); seeds prolonged, slightly bent and narrowed above and below 6. *kusnetzovii*
- Leaves orbicular, oval or broadly obovate, acutely or obtusely dentate, densely white-pubescent beneath; fruit with sepals not tightly closed, bright red, puncticulate only at the base (at maturity); seeds oval 7. *graeca*

Sect. *SORBUS*. Syn. Sect. *Cormus* (Spach) Schneider, Ill. Handb. Laubholz. i, 683 (1906).

1. *S. domestica* L., Sp. Pl. 477 (1753).

Syn. *Cormus domestica* (L.) Spach, Hist. Nat. Veg. ii, 96 (1834).

Paphlagonia, vilayet Kastambuli (Kastamonu), Tossia, Karkun in Elmaludagh, 24 May 1892, *Sintenis* 3991 (LE) V'ave^t Kastambuli,

Tossia, in vineis, 20 July, *Sintenis* 4776 (LE). Asia Minor, Tokat, *Wiedemann* (LE). Tokat, Tossia, (LE). Asian Turkey, Morsuvani, in the gardens, 20 June 1914, *Tchekalov* (LE). Prov. Sinop: Gerze—Boyabat, 800 m., 8 m. tree, fruits round, nearly 1 in. across, 7 Sept. 1954, *Davis* 25033 (E, K, det. Davis).—Map 1.

Sect. AUCUPARIA (Medic.) K. Koch, *Dendrol. i*, 188 (1869).

2. *S. aucuparia* L., Sp. Pl. 477 (1753).

Syn. *S. boissieri* C. K. Schneid. in *Bull. Herb. Boiss.* vi, 312 (1906). Turkish border, 1880, *Radde* (LE). Lazistan, Arsianic range, rarely at 1600 m., more often at the forest limit, 22 July 1885, *Massalsky* (LE). Ardahan, between Kadi village and Eznos-yaila, 1 Sept. 1902, *Satunin* (LE). Prov. Olty, Aguldır, 8 July 1903, *Koenig* (LE). Salelet post, 8 July 1904, *Mikhailovsky* (LE). Koid village, 19 June 1907, *Satunin* (LE). Forest above Djinal village, 17 June 1907 (LE). Between Saltet and Kikzont, 7 June 1907, *Woronov* (LE). Promezhutochnaya station, 6 July 1910, *T. Roop* (Tbilisi). Near Keor-ogli, in pine grove, 1 July 1911, *Sosnovsky* (Tbilisi). Prov. Kars: near Sarikamisch (about 2500 m.), in a garden, 18 July 1914, *Litvinov* (LE). Prov. Artvin: Şavval Tepe above Murgul (igneous), 1500 m., mixed *Picea* forest, 4–5 m. tree, fruits orange, 10 August 1957, *Davis* 32209 (E). Prov. Artvin: Tiryal Dağ above Murgul, 1700 m., mixed forest with Rhododendrons, small tree, fl. white, fragrant, 23 June 1957, *Davis* 29925 (E). Prov. Artvin: mountain above Artvin (igneous), 1300 m., edge of forest, small tree, 19 June 1957, *Davis* 29739 (E). Tshakilisa, 2600 m. (ann. ign.), in herb. *Woronov* (LE). Ararat minor (ann. ign.), *Prostoserdov* (LE). Prov. Kastamonu: N. side of Ilgaz Dağ, 8 September 1954, *Davis* 25072 (K, det. Davis). Amasya, *Manisadjian* 801 (K, det. Davis). Prov. Bursa: Uludağ, Septabogdan, 2 July 1944, *M.*



Map 1. Distribution of *Sorbus* species in Turkey

- *S. domestica*.
- *S. aucuparia*.
- *S. torminalis* var. *torminalis*.
- *S. torminalis* var. *pinnatifida*.

Heimann (K, det. Davis; leaflets doubly serrate—probably juvenile foliage).—Map 1.

Comparative studies of *S. aucuparia* from the Caucasus and Europe, as well as of the plants determined as *S. boissieri*, show that they are conspecific. The recognition of *S. boissieri* is impossible because of the inconstancy of the main diagnostic character (dentation of the leaflets). Besides this, the examination of the morphological and anatomical structure of flowers, fruit and wood, as well as the construction of the epidermis beneath the leaflets—a feature characteristic of pinnate mountain-ash—revealed no differences between *S. aucuparia* and *S. boissieri* (Gabrielian 1954, 1958). Their geographical distribution also confirms that we are dealing with only one species.

Sect. ARIA Persoon, *Synops. Plant.* ii, 38 (1807).

3. *S. subfusca* (Ledeb.) Boiss., *Fl. Or.* ii, 658 (1872); *Fl. Armen.* (edit. Takhtajan) ii, t. 76 (1958).

Syn. *Crataegus subfusca* Ledeb. apud Nordmann, *Vorl. Diagn. in Bull. Sci. Acad. St.-Petersb.* ii, 313 (1837).

Sorbus aria (L.) Crantz var. *concolor* Boiss., *Fl. Or.* ii, 658 (1872).

Aria szovitsii Decaisne, *Mém. Fam. Pom. in Nouv. arch. mus. l'hist. nat. Paris*, x, 165 (1874).

S. concolor (Boiss.) C. K. Schneid., *Handb. Laubholzk.* i, 685 (1906).

S. albovii Zinserl., *Fl. URSS*, ix, 390 et Add. vii, 493 (1939).

Prov. Rize distr. Hemşin: Ortaköy—Çat, 1700 m., on rocks in hazel scrub, 2 Sept. 1952, *Davis* 21265 (E—form with leaves subtomentose below). Prov. Trabzon: Of, near Trebizon, just below alpine meadow land, a. 1933, *Balls & Gourlay* 24 (K, det. Davis).—Map 2.

This polymorphic species varies greatly in the shape, size and pubescence of its leaves. These variants have been described by Zinserling as species, which is why it is quite impossible to determine these artificially mixed-up groups. Field study has shown that the degree of pubescence of the leaves as well as their shape change considerably according to the period of vegetation.

It is necessary to mention that *S. subfusca* was described by Ledebour and Boissier on the basis of flowering specimens collected by Nordmann; in this state the leaves have an obovate-elliptical form. The mature leaves differ greatly in size and shape from the young ones. They become larger and acquire a broadly obovate or broadly orbicular-elliptical form. The leaves of the sterile and fertile shoots differ from each other too. Besides that, the density of pubescence and partly the size of the leaves depend on ecological conditions. The degree of pubescence of the leaves as well as their size and shape are therefore too variable in this species to consider them as constant diagnostic characters.

4. *S. armeniaca* Hedl., *Monogr. Gatt. Sorbus*, 69 (1901); *Fl. Armen.* (edit. Takhtajan), iii, t. 79 (1958).

Turkish Armenia, prov. Kars, Akh-tchai, 21 June 1886, *Massalsky* (LE); upper Akh-tchai, 1700-2250 m., Djigav-Tur, 21 June 1886, *Massalsky* (LE).—Map 2.

Misunderstandings have often occurred in the determination of this species. Very often *S. persica* Hedl., *S. caucasica* Zinserl., *S. dualis* Zinserl. and even the distantly related *S. kusnetzovii* Zinserl. are found under the name *S. armeniaca*. Hedlund described this somewhat doubtful species on the material collected by Szovits in Armenia. The holotype of *S. armeniaca* has not been studied by us as it is kept in Sweden. After a thorough examination of Szovits' itineraries in the Caucasus and Armenia in particular, and taking into consideration that the holotype had mature fruits, we have come to the conclusion that the plant described by Hedlund could have been collected in September in Karabakh (Mt. Major Kirs); this was formerly part of Armenia which explains why Hedlund named the plant *S. armeniaca*. In the herbarium of the Botanical Institute in Leningrad there are two specimens from this mountain matching Hedlund's description. These are evidently to be considered as isotypes of *S. armeniaca*.

Of all the material of this species examined, the specimens collected by Massalsky in Turkish Armenia proved to be most similar to the isotype. The rest of the material seen from the Caucasus differs from the author's description, isotypes and Turkish plants in having broader leaves, denser pubescence and very sparse glands placed over the veins above.

It is necessary to mention that Hedlund himself considered his description not to be complete because of the scarcity of the material at his disposal. He recommended a thorough examination of this form in Armenia to find out if it was an independent species or a hybrid. Unfortunately numerous and thorough searches for this taxon in the territory of Armenia were unsuccessful. Not having found and studied *S. armeniaca* in nature, it is impossible to decide more definitely on the independence of this species.



Map 2. Distribution of *Sorbus* species in Turkey

● <i>S. subfusca</i> .	▲ <i>S. persica</i> var. <i>acutiloba</i> .
■ <i>S. armeniaca</i> .	○ <i>S. kusnetzovii</i> .
△ <i>S. persica</i> var. <i>persica</i> .	□ <i>S. roopiana</i> .

5. *S. persica* Hedl., Monogr. Gatt. Sorbus, 70 (1901); Fl. Armen. (edit. Takhtajan), iii, t. 80 (1958).

Syn. *S. aria* (L.) Crantz subsp. *persica* (Hedl.) Bornm. in Beih. Bot. Centralbl. xix (2), 353 (1906).

S. aria subsp. *luristanica* Bornm. in Beih. Bot. Centralbl. xxviii (2), 227 (1911).

The analysis of the present herbarium material (mainly from Armenia), which is far more than Hedlund had at his disposal when describing *S. persica*, has compelled us to take a somewhat wider circumscription for this species than was given by Hedlund, Schneider and others. This polymorphic species may be divided into several infra-specific taxa related to different ecological conditions and geographical areas. These taxa do not differ in their anatomy or in the construction of their flowers and fruits. A key for their determination is given below:

1. Leaves rhombic-elliptical, dark green above, greenish white-pubescent beneath, with lobes and apex more or less acuminate
subsp. *persica* var. *acutilobata*
- Leaves broadly elliptical to linear-elliptical, usually broadest below the middle, light green above, white-tomentose beneath, lobes obtuse or \pm obtuse 2
2. Lobes of leaves rather deep (up to 10 mm.); leaves broadly elliptical, usually entire only near the base, small-dentate above, with 7 pairs of veins subsp. *persica* var. *persica*
- Lobes of leaves not so deep (2–4 mm.); leaves entire in lower half or lower third, with 5–6 pairs of veins 3
3. Leaves linear-elliptical, lobes very short with abruptly acuminate apex; veins arch-like ascendant (Iran, Luristan, Nakhichevan)
subsp. *luristanica*
- Leaves orbicular-elliptical, lobes very obtuse, veins stretching from central nerve at sharp angles (Armenia, Megri) subsp. *obtusilobata*

subsp. *persica* var. *persica*.

Prov. Kars: Kara-dash range near Kaghyzman, 5 June 1904, *Mikhailovsky* (LE). Turkish Kurdistan, Shamsdinan, Benarve, 2 June 1916, *Schelkovnikov & Schipchinsky* (Tbilisi). Prov. Van: 15 km. N. of Şatak, in *Quercus* scrub, 3 m. shrub, 25 July 1954, *Davis* 23153 (E). Natolia, *Tschikhatschev* 696 (ann. ign.), Reliq. Fischer (LE).—Map 2.

Usually growing alone, on very rocky, open slopes or in bushy thickets, in sparse Juniper woodlands, rarely in forest.

subsp. *persica* var. *acutilobata* Gabr., var. nov.

A var. *persica* foliis rhomboideis subitus albo-virescentibus lobis acutis differt.

Prov. Bitlis: Karz Dağ above Kotum, 1950 m., in oak wood, 10 ft. tree with bright orange-brown bark, 28 June 1954, *Davis* 22270 (holo. E)—Map 2.

In Armenia it usually grows in oak forest, in groups.

6. *S. kusnetzovii* Zinserl. in Fl. URSS, ix, 397 et Add. vii, 496 (1939); Fl. Armen. (edit. Takhtajan), iii, t. 82 (1958).

Armenia turcica, Szandschak Gümuschkhane: Tempede, 22 August 1894, *Sintenis* 7126 (LE). Prov. Kars: Kars, canyon near the fortress, 26 August 1910, *T. Roop* (Tbilisi). Prov. Kars: Kaghyzman, canyon near the post of the Iron Gates (Demur-Kapi), 4 June 1913, *Woronow* 12404 (LE). Prov. Erzincan: foot of Keşit Dağ above Cimin, 2500 m., bushy igneous N. slope, 3 m. shrub, 27 July 1957, *Davis* 31965 (E). Prov. Ankara: Beynam, 1200 m., woods with *Juniperus oxycedrus*, 5 July 1947, *Davis* 13042 (E). Prov. Denizli (Caria): Boz Dağ above Geyran yayla, 1540–1700 m., 16 July 1947, *Davis* 13446.—Map 2.

S. kusnetzovii is rather closely related to *S. graeca*. The species, however, is clearly distinguished from the latter by its more elongated, small-serrate leaves (the teeth forming a slight serration about or below the middle of the blade), characteristic colour of the leaf pubescence, shape of the flower and fruit, and even by the anatomy of the wood.

Specimens from Kars, gathered by Tatiana Roop and described by E. Bordzilovsky as *S. meridionalis* var. *baldaccii* f. *hajastanica*, appeared to be typical *S. kusnetzovii*.

S. baldaccii is a *nomen nudum*. Having had no opportunity to compare authentic specimens of this “species” with *S. kusnetzovii*, it is impossible to speak about the degree of relationship or identity of these two plants.

7. *S. graeca* (Spach) Hedl., Monogr. Gatt. Sorbus, 75 (1901); Fl. Armen. (edit. Takhtajan), iii, t. 83 (1958).

Syn. *Pyrus aria* sensu Sibth. & Sm., Fl. Gr. Prodr. i, 345 (1806), non *Sorbus aria* (L.) Crantz.

P. aria (L.) Ehrh. var. *cretica* Lindl. in Trans. Hort. Soc. London, vii, 235 (1828).

Crataegus graeca Spach, Hist. Nat. Veg. ii, 102 (1834).

Pyrus meridionalis Guss., Syn. Fl. Sic. ii, 831 (1844), *pro parte*.

Sorbus cretica (Lindley) Fritsch in Kerner, Schedae Fl. Exsicc. Austro-Hungar. vii, p. 18 No. 2448 (1896).

Sorbus turcica Zinserl. in Fl. URSS, ix, 399 et Add. viii, 497 (1939).

S. obtusidentata Zinserl., l.c. 400 et Add. viii, 498 (1939).

S. taurica Zinserl., l.c. 400 et Add. viii, 497 (1939).

The synonymy of this polymorphic species given above is incomplete. Contrary to the opinion of Kárpáti (1960, p. 168), *S. graeca*, not *S. cretica*, is the correct name for this species, *graeca* being the earliest available epithet at specific rank. *S. graeca* has a wide ecological amplitude and numerous forms, some of which have been described as independent species, differing mainly in leaf shape and dentation. These characters are too variable to serve as a basis for independent species. When examining *S. graeca* in nature, numerous diversities can be noticed not only on different specimens but even on the same shrub or branch. It is necessary to take into account that the age of the leaves also affects their shape. The leaves of *S. graeca* gathered in early spring differ very much in shape, texture and pubescence from mature leaves. This has often caused misunderstanding, particularly when work is based only on herbarium material. Thus, two branches gathered from the same place at the time of flowering and fruit-bearing and mounted on the same sheet were determined by Zinserling as *S. baldaccii* and *S. graeca* var. *cuneata* (i.e. var. *graeca*) respectively. To avoid such errors the limits of variability in every

group must be very carefully studied. Below a key is given to the varieties of *S. graeca* that can be recognised in Turkey.

1. Leaves light green above, each side with not more than 15 large teeth that are broad at the base; 6-8 pairs of veins. var. *turcica*
- Leaves dark green above, each side with 20-35 acute, closely placed teeth; 7-9 pairs of veins 2
2. Leaves rounded at base var. *orbiculata*
- Leaves slightly cuneate at base var. *graeca*

var. *graeca*.

Syn. *Sorbus cretica* (Lindley) Fritsch (1896).

S. graeca var. *cuneata* Zinserl. in Fl. URSS, ix, 398 (1939)—*rossice*.

Cilicia in Tauri alpes Bulgar Dagh, in devexis septentrionalis observis infra castellum Gullek, 1350 m., et ad Cydni or., 23 August 1853, Kotschy (LE). Prov. Niğde, distr. Ulukışla (Cilicia): Bulgar Dağ, between Alihoca and Gazitepe yayla, 3-4 m. shrub, growing with *Carpinus orientalis*, 3 September 1945, Davis 16531 (E). Near Smyrna, July 1854, *Balansa*. Prov. Antalya, distr. Gebiz (Pisidia): Bozburun Dağ near Taşlı yayla, 1700 m., in rock, 26 July 1949, Davis 15600 (E). Prov. Isparta distr. Sütçüler (Isauria): Dedeğöl Dağ between Selköse and Oruz Gaz yayla in ravine on metamorphic rock, 1200-1400 m., 1 August 1949, Davis 15911 (E). Troas, mt. Ida, in silvis prope Kareikos, 23 June 1883, *Sintenis* 463 (LE, E). Paphlagonia, Vilayet Kastambuli, Kûre-Nahas, in sylvis, 28 August 1892, *Sintenis* 5128 (LE). Akdagl [Prov. Amasia], *Manisadjian*. Cappadocia: Argaeus, alt. 2000 m., 30 July 1898, *Siehe* 319 (LE). Anti-Taurus: Zeytun, limestone slopes, trees to 3.5 m. tall, fls. cream 18 mm. diam., reverse of leaves, fl. stems and calyces white with dense hairs, (*Aialma*= Bear Apple), 13 May 1934, *Balls* 1068 (E). Prov. Tunçeli: Munzur Dağ, in Aksu dere above Ovacik, 1700 m., edge of stream, 2-3 m. shrub, 21 July 1957, Davis 31499 (E). Turkish Armenia, border range Shakh-ioly, 19 July 1886, *Massalsky* (LE). Prov. Kars: in monte Sakal-Tutan, distr. Olty, 2250 m., 20 July 1906, *Koenig* (LE); distr. Olty, post Keor-ogly, 1 July 1911, *Sosnovsky* (Tbilisi); *ibid.*, 1950 m., 25 August 1905, *Koenig* (LE). Prov. Bitlis: Nemrut Dağ, 2300 m., in crater, 1 July 1954, Davis 23501 (E); crater of Nemrut Dağ, 2400 m., stony ground with *Betula* sp., trees c. 3 m. tall, lower branches often trailing on ground, 11 August 1956, *McNeill* 561 (E). Prov. Artvin: mountain above Artvin, 1700 m., edge of forest, 2-3 m. shrub, 19 June 1957, Davis 29756.—Map 3.

This is the most widely distributed variety. It occurs in Greece, Albania, Yugoslavia, Bulgaria, Roumania (Transsylvania), Hungary, Italy, Spain (Sierra Nevada), Western Alps, Cyprus, Crete, Lebanon, Syria, Jordan, Turkey, Crimea, Caucasus, Iran and Kopet Dagh (Middle Asia).

According to Hedlund (p. 130), *S. graeca* originated in the Balkan Peninsula and the islands in the eastern part of the Mediterranean. He evidently meant this particular variety, because in the west part of its area *S. graeca* is chiefly represented by this one form, whereas in the East other varieties grow together with var. *graeca*. Such different forms of one species occurring under different conditions may seem to be independent species. However, examination in the field shows that they are better treated as varieties of a single species.

var. *orbiculata* (Kárpáti) Gabrielian, comb. et stat. nov.

Syn. *S. cretica* (Lindley) Fritsch forma *orbiculata* Kárpáti in Feddes Rep. lxii, 171 (1960): *Sorbus graeca* var. *orbiculata* Zinserl.—*rossice*.

Mt. Ararat, *Owerin*, Herb. Ledeb. (LE). Prov. Kars: Kaghyzman, ravine Demur-Kapi, 8 June 1904, *Mikhailovsky* (LE). Artvin, between Surevan and Tshuared villages, 18 June 1907, *Woronow* (LE). Artvin, near Kutshen village in forest, 6 July 1911, *Vvedensky* (LE). Artvin: Ardanuch, forest on N.E. slopes of Mt. Vartskhet (middle third), 26 May 1914, *Turkevitch* (LE).—Map 3.

This variety is not as widespread as var. *graeca*, though often it occurs together with it.



Map 3. Distribution of *Sorbus graeca* in Turkey

- *S. graeca* var. *graeca*.
- *S. graeca* var. *orbiculata*.
- *S. graeca* var. *turcica*.

var. *turcica* (Zinserl.) Gabrielian, comb. nov.

Syn. *S. turcica* Zinserl. in Fl. URSS. ix, 399 et Add. viii, 497 (1939). Lycaonia régio super. montis Karadagh, July 1845, *Heldreich* (E). Cilicia, Bulgar dagh, infra castellum Gullek, 1350 m., 21 September 1853, *Kotschy* (LE). Cilicia: Gullek Gala, 1400 m., a. 1896, *Siehe* 451. Cilician Taurus: Burujik, limestone slopes, tree to 6 m. tall, 7 June 1934, *Balls* 1068A (E). Prov. Muğla: Baba Dağ (Fethiye) above Akbel yayla, 1500 m., 30 July 1947, *Davis* 13649 (E). Amasia, in rupestr. reg. subalp. Ak Dagh, 24 August 1889, *Bornmüller* 305 (LE). Pontus Galaticus: Amasia, in mt. Sana Dagh, 1000 m., 14 May 1890, *Bornmüller* 2715 (LE). Prov. Malatya: Gürün—Malatya, c. 40 km. from Malatya, c. 1400 m., gully among cliffs, 4 m. tree, 7 August 1956, *McNeill* 469 (E). Distr. Bayazet: Kasikiboran, ad fines Armeniae et Turciae, 28 July 1871, *Radde* (LE—3 samples). Prov. Kars: Kaghyzman, canyon of the river Zoghrab-khan-tchai, on slopes, 3 June 1913, *Woronow* 13142 (LE).—Map 3.

The diagnostic features of this variety (the colour of the leaf, number of teeth and veins) are not sufficient to treat it as an independent species, as was done by Zinserling. Our examination of the anatomical structure of the wood and fruits, and the morphological analysis of the flower, confirmed the conclusion that *S. turcica* is only one of the manifestations of the polymorphic *S. graeca* and should be recognised as var. *turcica* (Gabrielian, 1958a).

As can be seen from the cited specimens of *S. graeca* and Map 3, var. *graeca* and var. *turcica* are the most widespread varieties in Turkey; var. *orbiculata* occurs only in the North-East, but var. *taurica* (Zinserl.) Gabr. does not occur in Turkey at all. In the Crimea and Caucasus all four varieties (and perhaps others) are known to occur.* In the Caucasus var. *turcica* is met with in Georgia (in the vicinity of Tbilisi-Mtskheti, Ateni and elsewhere) and not far from Novorossiysk. In Europe all the examined specimens of *S. graeca* from the Mediterranean region and South-East Europe chiefly represent var. *graeca*, except for one specimen of var. *turcica* from Bulgaria (Bulgaria australis, in sylvaticis pr. Causovo, 28 August 1897, *Stibrny*).† The sample from Spain, which shows some resemblance to var. *turcica*, evidently represents a local form of var. *graeca*.

8. *S. roopiana* Bordz. in Bull. Jard. Bot. Kieff. xii-xiii, 131 (1931), *pro hybr.* Fl. Armen. (edit. Takhtajan) iii, t. 84 (1958), as *S. dualis*.

Syn. *S. dualis* Zinserl., Fl. URSS. ix, 402 et Add. viii, 498 (1939). Prov. Kars, distr. Kaghyzman, ad rivulum in declivi montis Kecza-czii, 31 July 1910, *Roop* (LE—isotype). Distr. Olty, between Lespek and Karnavaz, edge of forest, 8 July 1911, *Sosnovsky* (LE, Tbilisi). Prov. Bitlis: Nemrut Dağ, 2300 m., in crater, 2.5 m. shrub with *Populus tremula*, 3 July 1954, *Davis* 23500 (E); scree on N. slope of crater of Nemrut Dağ, 2600 m., open community, single shrub 2 m. tall, among trees, resembling *McNeill* 561 (*S. graeca* var. *graeca*), 12 August 1956, *McNeill* 594 (E).—Map 2.

The name *S. dualis* Zinserl. must be replaced by the earlier *S. roopiana* Bordz. described from the Kaghyzman district on the slope of Mt. Ketcha-tchi; this is identical with the holotype of *S. dualis* (described from the vicinity of Kadjaran in Armenia) in the structure of leaves and fruit.

The formation of hybrids in the genus *Sorbus* as in other genera of the Rosaceae is a rather frequent phenomenon which makes its taxonomy very difficult. In some species the pollen grains are uniform in size and shape, while in others there is considerable variation in size, with various irregularities in shape and a large proportion of abortive grains. The latter features occur in *S. roopiana* and suggest a hybrid origin.

In the Caucasus the hybrid forms of the species in Sections *Aucuparia* and *Aria* occur particularly frequently in adjacent localities within the same general area. In this case the leaves usually have 1–3 pairs of leaflets at the base or have deeply cut lobes and the upper part of the blade dentate. One of these hybrid forms growing in Armenia, in the upper reaches of the river Vokhtchi (Zanghezur), was described by Zinserling as

* var. *taurica*, outside the Crimea, has so far been found only in the North Caucasus by K. Popov.

† In the Kew herbarium the Lebanon material belongs to var. *turcica* (Davis).

S. dualis. He considered that the species had arisen by a cross between *S. aucuparia* and *S. armeniaca*. However, a thorough search for *S. armeniaca* in the near and distant neighbourhood of the *locus classicus* of *S. dualis* proved unsuccessful. Instead, *S. aucuparia*, *S. graeca* and *S. subfusca* grew near the "hybrid" species. These probably represent the most likely parents for *S. dualis*. To determine the exact parental form of this taxon (as well as of others), a special experimental study is to be performed. Being unable to do it now, we are to adopt for the hybrid forms, which may have a different origin, the earliest available epithet, *S. roopiana*.

According to the general distribution of the species of *Sorbus* in Turkey allied to *S. roopiana* and gathered on Nemrut Dağ by Davis and McNeill, only *S. graeca* and *S. persica*, but not *S. aucuparia*, occur in the neighbourhood at the present time. The leaves of the cited specimens of *S. roopiana* from Nemrut Dağ are deeply cut at the base and do not have 1-3 pairs of leaflets. In its *locus classicus* (distr. Kaghyzman) *S. roopiana* grows in the neighbourhood of *S. aucuparia*, *S. kusnetzovii*, *S. graeca* and *S. armeniaca*. If *S. roopiana* should prove to be an apomictic allopolyploid (as is often the case with such forms in Western Europe), it would of course be able to perpetuate itself in areas where the parental species no longer occur at the present time.

Sect. TORMINARIA (DC.) Zabel in Beissner, Schelle & Zabel, Handb. Laubholzneennung, 197 (1903).

9. *S. terminalis* (L.) Crantz, Stirp. Austr. ii, 87 (1769).

Syn. *Crataegus terminalis* L., Sp. Pl. 476 (1753).

In Turkey this species is represented by the following two varieties:

Leaves with 3-5 pairs of triangular-ovate lobes, the lower sinus reaching about half way to the midrib var. *terminalis*

Leaves with 3-7 pairs of longer sharper lobes, sinuses reaching further towards the midrib var. *pinnatifida*

var. *terminalis*

Cilicia, alp. Bulgar Dagh in convalli Agatsch Kisse, regione Abietis, 27 August 1853, *Kotschy* (LE). Kalanemo valley, a single small tree, 1.5 m. tall, growing out of cliffs, 1934, *Balls* 332 (E). Paphlagonia, vil. Kastambuli, Küre-Nahas, in sylva prope Topschi-Chan, 18 August 1892, *Sintenis* 5011 (LE). Prov. Kastamonu: Inebolu—Küre, 450 m., hanging down shale bank (ecological relict), 8 June 1954, *Davis* 21669 (E). Prov. Tokat: Tokat—Artova, in oak scrub, 4 September 1954, *Davis* 24858 (E). Cappadocia, Hadjin (ann. ign.), *Manisadjian* (LE). Prov. Tunçeli: above Pülümür, 1700 m., in oak scrub, small tree (4-5 m.), fls. creamy white, fragrant, 8 June 1957, *Davis* 29279 (E). Distr. Artvin, near Ardanuch, Mt. Vartskhet, east slope (middle third), xerophilous forest, 26 May 1914, *Turkevitch* (LE, 2 samples).—Map 1.

var. *pinnatifida* Boiss., Fl. Or. ii, 659 (1872).

Cilician Taurus: Burujik, Asir gedigi, small round-headed trees up to 0.3 m. diam., 1200 m., lime slopes in small thickets with *Carpinus* (*Ostrya*?) sp. 7 May 1934, *Balls* 1294. Amanus: Osmaniye-Gaurdağı, c. 1200 m.,

with *Quercus cerris*, July 1942, Kazim ?Mchcioğlu 252 (K, det. Davis). N. Syria (near Slenfe), leg.? (K, det. Davis).—Map 1.

DISCUSSION

The Anatolian material examined shows that the establishing of Caucasian endemics must be done with great care. This paper demonstrates that a set of hitherto accepted Caucasian endemics (*S. subfusca*, *S. kusnetzovii*, *S. armeniaca*) grow in Turkey contiguous to Caucasia.

The general distribution of all the species of the genus *Sorbus* found in the territory of Turkey compared with their distribution in Caucasia is of great interest. It is known that Caucasia is the area where the greatest diversity of the species in Sect. *Aria* is concentrated. As we withdraw from this area the concentration of species diminishes. It confirms our suggestion that Caucasia has seen the origin at least of part of the representatives of Sect. *Aria* (chiefly the more xeromorphic species) and is one of the largest centres of the genus as a whole.

It is interesting that *S. subfusca*, the least xeromorphic species in Sect. *Aria* and hitherto considered as a strict Caucasian endemic, is found in the territory of Turkey only in Lazistan. In 1955, after morphological-anatomical and botanical-geographical studies, a close taxonomic relationship was revealed by us between this species and a group of species in East Asia. This relation rests on an extraordinary resemblance in the fruit. The main fairly specific distinguishing character for the group is the deciduous calyx of the mature fruit. Besides this there is a resemblance in anatomical fruit structure, leaf shape, serration and nervation, and in the structure of different parts of the flower, etc. Taking into consideration that the Caucasian phytogeographical region (particularly Colchis and Hyrcania) is considered to be a big refugium for representatives of the formerly widely distributed Tertiary, deciduous, temperate, so-called Arcto-Tertiary flora, the great disjunction of this closely related group of species can be readily understood.

This is confirmed by numerous palaeobotanical materials; among them is a wonderful finding of a fossil *Sorbus* from the Oligocene flora of the North Aralian region (Budanstev, 1959). This species, named *S. gabrieliana* by its author, is very close to the Caucasian *S. subfusca* in its leaf morphology. The taxonomic closeness of these species is seen in the shape and size of the leaf blade as well as in its nervation and serration. Thus the location of *S. gabrieliana*, a fossil analogue of *S. subfusca*, lies between the Caucasian species and the group closely allied to the South-West and Central Chinese species. We can therefore assume that the species in this relationship were more widely distributed in ancient times. It is evident too that the contemporary East Asian flora, which at present is perfectly preserved, was in former times united with that of the Caucasus.

The finding of this fossil *Sorbus* is of great value for the light it sheds on the period of origin of the genus. On the basis of comparative analysis of palaeobotanical data, it is possible to conclude that *Sorbus*, being a representative of the ancient warm temperate mesophyte flora, was widespread as early as the Tertiary period. Fossil remains found in the deposits of the Tertiary and Quaternary periods prove the antiquity and wider distribution of contemporary species of the genus *Sorbus*. However,

all the previous findings of fossil species in Sections *Aucuparia*, *Aria* and *Torminaria* were from Miocene and Pliocene deposits, i.e. from the Neogene (Gabrielian, 1958a). While the finding of *S. gabrielianae* in Oligocene deposits shows that even in the Paleogene representatives of the genus had a widespread distribution. The origin of the genus presumably took place much earlier than the Paleogene. This supposition is confirmed by the fact that *Sorbus* occurs in N. America, too, where it is represented only by Sect. *Aucuparia*.

If the distribution of *S. subfusca* in Turkey is limited only to Lazistan, such typical xerophytes as *S. armeniaca*, *S. persica*, *S. roopiana*, *S. kusnetzovii* are distributed more widely. *S. kusnetzovii* (hitherto believed to be endemic to Caucasia) has an interrupted distribution right across Asia Minor, extending as far as Caria. Evidently the formation of xerophilous species of *Sorbus* took place in the Neogene, when in connection with the general aridity of the climate the xerophilisation of the Tertiary forests was going on. The result of this was the formation of new coenoses by the transformation of old ones. Among these new formations there probably originated at that time xerophilous sparse woodlands and light oak forests of park-like landscape. Xeromorphic species of the genus *Pyrus*, *Rhamnus*, *Amygdalus*, *Crataegus* and others evidently grew together with the oak in these communities. Among them were apparently the xerophilous species of *Sorbus*. Xerophilous formations of this type now often occur in Trans-Caucasia, Middle Asia, Asia Minor and Iran, in the Crimea and in the Balkan Peninsula.

In addition to this, we must say a word about parallelism in the evolution and geographical distribution of *Pyrus*, a genus which is closely related to *Sorbus* (A. A. Fedorov, 1958). This parallelism appears in everything, up to the existence in the genus of a certain group of Hyrcanian pears, bearing fruit with a deciduous calyx as in *Sorbus subfusca*! which is closely related to the East Asiatic species of *Pyrus*. Besides this, Fedorov mentions an interesting feature in the evolution of pears: the representatives of this genus, almost throughout the extent of their range, grow together with various species of oaks. It is possible to say just the same about the xerophilous species of *Sorbus*. These no doubt evolved together with the open xerophilous woodlands and oak forests with which they are still associated.

I wish to express my gratitude to Dr. P. H. Davis for kindly editing this paper. Since the main part of the work was written, Z. Kárpáti (1960) has published his revision of the Sorbi of Hungary and adjacent regions—a detailed work in which a very large number of *formae* are recognised.

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