

## *Aubrieta* (*Brassicaceae*) in the Bulgarian flora

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**Abstract.** The genus *Aubrieta* is represented in the Bulgarian flora by two species and three not nominal subspecies, perennial, mostly calciphylous plants: *A. columnae* subsp. *pirinica* ( $2n = 16$ ), is distributed in the coniferous belt of Pirin Mts and Mt Slavyanka; *A. columnae* subsp. *bulgarica* ( $2n = 16$ ), occurs in SW Bulgaria, on the slopes of the low Konyavska and Zemenska mountains; *A. intermedia* auct. is referred to the synonymy of *A. columnae* subsp. *pirinica* and *A. columnae* subsp. *bulgarica*; *A. gracilis* subsp. *scardica* ( $2n = 16$ ), occurs in the high mountainous parts of N Pirin Mts and Rila Mts; *A. deltoidea*, reported for Bulgaria, is known as an ornamental plant only. The taxonomy, synonymy and plant reproduction are discussed.

**Key words:** *Aubrieta columnae*, *A. deltoidea*, *A. gracilis*, *Brassicaceae*, Bulgaria, chromosome numbers, distribution, ecology, reproduction

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### Introduction

Genus *Aubrieta* comprises perennial herbs distributed in Southwest Asia (mostly Anatolia) and S & SE Europe (Balkan Peninsula, Italy, SW Romania). According to the critical review of the systematics of *Brassicaceae* by Al-Shehbaz & al. (2006), the number of species in the genus amounts to 12, which considerably differs from the reports of earlier authors, according to whom the genus comprises about 20 species (Gustavsson 1986; Phitos 2002). Judging by the distribution and phytogeographical connections of the species, the origin of genus *Aubrieta* is related to Southwest Asia, a region regarded as the primary centre of origin and distribution of *Brassicaceae* (Cullen 1965; Hedge 1976; Al-Shehbaz & al. 2006).

Six species of genus *Aubrieta* occur in Europe, five of which are continental endemics. Four of these – *A. erubescens* Griseb., *A. gracilis* Spruner ex Boiss. (*A. g.* subsp. *gracilis*, *A. g.* subsp. *scardica* (Wettst.) Phitos and *A. g.* subsp. *glabrescens* (Turrill) Akeroyd), *A.*

*scyria* Halásczy and *A. thessala* Boissieu are Balkan endemics, with more or less isolated distribution in the mountains of Albania, Bulgaria and Greece (Phitos 1970, 2002; Akeroyd & Ball 1993; J alas & Suominen 1994; Authier 1998; Ančev 2007). *Aubrieta deltoidea* (L.) DC. has an Anatolian-Balkan-Appennines area of distribution, and *A. columnae* Guss. has an Appennines-Balkan area.

The basic chromosome number in the genus is  $x = 8$  (Warwick & Al-Shehbaz 2006). Four of the European species are diploid, with  $2n = 16$ , while in *A. gracilis* subsp. *scardica* diploid plants have been found with  $2n = 16$  (Ančev 1978; Ančev & Hardalova 1989), as well as polyploid ones with  $2n = 32$  (Franzén & Gustavsson 1983: 103; Gustavsson 1986: 271, as *A. scardica*). There are no data on the chromosome number of *A. scyria* and *A. thessala*.

In some of the earliest publications on the Bulgarian flora, among which are those by Urumov (1911, 1912, 1913), Stojanov & Stefanov (1922) and Stojanov (1924), and subsequently in the editions of *Flora of Bulgaria* (Stojanov & Stefanov 1924, 1933, 1948; Stojanov

& al. 1966) and *Flora RP Bulgaricae* (Assenov 1970)<sup>1</sup> different views were expressed about the taxa of genus *Aubrieta* distributed in the country. Probably owing to this, or to the complicated synonymy, some of the species have been included with incomplete or unconfirmed data about their distribution in Bulgaria in the *Med-Checklist* (Greuter & al. 1986), *Flora Europaea* (Tutin & al. 1993) and *Atlas Florae Europaeae* (Jalas & Suominen 1994).

The review of literature on the taxonomy and chorology of the species of genus *Aubrieta* distributed on the Balkan Peninsula, the field investigations in recent years, the comparative morphological studies of herbarium materials in Bulgarian and European herbaria, along with the karyological research have shown that *A. columnae* subsp. *pirinica* Assenov, *A. columnae* subsp. *bulgarica* Ančev and *A. gracilis* subsp. *scardica* are distributed in the Bulgarian flora.

## Material and methods

The study is based on herbarium material from the herbaria B, SO, SOA, SOM, UPA, W, WU, as well as on field investigations and plants collected in the mountains of SW Bulgaria.

The chromosome numbers were counted on mitotic metaphase plates obtained from seedling root-tips, fixed in ethanol-acid (3:1), hydrolyzed in 1N HCl at 60 °C for 30 min and stained with hematoxyline after Gomori (Melander & Wingstrand 1953). In the lists of examined specimens, the karyologically investigated Bulgarian populations are marked with an asterisk (\*). The morphology of trichomes follows the terminology of Theobald & al. (1979), see also Ančev & Goranova (2006). The voucher specimens have been deposited in SOM.

## Results and discussion

### *Aubrieta* Adans.

- 1 Fruits with an indumentum of stalked 3–4-armed and more or less appressed stellate trichomes, mixed with distinctly longer simple and forked ones ..... *A. deltoidea*

- 1\* Fruits with an indumentum of stalked (3) 4-armed and more or less appressed stellate trichomes, occasionally on the margins with a few short forked ones ..... 2

- 2 Style 7–10 mm; leaves entire or with 1–3 teeth on each side; petals 11–25 mm long ..... 1. *A. columnae*

- 2\* Style 4–6 (7) mm; leaves entire or with 1–2 teeth on each side; petals 7–16 (18) mm long ... 2. *A. gracilis*

1. *A. columnae* Guss., Pl. Rar. (1826) 266; Assenov, Fl. Reipubl. Popularis Bulgaricae 4 (1970) 473; Akeroyd & Ball, Fl. Eur. ed. 2, 1 (1993) 357; Ančev, Phytol. Balcan. 13(2) (2007) 160.

Loosely caespitose plant, with slender underground rhizome, occasionally with aboveground runners. Flowering stems slender, (5)10–25(30) cm, with 3–10 flowers. Leaves oblong, oblanceolate to obovate, entire or with 1–3 teeth on each side. Petals 11–25 mm long, reddish to violet. Fruits 5–25 mm long, 2–4 mm wide, slightly compressed, mature valves slightly reticulate-veined; indumentum with simple stellate and short stalked (3)4-armed trichomes, occasionally on the margins with few forked ones; style 7–10 mm long. *Flowering*: (late May) June–July.

**Distribution in Bulgaria.** Valley of Struma River (*North*), Mt Slavyanka and Pirin Mts, from 600 up to 1800 m a.s.l.

**Habitats.** On open slopes and gravelly grasslands at the foothills and in the mountains, on shallow and eroded humus-carbonate soils, from the xerothermous oak-hornbeam forests up to the coniferous forest belt.

**General distribution.** Balkan Peninsula (N Albania, SW Bulgaria, Croatia, R Macedonia), Italy, SW Romania.

- 1 Petals 11–16(17) mm long; leaves entire ..... subsp. *columnae*. Italy (C & S Appennini)

- 1\* Petals 14–25 mm long; leaves with 1–3 teeth on each side, occasionally entire ..... 2

- 2 Petals 14–20 mm long; fruits 5–14 mm; leaves with 1–3 teeth on each side, occasionally entire ..... subsp. *pirinica* Assenov in Jordanov, Fl. Reipubl. Popularis Bulgaricae 4 (1970) 474, 707; *A. intermedia* p.p., auct. bulg. non Heldr. & Orph. ex Boiss., Diagn. Pl. Or. Nov. ser. 2, 3(1) (1853) 36; *A. intermedia* var. *macedonica* auct. bulg. non Adam., Denschr. Acad. Wiss. Math.-Nat. Kl. (Wien) 74 (1904) 125.

<sup>1</sup> In the *Flora Bulgarica* and its Supplementum I (Velenovský 1891, 1898) there is no data on *Aubrieta*.

**Holotypus:** *A. columnnae* subsp. *pirinica* Assenov. Mt Slavyanka, in saxosis calcareis ad loco "Dolat" supra pag. Paril, 1300 m, 24.05.1934, leg. B. Achtarov, sub *A. intermedia* var. *macedonica* Adam. (SOM 32757!).

**Chromosome number.**  $2n = 16$  (Ančev 1978; Ančev & Hardalova 1989).

**Distribution.** Pirin Mts and Mt Slavyanka, from 1200 up to about 1800 m a.s.l. (Fig. 1).

2\* Petals 18–25 mm long; fruits (12) 14–25 mm; leaves with 1 (2) teeth on each side . . . subsp. *bulgarica* Ančev, Phytol. Balcan. 13(2) (2007) 160; *A. intermedia* p.p., auct. bulg. non Heldr. & Orph. ex Boiss., l.c.; Assenov in Jordanov, Fl. Reipubl. Popularis Bulgariae 4 (1970) 474.

**Holotypus:** In fisuris rupium calcarearum ad pagum Belovo (Zemen), Kyustendil District, 15.04.1907, leg. I. Urumov as *A. intermedia* Heldr. & Orph. ex Boiss. (SOM 32751!).

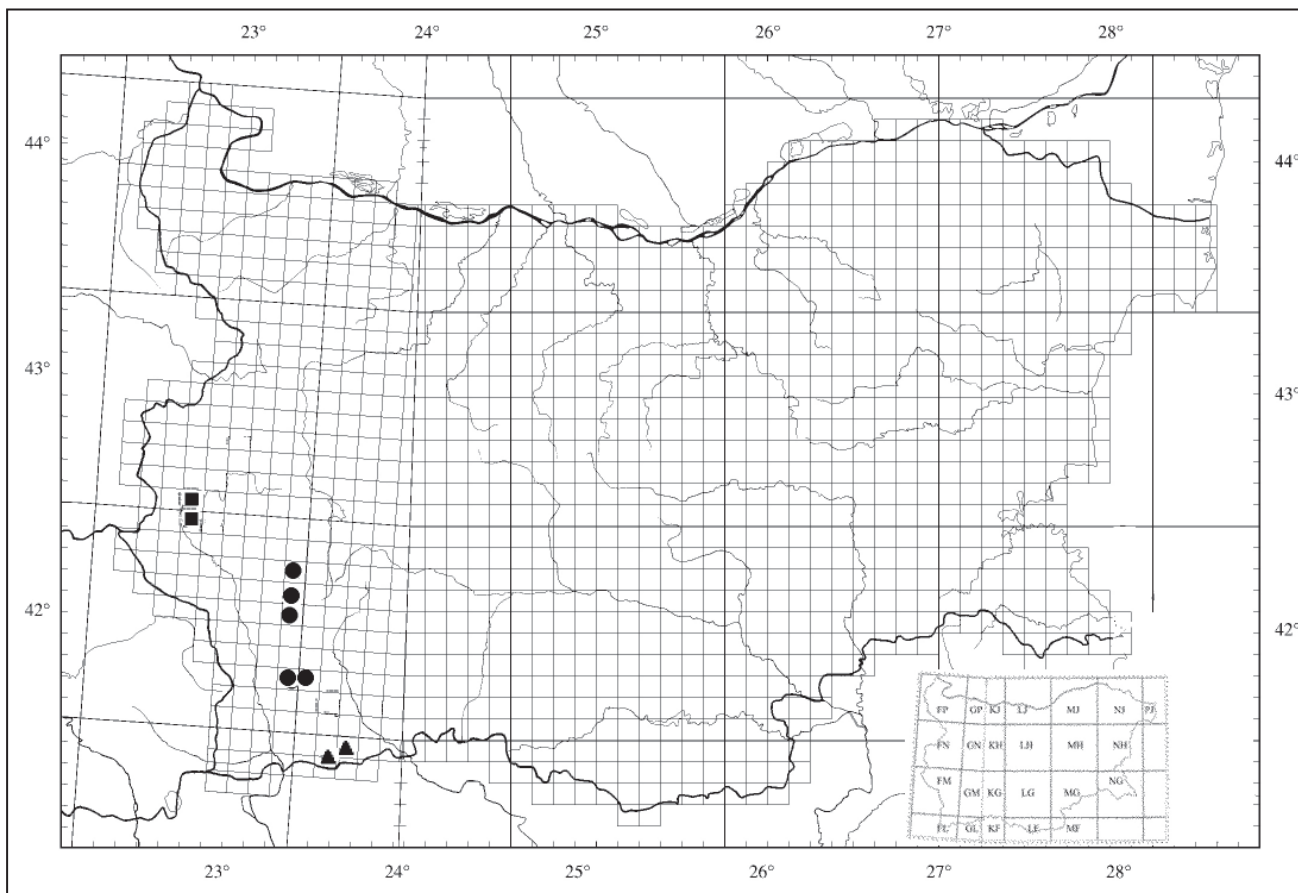
**Chromosome number.**  $2n = 16$  (Ančev & Hardalova 1978, as *A. intermedia*).

**Distribution.** Valley of Struma River (North): Mt Konyavska, Mt Zemenska, from 600 to 1000 m a.s.l.,

often together with *Erysimum comatum*, *Scutellaria orientalis*, *Micromeria cristata*, *Stipa pennata*, *Asplenium rutamuraria*, *Campanula versicolor*, etc. (Fig. 1).

### Taxonomic notes

Urumov (1911) was the first to report plants of *Aubrieta* in the Valley of River Struma, at Belovo (= Zemen), which he determined as *A. deltoidea*. The species was accompanied with a short morphological description. Subsequently, from the same region he reported *A. intermedia* (Urumov 1912: 2; 1913: 22). Stojanov & Stefanov (1922) had mentioned "*A. intermedia*" for Pirin, along with other high-mountainous calciphylous species, probably instead of *A. gracilis*. Subsequently, Urumov (1923: 113) also reported "*A. intermedia*" from that region, while Stojanov (1924: 129) reported it for Mt Slavyanka. Data on the distribution of *A. intermedia* were summarised in the first edition of *Flora Bulgariae* (Stojanov & Stefanov 1924: 514). Later Stojanoff (1926: 72) analysed the variability, chorology and possible relations of the Bulgarian populations referred so far to



**Fig. 1.** Distribution of *Aubrieta* in Bulgaria; ● – *A. gracilis* subsp. *scardica*; ■ – *A. columnnae* subsp. *bulgarica*; ▲ – *A. columnnae* subsp. *pirinica*.



"*A. intermedia*". He maintained that in their morphology the plants of "*A. intermedia*" distributed in the region of "Bulgarien und Ost Mazedonien vorkommende Pflanze, Z-B. die bei Kajali (leg. Th. Nikolov), Dedeli (leg. N. Stojanov), auf Konjava Planina (leg. I. Urumov, leg. N. Stojanov et B. Stefanov) und Ali-Botus (leg. N. Stojanov)" represented some transitional forms between *A. deltoidea* and *A. intermedia*. On the grounds of their variability N. Stojanov explained why these two taxa had been often analysed within the boundaries of one and the same species (*A. deltoidea* var. *deltoidea* and *A. deltoidea* var. *intermedia*). Irrespective of the fact that in this article the author directed the attention to the closeness of *A. intermedia* with *A. deltoidea*, the "*A. intermedia*" problem remained in the Bulgarian flora. *Aubrieta deltoidea* is a Balkan-Anatolian species, which differs in the indumentum of fruits from the other species in the genus distributed in the flora of the Balkan Peninsula. While in *A. deltoidea* the fruit indumentum consists of long-stalked and more or less appressed stellate trichomes, mixed with apparently longer, simple and forked bristles, in the other Balkan species the fruit indumentum is of stalked 3–4 armed trichomes, mixed with stellate ones (Phitos 1970: 74–82, Fig. 2). Owing to the close morphology and close geographical relations of these two taxa, Phitos (1970) accepted the combination *A. deltoidea* var. *intermedia* (Boiss.) Bald. Subsequently, Greuter & al. (1986), Akeroyd & Ball (1993) and Jalas & Suominen (1994) referred *A. intermedia* to the synonymy of *A. deltoidea*.



Fig. 2. *Aubrieta gracilis* subsp. *scardica* (photo P. Buckle).

The populations distributed in the oak belt of the lower mountains in the northern River Struma Valley, connected earlier to "*A. intermedia*", in the form and size of the leaves, morphology of the leaf margins and indumentum of the fruits are referred to *A. columnae*. Being morphologically well differentiated from *A. columnae* subsp. *pirinica*, they were set apart into an independent subspecies: *A. columnae* subsp. *bulgarica* (Ančev 2007).

### Reproductive biology

Both subspecies *A. columnae* subsp. *pirinica* and *A. columnae* subsp. *bulgarica* are entomophylous plants, with functionally protogynous flowers, visited by bees from the family *Andrenidae* and syrphid flies. In addition to sexual reproduction by seeds, the plants reproduce by underground rhizomes. They form small patchy colonies of loose cushions.

### Examined specimens

#### *A. columnae* subsp. *pirinica*

**Mt Slavyanka** (Ali-Botush): Dola above Paril, on rocks, 23.06.1923, coll. & det. N. Stojanov, as *A. intermedia* (SOA 4354); In saxosis calcareis ad Dolat, supra pagum Paril, 1300 m, 24.05.1934, coll. & det. B. Achtarov as *A. intermedia* var. *macedonica* (SOM 32758); 1300 m, 02.05.1930, coll. & det. A. Dryanovski, as *A. intermedia* var. *macedonica* (SOM 32752); – 1000–1300 m, 26.V.1930, A. Dryanovski, as *A. intermedia* var. *macedonica* (SOM 32759); Dola above Paril, 1100 m, 29.05.1930, coll. & det. A. Dryanovski, as *A. intermedia* var. *macedonica* (SOM 32761); Leten Post, 1500 m, 13.06.1933, coll. & det. A. Dryanovski, as *A. intermedia* var. *macedonica* (SOM 32765 & 32766); Ali-Botush, 1000 m, 07.1930, coll. & det. A. Dryanovski, as *A. intermedia* (SOM 32767); Parilski Dol, on calcareous rocks, 25.06.1969, coll. & det. V. Velchev & P. Vasiliev (SOM 154550); west of Nova Lovcha village, peak Tsatsyuvu Mandrishte, on calcareous rocks, 1000 m, 30.05.1992, coll. & det. I. Pashaliev (SOM 151501); Ambar-Dere, Ca, 27.08.1977, coll. & det. M. Anchev (SOM 2592)\*; Parilski Dol, 30.05.2004, coll. & det. D. Pavlova (SO 103590); Ambar-Dere, 1400 m, 05.07.1980, coll. & det. B. Kitanov (SO 93341);

**Pirin Mts (South)**: at the crossroads near Musalitsa village, on rocks, 28.05.1930, coll. & det. A. Dryanovski, as *A. intermedia* var. *macedonica* (SOM 32760); on calcareous rocks above Musalitsa village, 850 m, 08.06.1988, coll. & det. D. Stoyanov (SO 94091); peak Lyaskovski, Ca, 1350 m, 08.05. 1941, coll. & det. B. Kitanov (SO 93341).

**A. columnae** subsp. **bulgarica**

**Valley of Struma River:** in fissuris rupium calcarearum ad pagum Belovo [= Zemen], Kyustendil District, 12.04.1909, coll. & det. *I. Urumov*, as *A. intermedia* (SOM 32745); ad pagum Belovo, 15.04.1910, coll. & det. *I. Urumov*, as *A. intermedia* (SO 83238; SOM 32747 & 32749); ad Belovo, 1910, coll. & det. *I. Urumov*, as *A. deltoidea* (SOM 32768); Mt Konyavska, on limestone rocks near Choklyovo village, 29.05.1921, coll. & det. *N. Stojanov* as *A. intermedia*; ad rupibus calcareis supra Gara Zemen, 14.05.1932, coll. & det. *B. Achtarov*, as *A. intermedia* var. *eu-intermedia* (SOM 32756); in saxosis calcareis Mt Risha, inter Zemen et Razhdavitsa, ca. 1000 m, 14.04.1934, coll. & det. *N. Stojanov*, as *A. intermedia* (SOA 13669); Mt Zemenska, on rocky slopes near Polska Skakavitsa railway station, 19.08.1977, coll. & det. *M. Anchev* (SOM 2590)\*; north of Polska Skakavitsa railway station, on limestone rocks, 03.06.1992, coll. & det. *M. Anchev* (SOM 153896).

**A. columnae** subsp. **columnae**

**Italy.** Ad rupes montis Morrone in Aprutio, 2300 m, Jun. 1888 (WU).

**2. A. gracilis** Spruner ex Boiss., Diagn. Pl. Or. Nov. ser. 1, 1 (1843) 74; Assenov, Fl. Reipubl. Popularis Bulgariae 4 (1970) 477; Akeroyd & Ball, Fl. Eur. ed. 2, 1 (1993) 357; Anchev, Phytol. Balcan. 13(2) (2007) 161.

Caespitose plant with aboveground runners, forming lax to dense cushions. Flowering stems slender, 3-8(10) cm, with (2) 3-6 flowers. Leaves linear, linear-lanceolate to oblong-obovate, entire or with 1-2 teeth on each side. Petals 7-16(18) mm long, purple, violet, seldom almost white. Fruits 20-28(35) mm long, 2-4 mm wide, strongly compressed, mature valves reticulate-veined; indumentum with simple stellate and branched short-stalked, 3 to 4-armed trichomes; style 4-6(7) mm long. *Flowering:* early July to mid-August.

**Distribution in Bulgaria.** Pirin Mts (*North*) and Rila Mts, from 1900 m up to 2500 m a.s.l.

**Habitats.** On open mountainous stony and rocky slopes and grasslands, preferably with south-facing exposition, from the upper part of the coniferous belt and up to the alpine vegetation belt, on shallow and eroded humus-carbonate soils, on limestone, seldom on granite substrate, often together with *Thlaspi belidifolium*, *Campanula cochlearifolia*, *Androsace villosa*, *Alyssum pirinicum*, *Iberis saxatilis* subsp. *longistyla*, *Arabis ferdinandi-coburgii*, etc.

**General distribution.** Balkan Peninsula (Albania, SW Bulgaria, Greece, R Macedonia).

**A. gracilis** subsp. **gracilis**

Leaves linear to lanceolate, 3.5-7.5 times as long as broad, entire.

**General distribution.** Greece (Sterea Ellas, S. Pindos) (Phitos 2002).

**A. gracilis** subsp. **scardica** (Wettst.) Phitos, Candollea 25 (1970) 84; *A. croatica* var. *scardica* Wettst., Biblioth. Bot. 26 (1892) 21; *A. scardica* (Wettst.) Gustavsson, Mount. Fl. Greece, 1 (1986) 271; *A. intermedia* var. *pirinica* Stoj., Izv. Bulg. Bot. Druzh. 1 (1926) 72; *A. gracilis* var. *pirinica* Stoj. & Acht., Izv. Tsarsk. Prir. Inst. Sofia 12 (1939) 184; Stoj. & Stef., Fl. Bulg. ed. 3 (1948) 516, sub "*pirinensis*"; *A. gracilis* f. "*pirinensis*" (Stoj. & Acht.) Stoj., Stef. & Kitan., Fl. Bulg. ed. 4, 1 (1966) 475, comb. inval.<sup>2</sup>

**Lectotypus.** *Aubrieta croatica* var. *scardica* Wettst., Scardus [Šar Planina], in cacumine montis Ljubatrin, 15.08.1890, leg. *J. Doerfler* s.n.; det. *R. v. Wettstein* (B !).

**Lectotypus** (hic designatus). *Aubrieta gracilis* var. *pirinica* Stoj. & Acht. In glareosis marmoreis Mt Pirin ad Malkia Valog, sub Eltepe, ca 2300 m, 12.08.1938, coll. *B. Achtarov*, det. *N. Stoyanov* & *B. Achtarov* as *A. gracilis* var. *pirinensis* (SOM 32769).

Leaves broadly lanceolate to oblong-obovate, 2-3(4) times as long as broad, with 1-2 teeth on each side, occasionally entire (Fig. 2).

**Distribution in Bulgaria.** N Pirin Mts (Vihren divide area) and Rila Mts (Zlite Pototsi locality at the foot of peak Dvuglav, Chatal-Tepe, peak Tsarev and peak Mussov) (Fig. 1).

**General distribution.** Balkan Peninsula (Albania, SW Bulgaria, N & C Greece, R Macedonia, Kosovo).

**Taxonomic notes**

*Aubrieta gracilis* is a Balkan endemic with three subspecies: *A. gracilis* subsp. *gracilis* distributed in the mountains of Central Greece; *A. gracilis* subsp. *glabrescens* (Turrill) Akeroyd, a local endemic characteristic of the serpentinites in Northwestern Greece (Mt Smo-

<sup>2</sup> The misuse of the name "*A. gracilis* var. *pirinensis* Stoj. & Acht.", instead of *A. gracilis* var. *pirinica* Stoj. & Acht., as it is in the protologue of the taxon, was probably not an orthographical error, but rather an attempt to avoid any confusion with the earlier described *A. intermedia* var. *pirinica* Stoj..

likas), and *A. gracilis* subsp. *scardica* distributed in the mountains of N Albania, N & C Greece (Sterea Elas, Pindos and Olimbos), R Macedonia, Kosovo and Bulgaria (Phitos 1970, 2002; Gustavsson 1986; Akeroyd & Ball 1993; Jalas & Suominen 1994; Ančev 2007).

*Aubrieta gracilis* subsp. *scardica* was probably reported for the first time for Bulgaria by Urumov (1911: 65, as *A. gracilis*). A year later Urumov (1912) reported *A. alpina* for "Pirin, 2000 m a.s.l., on calcareous rocks (SOM 32772)". The herbarium material was revised by N. Stojanov and referred to *A. gracilis*. Probably on the basis of these data of I. Urumov, Stojanov & Stefanoff (1924) reported *A. gracilis* for the Pirin Mts. Subsequently, Stojanov (1926) rejected this distribution of *A. gracilis* in the alpine belt of Pirin Mt. He maintained that *A. gracilis* is "...nur eine alpine Rasse...(var. *pirinica*)" of *A. intermedia*. The type specimen of *A. intermedia* var. *pirinica* Stoj. was not found in the Bulgarian herbaria. The morphological description of the leaves and the mentioned distribution presume that the author of "*A. intermedia* var. *pirinica*" had had in mind plants referred subsequently to *A. gracilis* (cf. Stojanov & Stefanov 1933; Stojanov & Achtarov 1939).

In the subsequent editions of *Flora of Bulgaria*, *A. intermedia* var. *pirinica* Stoj. was retained, and disregarding the statement that "*A. intermedia* var. *pirinica*" was described from the Northern Pirin Mts as "**eine alpine Rasse**" (Stojanov 1926: 73), this taxon had been connected further on to a domain of forms of *A. columnae* subsp. *pirinica* Assenov, distributed in the zone of the beech and coniferous belts of Pirin Mts, and Mt Slavyanka (cf. Assenov 1970). In the second edition of *Flora of Bulgaria* (Stojanov & Stefanoff 1933), *A. gracilis* was reported again for "calcareous rocks in the alpine belt of the Pirin Mts", along with *A. intermedia* var. *pirinica* Stoj.

Studying the Pirin populations of *A. gracilis*, on the basis of the morphology of leaf margins, Stojanoff & Achtaroff (1939) distinguished *A. gracilis* var. *pirinica* Stoj. & Ach., where the leaf margins usually have 1–2 pairs of teeth, contrary to the typical variety where the leaves are entire. The lack of morphological differences between the plants occurring in the alpine belt of N Pirin Mts and the type specimen of *A. gracilis* subsp. *scardica* (Wettst.) Phitos (*A. croatica* var. *scardica* Wettst.) are the reason to accept its distribution in Bulgaria. *Aubrieta gracilis* var. *pirinica* Stoj. & Ach. is treated in its syn-

onymy. The plants studied karyologically in N Pirin Mts were diploid ( $2n = 16$ ). Gustavsson (1986: 271) reported for "*A. scardica* (Wettst.) Gustavsson" polyploid chromosome number ( $2n = 32$ ) for plants from few different localities. The only finding of chromosome number  $2n = 16$  reported for *A. gracilis* subsp. *scardica* from Greece (Phitos 1970) according to Gustavsson (l.c.) "applies to *A. glabrescens*". Although the interspecific polyploidy is not a rare case in the perennial plants (cf. Ančev 2006 and Marhold & Lihova 2006, for *Brassicaceae*), the problem deserves attention in future studies on the genus *Aubrieta* in the Balkan Peninsula.

### Reproductive biology

*Aubrieta gracilis* subsp. *scardica* is an entomophilous plant, with functionally protogynous flowers, visited by bees and syrphid flies. The plants reproduce by seeds and underground rhizomes, forming small colonies of lax to dense cushions.

### Examined specimens

#### *A. gracilis* subsp. *scardica*

##### Bulgaria

**Pirin Mts (North):** 18.07.1909, coll. & det. I. Urumov as *A. alpina* et rev. N. Stojanov as *A. gracilis* (SOM 32772); in saxosis umbrosis supra riv. Banderitsa, 2250 m, 22.07.1915, coll. & det. B. Davidoff as *A. gracilis* (SOM 102740); El-Tepe (Vihren), 12.08.1915, coll. T. Nikolov, det. N. Stojanov as *A. gracilis* (SOA 4352); El-Tepe, granite, coll. & det. N. Stojanov & B. Stefanov, 08.1921 as *A. gracilis* (SOA 4653); in saxosis alpinis Mt Pirin, 19.07.1915, coll. & det. I. Urumov as *A. intermedia* (SOM 32771); on the rocks of peak El-Tepe (Vihren), 15.07.1926, coll. & det. D. Jordanov as *A. intermedia* (SO 28736); in glareosis marmoreis Mt Pirin ad Malkia Valog, sub Eltepe, ca 2300 m, 12.08.1938, coll. B. Achtarov, det. N. Stojanov & B. Achtarov as *A. gracilis* var. *pirinensis* (SOM 32769); east of Kazana, 14.07.1972, coll. & det. B. Kuzmanov as *A. gracilis* (SOM 127930); meadows along the path to Vihren, 2300 m, 13.08.1975, coll. & det. M. Ančev (SOM 2591)\*; Kazana, 26.07.1980, coll. & det. B. Kuzmanov, as *A. columnae* subsp. *Pirinica* (SOM 145113, 146451); along the path to Vihren chalet – Kazana, 19.08.1987, coll. & det. R. Hardalova as *A. gracilis* (SOM 150318); between Golyam Kazan and Premkata locality, 2400 m, 22.07.1991, coll. & det. E. Kozhuharova; Dalbokoto Dere, 2200 m, coll.



& det. *M. Anchev*, A9655, 12.07.1996; between the Vihren chalet and loc. Dzhamdzhievi Skali, 2210 m, 21.07.2004, coll. & det. *V. Goranova* (SOM 160602); on limestone rocks above the circus Golyam Kazan, 12.07.1985, coll. & det. *D. Stoyanov* (SO 92867).

**Rila Mts:** peaks Chatal-Tepe, Tsarev and Mussov, 2100 m, 02.09.1930, coll. & det. *N. Fenenko*, as *A. gracilis* (SOM 32770); loc. Zlite Pototsi above Kirilova Polyana, at the foot of peak Dvuglav, 2500 m, 18.04.1994, coll. & det. *Denchev, Dimitrov & Sharkova*, as *A. gracilis* (SO 92867; SOM 32770).

**Greece.** Nomos Ioanninon, Ep. Konitsis: mons Smolikas, in rupestribus alpinis, 23.06.1961, coll. & det. *D. Phitos* (Herb. D. Phitos & G. Kamari, UPA ).

***A. deltoidea*** (L.) DC., Reg. Veg. Syst. Nat. 2 (1821) 294.

A caespitose plant forming lax to dense cushions or mats. Flowering stems with not many flowers. Leaves linear-spatulate to obovate-cuneate or rhombic, entire or with 1–3 teeth on each side. Petals 12–28 mm long, reddish-purple to violet, seldom white. Fruits (6)7–16(23) mm long, 1.8–3.5(4.8) mm wide, slightly compressed, not or slightly reticulate-veined; indumentum of long, simple and/or long-stalked, forked or branched bristles and more or less appressed stellate hairs; style 4–12 mm long.

**Distribution in Bulgaria.** The species is an ornamental plant cultivated mostly in parks and alpine gardens.

**General distribution.** S Europe (Balkan Peninsula: Greece, ?R Macedonia and ?Serbia, Sicilia; SW Asia (W Anatolia).

#### Examined specimens

**Greece.** Insula Thassos: pr. pagum Theologos, 250 m, 13.04.1942, coll. & det. *N. Stojanov* (SO 28724); Ipsarion, 03.06.1942, coll. & det. B. Kitanov (SO 28722); Mt Trapez., 17.05.1891, coll. & det. *E. v. Halácsy* (SO 28717); Chaliki, Mt Ghavelu, 10.08.1896, coll. & det. *Hausknecht* (SO 28721); in saxosis calcareis Mt Parnes Atticae, ca. 1200–1400 m 16.07.1937, coll. & det. *N. Stojanov & D. Jordanov* (SO 28716); Arcadia Peloponesos: in rupibus calcareis Mt Kastro, ut Cheimos, 750 m, 15.06.1893, coll. & det. *E. Halácsy* (W 2513); *A. deltoidea* var. *deltoidea*. Ins. Kephallinia, mons Aenos, ad cacumen 1550 m, 29.05.1967, coll. & det. *D. Phitos* (SOM 130676); Sterea Ellas, nom. Evritanias, mons Kaliakouda, 1750–1950 m, in saxosis calcareis, 26.06.1994, coll. & det. *D. Phitos & al.* (SOM 156189).

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