

TAXONOMIC ASSESSMENT AND REARRANGEMENT OF ENDEMIC *JASIONE SUPINA*-COMPLEX FROM TURKEY

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Abstract

Jasione supina (Campanulaceae) is a Turkish endemic and a variable species represented by 4 subspecies in the Flora of Turkey (*J. supina* subsp. *pontica*, subsp. *akmanii*, subsp. *supina* and subsp. *tmolea*). The morphological and anatomical characteristics of these taxa and their distribution area have been identified. Morphological characteristics of *J. supina* taxa such as involucre bracts, calyx and leaves have been compared with morphological characteristics given in Flora of Turkey. In consideration of collected morphological data, the description related to the Flora of Turkey has been updated and revised within the study. Besides, a new identification key has been created by correcting the existing mistakes in the earlier identification key of *J. supina* taxa. There has been found a high similarity between *J. supina* subsp. *supina* and *J. supina* subsp. *akmanii* in terms of morphological, anatomical and ecological characteristics. Also *J. supina* subsp. *pontica* individuals have been collected from the distribution area of *J. supina* subsp. *akmanii* (the peak of Mountain Koroğlu /Bolu and the peak of Mountain Murat/Kütahya). By considering the findings of the study, it is recommended that these two subspecies should be classified as a variety (*J. supina* subsp. *pontica* (Boiss.) Damboldt var *pontica* stat. nov. and *J. supina* subsp. *pontica* (Boiss.) Damboldt var *akmanii* (Damboldt) Sezer stat. nov.).

Key words: *Jasione supina*, Campanulaceae, morphology, anatomy, endemic, flora, Turkey

Introduction

Campanulaceae L. has by 84 genera and about 2.400 species distributed in 5 subfamilies. The name of the family based on the largest genus *Campanula* L. of the family (Lammers, 2007). The Campanulaceae family is represented through *Asyneuma* Griseb. & Schenk, *Campanula* L., *Jasione* L., *Legousia* Durande, *Michauxia* L'Hér., *Sachokiella* Kolak., *Solenopsis* C.Presl and *Theodorovia* Kolak. ex Ogan. in the Flora of Turkey. Among these genera, the richest one in terms of the number of taxa is *Campanula* which contains 139 taxa, of which 73 is endemic. The genus *Campanula* is followed by *Asyneuma* (31 spp.), *Jasione* (7 spp.), *Michauxia* (5 spp.), *Legousia* (4 spp.), *Sachokiella* (1 sp.), *Solenopsis* (1 sp.), and *Theodorovia* (1 sp.) in terms of the number of taxa. When these genera are ranked with regard to the percentage of endemism, *Jasione* comes first with a percentage of 71.4 (5 taxa) and is followed by *Asyneuma* with 67.7% (21 taxa) and *Campanula* with 52.5% (73 taxa). The species of *Sachokiella*, *Solenopsis*, and *Theodorovia* does not endemic (Güner *et al.*, 2012; Dülgeroğlu, 2019).

The Campanulaceae family is represented in different forms by different researchers in the past. De Candolle (1830) separated the family into two subtribes as Campanulae and Wahlenbergeae by considering the way of splitting of capsules as apical or lateral. Then, Schönland (1889-1894) splitted the Campanulaceae into three subtribes as Campanulinae, Wahlenberginae, and Platycodinae according to flower symmetry and splitting of capsules. *Jasione* was placed in Wahlenbergeae subtribe within the first system and in Wahlenberginae subtribe within the second system. While researchers like Fedorov (1957) has accepted *Jasioneae* as a separate tribe, recent classifications carried out through ITS and trnL-F datasets indicate that *Jasione* occupies a place somewhere between Wahlenbergioids and Campanuloids (Eddie, 1997; Eddie *et al.*, 2003).

Jasione genus is represented by 16 species, worldwide distribution from sea levels to Alpine regions upto 3.500 metres in Europe, Northwest Africa, and northern and western Turkey. Actually, taxa belonging to *Jasione* could be divided in two groups in terms of their distribution area. Those in the first taxa group has higher ecological tolerance and occupy large distribution area. Plants of this group are quite polymorphic and have large number of ecological variants. On the contrary, the *Jasione* taxa in the second group has a very limited distribution area compared to those on the first group and have rather lower polymorphism. These plants have very limited morphological variations, as well (Sales & Hedge, 2001).

The centre of diversity of *Jasione* genus is Iberian Peninsula to having the largest number of species with 10 species of *Jasione* occupying here (Bokhari & Sales, 2001; Sales & Hedge, 2001). As for the Flora of Turkey, there are seven *Jasione* taxa (4 species and 3 sub-species). 5 of these seven taxa are endemic to Turkey and 4 of these five taxa are subspecies *Jasione supina* Sieber ex Spreng. (*J. supina* subsp. *pontica* (Boiss.) Damboldt, *J. supina* subsp. *akmanii* Damboldt, *J. supina* subsp. *supina* and *J. supina* subsp. *tmolea* (Stoj.) Damboldt) (Güner *et al.*, 2012). There are so few references on the classification of endemic *Jasione* taxa apart from the Flora of Turkey (Stojanov, 1926; Parnell, 1987; Sales *et al.*, 2004; Pérez-Espona *et al.*, 2005; Eroğlu, 2011, 2016; Çelemlı, 2019). Almost the whole literature is related to floristic studies of these taxa (Çırpıcı, 1988; Acar, 1997; Uzun Palabaş & Anşın, 2006; Uysal, 2007; Daşkın & Kaynak, 2010, 2011; Şenel *et al.*, 2014; Özkan, 2016; Hüseyinoğlu *et al.*, 2017).

When the flora of Turkey is examined, it is observed that traditional classification was used based on morphological characters for grouping *Jasione* taxa. The most important morphological characters for grouping subspecies of *Jasione supina* are calyx lobes and involucre bracts. However, except these characters, there are no distinctive character subspecies.

The fact is that the species having high level of polymorphism lack clear distinguishing characters thus creating some doubts about whether the characters used for the distinction of *J. supina* subspecies are stable characters or simply variation only. The objective of the present study is to find the morphological and anatomic characters of *J. supina* subspecies. Besides, during the field works, it was found that some characters are used for the distinction of these taxa in the Flora of Turkey at the subspecies level are not stable and exhibited continuous variation.

Materials and Methods

The specimens of *Jasione supina* taxa were collected from type localities in 2019. In order to ensure a systematic study of the material, herbarium samples were prepared and kept as voucher specimens at the Eskişehir Osmangazi University Herbarium (OUFE).

For the anatomical studies, fresh plant specimens collected from type localities were fixed in 70% alcohol. Transverse sections of the stem and root were taken by hand and scalpel. The photograph dimensions of the anatomical sections were 100 µm. Morphological characteristics of *J. supina* taxa were studied through Leica EZ-40 stereomicroscope from fresh plant and herbarium specimens housed in ANK and OUFE. To study the variation range of morphologic characters, 25 plant specimens collected from different points of type populations were investigated and compared with a number of studies (Garjeanne, 1953, Damboldt, 1978, Esau, 1967, Fahn, 1967, Yentür, 1995, Güner *et al.*, 2000, Bohkari & Sales, 2001).

Specimens examined

***Jasione supina* subsp. *pontica* var. *pontica*:** Turkey A3 Bolu: Kartalkaya, ca. 2100 m, 23 July 2019, *O. Sezer*, O.S. 1970 (OUFE); Turkey B2 Kütahya: Mountain Murat, ca. 2000-2100 m, 17 July 2019, *O. Sezer*, O.S. 1925 (OUFE); Turkey A7 Trabzon: Selboğazi plateau road, 2100 m, 07 July 2019, *O. Sezer*, O.S. 1817; Turkey A4 Kastamonu: Mountain Ilgaz, Küçük Hacet Hill, ca. 2000-2500 m, 15 September 1982, *O. Ketenoglu*, *Y. Akman* and *E. Yurdakulol*, (ANK-12608); Turkey A4 Kastamonu: Mountain Ilgaz, Büyük Hacet Hill, with *Thymus praecox* community, ca. 2400-2690 m, 14 September 1982, *O. Ketenoglu*, *Y. Akman* and *E. Yurdakulol*, (ANK-12607); Turkey A4 Kastamonu: Mountain Ilgaz, Büyük Hacet Hill, Open areas of *Juniperus nana*, wet meadows, ca. 2000 m, 27 July 1982, *Y. Akman*, *E. Yurdakulol* and *M. Demirörs*, (ANK-12228); Turkey A4 Kastamonu: Mountain Ilgaz, Büyük Hacet Hill, with *Festuca varia* communities, ca. 2300 m, 27 July 1982, *Y. Akman*, *E. Yurdakulol* and *M. Demirörs*, (ANK-12230); Turkey: Mountain Maden, 02 August 1933, *Balls and Gourlay*, (ANK-555); Turkey A4 Kastamonu: Tosya, Mountain Ilgaz, Alpine meadows, 23 July 1892, *Prof. C. Haussknecht*, 4771 (Herb. Muséum Paris-P00270581); Turkey A7 Trabzon: Maçka, Alpine pastures, 02 August 1889, *Dr. O. Stapf*, 1565 (Herb. Muséum Paris-P00270583).

***Jasione supina* subsp. *pontica* var. *akmanii*:** Turkey A3 Bolu: Kıbrısçık, Mountain Koroğlu, Alpine meadows, 1800-2200 m, 23 July 2019, *O. Sezer*, O.S. 1956, (OUFE); Turkey B2 Kütahya: Mountain Murat, ca. 2000-2100 m, 17 July 2019, *O. Sezer*, O.S. 1946 (OUFE); Turkey A4 Bolu: Peak of Mountain Koroğlu, Volcanic base rock, ca. 2000-2300 m, 24 August 1975, *P.H. Davis* and *Y. Akman*, (ISOTYPUS-ANK-3051).

***Jasione supina* subsp. *supina*:** Turkey A2 Bursa: Mount Olympus, By the roadside and in the open areas of *Abies nordmanniana* subsp. *bornmuelleriana* communities, 1950 m, 16 July 2019, *O. Sezer*, O.S. 1910, (OUFE); Turkey A2 Bursa: Mount Olympus, 28 August 1996, *M.G. Pimenov* and *E.V. Kljuykov*, N T96-357, (Herbarium Universitatis Mosquensis Plantae Turcicae); Turkey A2 Bursa: Mount Olympus, ca. 1750 m, 30 July 1945, *B. Kasapgil*, (ANK); Turkey A2 Bursa: Mountain Keşiş, ca. 2600 m, 17 August 1932, *W. Kotte*, (ANK); Turkey A2 Bursa: Mount Olympus, Open areas of *Pinus nigra*, ca. 1900 m, 10 August 1960, *P.H. Davis* and *K. Karamanoğlu*, (ANK-14836).

***Jasione supina* subsp. *tmolea*:** Turkey B2 İzmir: Bozdağ, By the roadside and in the open areas of *Juniperus communis* subsp. *saxatilis*, between 1600-2100 m, 09 August 2019, *O. Sezer*, O.S. 2042, (OUFE); Turkey B2 İzmir: Bozdağ, 1854, *Julliet*, (TYPUS-Herb. Goettingen-GOET005895); Turkey B2 İzmir: Bozdağ, West peak of Bozdağ, upper parts of Bozdağ plateau, 1854, *Julliet*, (SYNTYPUS-Herb. Muséum Paris-P00270578).

Results

Morphological characteristics: Examined morphological characteristics of *J. supina* taxa were compared with the description of Damboldt (1978). Some identic characteristics of these investigated taxa in type description were confirmed. Besides, some characteristics not mentioned in type description and earlier studies were given in here for the first time (Figs. 1-5 and Table 1).

Taxonomic treatment: According to the morphological investigations of infra specific taxa of *J. supina*, it was found that they were resemblances in terms of many characteristics (habit, stem, inflorescence, corolla, stamens, ovary, style, flowering, and fruiting). In spite of this, some differences were also recorded in terms of following characteristics:

subsp. *pontica* var. *pontica*; involucre bracts; ± ovate-lanceolate, acuminate to obtuse, dentate, slightly ciliate at base or not, glabrous or a little short hair on the inner side, glabrous at the outer side, calyx; lobes 1-1.7 × 0.2-0.6 mm, small, triangular-linear, acute, wholly violet or only at apex, basal leaves; oblong spatulate, ± obtuse, margins entire (not ciliate), (5)10-24 × 2.5-4 mm, cauline leaves; ovate-lanceolate, sessile, margins entire (not ciliate), 5-15(17) × 1-4 mm.

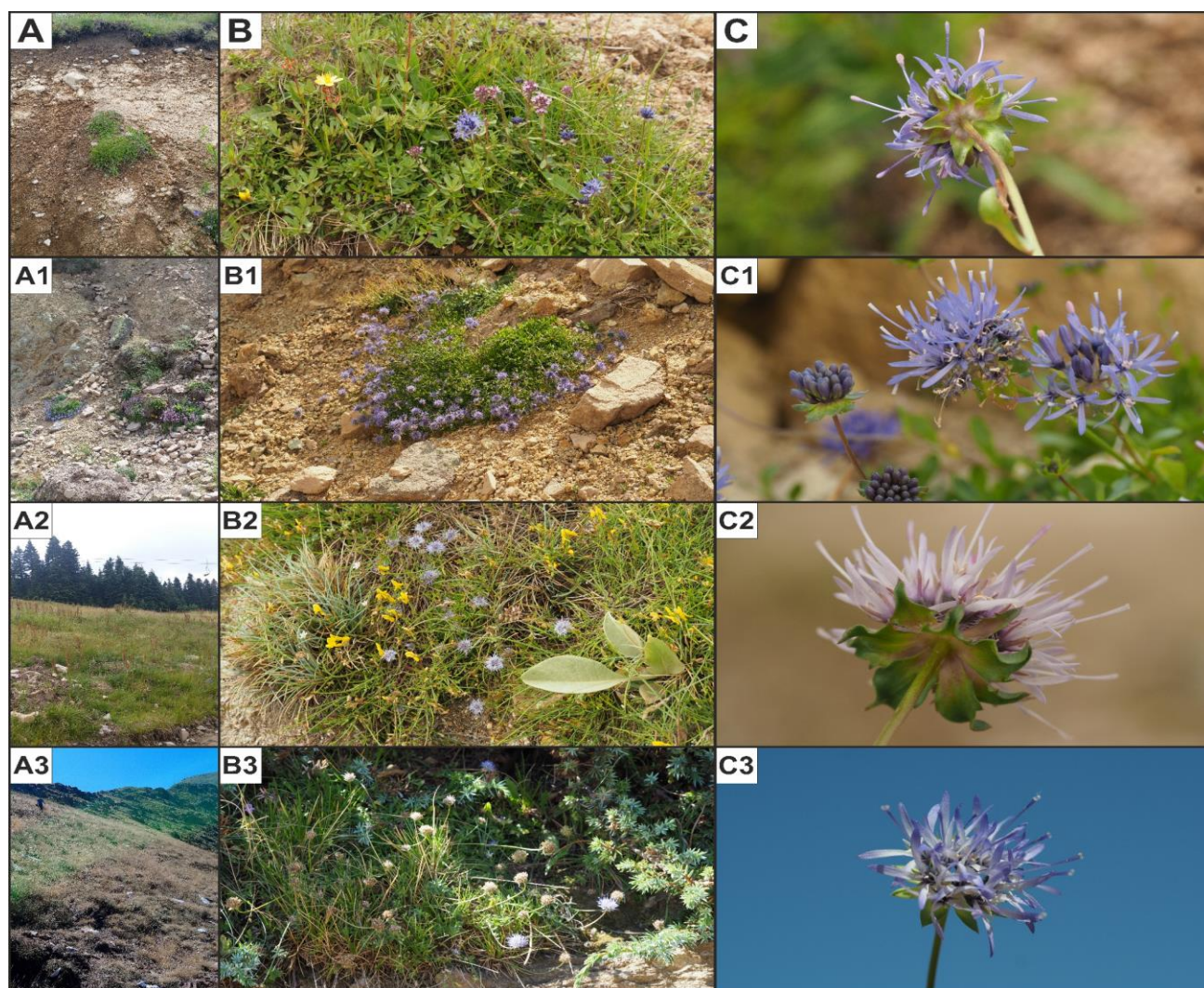


Fig. 1. *Jasione supina* taxa in its habitat (A, B, C: *J. supina* subsp. *pontica* var. *pontica*; A1, B1, C1: *J. supina* subsp. *pontica* var. *akmanii*; A2, B2, C2: *J. supina* subsp. *supina*; A3, B3, C3: *J. supina* subsp. *tmolea*).

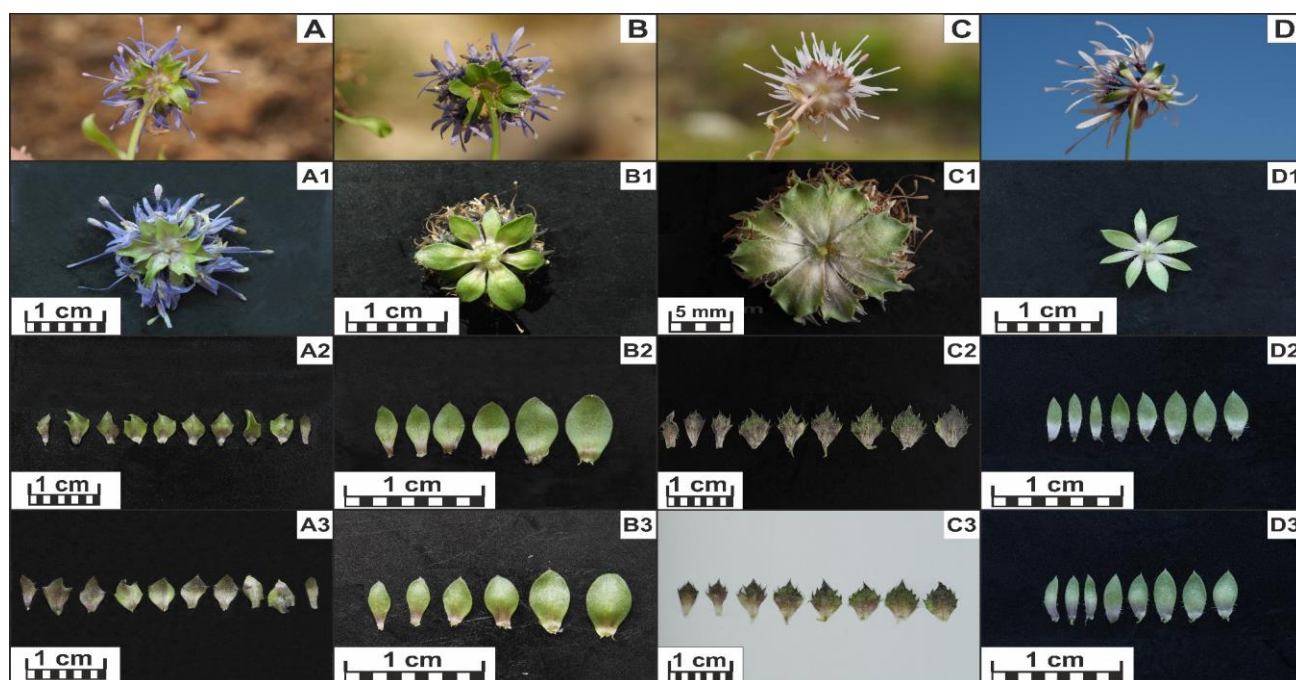


Fig. 2. Capitula (A-D; A1-D1) and bracts (A2-D2: Upper surface of bracts; A3-D3: Lower surface of bracts) of *Jasione supina* taxa (A-A3: *J. supina* subsp. *pontica* var. *pontica*; B-B3: *J. supina* subsp. *pontica* var. *akmanii*; C-C3: *J. supina* subsp. *supina*; D-D3: *J. supina* subsp. *tmolea*).

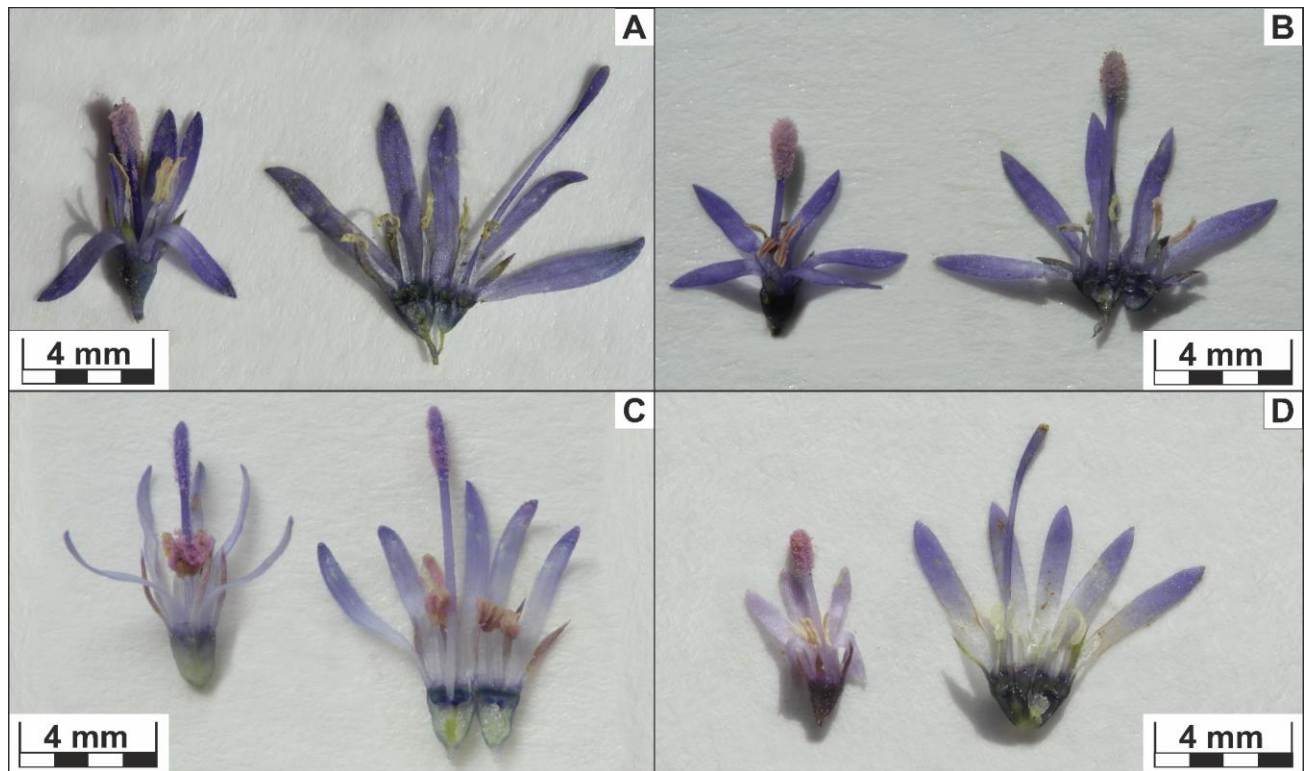


Fig. 3. Dissected flowers of *Jasione supina* taxa (A: *J. supina* subsp. *pontica* var. *pontica*; B: *J. supina* subsp. *pontica* var. *akmanii*; C: *J. supina* subsp. *supina*; D: *J. supina* subsp. *molea*).

subsp. *pontica* var. *akmanii*; all morphological characters of this taxa are similar to var. *pontica* except some morphological characters of involucre bracts. Involucral bracts of var. *akmanii* entire (dentate in var. *pontica*), not ciliate (sparsely ciliate at base or not in var. *pontica*), glabrous (glabrous on the inner side or with a little short hairs in var. *pontica*). In contrast to subsp. *supina* and subsp. *molea*, this taxon shows sympatric distribution with var. *pontica* (Fig. 9).

subsp. *supina*; involucre bracts; \pm ovate-lanceolate, acuminate to obtuse, outer involucre bracts usually broad, dentate margins, ciliate at the base, glabrous inner side, outer side sparsely bears simple hairs or glabrous. Calyx; lobes 2-3 \times 0.2-0.4 mm, ovate-lanceolate, pink to purple, basal leaves; oblong spatulate, \pm obtuse, ciliate at base, 10-20 \times 2.5-4 mm, cauline leaves; ovate-lanceolate, sessile, undulate, ciliate at base, 5-11 \times 1-2 mm.

subsp. *molea*; involucre bracts; \pm ovate-lanceolate, acuminate to obtuse, broader outer involucre bracts than inner ones, ovate-elliptic, entire margins, ciliate, sparse short hairs at inner side or glabrous, glabrous outer side. Calyx lobes 1.5-2.1 \times 0.2-0.4 mm, ovate-lanceolate, pink to green, basal leaves; oblong spatulate, \pm obtuse, ciliate at base, 10-24 \times (1)1.5-4 mm, cauline leaves; ovate-lanceolate, sessile, ciliate at base, 5-9 \times 1-2 mm.

***Jasione supina* Sieber ex Spreng. subsp. *pontica* (Boiss.) Damboldt var. *pontica*, Notes Roy. Bot. Gard. Edinburgh 35(1): 51 (1976)**

Synonyms: *Jasione supina* Sieber var. *pontica* Boiss., Fl. Or. 3:886 (1975)!; *Jasione pontica* (Boiss.) Hand.-Mazz.,

Ann. Nat. Hofmus. Wien xxiii. 192 (1909); *Jasione pontica* var. *microcephala* Freyn ex Stoj., Notizbl. Bot. Gart. Berlin-Dahlem 9: 551 1926.

Type: Turkey A7 Trabzon: in pascuis alpinis inter Tschayrlar (Çayirlar) et Alischeri Chan, 28 July 1859, Kotschy 208 (holo. G! iso. W!).

***Jasione supina* Sieber ex Spreng. subsp. *pontica* (Boiss.) Damboldt var. *akmanii* (Damboldt) Sezer stat. nov.**

Basionym: *Jasione supina* Sieber ex Spreng. subsp. *akmanii* Damboldt, Notes Roy. Bot. Gard. Edinburgh 35(1): 51 (1976).

Type: Turkey A4 Bolu: summit of Mountain Koroğlu, volcanic rock, 2000-2400 m, 24 August 1975, Akman 3051 (holo. E! iso. ANK).

***Jasione supina* Sieber ex Spreng. subsp. *supina*, Syst. Veg., ed. 16 [Sprengel] 1: 810 (1824)**

Synonyms: *Jasione orbiculata* Griseb., Spic. Fl. Rumel. 2(5/6): 293 (1846); *Jasione propullulans* Freyn, Verh. K.K. Zool.-Bot. Ges. Wien 38: 618 (1888); *Jasione supina* var. *hirtula* Stoj., Notizbl. Bot. Gart. Berlin-Dahlem 9: 554 (1926); *Phyteuma supinum* G. Don, Gen. Hist. 3: 749 (1834).

Neotype: Turkey A2 Bursa: Olympus Bithynus (Ulu Da.), 1837, Aucher 1881 (G! W!).

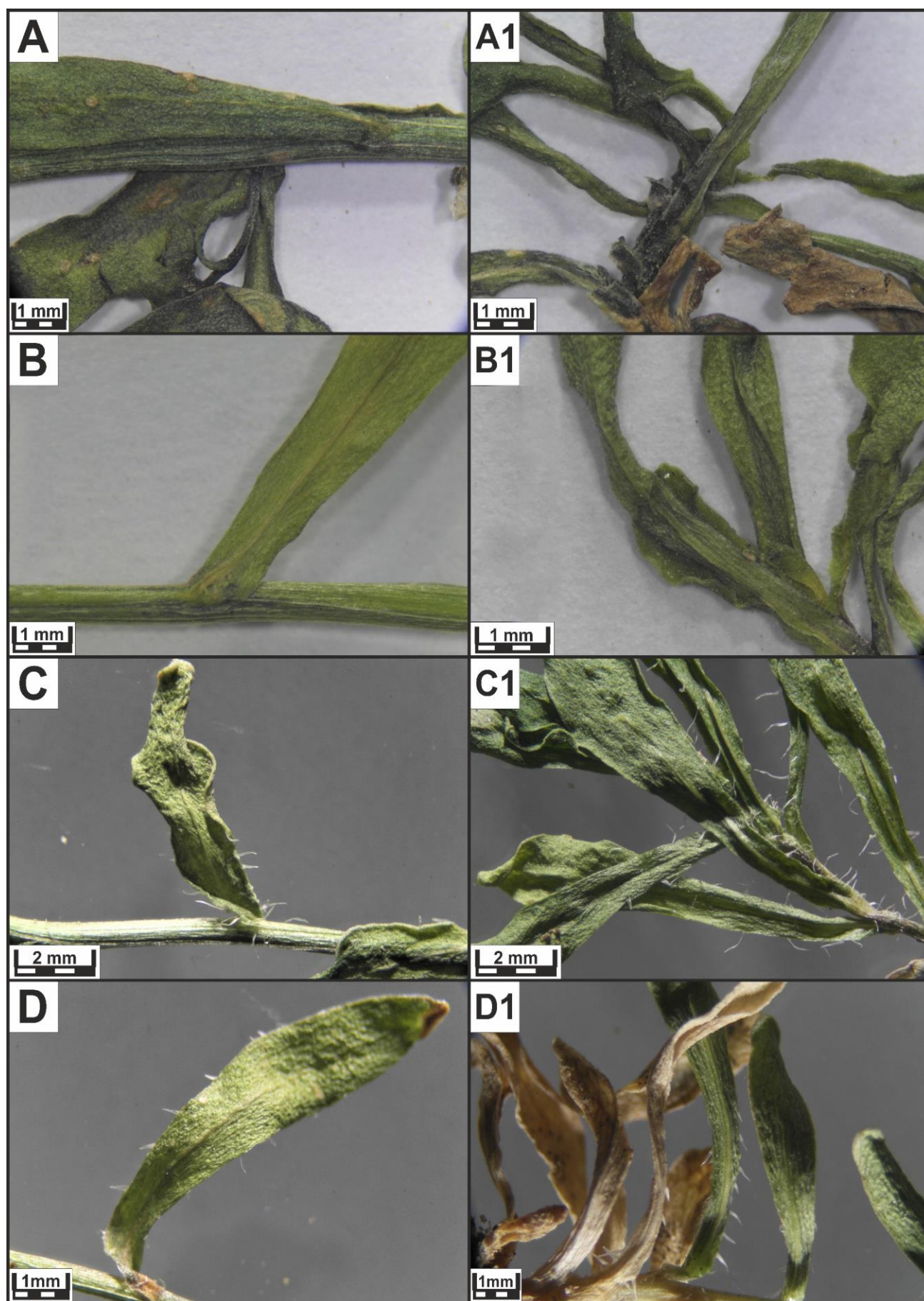


Fig. 4. Comparison of the cauline (A-D) and basal leaves (A1-D1) of *Jasion supina* taxa in terms of ciliate margin (A, A1: *J. supina* subsp. *pontica* var. *pontica*; B, B1: *J. supina* subsp. *pontica* var. *akmanii*; C, C1: *J. supina* subsp. *supina*; D, D1: *J. supina* subsp. *tmolea*).

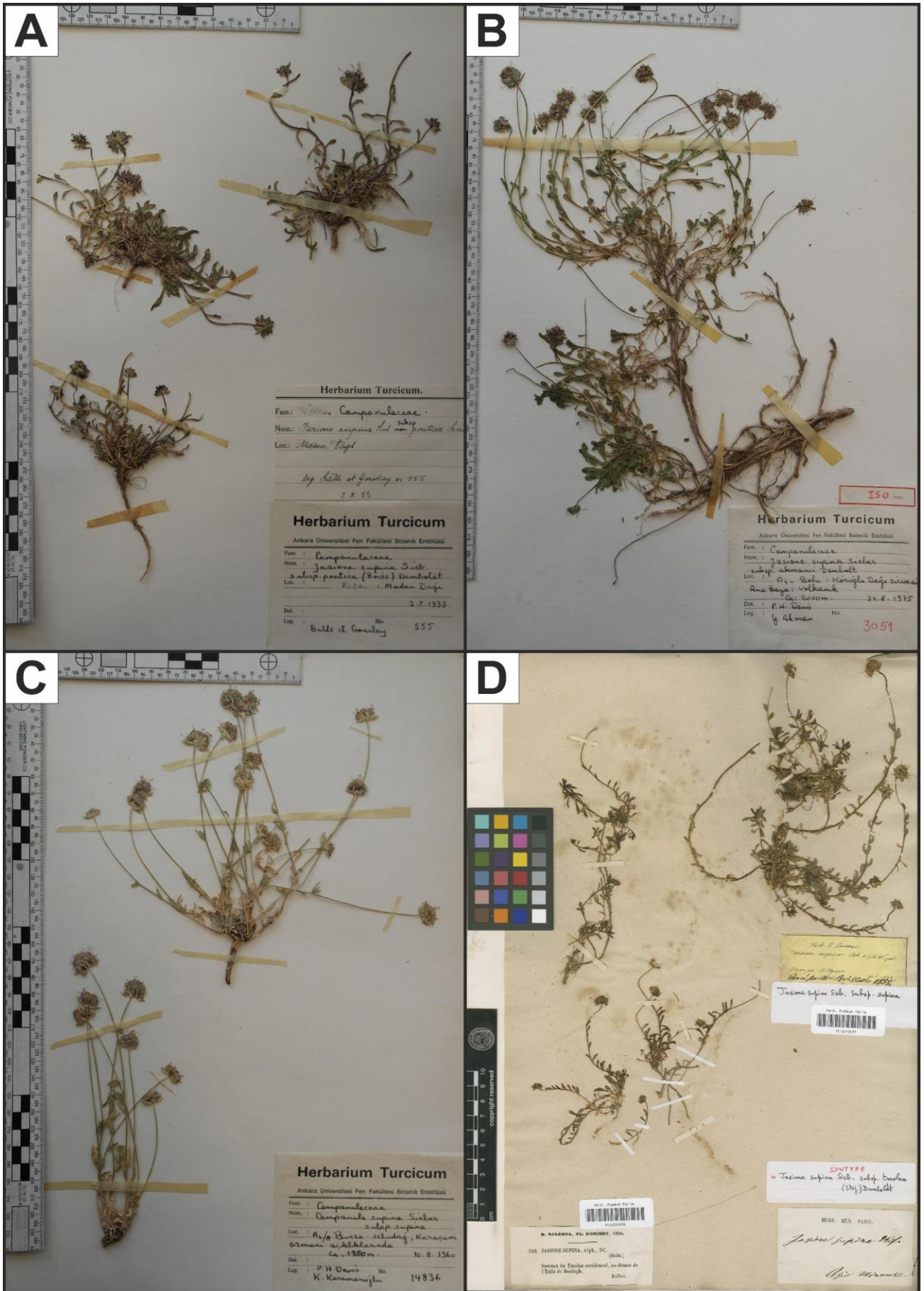


Fig. 5. Herbarium specimens of *Jasion supina* taxa (A: *J. supina* subsp. *pontica* var. *pontica*; B: *J. supina* subsp. *pontica* var. *akmanii*; C: *J. supina* subsp. *supina*; D: *J. supina* subsp. *tmolea*).

Table 1. Comparative morphological characters of *Jasione supina* taxa.

	Flora of Turkey	Freshspecimens	Flora of Turkey	Freshspecimens	Flora of Turkey	Freshspecimens
Characters	<i>J. supina</i> subsp. <i>pontica</i> var. <i>pontica</i>	<i>J. supina</i> subsp. <i>pontica</i> var. <i>akmanii</i>	<i>J. supina</i> subsp. <i>pontica</i> var. <i>akmanii</i>	<i>J. supina</i> subsp. <i>pontica</i> var. <i>akmanii</i>	<i>J. supina</i> subsp. <i>supina</i>	<i>J. supina</i> subsp. <i>tmolea</i>
Habit	Perennial	Perennial	Perennial	Perennial	Perennial	Perennial
Stem indumentum	Hairy to 5-10 cm from base, glabrous above	Hairy to 5-10 cm from base, glabrous above	Hairy to 5-10 cm from base, glabrous above	Hairy to 5-10 cm from base, glabrous above	Hairy to 5-10 cm from base, glabrous above	Totally glabrous or sparsely hairy to 510 cm from base
Inflorescence	Capitula 10(20) mm diam.	Capitula 8-14(20) mm diam.	Capitula 10(20) mm diam.	Capitula 8-14(20) mm diam.	Capitula 10(20) mm diam.	Capitula 515 mm diam.
Involucral bracts	± ovate -lanceolate, acuminate to obtuse, dentate, slightly ciliate	± ovate -lanceolate, acuminate to obtuse, entire, not ciliate, inner side or with a few short hairs, outer side glabrous	± ovate -lanceolate, acuminate to obtuse, entire, not ciliate, inner side or with a few short hairs	± ovate -lanceolate, acuminate to obtuse, usually broad, margins dentate, ciliate into the base, inner side glabrous, outer side bears sparsely simple hairs or glabrous	± ovate -lanceolate, acuminate to obtuse, usually broad, margins dentate, ciliate into the base, inner side glabrous, outer side bears sparsely simple hairs or glabrous	± ovate -lanceolate, acuminate to obtuse, broader than inner ones (not narrow), ovate -elliptic, margins entire, sub-entire, with few short ciliate, inner side bears sparsely simple hairs or glabrous, outer side glabrous
Calyx	Calyx lobes 1-1.5 mm, small, triangular-linear, violet throughout or only at apex	Calyx lobes 1-1.7 × 0.2-0.6 mm, small, triangular-linear, violet throughout or only at apex	Calyx lobes 1-1.5 mm, small, triangular-linear, violet throughout or only at apex	Calyx lobes 2-3 mm, ovate-lanceolate, green	Calyx lobes 23 × 0.20-0.4 mm, ovate-lanceolate, green	Calyx lobes 1.5-2.1 × 0.2-0.4 mm, ovate-lanceolate, pink to green
Corolla	Corolla split nearly to base into 5 linear lanceolate lobes	Corolla pale to dark purple, split nearly to base into 5 linear lanceolate lobes	Corolla split nearly to base into 5 linear lanceolate lobes	Corolla split nearly to base into 5 linear lanceolate lobes	Corolla pink to dark purple, split nearly to base into 5 linear lanceolate lobes	Corolla pale to dark purple, split nearly to base into 5 linear lanceolate lobes
Stamens	Stamens 5, filaments subulate, anthers connate at base, equal or longer than filaments in young at base	Stamens 5, filaments subulate, anthers connate at base, equal or longer than filaments in young at base	Stamens 5, filaments subulate, anthers connate at base, equal or longer than filaments in young at base	Stamens 5, filaments subulate, anthers connate at base, equal or longer than filaments in young at base	Stamens 5, filaments subulate, anthers connate at base, equal or longer than filaments in young at base	Stamens 5, filaments subulate, anthers connate at base, equal or longer than filaments in young at base
Ovary	Ovary 2-locular	Ovary 2-locular	Ovary 2-locular	Ovary 2-locular	Ovary 2-locular	Ovary epigynous, 1-2 locular
Style	Style hairy in upper part, with 2 short, thick stigmas	Style hairy in upper part, with 2 short, thick stigmas	Style hairy in upper part, with 2 short, thick stigmas	Style hairy in upper part, with 2 short, thick stigmas	Style hairy in upper part, with 2 short, thick stigmas	Style 5-10 mm long, hairy in upper part, with 2 short, thick stigmas
Stems	± caespitose, with numerous procumbent ascending stems	± caespitose, with numerous procumbent ascending stems	± caespitose, with numerous procumbent ascending stems	± caespitose, with numerous procumbent ascending stems	± caespitose, with numerous procumbent ascending stems	± caespitose, with numerous procumbent ascending stems
Basal leaves	Basal leaves oblong spatulate, ± obtuse, ciliate at base, 10-15 × 2.5-4 mm	Basal leaves oblong spatulate, ± obtuse, margins entire (not ciliate), (5)10-24 × 2.5-4 mm	Basal leaves oblong spatulate, ± obtuse, margins entire (not ciliate), (5)10-24 × 2.5-4 mm	Basal leaves oblong spatulate, ± obtuse, margins entire (not ciliate), (5)10-24 × 2.5-4 mm	Basal leaves oblong spatulate, ± obtuse, ciliate at base, 10-15 × 2.5-4 mm	Basal leaves oblong spatulate, ± obtuse, ciliate at base, 10-24 × (1)1.5-4 mm
Cauline leaves	Cauline leaves ovate lanceolate, sessile	Cauline leaves ovate lanceolate, sessile (not ciliate), 5-15(17) × 1-4 mm	Cauline leaves ovate lanceolate, sessile (not ciliate), 5-15(17) × 1-4 mm	Cauline leaves ovate lanceolate, sessile (not ciliate), 5-15(17) × 1-4 mm	Cauline leaves ovate lanceolate, sessile (not ciliate), 5-11 × 1-2 mm	Cauline leaves ovate lanceolate, sessile, ciliate at base, 59 × 1-2 mm
Leaf indumentum	-	Upper and lower surface of the basal and cauline leaves are glabrous	Upper and lower surface of the basal and cauline leaves are glabrous	Upper and lower surface of the basal and cauline leaves are glabrous	Upper and lower surface of the basal and cauline leaves are glabrous	Upper and lower surface of the basal and cauline leaves are glabrous
Flowering	7-8	7-8	8	7-8	7-8	7-8

Jasione supina Sieber ex Spreng. subsp. *tmolea* (Stoj.) Damboldt, Notes Roy. Bot. Gard. Edinburgh 35(1): 51 (1976)

Synonyms: *Jasione supina* sensu Boiss., Fl. Or. 3: 886 (1875) p.p., non Sieber emend. A.DC.; *Jasione tmolea* Stoj., Notizbl. Bot. Gart. Berlin-Dahlem 9: 550 (1926).

Syntypes: Turkey B2 İzmir: Sommet du Tmolus Occidentalis, au dessus de l'Yaila de Bazdagh, 1854, Balansa 333 (G! W!); Turkey B2 İzmir: Tmolus (Boz Da.), 1842, Boissier 1866 (G!).

Description of *Jasione supina* Sieber ex Spreng. in Syst. Veg., ed. 16 [Sprengel] 1: 810 (1824).

Perennial, ± caespitose, with numerous procumbent or ascending stems, totally glabrous or sparsely hairy to 5-

10 cm from base. Basal leaves oblong spatulate, ± obtuse, ciliate at base, margins entire, (5)10-24 × (1)1.5-4 mm. Cauline leaves glabrous, ovate-lanceolate, sessile, entire margins or ciliate at base, undulate or not, 5-15(17) × 1-4 mm. Capitula 5-15(20) mm diam. Flowers small, shortly pedicellate, 1 or more rows of involucre bracts in terminal heads. Involucre bracts ± ovate-lanceolate, acuminate to obtuse, entire or dentate, glabrous or a little short hair on the inner side, outer side bears sparsely simple hair or glabrous. Calyx lobes linear-lanceolate, 1-3 × 0.2-0.6 mm. Pale to dark purple corolla, split nearly to base into 5 linear-lanceolate lobes. Stamens 5, filaments subulate, anthers connate at base, equal or longer than filaments in young flowers. Ovary epigynous, 1-2 locular, axile placentation. Style 5-10 mm long, hairy in upper part, with 2 short, thick stigmas. Flowering from July to September. Alpine pastures, rocky slopes screes, (1600)1800-2600 m.

Identification key (Revised from Flora of Turkey)

- A. Calyx lobes 1-1.7 × 0.2-0.6 mm, involucre bracts and leaves not ciliate or sparsely ciliate at the base Only subsp. *pontica*
- B. Involucre bracts dentate, sparsely ciliate at base or not var. *pontica*
- B. Involucre bracts entire, not ciliate var. *akmanii*
- A. Calyx lobes 1.5-3 × 0.2-0.4 mm, involucre bracts and basal parts of leaves distinctly ciliate
- C. Calyx lobes 2-3 × 0.2-0.4 mm; involucre bracts dentate subsp. *supina*
- C. Calyx lobes 1.5-2.1 × 0.2-0.4 mm; involucre bracts entire subsp. *tmolea*

Anatomical characteristics

Stem anatomy: Prominently winged stem covered by one layered epidermis. Outer side of the epidermal cells had cutinized walls. The wall of the epidermal cells was smooth. Epidermis had stomata and 3-10 layered photosynthetic cortex underlying. Cortex was composed of globular to semiglobular parenchymatous cells. Lignification was observed at the cell walls of older stems. All stems had one layered distinct endodermis. The casparian band was unclear. Phloem formed continuous slender ring and its cells diminishes throughout to the vascular cambium. Except young stems, xylem showed a continuous path. The pith was parenchymatous and shrivelled as it grown. No sclereid is seen in the pith (Fig. 6).

Leaf anatomy: In leaf transverse sections, adaxial and abaxial epidermal cells were ± oval shaped. The adaxial and abaxial cells were subequal. The outer epidermis cells were cutinized. The stomata were at the same level with epidermal cells. Mesophyll, the photosynthetic tissues were present between upper and lower epidermis. The mesophyll was undifferentiated, composed of rounded cells having distinct intracellular spaces (Fig. 7).

Root anatomy: The root was woody. The outer part of the root was covered with 3-5 layered peridermis. The cortex was located under the peridermis, composed of parenchymatous cells. The cortex and phloem could not be clearly distinguished from each other. The phloem sclerenchyma was scattered within phloem tissue. Between phloem and xylem, there was a vascular cambium composed of small cells with thin walls. The

pith was completely composed of xylem or it might include parenchymatous cells at the centre (Fig. 8).

Distribution and Ecology

The first records of *Jasione supina* in Turkey dates back the beginning of 18th century (Sprengel, 1826; De Candolle, 1839; Boissier, 1888; Stojanow, 1926; Damboldt, 1976). It has been identified that all the earlier studies related to *J. supina* were cited in the Flora of Turkey. During the period after the Flora of Turkey was published, the location information given in almost all the studies containing *J. supina* records is coherent with the distribution records in Turkish flora (Çırpıcı, 1988; Acar, 1997; Uzun Palabaş & Anşin, 2006; Uysal, 2007; Daşkın & Kaynak, 2010, 2011; Şenel *et al.*, 2014; Özkan, 2016; Hüseyinoğlu *et al.*, 2017, Çelemlı, 2019). The field studies to these localities carried out within this study confirms the floristic records in the literature. The distribution map of *J. supina* taxa within Turkey has been provided below (Fig. 9).

When the distribution area of *Jasione supina* taxa was critically examined, it was observed that the distribution area of *J. supina* subsp. *supina* and *J. supina* subsp. *tmolea* was more isolated than all the other *Jasione supina* taxa. These taxa could widely spread within type localities and the habitats having similar ecological characteristics in close proximity. As a result of the field studies carried out within this study, it was concluded that *J. supina* subsp. *tmolea* had spread from 1.500 metres altitude to the summit of Bozdağ located in Ödemiş/İzmir. Through the field studies, we were identified a new *J. supina* subsp. *tmolea* population in Kumpınar Hills whose altitude was up to 2.070 metres within the borders of Manisa province. This taxon was

different from other *J. supina* taxa as it had spread in subalpine and alpine areas having typical Mediterranean climatic conditions. The individuals of this new taxon were found to have diffused within the shadows of *Juniperus oxycedrus* L. individuals especially at roadsides. Along with *J. supina* subsp. *tmolea*, other endemic taxa at Bozdağ were *Sideritis tmolea* P.H.Davis, *Euphorbia anacampseros* var. *tmolea* M.L.S.Khan, *Arenaria tmolea* Boiss., *Minuartia anatolica* (Boiss.) Woronow, *Dianthus leucophaeus* Sm., *Astracantha tmolea* (Boiss.) Podl., *Jurinea cadmea* Boiss. and *Picris olympica* Boiss.

The individuals of *J. supina* subsp. *supina* were found at the *Abies* glades of Uludağ mountain range at the altitudes of higher than 1.600 metres and among *Juniperus communis* Thunb. and *Festuca punctoria* Sm. communities. Besides, *J. supina* individuals came across on wet-rocky slopes along roadsides and gravelled areas. Some of endemic taxa distribution within the same habitat of *J. supina* were *Olymposciadium caespitosum* (Sm.) H. Wolff, *Asyneuma rigidum* subsp. *sibthorpiatum* (Schult.) Damboldt, *Veronica cuneifolia* D.Don, *Dianthus recognitus* Schischk., *Trifolium repens* var. *orphanideum* (Boiss.) Boiss., *Silene lydia* Boiss., *Senecio olympicus* Boiss. and *Cota fulvida* (Grierson) Holub.

J. supina subsp. *pontica* var. *pontica* had the largest distribution area. Being a European-Siberian element, this taxon had spread within the alpine and subalpine zone in Central and Eastern Black Sea region. This taxon had been recorded from the provinces of Rize, Trabzon, Giresun, Kastamonu, and Bolu in Black Sea Region. The only known population of this taxon out of the Black Sea Region was recorded by Çırpıcı in 1988 in Mountain

Murat/Kütahya (Çırpıcı, 1988). Also, existence of the *J. supina* subsp. *pontica* var. *pontica* in this locality was confirmed by us. During the field studies, we also found populations of *J. supina* subsp. *pontica* var. *pontica* in alpine zone of Mountain Koroğlu/Bolu. This taxon has been recorded for the first time from this location.

It was determined that *J. supina* subsp. *pontica* var. *akmanii* has been found out restricted distribution and occurred in two locations including the type locality. *J. supina* subsp. *pontica* var. *pontica* were also observed from including these areas, Mountain Murat/Kütahya and Mountain Koroğlu/Bolu. These taxa had never been reported from the same location until now. Other endemic plant taxa present in near proximity to *J. supina* subsp. *pontica* var. *pontica* and *J. supina* subsp. *pontica* var. *akmanii* taxa in Mountain Murat were *Crenosciadium siifolium* Boiss. & Heldr., *Alyssum virgatum* Nyár., *Aubrieta canescens* (Boiss.) Bornm., *Prometheum muratdaghense* (Kit Tan) 't Hart, *Euphorbia anacampseros* Boiss., *Astragalus oxytropifolius* Boiss., *Hypericum origanifolium* var. *depilatum* (Freyn & Bornm.) N.Robson, *Allium olympicum* Boiss., *Festuca pinifolia* (Hack. ex Boiss.) Bornm. and *Verbascum coronopifolium* Kuntze. As for Mountain Koroğlu/Bolu, the taxa living near these plants are *Euphorbia anacampseros*, *Phlomis armeniaca* Willd., *Silene olympica* Boiss., *Papaver pilosum* Sm. and *Senecio olympicus* Boiss..

Through the data collected within the study, the taxonomical category of *J. supina* subsp. *akmanii* has been reorganised as *J. supina* subsp. *pontica* var. *akmanii*. It has been anticipated that the data obtained within this study will be a reference point for future taxonomic studies of Turkish *Jasione* taxa.

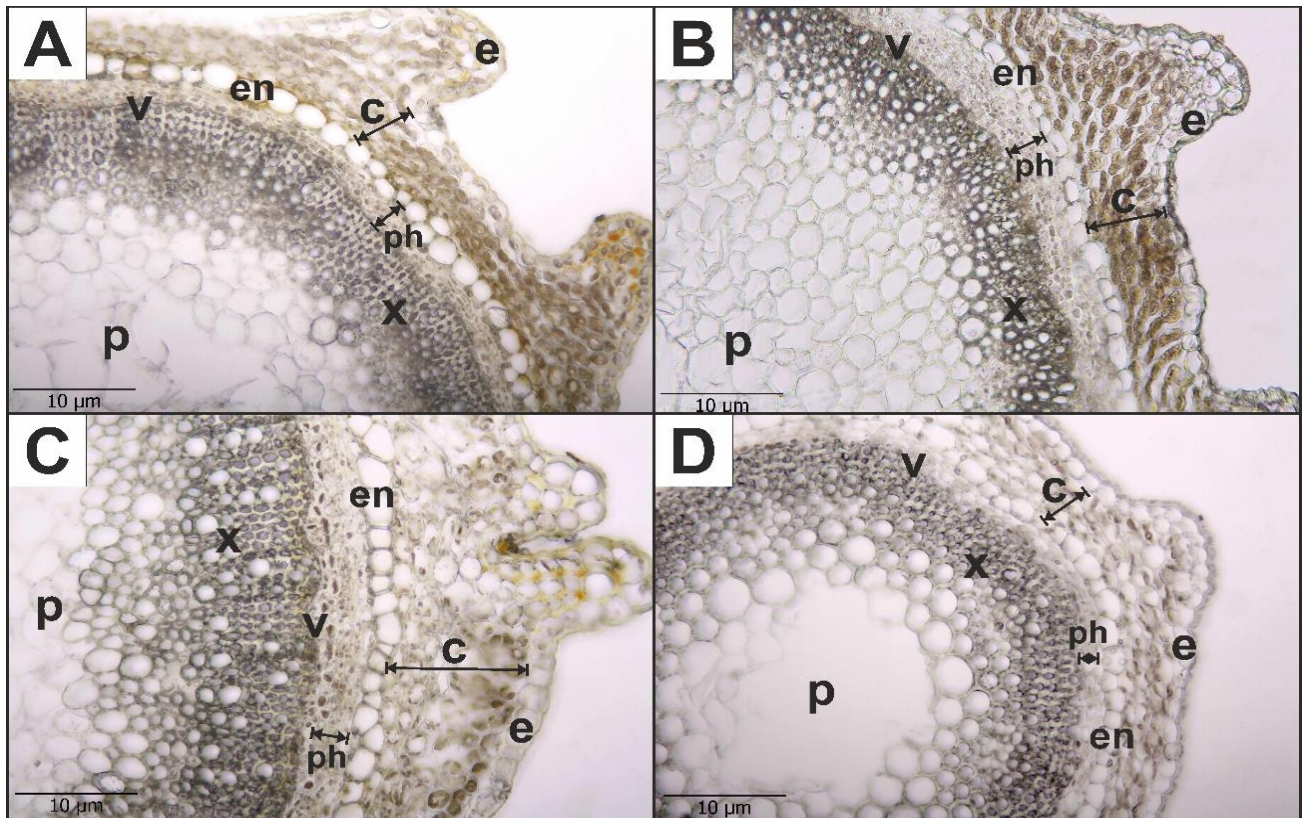


Fig. 6. Stem transverse sections of *Jasione supina* taxa (A: *J. supina* subsp. *pontica* var. *pontica*; B: *J. supina* subsp. *pontica* var. *akmanii*; C: *J. supina* subsp. *supina*; D: *J. supina* subsp. *tmolea*) (e: epidermis; c: cortex; en: endodermis; ph: floem; v: vascular cambium; x: xylem; p: pith).

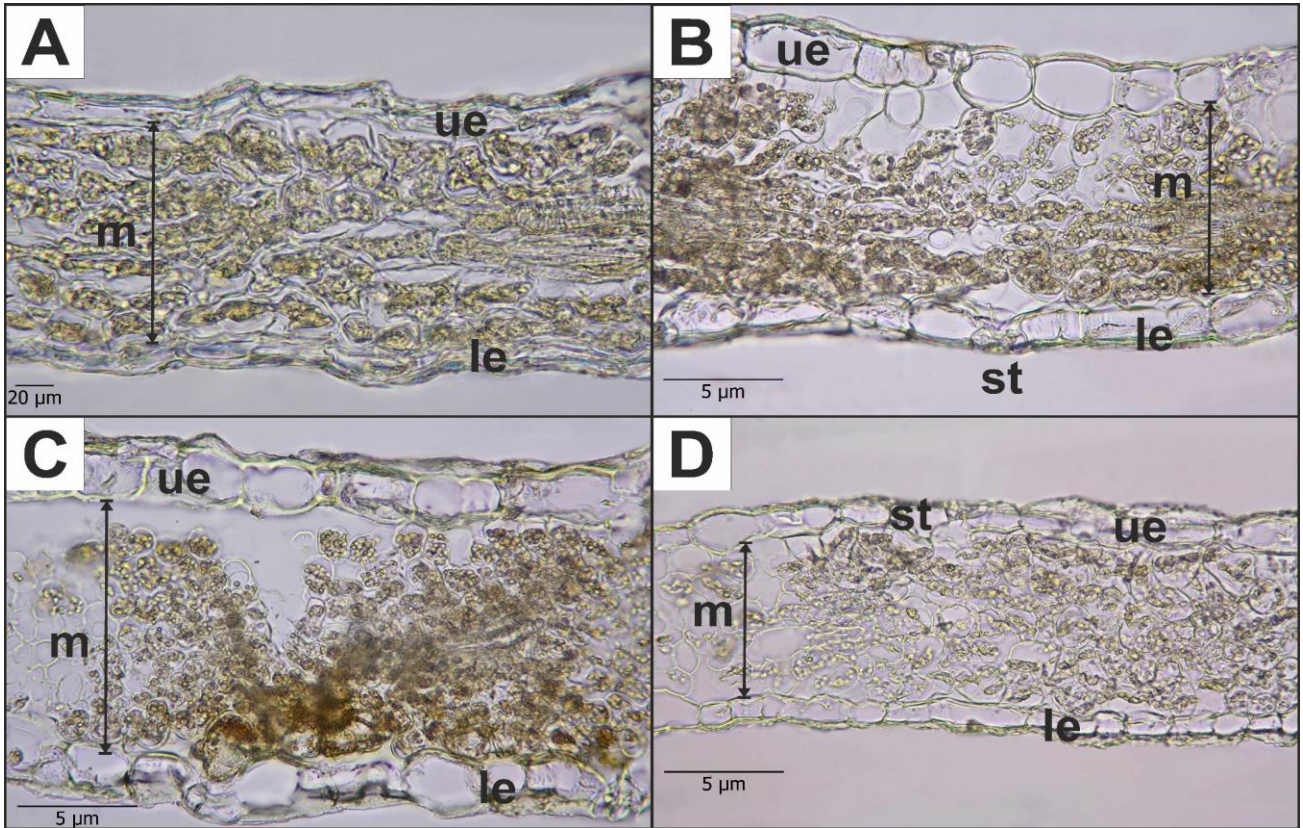


Fig. 7. Leaf transverse sections of *Jasione supina* taxa (A: *J. supina* subsp. *pontica* var. *pontica*; B: *J. supina* subsp. *pontica* var. *akmanii*; C: *J. supina* subsp. *supina*; D: *J. supina* subsp. *tmolea*) (ue: upper epidermis; le: lower epidermis; m: mesophyll; st: stomata).

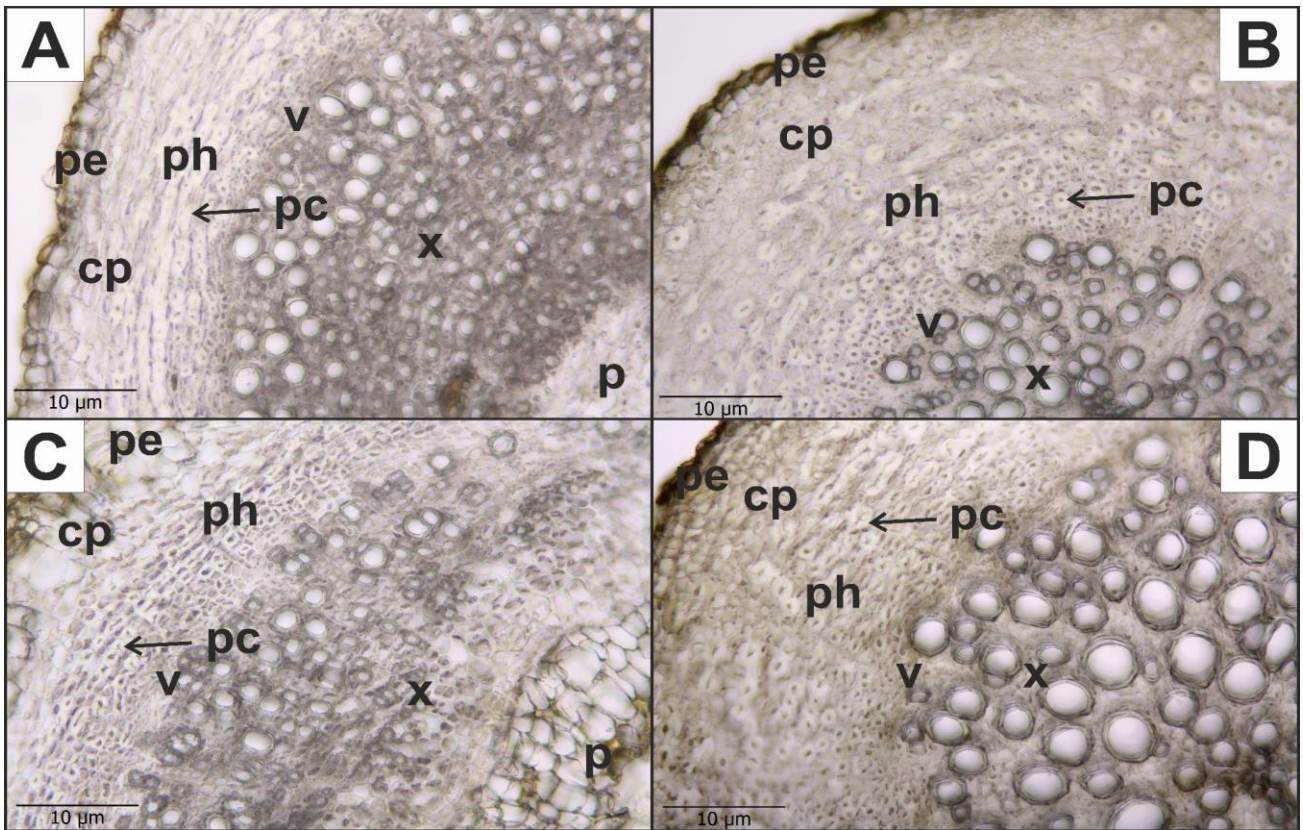


Fig. 8. Root transverse sections of *Jasione supina* taxa (A: *J. supina* subsp. *pontica* var. *pontica*; B: *J. supina* subsp. *pontica* var. *akmanii*; C: *J. supina* subsp. *supina*; D: *J. supina* subsp. *tmolea*) (pe: periderma; cp: cortex parenchyma; ph: phloem; pc: phloem sclerenchyma; v: vascular cambium; x: xylem; p: pith).

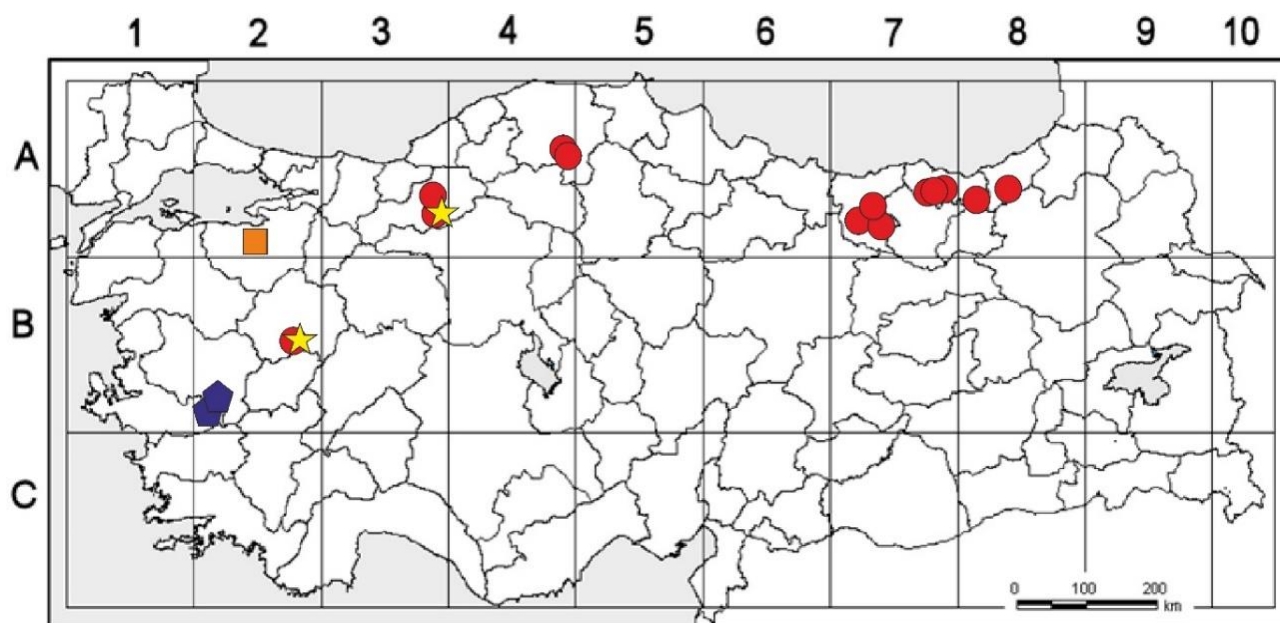


Fig. 9. Distribution map of *Jasiona supina* taxa in the Flora of Turkey (● *J. supina* subsp. *pontica* var. *pontica*; ★ *J. supina* subsp. *pontica* var. *akmanii*; ■ *J. supina* subsp. *supina*; ◆ *J. supina* subsp. *tmolea*).

Discussion

Jasiona taxa have spread in Europe and Northwestern Africa while their distribution area in Turkey is Northern and Western regions (Sales & Hedge, 2001). The fact that this genus has such a limited distribution area and that more than half of the identified taxa spread in Turkey are endemic necessitates the importance to investigate Turkey in terms of *Jasiona* taxa. In spite of this necessity, there has been so few taxonomic studies in Turkey related to the *Jasiona* genus. The Flora of Turkey is now the only reference point for the researches on endemic *Jasiona* taxa.

While *Jasiona supina* is represented through 4 subspecies in the flora of Turkey, it has been found out that the distinctive characteristics of these subspecies are not clearly identified within the Flora and the characters in the identification key are insufficient. For instance, *J. supina* subsp. *pontica* and subsp. *akmanii* were separated in the key on the basis of their entire or dentate involucre bracts. However, it was found during the present study of these taxa that all the involucre bracts of subsp. *akmanii* could have on even both entire or dentate could be present in the same individual. On the other hand, the involucre bracts of subsp. *pontica* individuals were all dentate. Additionally, these bracts could sometimes be ciliate towards to the base. Apart from these characters, no distinctness had been observed between subsp. *pontica* and subsp. *akmanii*.

Another unclear point about *Jasiona supina* subsp. *pontica* and subsp. *akmanii* in Flora of Turkey is the distribution area of these taxa. Kartalkaya/Bolu has been specified as the distribution area of subsp. *pontica* in the Flora of Turkey. The aerial distance between this location and the type locality of subsp. *akmanii* is 17 kilometres. During the field studies carried out within these locations, it was found out that the individuals of subsp. *pontica* had spread in Mountain Koroğlu/Bolu and particularly, within the type locality of subsp. *akmanii*. Having few

morphological characters used in the separation of these two taxa and the identification of the subsp. *pontica* populations at the type location of subsp. *akmanii* have revealed that their classification at the subspecies category is not suitable. Two of the most important criteria for accepting different populations as distinct species or subspecies are that they should have both morphological differentiations inherited hereditarily in their phenotypes and an isolation mechanism in-between to prevent gene flow. The characters used to differentiate the taxa are both limited in number and show variations and it's impossible to mention about an isolation between the taxa. In consideration with the findings obtained from the study, we have reviewed the categories of *J. supina* subsp. *pontica* and subsp. *akmanii* and reorganised them as *J. supina* subsp. *pontica* (Boiss.) Damboldt var. *pontica* and *J. supina* subsp. *pontica* (Boiss.) Damboldt var. *akmanii* (Damboldt) Sezer, respectively.

The problems related to distinguishing these two taxa were revealed in some earlier studies. For instance, Özkan (2016) pointed out that *Jasiona supina* subsp. *akmanii* should be merged with subsp. *pontica* as in individuals of the related taxon had entire and dentate involucre bracts (Özkan, 2016). However, it will be wrong to make such a statement without examining the individuals from other known localities, particularly those of subsp. *akmanii* and subsp. *pontica* populations. As a result of examining the herbarium specimens and field studies carried out in locations and also the previous studies, we concluded that subsp. *akmanii* existed in only two locations (Mountain Koroğlu/Bolu, Mountain Murat/Kütahya), one is being type locality (Damboldt, 1976; Çırpıcı, 1988; Özkan, 2016; Öztürk, 2019).

The Flora of Turkey differentiated the *Jasiona supina* subsp. *supina* and subsp. *tmolea* from subsp. *pontica* and subsp. *akmanii* by the length, shape and colour of Calyx; however, in the present study it was found that the other characteristics excluding the length of Calyx were

insufficient in distinguishing these taxa. These characters were replaced with the ciliate character of cauline and basal leaves. While the cauline and basal leaves of subsp. *supina* and subsp. *tmolea* has apparent ciliate characteristics, whereas leaves of subsp. *pontica* and subsp. *akmanii* were not ciliate.

The calyx lengths have been used as the first distinctive character for making a differentiation between *Jasione supina* subsp. *supina* and subsp. *tmolea* in Flora of Turkey. The reliability of this character in distinguishing the taxa has also been confirmed by us. The second distinctive character was the dimensions of outer involucre bracts with regard to those at the inner bracts. The study of fresh plants and herbarium specimens revealed that these characters were misused within the Flora since the outer involucre bracts of subsp. *tmolea* were larger than those of inner ones.

The distribution ranges of *Jasione supina* taxa given in the Flora of Turkey when compared with our data, also older studies carried out after the publishing of the Flora of Turkey and almost corresponds to those obtained through field studies. Different from the Flora of Turkey, new populations of subsp. *pontica* and subsp. *akmanii* existing in Mountain Murat/Kütahya have been recorded in different times (Çırpıcı, 1988; Öztürk, 2019). The field studies carried out in the region confirmed the findings of researchers.

The most comprehensive study on the anatomic characteristics of *Jasione* taxa has been carried out by Bokhari & Sales (2001). Who concluded that the anatomic characters could not be used to distinguish the taxa at the variety level. Moreover, they also reported that even though the anatomic characters used for diagnosis of some taxa at higher-variety categories, they are insufficient in revealing phylogenetic relationships when solely used. Our findings obtained from anatomical studies are in agreement with findings of Bokhari & Sales (2001) since no differentiations had been observed among *J. supina* taxa with anatomical features of stems, leaves, and roots.

Conclusion

The morphological characteristics of endemic *Jasione supina* taxa have been evaluated in terms of taxonomic features by comparing the characteristics with the description given in the Flora of Turkey and in the light of present findings, the description of *J. supina* was revised. The diagnostic characters of different subspecies of *J. supina* were recorded, photographed and tabulated. During the study, since some inaccurate characters were identified delimitation of *J. supina* taxa given in Flora of Turkey. These characters were replaced with new morphological characters having a higher distinctive feature and lower variations.

An up-to-date distribution map of *Jasione supina* taxa was prepared. In consideration of morphological findings and distribution data, the taxonomical status of *J. supina* subsp. *pontica* and subsp. *akmanii* have been revised as *J. supina* subsp. *pontica* (Boiss.) Damboldt var *pontica* stat. nov. and *J. supina* subsp. *pontica* (Boiss.) Damboldt var *akmanii* (Damboldt) Sezer stat. nov.

Being first of its kind, the study also presents the microphotographs of anatomical sections of roots, stems and leaves of *Jasione supina* taxa. Besides, the anatomical descriptions of roots, stems and leaves of these taxa have also been provided.

It has been aimed that this study will shed light on problems in classification of *Jasione supina* taxa and serve as a resource for future studies on the taxonomic characters of *Jasione* taxa.

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