

## The genus *Armeria* (*Plumbaginaceae*) in Turkey

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**Abstract.** The genus *Armeria* has been represented in *The Flora of Turkey and the East Aegean Islands* by three wild taxa (*Armeria cariensis* var. *carimensis*, *A. cariensis* var. *rumelica*, *A. trojana*). In this study, all specimens of *A. cariensis* var. *rumelica* collected from European Turkey and some specimens from Bulgaria have been examined and analyzed comparatively in regard to their morphological, anatomical and karyological features. As a result of this study, *Armeria rumelica* finally has been accepted as a species. Furthermore, by using some new diagnostic characteristics, a new identification key was created for the species growing in Turkey. Also, for the first time the chromosome number of the endemic species *A. trojana*, has been counted as  $2n:18$ , diploid.

**Key word:** *Armeria*, chromosome number, leaf anatomy, morphology, Turkey

## Introduction

The genus *Armeria* Willd. is known to be taxonomically difficult (Bernis 1954). A discussion of the generic status and nomenclature of the genus, briefly in *Species Plantarum* (Linnaeus 1753), had combined *Statice* and *Limonium* Mill. into a single genus represented by a single species *Statice armeria* L. Miller (1768) divided it into *Statice* and *Limonium*. Until 1809, there had been no further changes in the generic status, when Willdenow (1809) recognized them as constituting two genera, renamed *Armeria* and *Limonium*. Druce (1901) demonstrated that Miller's application of *Statice* had priority over Willdenow's name of *Armeria*. In *Flora Europaea* and many other floras this genus was accepted by the generic name *Armeria* Willd. In the *Flora of Turkey* (Bokhari & Edmondson 1982; Pinto da Silva 1972) the generic name *Armeria* Willd. syn. *Statice* had also been accepted. It is the richest genus with ca. 120 species in *Plumbaginaceae*, after the genera *Limonium* and *Acantholimon* Boiss. It is located primarily in the Mediterranean with 92 species, occurring from Turkey to Portugal and Madeira,

with a major centre of diversity on the Iberian Peninsula (Augilar 1999a, 1999b, 2003; Baumel 2009; Feliner 2001, 2004).

The genus *Armeria* Willd. is represented by three wild taxa in Turkey. Although *A. maritima* Willd. is also cited in the *Flora of Turkey* (Bokhari & Edmondson 1982), it is a cultivated species and for this reason it is excluded from this study. The history of nomenclature of *Armeria rumelica* must be also mentioned concisely (Petrova 2006). This taxon was described first in 1848 by E. Boissier (Type: [Bulgaria?]) in Rumelia, Frivaldsky as *A. rumelica* Boiss. Then several taxonomic statuses and names had changed, such as *A. cariensis* var. *rumelica*, Boiss. in *Flora Orientalis IV* (1873); *A. rumelica* Boiss. var. *genuina* sensu Novak in *Comm. Reg. Soc. Sci. Bohem. Mat. Nat.* 28, 12 (1939); *Armeria rumelica* Boiss. var. *tempuskyana* (Degen & Dörfl.) Vandas in *Reliq. Forman.* 502 (1909); *Armeria rumelica* Boiss. var. *adamovicii* (Halácsy) Novák in *Comm. Reg. Soc. Sci. Bohem. Mat. Nat.* 28: 19 1939; *Armeria adamovicii* Hal. in *Oesterr. Bot. Z.* 61:279 (1906); *Armeria rumelica* Boiss. var. *pseudocanescens* (Halácsy) Novák in *Comm. Reg. Soc. Sci. Bo-*

*hem. Mat. Nat.* 28: 15 (1939); *Armeria rumelica* Boiss. var. *rhodopaea* (Velen.) Beck *Ann. In K. K. Naturhist. Hofmus.* 13(2): 20 (1898); *Statice rumelica* (Boiss.) Degen & Dörfel in *Denkschr. Kaiserl. Akad. Wiss., Math.-Naturwiss. Kl.* 64: 734 734 1897; and *Statice rumelica* (Boiss.) Degen & Dörfel var. *tempuskyana* Degen & Dörfel in *Denkschr. Kaiserl. Akad. Wiss., Wien. Math.-Naturwiss. Kl.* 64: 734, 1897.

During the field survey for collection of specimens and their identification within the framework of Yıldız Dağları Project (EuropeAid/125289/D/SER/TR: *Technical assistance for protection and sustainable development of natural resources and biodiversity in the Yıldız Mountains, Turkey*), we have found that it was not easy to separate the two varieties (var. *cariensis* and var. *rumelica*.) by using only the characteristics given in the *Flora of Turkey* (Bokhari & Edmondson 1982). Both varieties are distributed in European Turkey according to literature. Then we decided to work in detail, and prepared a brief outline of the preliminary treatment, which we presented as a poster entitled 'The Genus *Armeria* Willd. in Turkey' and documented with photographs at the 5th International Balkan Botanical Congress (Yeşil & Özhatay 2009).

## Material and methods

The studied material consisted of 43 *Armeria* specimens kept in ISTE (Istanbul University, Faculty of Pharmacy), SOM (Bulgarian Academy of Sciences, Institute of Biodiversity and Ecosystem Research), ANK, HUB and GAZI herbaria and collected during the Yıldız Mountain Biosphere Project and the Project of a Revisional Study of *Plumbaginaceae* Family in Turkey, TBAG-2195 (102T088). Diagnostic characteristics were measured on the herbarium specimens. The six characters included in the key were derived from the measurements of 16 selected characters, according to the earlier systematic studies. For comparison, twenty-three samples of *A. rumelica* are taken from SOM, and two of them are from Turkish Thracia (European Turkey).

The leaf anatomy was examined from dried herbarium specimens (*A. rumelica* ISTE 92252, *A. cariensis* ISTE 70318). The material of *A. trojana* Bokhari & Quézel (ISTE 92708) was fresh. Dried leaves were soaked in warmish water, then surface and transverse sections were cut by hand. Sections were stained with

Sartur reagent (a compound reagent consisting of lactic acid, Sudan III, aniline, iodine, potassium iodide, alcohol, and water). Drawings were made with a camera lucida drawing tube attached to Leitz Wetzlar microscope. Photographs were taken with Olympus BH-2 microscope.

Chromosome numbers of *A. trojana* have been counted. Root tips were pretreated with 0.05% 1-bromonaphthalene solution at 4°C for 24 h and then fixed in fresh Carnoy solution overnight. Root tips were hydrolyzed for 10–12 min in 1 N HCl at 60°C, washed and stained in Feulgen solution for 1–2 h. Stained meristems were squashed in a drop of 2% aceto orcein and permanent preparations were made by the liquid CO<sub>2</sub> method. The image analysis systems KAMERAM© and Canon A640 camera were used for metaphase handling and chromosome measurements. An ideogram was prepared from the measurements made on enlarged microphotographs of well-spread metaphase plates of different individuals. For each chromosome, the total and relative lengths (percentage of total autosomal length) of haploid chromosome complements were determined. Chromosomes were classified by the nomenclature of Levan et al. (1964).

## Results and discussion

The result of such close examination has shown that morphological features of *A. cariensis* var. *rumelica* used in the *Flora of Turkey* as a diagnostic characteristic were very variable. Distinguished by features of the leaves (wide, monomorphic or dimorphic, indumentum), scape length has not been used as a diagnostic character for the two related taxa. Some distinctive features were obtained after a detailed study and those characteristics were used for the identification of species.

In this study, an identification key was compiled using new diagnostics characteristics for three wild species in Turkey (Table 1). Description of the species was rewritten on the basis of the examined specimens. Colour pictures, a distribution map, a table of characteristics used for comparison, and figures of distinguishing characters of the species were provided (Figs 5, 6, 7). Also, the leaves anatomy of the species and the chromosome count and karyotype of the endemic *A. trojana* are given.

### A new identification key

According to the new diagnostic characteristics, here is the compiled identification key as follows:

- 1- Scape 2–3.5 cm, pilose near base; leaves 4–15 mm  
 ..... **1. *A. trojana***
- 1- Scape 10–50 cm, glabrous; leaves 10–145 mm
- 2- Bracts shorter than calyx, tube hirsute on primary ribs, seldom on secondary ribs . . . **2. *A. cariensis***
- 2- Bracts as long as, or longer than calyx, tube hirsute on primary and secondary ribs . . . **3. *A. rumelica***

### Description of the species

**1. *Armeria trojana*** Bokhari & Quézel in *Candollea* 25: 376 (1970).

Dwarf, densely caespitose herb. Rootstock sparsely branched. Leaves linear, 4–15 × c.1 mm, margins ciliate. Scape 20–35 mm, pilose at base, glabrous above. Outer involucre bracts ovate-triangular, with broad scarious margin, inner similar but 1.5 × longer. Spikelets 2–3-flowered; pedicel 1 mm. Calyx infundibular, 6–7 mm; limb membranous, 5-lobed; lobes triangular, each with excurrent vein c. 1 mm; tube hirsute on primary and on secondary ribs. Ratio of calyx-tube and spur 4/1–3/1, awn c. 1 mm, corolla pinkish. Fruit 1-seeded, dispersed within calyx; perikarp dry, membranous.

**Flowering time:** June–July.

**Habitat:** Siliceous (schistose) rocks, stony places, 1500–1700 m.

**Type:** [Turkey B1 Balıkesir] Kaz dağ, pelouses rocailleuses sur schiste s, 1968, Quézel, Contandriopoulos & Pamukçuoğlu (holo. E! (photo.) iso. MARS).

**Distribution in Turkey:** N.W. Anatolia local (Fig. 1). **B1** Balıkesir: Kaz Dağı, 1500 m, A. Baytop (ISTE 20817!); ibid. summit of Mt. Gargari, Sint. 1883:743; Balıkesir Zeytinli Kaz Dağı Sarıkız Hill, Babadağ road, on limestone rocks, 1650 m, N. & E. Özhatay, M. Johnson (ISTE 70209!); Balıkesir, Kaz Dağı National Park, within sight of Sarıkız Hill, in rocky, flat fields, 1560 m, 16.07.2011, Yeşil & Taşkın (ISTE 92708!).



**Fig. 1.** *A. trojana* (Balıkesir-Kaz Dağı; photograph by Yeter Yeşil and Coşkun Taşkın).

**Table 1.** Characteristics used for comparison of the morphology of *Armeria* species in Turkey.

Morphological characteristics	<i>Armeria cariensis</i>	<i>A. rumelica</i>	<i>A. trojana</i>
Leaf length	30(40)–(110)(120)145 mm	40(65)(83)–110 mm	4(6)–15 mm, ciliate
Leaf width	1–1.2 mm	1–(1.8)(2)2.5 mm	1–1.5 mm
Scape length	16(22)–(31)42 cm	19(23)–(40)50 cm	1.5–4.5 cm
Diameter of the scape at base	1.5–1.7 mm	1–(1.8)2 mm	0.5 mm
Diameter of the involucre	17–27 mm	15–24 mm	10–15 mm
Ratio of the involucre diameter to the length of the involucre sheath	27/18 mm	21/22mm	10/4 mm
Number of the involucre bracts	3	3	3
Ratio of the shortest to the longest inner involucre bracts	5/7–6/7 mm	4.5/6–(5/6)6/7 mm	2/4 mm
Width of inner involucre bracts	4–5 mm	4–5 mm	4–6 mm
Length of spikelet bracts	7–8 mm	7–8 mm	6–7
Calyx length	10–11 mm	7–(8)9 mm	5–6 mm
Calyx lobe length	2 mm	2.5–2.7 mm	1.5 mm
Calyx tube length	2 mm	1–1.7 (2) mm	1.2–1.5 mm
Length of spur (calyx pedicel scar)	1.6–1.8 mm	1.2–1.5 mm	0.3–0.5 mm
Petal colour	pinkish	white, pale-pinkish	pinkish
Linear or non-linear leaves	dimorphic, filliform, linear	monomorphic, linear	monomorphic, linear



**Conservation:** Endemic to Kaz Dağı. E. Medit. (mt.) element. Related to *A. icarica* and also to *A. splendens* (Lag. & Rodr.) Webb from S. Spain.

**2. *Armeria cariensis*** Boiss. in DC., *Prodromus Systematis Naturalis Regni Vegetabilis* 12:677 (1848).

Syn. *Armeria alliacea* Griseb. in *Spicilegium florum rumelicae et bithynicae* 2: 296. 1846.

*Armeria alpina* Friv. ex Griseb. in *Spicilegium florum rumelicae et bithynicae* 2: 296 1846.

*Armeria thessala* (Boiss.) Boiss. in *Diagn. Pl. Orient. II*, 4: 70 1859.

Perennial caespitose herb. Rootstock sparingly branched. Leaves dimorphic; lower linear, ± undulate, 3-veined; upper filiform to linear, (30) 40–(110)120 × 0.5–2 (2.5) mm, 1 (sedum 3) veined, acute, glabrous. Scapus 15–42 cm, glabrous. Sheath c.22 mm. Outer involucral bracts shorter than inner, acuminate, ovate-triangular, with narrowly hyaline margin; inner broadly ovate, retuse or mucronate, with wide hyaline margin. Spikelets 2–4 flowered; partly enclosed by a large bract. Flowers distinctly pedicellate (1.5–2 mm). Calyx infundibular 8–10 mm; limb membranous, 5-lobed; lobes oblong-triangular, each with excurrent vein c. 1.5 mm; tube hirsute on primary ribs, seldom on secondary ones. Bract shorter than calyx; spur longer than 1.2 mm and ratio to calyx-tube is 1/1.5–2, awn c. 1–2 mm. Corolla white or pinkish. Fruit 1-seeded, dispersed within calyx; pericarp dry, membranous.

**Flowering time:** June–July.

**Habitat:** Grasslands, montane steppe, up to 1300 m.

**Type:** Syntypes: [Turkey] in *Caria Asiae minoris*, Aucher 2495 (BM, K!); [C2 Denizli] in *herbidis montis Cadmi* (Baba Da.), Boissier.

**Distribution in Turkey:** W. Turkey (Fig. 2); **B1** İzmir: Mesogis (Aydos Da.) above Tire, 600–700 m, Bornm. 1906: 9918, Balıkesir: Adramyti (Edremit) to Pergame (Bergama), 15.vi.1839, Montbret; Manisa: Salihli-Ödemiş road, around Kırkoluk Çeşme, 1100 m, 7 viii 2003, Doğan & Akaydın 7798!; Manisa: Salihli, along Bozdağ Municipality border, along road to ski facilities, 1550 m, 7.vii.2003, Doğan & Akaydın 7827!; Manisa: Salihli-Ödemiş road, Kırkoluk, in mountain meadow, 1100 m, 7.viii.2003, Doğan & Akaydın 7815!, Manisa: Salihli-Ödemiş road, Kırkoluk, in mountain meadow, 1100 m, 7.viii.2003, Doğan & Akaydın 7816!, İzmir: Aydos, around Tire, 600–700 m, 14.vi.1906,

Bornm. 9918; **B2** İzmir: Boz Da., 1270 m, Buttler & Erben 17469! Uşak: Mt. Kayagöl, Bal., Kütahya: Simav, between Kçıir and Hisarköy, 900 m, 19.vi.1965, Coode & Jones 2699; **B3** Isparta: Şarkikaraağaç, Kızıldağ National Park, between forest houses and the park entrance, *Cedrus libani* forest, 1100–1250 m, 27.iv.1994, Birol Mutlu571, 37119 (HUB!); Afyon: between Çiğiltepe and Ahmetpaşa, north of Çiğiltepe slopes, in forestation field, 1400–1500 m, 15.vi.1982, T. Ekim, H. Malyer & R. İlarşlan E5550 (ANK!), **C2** Denizli: Sarayköy-Babadağ, 5 km above Babadağ village, on north slopes, 950–1300 m, 27.05.1995, Neriman Özhatay et al (ISTE 70318!).

**Conservation:** Endemic? E. Medit. (mt.) element. Although the species in the *Flora Europaea* were recorded from Greece, Greek specimens of *A. cariensis* are included as a synonym with *A. rumelica* in *Flora of Greece* (Halácsy 1968).



**Fig. 2.** *A. cariensis* (İzmir-Ödemiş; photograph by Hulusi Kütük).

**3. *Armeria rumelica*** Boiss. in DC., *Prodromus Systematis Naturalis Regni Vegetabilis* 12:677 (1848)

Perennial caespitose herb. Skapus 20–35 cm, unbranched. Leaves not dimorphic; outer linear 2–3.5 mm wide, margin undulate, acuminate on the apex; inner linear to linear-lanceolate 1.5–3 mm wide, mucronulate flat, margin pilose. Scape glabrous at base 20–45 cm. Sheath 15–45 mm; capitule 20–38 mm wide; outer involucral bracts with narrow scarious margins; spikelets stipitate. Calyx infundibular 6–10 mm, limb membranous, 5-lobed; lobes oblong-triangular, each with excurrent vein c. 2.5 mm; tube hirsute on primary and on secondary ribs; bract as long as, or longer than calyx, spur always shorter than 1 mm and ratio

of calyx-tube is 1/2–2.5, awn 0.7–2 mm. Corolla pale-violet to pale-pink, seldom white. Fruit 1-seeded, dispersed within calyx; perikarp dry, membranous.

**Flowering time:** June–July

**Habitat:** Rocky places, 180–1030 m.

**Type:** [Bulgaria?] in Rumelia, Frivaldsky.

**Distribution in Turkey:** Turkey in Europe (Fig. 3).

**A1** Edirne: between Edirne and Lalapaşa, around Bağlık stream, N. & E. Özhatay (ISTE 29732!), Kırklareli; Kırklareli-Kofçaz road, 5 km to Kofçaz, 18 v 1995, E. Akalın & N. Frieser (ISTE 68248!), Tekirdağ: Çerkezköy-Çorlu road, Veliköy çevresi, 180 m, 3.vii.???2004, Doğan & Akaydın 9263!, Demirköy, ra-

dar road, 760–860 m, 4.vii.2004, Doğan & Akaydın 9298!, Kırklareli: Mt Mahya, 1030 m, 12.vi.1968, A. Baytop (ISTE 13258!), Mt Mahya, along hill road, 04.07.2009, 1031 m, E. Akalın & Y. Yeşil (ISTE 92252!). Kırklareli: along Dereköy-Şükrüpaşa road, 3<sup>rd</sup> km, around a Quercus forest, 457 m, 16.06.2009, Necmettin Güler & Hüseyin Ersoy, 12945! (EDTU!).

**Conservation:** Balkan endemic. Described in 1848 by the Swiss botanist E. Boissier according to materials from the Bulgarian collection of the Hungarian botanist E. Frivaldsky (Boissier 1848). Morphologically close to *A. canescens* (Host) Boiss. from NE Greece.



Fig. 3. *A. rumelica* (Kırklareli-Mahya Dağı; photograph by Emine Akalın).

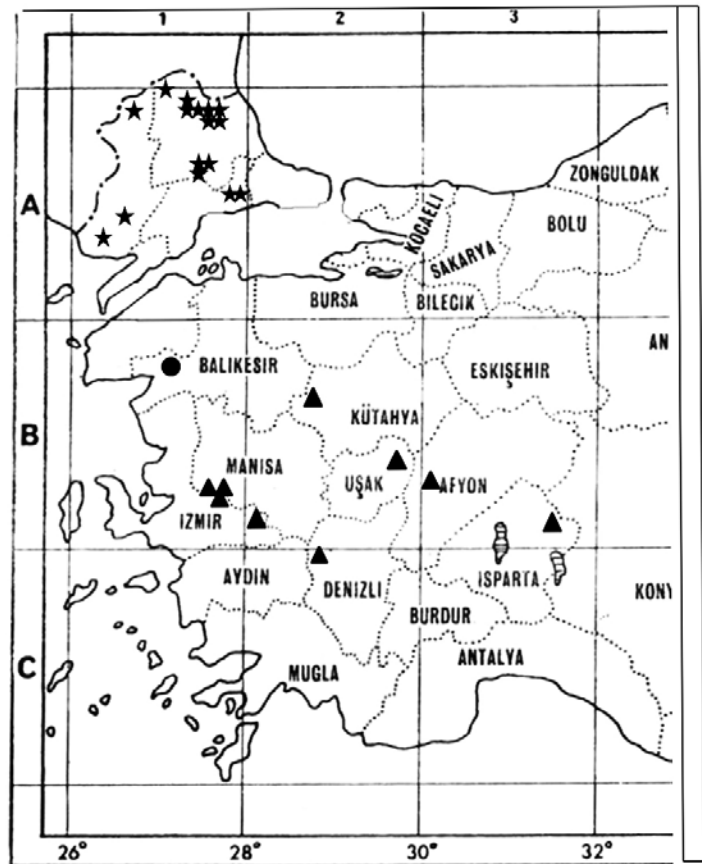


Fig. 4. Distribution of ▲ *Armeria cariensis*, ★ *A. rumelica*, ● *A. trojana* in western Turkey.



Fig. 5. Leaf tips of  
A – *A. cariensis*,  
B – *A. rumelica*,  
C – *A. trojana*  
(Scale bar: 0.5 mm).

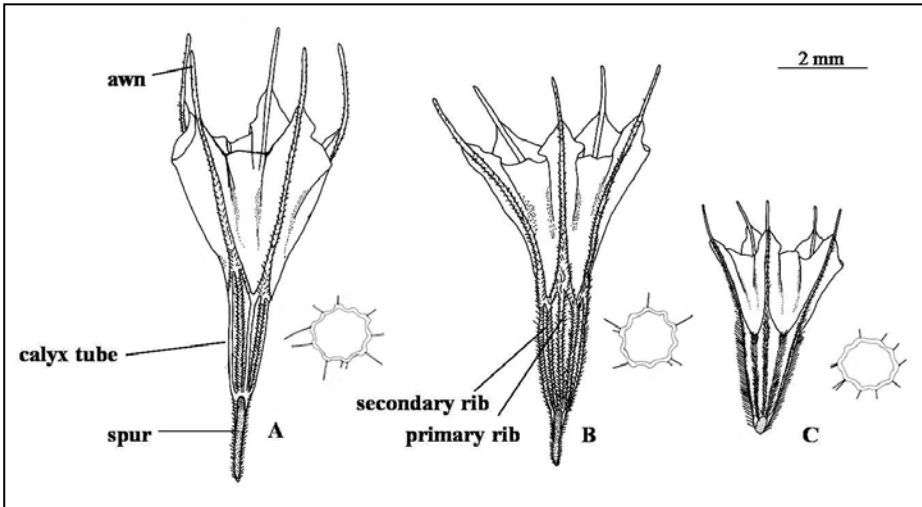


Fig. 6. Drawing of calyx and cross section of calyx tube. A - *A. cariensis*; B - *A. rumelica*; C - *A. trojana*.

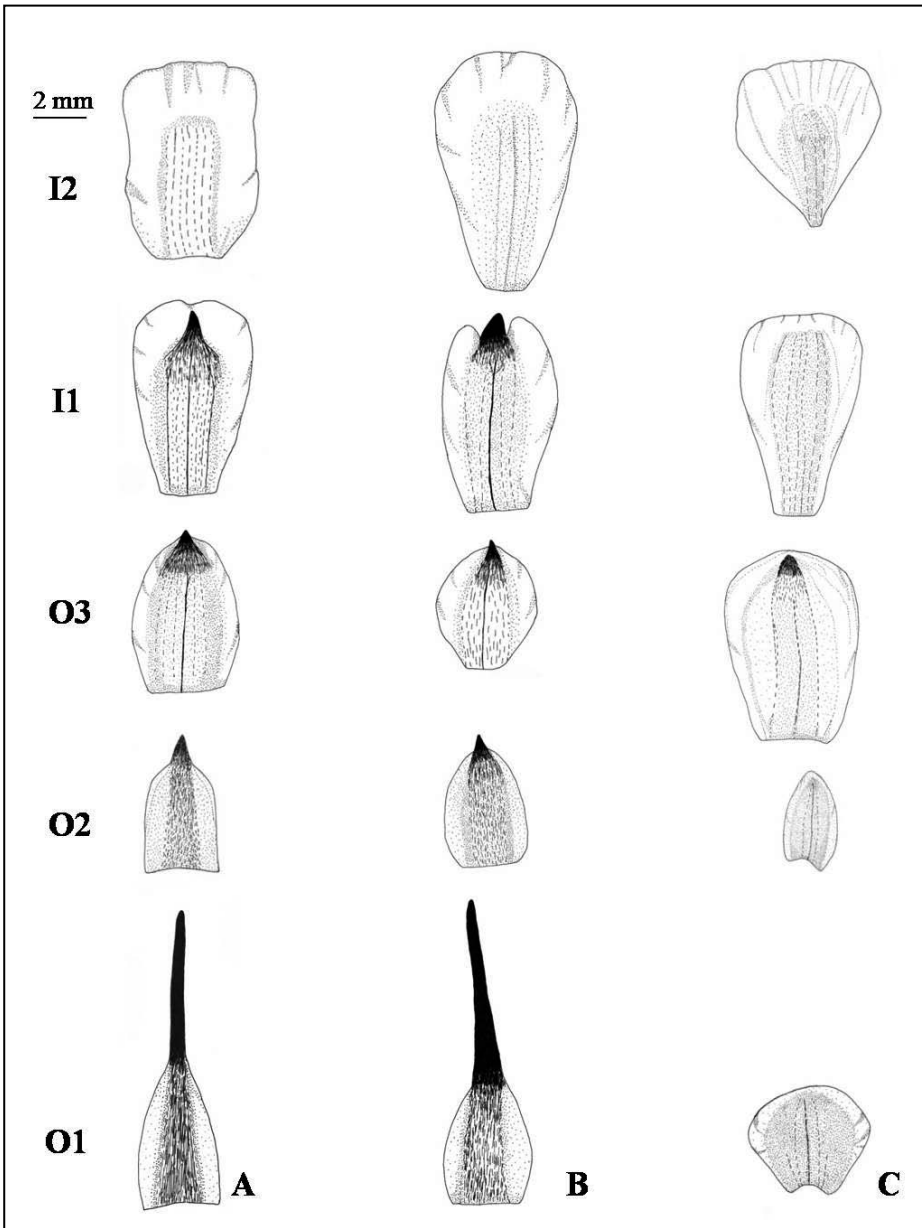


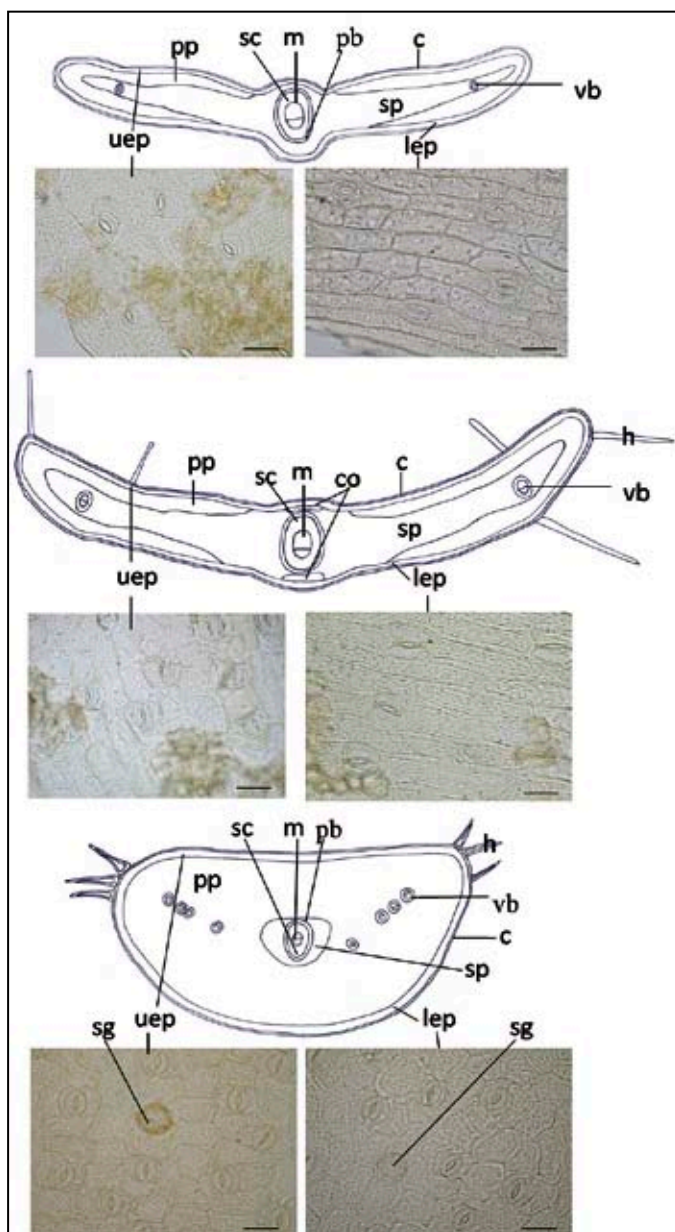
Fig. 7. Bracts of A - *A. cariensis*, B - *A. rumelica*, C - *A. trojana*; O - outer bract; I - inner bract.



### Leaf anatomical characteristics

Plumbaginaceae have a characteristic feature, namely occurrence on both leaf and stem of characteristic epidermal glands, which secrete mucilage and calcium salts. These secretory structures are occasionally referred to as chalk glands, on the account of the calcareous matter exuded from them which covers the leaf surface in some species. Secretory cells filled with plumbagin can also be found on the stem and root of many species (Metcalf 1950).

The secretory glands are clearly visible on both surface and cross section of leaves in the examined species (Figs 8, 9).



The leaves are of the isobilateral type and amphistomatic, with anisocytic stomata type (Fig. 8). The result of stomata index is given in the Table 2.

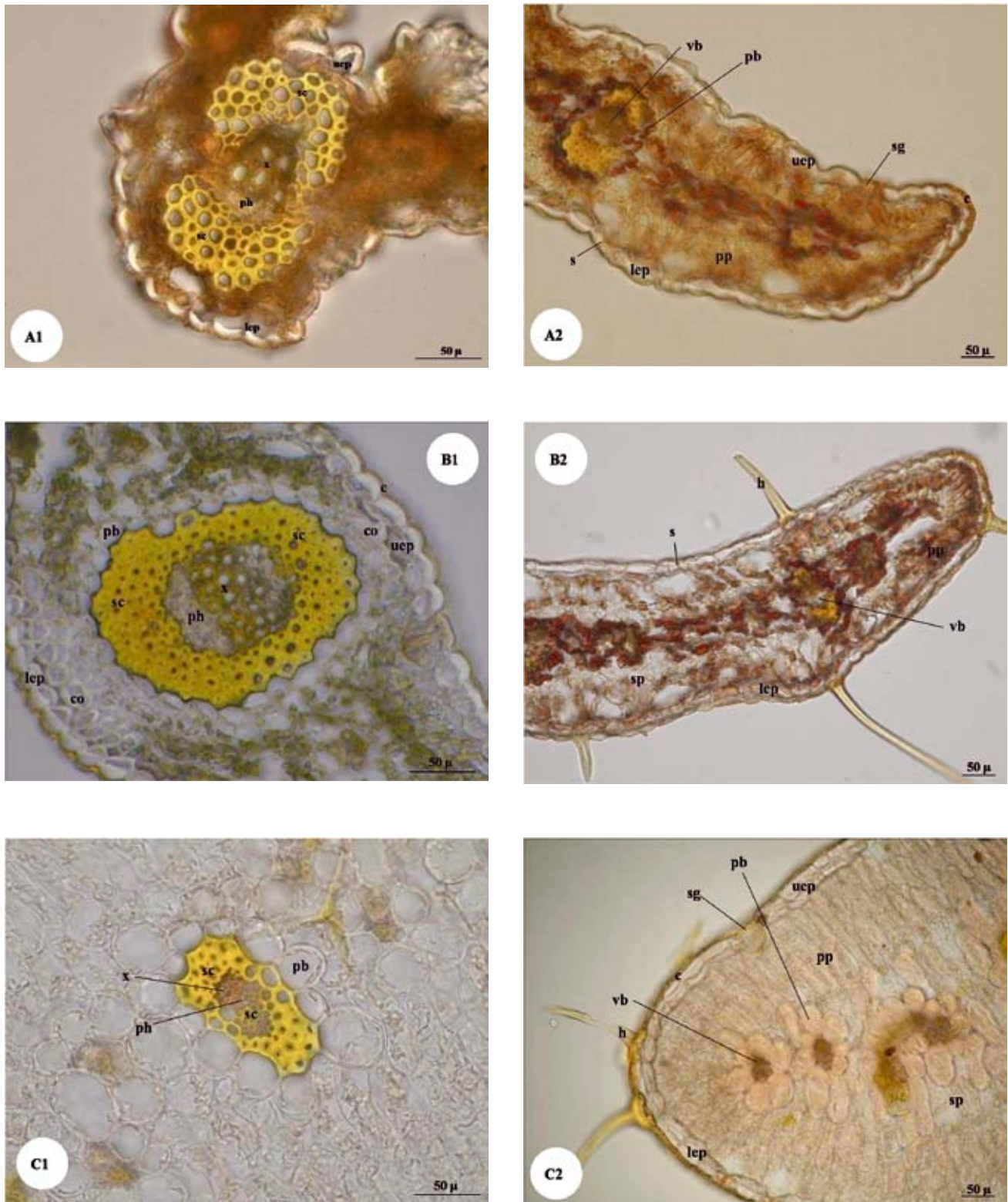
In the transverse section, the upper and lower epidermises comprise uniseriate oval, square and rectangular cells. Both epidermises are covered with a cuticle of approximately the same thickness. Covering trichomes are found generally in *A. trojana* and *A. rumelica*, seldom in *A. cariensis*. The trichomes are unicellular: long in *A. rumelica* and *A. cariensis*, short in *A. trojana*. The mesophyll is composed of (1-)2-4-layered palisade tissue and 1-2 layered spongy parenchyma. In *A. trojana*, the lower palisade parenchyma cells are 3-4 layered and the upper palisade parenchyma cells are 2-3 layered. Similarly, in *A. cariensis* and *A. rumelica* the lower and upper palisade parenchyma cells are 2-3 layered (Fig. 9).

Vascular bundles occur in the central area. The central vessel is more developed. The xylem faces towards the upper surface, while the phloem faces to the lower epidermis. All vascular bundles are generally surrounded first by a sclerenchymatic, then by a parenchymatic bundle.

In the midrib region, the vascular bundle is surrounded by 3-5 layered sclerenchymatic tissue in *A. cariensis* and *A. rumelica*, and 2-3 layered sclerenchymatic tissue in *A. trojana*. Only in *A. rumelica*, 1 seldom 2 seriate collenchymatous cells are found under the upper and lower epidermises.

In the surface section, epidermal cell sizes differ from the upper and lower surface in *A. cariensis* and *A. rumelica*. There is no obvious difference in *A. trojana*. Detailed characteristics of the species leaves in the surface section are given in Table 2.

**Fig. 8.** Schematic drawing of leaf cross section and photographs of leaf surface section: **A** - *Armeria cariensis*, **B** - *A. rumelica*, **C** - *A. trojana*; **c** - cuticule, **co** - collencyma, **h** - hair, **lep** - lower epidermis, **m** - midrib, **pb** - parenchymatic bundle, **pp** - palisade parenchyma, **sc** - sclerenchyma, **sp** - spongy parenchyma, **sg** - secretory gland, **uep** - upper epidermis, **vb** - vascular bundle. Scale bar; 50  $\mu$ m.



**Fig. 9.** Leaf anatomy. A1, B1 and C1 are midrib regions; A2, B2 and C2 are leaf parts; A1, A2 – *Armeria cariensis*, B1, B2 – *A. rumelica*, C1, C2 – *A. trojana*; h – hair, co – collenchyma, lep – lower epidermis, pp – palisade parenchyma, s – stomata, sc – sclerenchyma, sg – secretory gland, sp – spongy parenchyma, pb – parenchymatic bundle, ph – phloem, x – xylem, uep – upper epidermis, vb – vascular bundle.



Table 2. Characteristics of the *Armeria* species leaves in the surface section.

Taxon	Stomata index		Upper epidermal cells		Lower epidermal cells	
	Upper leaf surface	Lower leaf surface	Average thickness ( $\mu\text{m}$ ) (lowest-highest)	A. length ( $\mu\text{m}$ ) (lowest-highest)	A. thickness ( $\mu\text{m}$ ) (lowest-highest)	A. length ( $\mu\text{m}$ ) (lowest-highest)
<i>cariensis</i>	13.71	14.19	58.54 (47.62–79.77)	91.40 (68.55–120.24)	35.22 (21.68–47.65)	162.19 (96.71–250.57)
<i>rumelica</i>	12.36	13.46	31.42 (21.24–46.54)	84.40 (25.71–141–19)	48.94 (27.98–66–68)	89.17 (57.22–119.02)
<i>trojana</i>	10.65	11.13	33.53 (20.58–60.79)	51.58 (25.75–90.70)	39.89 (17.92–43.88)	61.66 (44–95–80.15)

### Chromosome numbers

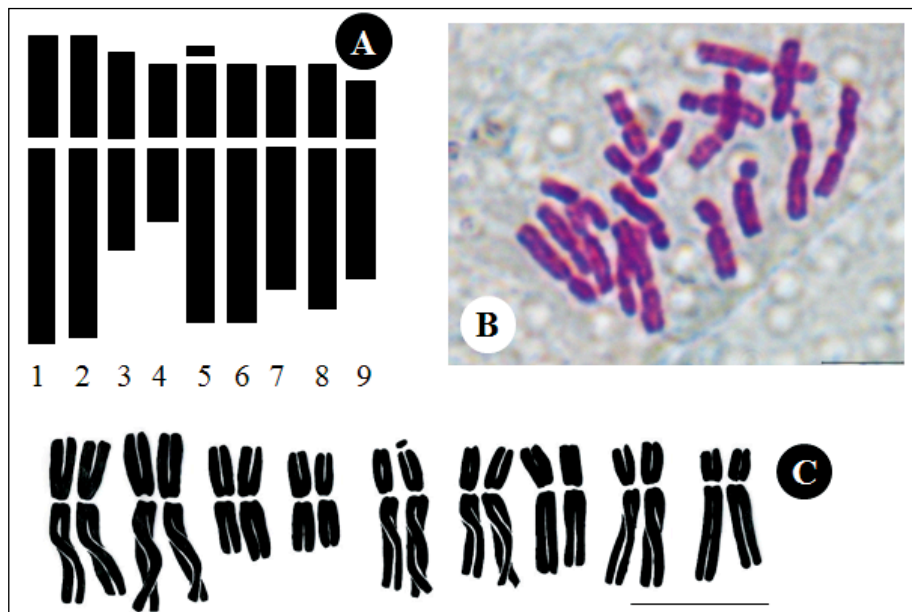
The chromosome number of *Armeria* is almost all diploid, with  $2n:18$ , and seldom polyploid (Anchev 1993; Baumel et al. 2009; Fedorov 1974). The chromosome number of *A. rumelica* was counted as  $2n:18$ , diploid, and a karyogram was prepared (Anchev 1993).

The chromosome number and karyotype morphology of *A. trojana* is presented here for the first time. The species is diploid, with  $2n=18$ . The chromosome

lengths range from  $7.2 \mu\text{m}$  to  $3.39 \mu\text{m}$ . The chromosome arm ratio ranges from  $1.04 \mu\text{m}$  to  $3.56 \mu\text{m}$ . Six out of nine pairs of the complements are metacentric, while the others are submetacentric and acrocentric. The karyotype formula is given as  $2n=6m+10sm+2as$  and one chromosome has a satellite. Detailed morphological features of the chromosomes obtained from these species are given in Table 3. The ideogram and karyogram are presented in Fig. 10.

Table 3. Morphomeric data on chromosomes of *A. trojana*.

Chromosome pair No	Long arm (L) ( $\mu\text{m}$ )	Short arm (S) ( $\mu\text{m}$ )	Total length ( $\mu\text{m}$ )	Arm ratio (L/S)	Relative length %	Chromosome type
1	4.33	2.51	6.84	1.72	14.52	sm
2	4.12	2.78	6.9	1.48	14.64	m
3	2.26	1.9	4.16	1.18	8.83	m
4	1.82	1.74	3.56	1.04	7.55	m
5	4.04	1.73	5.77	2.33	12.25	sm
6	3.19	1.64	4.83	1.94	10.25	sm
7	3.05	1.59	4.64	1.91	9.85	sm
8	3.74	1.86	5.6	2.01	11.88	sm
9	3.74	1.06	4.8	3.52	10.19	as

Fig. 10. Detailed karyological features of *A. trojana*.

A – ideogram,  
B – photograph of chromosomes,  
C – karyogram  
Scale bar  $5 \mu\text{m}$ .

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