



# *Anemone* L. (Ranunculaceae): comparative morphology and taxonomy of the species from the Balkan flora

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**ABSTRACT:** The results of the study of comparative morphology and taxonomy of ten species of the genus *Anemone* L. in the flora of the Balkan peninsula are presented. These ten species belong to five sections: *A. coronaria* L. and *A. hortensis* L. to sect. *Anemone*; *A. sylvestris* L. and *A. baldensis* L. to sect. *Eriosephalus* Hook. f. & Thoms.; *A. nemorosa* L., *A. ranunculoides* L. and *A. trifolia* L. to sect. *Anemonanthea* DC.; *A. apennina* L. and *A. blanda* Schott. & Kotschy to sect. *Tuberosa* (Ulbr.) Juz. and *A. narcissiflora* L. to sect. *Omalocarpus* DC. Special attention was paid to new and additional essential morphological characters: shape of fruiting heads, fruits and carpels (including styles and stigmas), and stamens (peculiarities of filaments and anthers), anastomosing veins on tepals, shape of caudices or rhizomes, monopodial or sympodial stems, involucral leaves (similar or dissimilar to basal leaves). In addition, some characters which were previously overlooked are also presented: dimorphic perianth in *A. nemorosa*, *A. ranunculoides*, *A. apennina* and *A. blanda*; stipule-like appendages at the base of basal leaf petioles in all species of the sections *Anemone* and *Tuberosa*; stolon-like ephemeric rhizomes in *A. coronaria* and finally seasonally dimorphic basal leaves in *A. hortensis* but also hypogean germination and developing of basal leaves after anthesis in all species of the section *Anemonanthea* in contrast to species of other sections, caudices and monopodial scapes in *A. baldensis* from sect. *Eriosephalus*, monopodial scapes but short vertical rhizomes in *A. narcissiflora* (and other species of sect. *Omalocarpus*).

**Key words:** Balkan peninsula, *Anemone* species, essential morphological characters, taxonomy.

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## INTRODUCTION

As a result of the long-standing comparative morphological analysis of the genus *Anemone* L. (Ranunculaceae Juss.), the worldwide treatment of *Anemone* was elaborated (ZIMAN *et al.* 2008) in which the modern view on its taxonomy was presented. The study was based on the main principles of monographs of the genus *Anemone* (ULBRICH 1905/1906; TAMURA, 1968, 1991), but these principles were considerably reviewed and, as a result, the distinguishing characters at each taxonomic level were changed and enlarged. Therefore, according to ZIMAN *et al.* (2008), the genus *Anemone* L. s. str. throughout the

world includes 15 subgenera, 23 sections, 4 subsections, 23 series and 118 species.

In the flora of the Balkans, there are ten *Anemone* species belonging to five sections: *A. coronaria* L. and *A. hortensis* L. (sect. *Anemone*); *A. sylvestris* L. and *A. baldensis* L. (sect. *Eriosephalus* Hook. f. & Thoms.); *A. nemorosa* L., *A. trifolia* L. and *A. ranunculoides* L. (sect. *Anemonanthea* DC.); *A. apennina* L. and *A. blanda* Schott. & Kotschy (sect. *Tuberosa* (Ulbr.) Juz.) and *A. narcissiflora* L. (sect. *Omalocarpus* DC.).

The initial objectives of this study were to give new essential morphological characters relevant for the differentiation of the species of the genus *Anemone* in the

Balkan peninsula, as well as to present some additional morphological characters which were previously overlooked, and to add some geographical and ecological comments on *Anemone* species in the local floras in the Balkans.

## MATERIAL AND METHODS

The basis of our treatment of *Anemone* was the examination of herbarium material which included c. 10000 specimens from more than 30 major herbaria in Central and partly in South Europe (e.g., UK – K, BM, E, LINN; Austria – W, WU; France – P, MARSSJ, etc.), North America (US, BKL, GH), and a lot of herbaria from the former Soviet Union (KW, LE, MHA, LWS, TASH, TAD, TBI, VLA, etc.). Besides, we analyzed more than 1000 living plants from approximately 100 *Anemone* populations belonging to these ten species. Both flowers and fruits samples (c. 500) were examined in detail including light and scanning microscopy.

For this manuscript we used our data from herbaria of Central Europe but also from Bulgaria (SO, SOM) and Serbia (BEO, BEOU) in which we worked while taking part in IV and V Balkan Botanical Congresses (in 2006 in Bulgaria – SO, SOM, in 2009 in Serbia – BEO, BEOU). In addition, during Mid-Congress and Post-Congress botanical field trips we made field observations in Bulgaria (Vitosha National Park, Rhodopes, Beglika Nature Reserve and Koupena) and Serbia (Maljen Mts., Medvednik and Jablanik Ranges). We also visited the Montenegro stands: briefly in June 2009 in the Durmitor National Park and during ten days in August 2010 in Durmitor and Canyon Tara. As a whole, in the Balkans we collected four *Anemone* species (*A. nemorosa*, *A. ranunculoides*, *A. sylvestris* and *A. narcissiflora*), but we studied these species in detail (including a field study) in the Ukraine, especially in the Carpathians and Crimea. A further six *Anemone* species were studied in natural populations in Mediterranean Europe (*A. coronaria* and *A. hortensis* in SW France and E Spain), North Caucasus (*A. blanda* and *A. apennina* in the Stavropol Region of Russia) and in the Alps (*A. baldensis* and *A. trifolia* in Austria).

## RESULTS AND DISCUSSION

In preparing the comparative-morphological treatment, we paid peculiar attention to principles of the distinguishing Keys in the “Flora Europaea” (TUTIN 1964; CHATER 1973) and in TAMURA (1968, 1991) and to the participation of *Anemone* species in the local “Floras” of the Balkans (BECK 1903; BORNMÜLLER 1933; KUZMANOV 1970; GAJIĆ 1992; MICEVSKI 1985; STRID 2002; STRID & TAN 1986; ANČEV 1992; DOMAC 1994; NIKOLIĆ 1997; MARTINČIĆ *et al.*

1999; ROHLENA 1942). We also examined the initial papers on *Anemone* throughout the world and in the Balkans including valuable data on its taxa (e.g., PRITZEL 1842; VISIANI 1847; SCHLÖSSER & VUKOTINOVIĆ 1876; FRITSCH 1894; ULBRICH 1905/1906; HAYEK 1927).

For the preparation of ecological and geographical notes we used the following literature sources: GAJIĆ 1984; REDŽIĆ 1988, 2007; GEORGIADIS *et al.* 1990; OBRATOV-PETKOVIĆ *et al.* 2007; TRPIN & VREŠ 1995; ELEFTHERIADOU & RAUS 1996; HANLIDOU & KOKKINI 1997; DAKSKOBLER 1994; DZWONKO *et al.* 1999; REDŽIĆ *et al.* 2000; PANDŽA 2003; LAKUŠIĆ *et al.* 2004; FET & POPOV 2007; RANĐELOVIĆ *et al.* 2008; BULIĆ *et al.* 2008; BERGMEIER & DIMOPOLUOS 2001; RAKAJ 2009; REDŽIĆ & BARUDANOVIĆ 2010.

## CONSPECTUS

*Anemone* L., Sp. Pl., 1: 538, 1753, nom.cons.

Type species: *A. coronaria* L.

Subgen. *Anemone*, Tamura, Acta Phytotax. Geobot.

42: 180, 1991

Sect. *Anemone*, Tamura, Acta Phytotax. Geobot. 42:

180, 1991

=*Oriba* Adans. p.p., Fam. Pl. 2: 459, 1763.

=section *Oriba* (Adans.) Spach, Hist. Nat. Veg. 7: 250, 1839

=section *Anemonanthea* DC. p.p., Syst. 1: 196, 1817.

=section *Eriocephalus* Hook f. & Thomson p.p., Pl. Ind. 1: 20, 1855.

Subsection *Anemone* Starod., Vetrenytsy 120. 1991

=subsection *Coronarioides* P. Popov, Tr. Tiflis. Bot.

Sada 12: 4, 1913.

1. *A. coronaria* L., Sp. Pl. 1: 538, 1753

Type: “Habitat in Oriente, Constantinopoliallata”

(Conserved type: LINN n. 710.9.1)

2. *A. hortensis* L., Sp. Pl. 1: 540, 1753 Type:

“Habitat ad Rhenum et Italia” (Lectotype herb. Clifford n. 334)

Sect. *Eriocephalus* Hooker f. & Thomson, Fl. Ind. 1: 20, 1855

=sect. *Anemonospermos* DC., Syst. I: 196, 1817, p.p.

=sect. *Diplocalymnata* Spreng., Syst. Veg. 2: 660, 1825

Ser. *Baldenses* Ulbr., Bot. Jahrb. 36: 204, 1906

3. *A. baldensis* L., Mantissa 78, 1767

Type: “Gallia, Alpes Delphinatus et Galloprovinciae”

(lectotype: LINN)

Ser. *Sylvestres* Juz., Komarov Fl. URSS 7: 252, 1937

4. *A. sylvestis* L., Sp. Pl. 1: 540, 1753.

Type: “Habitat in Germania” (Lectotype: LINN

n.710.18)

Subgen. *Anemonanthea* (DC.) Juz., Komarov Fl.

URSS 7: 241, 1937

=*Anemonoides* Mill., Gard. Dict. Ed. 4: 91, 1754

=*Anemonanthea* S.F. Gray, Nat. Arr. Brit. Pl. 2: 724, 1821

=*Arsenjevia* Starod., l.c., 1989

Sect. *Anemonanthea* DC., Syst. Nat. 1: 196, 1817

=sect. *Sylvia* Gaudin, Fl. Helvet. 3: 490, 1828, p.p.

=sect. *Hylaelectron* Irmisch, Bot. Zeitung 19, 1856

Ser. *Anemonanthea* Juz., l.c., 1937

5. *A. nemorosa* L., Sp. Pl. 1: 541, 1753

Type: "Fl. Suec. 459 *Ranunculus sylvarum*. Habitat in Europaea asperis, duris, nemoribus" (lectotype: LINN n. 710.15)

6. *A. ranunculoides* L., Sp. Pl. 1:541, 1753

Type: *Ranunculus nemorosus luteus*. Habitat in Europe borealis pratis nemorosis" (lectotype: LINN n. 710.30)

Sect. *Tuberosa* (Ulbr.) Juz., Komarov Fl. URSS 7: 241, 1937

=Subsect. *Tuberosa* Ulbr., Bot. Jahrb. 36: 204, 1906

7. *A. apennina* L., Sp. Pl. 1: 541, 1753

Type: "Habitat in Apenninis, Anghia. *Ranunculus nemorosus, florum caeruleo*" (lectotype: LINN n. 710.28)

8. *A. blanda* Schott & Kotschy, Osterr. Bot.

Wochenbl. 4: 129, 1854

Type: Turkey. "In monte Tauro. Aestate 1836, Th.

Kotschy (isotype designated by Demiriz in 1967 – K)

Subgen. *Omalocarpus* (DC.) Juz., Komarov Fl. URSS 7: 241, 1937

Sect. *Omalocarpus* DC., Syst. 1: 196, 1817

=*Homalocarpus* Schur, Enum. Pl. Transsily. 2: 1886

=*Anemonastrum* Holub, Folia Geobot. Phytotax. 8: 165, 1973

Ser. *Involucratae* Ulbr., Bot. Jahrb. 36: 252, 1906

9. *A. narcissiflora* L., Sp. Pl., 1: 542, 1753

Type: "Habitat in Alpihus Austriae, Helvetiae, Sibiriae" (lectotype: LINN n. 710.19)

subsp. *narcissiflora*

var. *narcissiflora*, Taxon. Evol. *Anemone narcissiflora* complex 34, 1997

**Distribution of *Anemone* species in the floras of the Balkans.** *Anemone* species in the territory of the Balkans belong to several floristic elements [Mediterranean xerophytic (*A. coronaria*, *A. hortensis*), Mediterranean-Pontic (*A. apennina*, *A. blanda*), European mountain-forest (*A. trifolia*), European high-mountain (*A. baldensis*), Eurasian steppe-forest (*A. sylvestris*), Eurasian forest (*A. nemorosa*, *A. ranunculoides*) and Eurasian high-mountain (*A. narcissiflora*)]. According to literature and our data, the habitats of *Anemone* species in the Balkans are as follows: *A. apennina* – mainly semi-shaded forest habitats, alt. 500-1500 m; *A. baldensis* – subalpine and alpine habitats, alt. over 1800 m; *A. blanda* – semi-shaded or open slopes, alt. 150-1000 m; *A. coronaria* – mainly open slopes, olive grove, garigue, maquis, phrigana but sometimes

abandoned fields, alt. 0-500 m; *A. hortensis* – herbaceous communities, alt. 0-500 m; *A. narcissiflora* – subalpine and alpine habitats, mainly open slopes, alt. 1500-2500 m; *A. nemorosa* – shady or semi-shady forests, alt. 100-1800 m; *A. ranunculoides* – shady or semi-shady forests, alt. 100-1800 m; *A. sylvestris* – semi-shady steppe-forest communities, alt. 100-1500 m; *A. trifolia* – high-mountain forests, alt. 800-1800 m.

Analysis of the distribution of *Anemone* species in the local floras in the territory of the Balkans (Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Macedonia, Montenegro, Serbia and Slovenia) showed that only three species (*A. nemorosa*, *A. ranunculoides*, *A. sylvestris*) are common to all floras. Such phenomenon possibly reflects the long-standing participation of *Anemone* species in the different floristic complexes (mainly mountain).

We used the brief but excellent survey of STEVANOVIĆ *et al.* (2009) on the structure of mountain ranges throughout the Balkans to understand the patterns of participation of *Anemone* species in the Balkan floras. According to these data, the Dinaric Mts. (very close to the Alpine mountain system) are situated in the territory of Slovenia (extreme north-west of the Balkans) and they extend down throughout Croatia, Bosnia and Herzegovina, and Montenegro to N Albania. The next Scardo-Pindic mountain system includes the southern part of the Balkan peninsula and its ranges are situated in the territories of Serbia, W Macedonia, Albania, Bulgaria and Greece. Meanwhile, the Rhodope-Rila mountain system includes SE Serbia, E Macedonia and mainly Bulgaria.

The largest number of *Anemone* species (9) was noted in the flora of Montenegro (because of the presence of high mountains and sea coast). *A. nemorosa*, *A. ranunculoides* and *A. sylvestris* are widely distributed here but the Mediterranean species (*A. coronaria*, *A. hortensis*, *A. apennina*, *A. blanda*), Eurasian *A. narcissiflora* and C European *A. baldensis* are rare (BULIĆ *et al.* 2008), and C European *A. trifolia* is absent.

The flora of Slovenia includes 8 *Anemone* species. *A. trifolia* grows only in Slovenia (in the subalpine beech forests), and after MARINČEK *et al.* (1989), there are more than 40 localities of this plant. Moreover, SURINA (2002) noted that in the western part of the Trnovski Mt. this plant is the differential species of the alliance *Omphalodo-Fagetion*. However, the Mediterranean species *A. hortensis* and *A. apennina* are rare (RAKAJ 2009), and the Mediterranean *A. coronaria* and *A. blanda* are absent.

There are 8 *Anemone* species occurring in the floras of Croatia and Macedonia. In these floras 7 *Anemone* species are common. In both of them *A. trifolia* is regarded as absent, while in Macedonia *A. narcissiflora* and in Croatia *A. blanda* are absent. In addition, in Croatia *A. baldensis* is rare and in Macedonia its localities are unknown (only

short notes from Orlovo Brdo).

The floras of **Albania**, **Bosnia** and **Herzegovina** and **Bulgaria** include 7 *Anemone* species. The C Europaeen *A. baldensis* and *A. trifolia* are absent in all of them but *A. coronaria* is absent in the natural flora of Bulgaria, *A. blanda* in Bosnia and Herzegovina and *A. narcissiflora* in Albania and Greece. Although Albania is situated in the SE of the Balkans, its flora includes *A. apennina* (growing in the National Park Thethl in forests of *Picea* and *Fagus* – RAKAJ 2009), meanwhile *A. coronaria* and *A. hortensis* are participants of its coastal vegetation.

The smallest number of *Anemone* species is in the flora of **Serbia** and **Greece** (5). STRID (1986) recognized in the mountain flora of Greece only *A. blanda* and *A. nemorosa* (growing at 300 to 1500 m), and he noted *A. sylvestris* and *A. narcissiflora* as doubtfully recorded species. Meanwhile, GEORGIADIS *et al.* (1990) found *A. coronaria* and *A. hortensis* at NW Peloponnese, Strofilia, in the mountain forests of *Quercus macrolepis* and *Pinus halepensis*. Subsequently, *A. nemorosa* and *A. ranunculoides* were found by ELEFTHERIADOU & RAUS (1996) in the virgin forest of *Picea abies*. In addition, BERGMEIER & DIMOPOULOS (2001) examined both latter species on shady slopes of the Mts. Voras, at 500-1500 m, in the northern part of Greece, on the border of Macedonia in forest of *Fagus sylvatica*.

The low number of *Anemone* species in the flora of **Serbia** is possibly because of its remoteness from the sea coast (absence of the Mediterranean *A. coronaria*, *A. hortensis* and *A. blanda*) and from the C Asian centre of distribution of the high-mountain plants (absence of *A. baldensis* and *A. trifolia*). The mountain Mediterranean *A. apennina* is rarely noted in C Serbia – Župa region, Šumadija – village Jasika near Kruševac and in Metohija

region – Mt Koritnik (GAJIĆ 1992). In recent times it was also recorded in SE Serbia in the gorge of the river Svrljiški Timok, on open slopes (BOGOSAVLJEVIĆ *et al.* 2008).

#### Survey of *Anemone* species in limits of five sections in the flora of the Balkans

*Anemone* sect. *Eriocephalus* in the Balkans

**Specimens** examined in the Balkan peninsula:

***A. coronaria***

**Greece:** prope Athenas, 13.3.1850, Orphanides (KW)

***A. hortensis***

**Albania:** Bucht von Valona, am Amfstieg nach Kanina, 1980, K. Riedl (WU)

**Bulgaria:** Strandza, Zwerdec, ad rivum Veleka Elesnica, 1956, Petric (WU)

**Greece:** Attica, Mt. Pentelico, 13.3.1850, Orphanides (KW); Hagia Glykaria, 3.4.1874, Th.Heldreich, (WU); 17.3.1894, Th.Heldreich (WU); Athene, 6.3.1969, K.Riedl (WU); Kavadari, Drenovo, 1972, Th.Heldreich (WU).

**Macedonia:** Hagion Oros prope coenobium Prodrom, 1975, K. Riedl (WU)

The essential characters of subgen. *Anemone* and sect. *Anemone* given by TUTIN (1964) and CHATER (1993) are densely lanate fruits (achenes) with hairs longer than their diameter and by TAMURA (1991) – sessile fruits densely covered with long woolly hairs, subsessile involucre leaves, 5-20 tepals and tuberous rhizomes. As a result of the field study of *A. coronaria* and *A. hortensis* which was done by Ziman & Medail in early spring of 1997 in South Western Europe (France, Maritime Alps), they noted in both species stipule-like appendages at the base of basal leaf petioles (Fig. 1) and stolon-like ephemeric rhizomes (present during about three weeks in the early spring)



Fig. 1. Stipule-like bases of basal leaf petioles from species of *Anemone* section *Anemone*: A. *A. coronaria*; B. *A. hortensis*.



in *A. coronaria*. In *A. hortensis* these authors observed seasonally dimorphic basal leaves: in early spring trisected blades with few obtuse lobules develop, while in late spring much divided blades with numerous acute lobules appear. In a recent publication (EHRENDORFER *et al.* 2009), we supplementarily provided additional characters, such as: shape of fruiting heads, fruits and carpels (including styles and stigmas), shape of basal leaves (in rosette) and shape of tubers and rhizomes.

According to TUTIN (1964) *A. coronaria* is characterized by non-yellow flowers having 5-8 elliptic tepals and deeply cut basal leaves. Beside these characters, we added the following: much divided basal and involucreal leaves, 6-13 tepals with 5-9 basal veins and 15 or more anastomoses, and achenes with marginal ribs 0.3-0.4 mm wide (Figs. 2A, 3A).

As a different feature of *A. hortensis*, 12-19 narrowly elliptic tepals were also reported by TUTIN (1964). Beside this character, we considered small divided basal and involucreal leaves, 10-18 tepals with 3-5 basal veins and 1-3 anastomoses, and achenes with marginal ribs c. 0.2 mm wide (Figs. 2B, 3B).

After a critical survey of many specimens of *A. hortensis*, *A. pavonina* Lam., *A. fulgens* J. Gay, *A. stellata* Lam., *A. latifolia* Bellardi ex Re and *A. heldreichiana* Gand., we regard the latter to be synonyms of the former (*A. hortensis*). Also we consider *A. hortensis* as a rather polymorphic species without distinct infraspecific taxa. Future chromosomal or DNA studies of the population would help to resolve the problem of the *A. hortensis*-aggregate.

#### *Anemone* sect. *Eriosephalus* in the Balkans

**Specimens** examined in the Balkan peninsula:

##### *A. baldensis*

**Slovenia:** Dinaric Alps, Felsen und Schutthalden des Troglavkessels, 4.7.1907, Janchen (WU); Kameshnica, Auf dem Kamme der Gipfel Kote, 4.7.1909, Handel-Mazzetti (WU).

##### *A. sylvestris*

**Bulgaria:** С Пирин, над град Бансю, 17.06.1902, Д Стоянов (SOM); Витоша, около Меча Могила, 30.05.1997, С. Санев (SOM); Витоша, около Боснек, 15.05.2005, 30.05.1997, М. Куртева (SOM); Лозенска Планина, в р-не Повлорак, 25.06.1999, А. Виткова (SOM); Знеполски р-н, Земенска Планина, Полска Скаквица, 23.07.2003, А. Япракова (SOM); Знеполски р-н, Ченчи Планина, под Петров кръст, 04.06.2005, К. Василев (SOM); Тепичките край, с. Невша, Варненско, 09.05.2007, А. Петрова (SOM).

TUTIN (1964) in his treatment of the genus *Anemone* included *A. sylvestris* and *A. baldensis* in sect. *Anemone*, while ULBRICH (1905/1906) and TAMURA (1991) treated these two species as members of the sect. *Eriosephalus*.

According to TAMURA (1991), the most essential characters of representatives of the sect. *Eriosephalus* are subsessile fruits, involucreal leaves resembling the basal, 5-10 tepals and not tuberous rhizomes. We accepted the opinion of both ULBRICH (1905/1906) and TAMURA (1991), but also suggested that not compressed fruits should be added to the list of important morphometric characters. We also observed noticeable distinctions among these two species, since they belong to two different groups of plants whose status corresponds to various series. *A. baldensis* belongs to ser. *Multifida* Ulbr. and is characterized by caudices, monopodial stems and root-stocks, subsessile involucreal leaves, tepals with few anastomosing veins, basally dilated carpels-fruits with styles 2-6 mm long and linear stigmas (Fig. 2C, 3C). *A. sylvestris* belongs to ser. *Sylvestres* and has rhizomes, sympodial stems and adventitious roots, petiolate involucreal leaves, tepals with many anastomosing veins, basally narrowed carpels-fruits with styles c. 1 mm long and globose stigmas (Figs. 2D, 3D) (ZIMAN *et al.* 2008).

#### *Anemone* sect. *Anemonanthea* in the Balkans

**Specimens** examined in the Balkan peninsula:

##### *A. nemorosa*

**Bulgaria:** Mt. Vitosha, 22.06.2006, S. Ziman (KW); Balkan Natural Park Vrachanski, *Fagus sylvatica* community, 26.06.2006, E. Bulakh (KW); Beglika Nature Reserve, Trigrad village, 27.06.2006, O. Korableva (KW)

**Serbia:** Maljen Mt., forest of *Pinus sylvestris*, 09.09.2009, O. Korableva (KW);

National Park Tara, Tara plateau, Mitrovac, 13.09.2009, O. Korableva (KW);

Mt. Kopaonik, forest of *Fagus moesiaca*, 14.09.2009, O. Korableva (KW).

**Montenegro:** Durmitor, 12.09.2009, S. Ziman, N. Dremljuga (KW); Žabljak, Tara, 26.08.2010, S. Ziman, N. Dremljuga (KW); Durmitor, forest close Black Lake, 28.08.2010, S. Ziman, N. Fedoronchuk (KW).

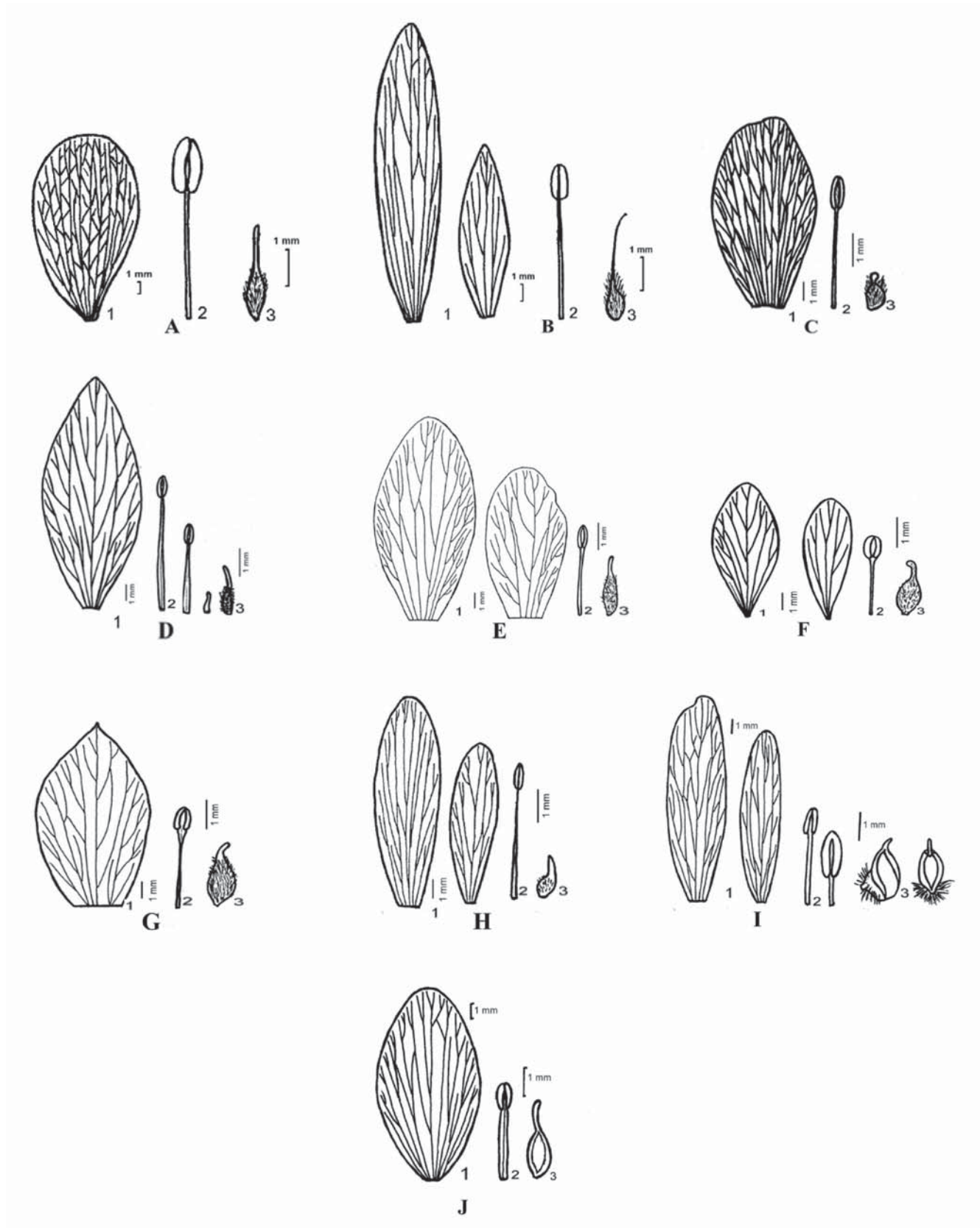
##### *A. ranunculoides*

**Bulgaria:** Mt. Vitosha, 22.04.1952, B. Kitanov (KW); Mt. Vitosha, 22.06.2006, S. Ziman (KW).

**Montenegro:** Durmitor, 12.09.2009, S. Ziman, N. Dremljuga (KW); Žabljak, Tara, 26.08.2010, S. Ziman, N. Dremljuga (KW); Durmitor, forest close to Black Lake, 28.08.2010, S. Ziman, N. Fedoronchuk (KW).

**Slovenia:** Kobic, Kobarid, 25.4.1980, Chiapella 10186 (MHA).

In the flora of the Balkans there are two species included into sect. *Sylvia* Gaudin and characterized with not wooly achenes and short hooked styles (TUTIN 1964). However, in the monographs of the genus *Anemone* (ULBRICH 1905/1906, TAMURA 1968, 1991) these two species were included into the sect. *Anemonanthea* (DC.) Juz. According to recent publications (ZIMAN *et al.*



**Fig. 2.** Floral parts (1 – sepals; 2 – anthers; 3 – carpels) from taxa of *Anemone*: A. *A. coronaria*; B. *A. hortensis*; C. *A. sylvestris*; D. *A. baldensis*; E. *A. nemorosa*; F. *A. ranunculoides*; G. *A. trifolia*; H. *A. apennina*; I. *A. blanda*; J. *A. narcissiflora*

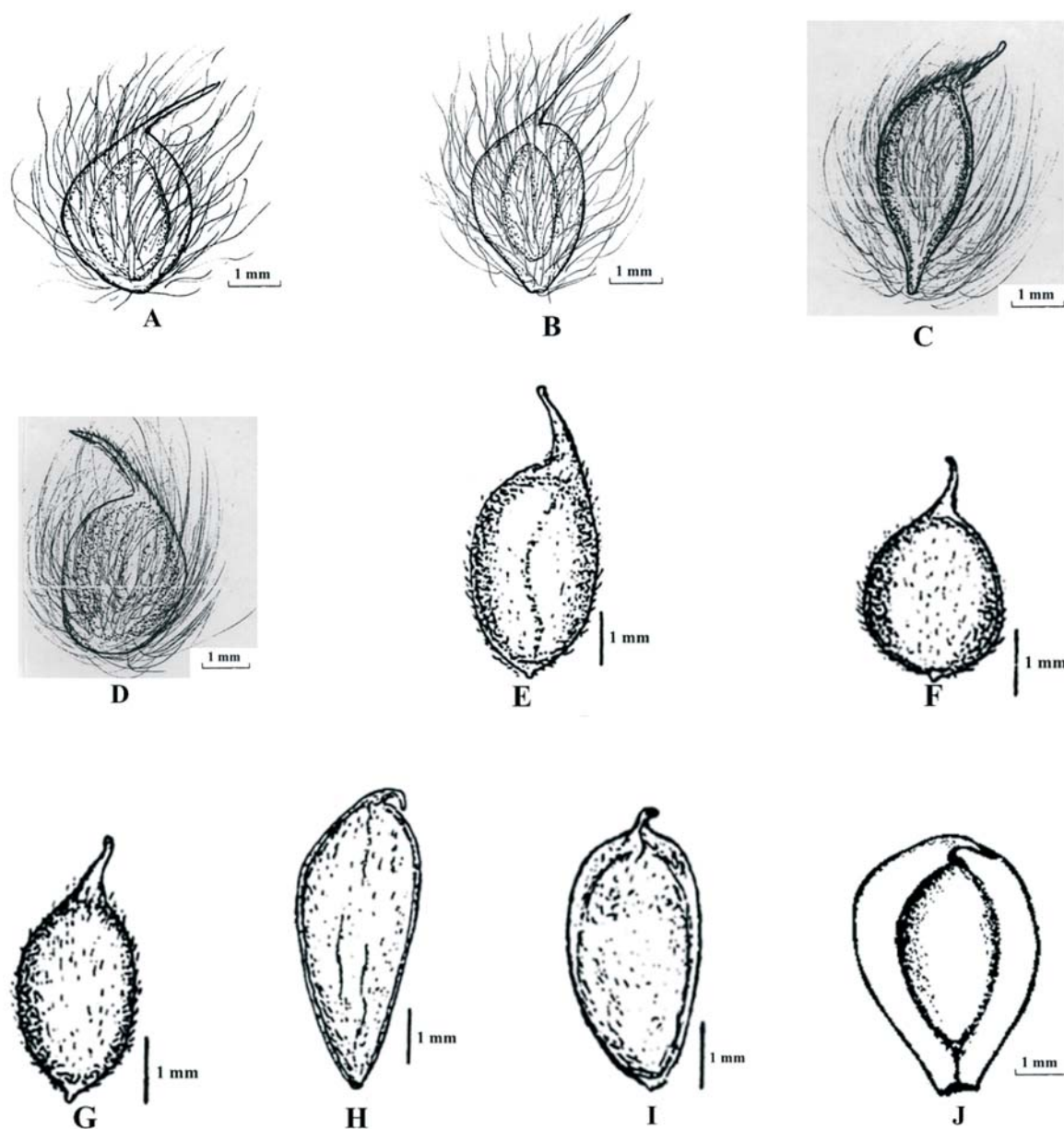


Fig. 3. Achenes from species of *Anemone*: A. *A. coronaria*; B. *A. hortensis*; C. *A. sylvestris*; D. *A. baldensis*; E. *A. nemorosa*; F. *A. ranunculoides*; G. *A. trifolia*; H. *A. apennina*; I. *A. blanda*; J. *A. narcissiflora*

2004), this section, together with sections *Tuberosa* Ulbr. and *Rosulantes* Ziman et Kadota, belongs to subgenus *Anemonanthea* (DC.) Juz.

TAMURA (1991) considered the following characters essential for sect. *Anemonanthea*: sessile, hardly compressed, shortly pubescent fruits, solitary or few flowers, petiolate involucrel leaves and usually elongate rhizomes. We added the following very important characters: mainly ovoid fruits-achenes covered with hairs shorter than 1 mm, involucrel leaves similar to basal leaves

and frequently of a larger size. It is interesting to note that in all specimens solitary basal leaves with distinct blades develop on rhizomes before blossoming, while few scale-like leaves develop at the base of the flowering shoot after blossoming.

According to TUTIN (1964), *A. nemorosa* is characterized by white petals glabrous beneath, *A. ranunculoides* by yellow petals with white hairs beneath, and *A. trifolia* – by tripartite leaves with serrate lobes. We regard such distinguishing characters essential and diagnostic for



differentiation at the specific level. In *A. nemorosa* carpel styles are c. 1 mm long, with dilated stigmas, 6-10 basally rounded tepals and petioles of involucreal leaves 1-3 cm long (Figs. 2E, 3E). In *A. ranunculoides*– carpel styles are 0.8-1.5 mm long, with linear stigmas, 5 basally narrowed tepals and involucreal leaf petioles 3-5 cm long. In *A. nemorosa* and *A. ranunculoides* cymes are one-flowered, dimorphic tepals are with several anastomosing veins, and basal and involucreal leaflets are 3-5-lobed, in *A. trifolia* cymes are few-flowered, monomorphic tepals are with solitary anastomosing veins and basal and involucreal leaflets are undivided (Figs. 2G, 3G). All three species are rather polymorphic, with several infraspecific taxa, for example: *A. nemorosa* – 17 varieties and 3 forms, *A. ranunculoides* – 3 subspecies and 2 varieties, *A. trifolia* – 3 subspecies. We accepted only 3 subspecies of *A. trifolia*: subsp. *trifolia*, *albida* (Mariz.) Ulbr. and *brevidentata* Ubaldi & Puppi.

**Anemone** sect. **Tuberosa** in the Balkans

Specimens examined in the Balkan peninsula

**A. apennina**

**Montenegro:** Montenegro, 10.05.1934, Piejovich (KRA); Pasma Lovzane, Cetyni do Ivanovej Korriy, 24.05.1973, Jasiewicz (KRAM).

**Greece:** Attica, Pentelico, 13.3.1850, Orphanides (KW).

**Macedonia:** Orlovo Brdo, prope Krilovak, 31.03.1965, Majer (Kram).

**A. blanda**

**Bulgaria:** prope Janevo, Sandanski, 22.04.1958, V. Velcev (CLUJ).

**Greece:** Attica, Pentelico, 03.04.1891, Halaczy (WU); Cephalonia, Mt. Ainos, 19.05.1951, Bolos *et al.* (BCC); Vigo, Bolos, Massales, 1958, Ninot (BCC); Rhodos Isl., Mt. Profet Elias, 24.03.1965, P. Davis 40348 (K).

*A. apennina* and *A. blanda* are members of sect. *Tuberosa* which is characterized by globose or irregular-shaped rhizomes, involucreal leaves having distinct petioles, solitary flowers with 8-20 tepals, sessile and hardly compressed, shortly pubescent fruits (TAMURA 1991). TUTIN (1964) included these two species into sect. *Sylvia* and he considered the specific state of *A. blanda* to be doubtful. KUZMANOV (1970) supported this opinion and accepted *A. blanda* as a subspecies of *A. apennina*.

From our data (ZIMAN *et al.* 2004, 2008), the most essential characters of the sect. *Tuberosa* are tuberous rhizomes, stipule-like bases of basal leaf petioles, dimorphic perianth (previously overlooked characters), and ellipsoid, sparsely puberulent fruits. Within this section we described two series, ser. *Tuberosae* and ser. *Caucasicae* Ziman, Bulakh & Kadota. Both *A. apennina* and *A. blanda* are members of the ser. *Tuberosae*, which differ from ser. *Caucasicae* by length of fruit styles, shape of carpel stigmas, number of tepals, as well as tepal length, length of

involucreal leaf petioles and shape of rhizomes. We accept *A. blanda* as a separate species on the basis of the following essential differences: *A. apennina* – carpels and fruits without lateral ribs and scarcely pubescent throughout, tepals of the outer whorl with 1-3 anastomosing veins – and ternate basal leaf blades with petioles 3-5 mm long (Figs. 2H, 3H); *A. blanda* – carpels and fruits with distinct lateral ribs and pubescent at the base only, tepals of the outer whorl with 5-9 anastomosing veins, basal leaf blades 3-sected, with sessile segments (Figs. 2I, 3I).

**Anemone** sect. **Omalocarpus** in the Balkans

Specimens examined in the Balkan peninsula:

**Albania:** Scardus, Ljubitrn, 15.07.1890, Dorfler 1187, 2276 (W).

**Bosnia:** Ljubična, 1965, Jasiewicz (W).

**Bulgaria:** Vitosha Mts., Stribrny, 16.06.1955, Vihodzewski 569 (CLUJ); Stara Planina, 13.06.1972, Kozuharov 809 (LE); 13.06.1976, Kozuharov & Petrova (BCC).

**Macedonia:** Mt. Konjuška, 1980, Jasiewicz (KRA).

**Montenegro:** Durmitor, Mt. Bobotov Kuk, close summit, 29.08.2010, S. Ziman, N. Fedoronchuk (KW).

**Slovenia:** Kamniske Alpe, 28.06.1965, Martinčić 57417, (LE); Gorenjsko, Korsko Sedlo, 06.06.1965, Martinčić (CLUJ).

In the flora of the Balkan peninsula, the most distinct species in the genus *Anemone* is *A. narcissiflora* belonging to subgen. *Omalocarpus* sect. *Omalocarpus* ser. *Involucratae* Ulbr.

TUTIN (1964) emphasized that species of the subgen. *Omalocarpus* have compressed, often winged fruits with short hooked styles, and TAMURA (1991) reported that these species are characterized by erect rhizomes, basal leaves on long petioles, with 3-5-sect or ternate blades, sessile involucreal leaves, large, strongly compressed, broadly winged fruits and predominating of the umbelliferous cymes. In our opinion, some morphological characters are also important for the representatives of this section: short rhizomes, monopodial stems, tepals having 1-7 anastomosing veins, oblong-ellipsoid fruits with lateral wings 1-3 mm wide, and similar basal and involucreal leaves. We regarded as essential for the ser. *Involucratae* styles pressed to fruit bodies and for the species *A. narcissiflora* monomorphic tepals, mainly solitary stems, and basal leaf blades wider than long.

From our data (ZIMAN *et al.* 2005), *A. narcissiflora* as a single species includes 8 subspecies and 12 varieties disjunctively distributed in the Northern Hemisphere (Figs. 2J, 3J). On the basis of the species examined from Bulgaria, Slovenia and Albania, we concluded that *A. narcissiflora* subsp. *narcissiflora* var. *narcissiflora* grows in the Balkan peninsula, having examined its specimens from Bulgaria, Slovenia and Albania.



## CONCLUSIONS

As a result of our long-standing study of 10 *Anemone* species in the flora of the Balkan peninsula, we proposed to use some new or additional essential morphological characters for differentiation of species: shape of fruiting heads, fruits and carpels (including their styles and stigmas), and stamens (peculiarities of filaments and anthers), anastomosing veins on tepals, shape of caudices or rhizomes, monopodial or sympodial stems, involucre leaves, similar or dissimilar to basal leaves.

In addition, we noticed stipule-like appendages at the base of basal leaf petioles in all species of subsection *Anemone* and section *Tuberosae*. Within the section *Anemone* we found stolon-like ephemeric rhizomes in *A. coronaria* and seasonally dimorphic basal leaves in *A. hortensis*. Within the section *Anemonanthea* we noticed solitary basal leaves with distinct blades developing on rhizomes before flowering and a few scale-like leaves developing at the base of the flowering shoots after flowering. Special attention was paid to the dimorphic perianth in *A. nemorosa*, *A. ranunculoides*, *A. apennina* and *A. blanda*.

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## Botanica SERBICA



## REZIME

## ***Anemone* L. (Ranunculaceae): comparative morphology and taxonomy of the species from the Balkan flora**

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U ovom radu predstavljani su podaci komparativne morfologije i taksonomije za deset vrsta roda *Anemone* L. u flori Balkanskog poluostrva. Ovih deset vrsta spada u pet sekcija: *A. coronaria* L. i *A. hortensis* L. u sekciji *Anemone*; *A. sylvestris* L. i *A. baldensis* L. u sekciji *Eriocephalus* Hook. f. & Thoms.; *A. nemorosa* L., *A. ranunculoides* L. i *A. trifolia* L. u sekciji *Anemonanthea* DC.; *A. apennina* L. i *A. blanda* Schott. & Kotschy u sekciji *Tuberosa* (Ulbr.) Juz. i *A. narcissiflora* L. u sekciji *Omalocarpus* DC. Posebna pažnja data je novim i dodadnim morfološkim karakterima: obliku glave ploda, plodovima i karpelama (uključujući tučkove i prašnike), stamena, anastomoznih sudova petala, oblik korenaka ili rizoma, monobodijalne ili simpodijalne stabljike, involukruma. Još neki karakteri koji su ranije previdjani su pridodati: dimorfni perijant *A. nemorosa*, *A. ranunculoides*, *A. apennina* i *A. blanda*; stipule na bazi petiole kod svih vrsta sekcija *Anemone* i *Tuberosa*; efemerni rizomi onlika stolona kod *A. coronaria* i sezonski dimorfni bazalni listovi kod *A. hortensis*, hipogeicno klijanje kod vrsta sekcije *Anemonanthea* nasuprot vrstama drugih sekcija, kratki vertikalni rizomi kod *A. narcissiflora* (i drugih vrsta iz sekcije *Omalocarpus*).

**Ključne reči:** Balkansko poluostrvo, *Anemone*, morfološke karakteristike, taksonomija.



