

*Taxonomic Structure of Genus *Carduus* L. in Bulgaria*

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Abstract. A key table for species determination of the Bulgarian representatives from the genus *Carduus* was modified, basing on the findings from the biosystematical study. Taxonomic classification of *C. nutans* and *C. thoermeri* was assumed, and new floristic regions of distribution were found for six species. The species *C. uncinatus* was not confirmed for the Bulgarian flora.

Key words: *Carduus*, biosystematic study, taxonomic structure.

Introduction

In the Bulgarian flora, the genus *Carduus* is represented by 14 species, and 5 of them are endemic (TUTIN *et al.*, 1976; DELIPAVLOV & CHESHMEDZHIEV, 2003; PETROVA & VLADIMIROV, 2010). Another species (*C. uncinatus* Bieb.) is included in "Flora of Bulgaria" (STOJANOV *et al.*, 1967), and in "Handbook of the vascular flora in Bulgaria" (KOZHUHAROV, 1992), however, it has not been confirmed so far. The species *Carduus rhodopaeus* and *Carduus thracicus* are of conservation status and they are included in both: Bulgarian Red Data Book (PEEV *et al.*, 2015) in the categories "endangered" for *C. rhodopaeus* and "vulnerable" for *C. thracicus*, respectively, and in Biological diversity act of Bulgaria (2002). The species *C. thracicus* is also

mentioned in Red list of the Bulgarian vascular plants (PETROVA & VLADIMIROV, 2009) in the category "vulnerable", and in the category "rare" in IUCN Red List of Threatened Plants (WALTER & GILLET, 1998).

This article is the result of a detailed biosystematic study on the genus *Carduus* in Bulgaria. It is a reasonable consequence of the fact that there are not any in-depth taxonomic studies, which have been done in Bulgaria recently on that genus, the conservation status of some species, as well as the widespread use of others in folk medicine. Good knowledge and determination of the morphological and taxonomic characteristics in species from the genus *Carduus* would inevitably help with their differentiation and application in various fields of science.

Materials and Methods

All these 14 species from the genus *Carduus*, that are common in Bulgaria, were studied – our own collections and herbarium samples. The materials were collected in the time period 2010-2016, from 15 floristic regions in Bulgaria. There were examined 337 herbarium samples of these species that are kept in the herbariums of Sofia University "St. Kliment Ohridski", Agricultural University, Plovdiv, IBER-BAS, Sofia and Regional Museum of Natural History, Plovdiv. Some of the collected plant materials were deposited in the herbarium of Agricultural University Plovdiv – 56 samples; another part is stored in the collection of the Department "Botany and Methods of Biology Teaching" in the Faculty of Biology at the University of Plovdiv.

Results and Discussion

From the genus *Carduus*, the group *C. nutans* is difficult to determine in taxonomic terms, so it is divided into at least 8 species and 14 subspecies by the European botanists, and it is included in "Flora Europaea" (1964-1980) (TUTIN *et al.*, 1976). The European species in this complex are as follows: 1 – *C. macrocephalus* Desf. (*C. m.* subsp. *macrocephalus*, *C. m.* subsp. *sporadum* (Halacsy) Franco, *C. m.* subsp. *siculi*'s Franco); 2 – *C. granatensis* Willk.; 3 – *C. taygeteus* Bioss. & Heldr. (*C. t.* subsp. *taygeteus* = *C. nutans* subsp. *taygeteus* (Boiss. & Heldr.) Hayek, *C. t.* subsp. *insularis* Franco); 4 – *C. thoermeri* Wienm. = *C. nutans* L., *C. lejophyllus* Petrovic; 5 – *C. nutans* L. (*C. n.* subsp. *nutans*, *C. n.* subsp. *alpicola* (Gillot) Chassagne, *C. n.* subsp. *platylepis* (Reichenb. & Sauter) Nyman = *C. platylepis* Reichenb. & Sauter); 6 – *C. micropterus* (Borbas) Teyber (*C. m.* subsp. *micropterus* = *C. nutans* subsp. *micropterus* (Borbas) Hayek, *C. m.* subsp. *perspinosus* (Fiori) Kazmi); 7 – *C. broteroi* Welw. ex Coutinho; 8 – *C. sandwithii* Kazmi. In this group, from the Bulgarian flora are the species *C. nutans* (*C. nutans* subsp. *nutans*) and *C. thoermeri* Wienm. (syn. *C. lejophyllus* Petrovic). In the third edition of the flora of

Bulgaria, STOYANOV & STEFANOV (1948) indicated the two species as one species – *C. nutans* with two subspecies, namely *C. nutans* subsp. *nutans* and *C. nutans* subsp. *lejophyllus*. In the fourth edition (STOYANOV *et al.*, 1967), the two taxa are represented as one species with two varieties, namely *C. nutans* var. *nutans* and *C. nutans* var. *lejophyllus*. Later, KOZHUHAROV (1992) and DELIPAVLOV & CHESHMEDZHIEV (2003) classified the taxonomic statuses of these species at a higher species level – *C. nutans* and *C. thoermeri* (*C. lejophyllus*).

The following taxonomic conclusions have been drawn, as well as the actualization of the key for determining the species of the genus *Carduus* in Bulgaria, basing on the investigated scientific literature and also on the conducted biosystematics study on the palynomorphological data about the genus (TODOROV *et al.*, 2014), the morphological and molecular-genetic research (DENEV *et al.*, 2018) and comparative-anatomical data on the species *C. nutans* and *C. thoermeri* (TODOROV *et al.*, 2017).

Taxonomic conclusions

We accept 12 species, belonging to the genus, as single and independent in their taxonomy, and they are – *C. pycnocephalus* L., *C. acicularis* Bertol, *C. thracicus* (Velen.) Hayek, *C. personata* (L.) Jacq., *C. hamulosus* Ehrh., *C. kernerii* Simonkai, *C. candicans* Waldst. & Kit., *C. carduelis* (L.) Gren., *C. rhodopaeus* Velen., *C. crispus* L., *C. acanthoides* L. and *C. armatus* Boiss. & Heldr. As far as the species *C. nutans* L. and *C. thoermeri* Wienm., we confirm the classification of STOYANOV & STEFANOV (1948) and DESROCHERS *et al.* (1988); we believe that the taxonomic status of both species should be changed, but at subspecies level, namely: *C. nutans* subsp. *nutans* and *C. nutans* subsp. *lejophyllus* (Petr.) Stoj. & Stef. As a result of the conducted fieldwork and examination of herbarium specimens, the species *C. uncinatus* (Velen.) Bieb. has not been confirmed in the Bulgarian flora, in the present study.

A key table for species from the genus *Carduus* L.

1. Capitula cylindrical, longer than wide. Florets regular..... 2
- + Capitula depressed-globose. Florets irregular/ one lobe of the corolla more or less longer than others.....3
2. Stem wings up to 4 mm wide, with an apical spine to 16 mm. Leaf lobes with apical spine up to 8 mm. The middle involucral bracts 2-4 mm wide. Annual or biennial up to 150 cm. Waste places and roadsides. Flowering V-VIII. Black Sea coast, Northeast Bulgaria, Valley of the river Strouma, Rhodope Mts (*Eastern*), **Thracian Lowland**, Toundzha Hilly Plain, Strandzha Mts. (-0.3).....1. *C. pycnocephalus* L.
- + Stem wings up to 10 mm wide, with an apical spine up to 3.5 mm. Leaf lobes with apical spine up to 5 mm. The middle involucral bracts 0.7-1.2 mm wide. Annual up to 70 cm. Waste places. Flowering V-VIII. Black Sea coast, Valley of the river Strouma, Thracian Lowland, Toundzha Hilly Plain, Strandzha Mts. (-0.8).....2. *C. acicularis* Bertol. [*C. argentatus* L. subsp. *acicularis* (Bertol.) Meikle]
3. Involucral bracts distinctly constricted in the proximal part. Leaves – 5-14-lobed.....3. *C. nutans* L.
- a. Lower part of the stem more or less arachnoid-hairy. Leaf lobes palmate. Capitula 1.5-3.5 cm in diameter. Involucral bracts in the distal part as wide as in the proximal. Pappus 20-34 mm. Biennial up to 110 cm. Cultivated ground. Flowering VI-X. Throughout Bulgaria. (-1.5)subsp. *nutans*
- + Lower part of the stem ± glabrous. Leaf lobes wide triangular shape. Capitula 2-8 cm in diameter. Involucral bracts distinctly widened /2-8 mm/ into a flat ovate-lanceolate. Pappus 21-50 mm. Biennial up to 200 cm. Cultivated ground. Flowering VI-X. Throughout Bulgaria. (-1.5).subsp. *lejophyllus* (Petr.) Stoj. & Stef. (*C. thoermeri*)
- + Involucral bracts not constricted in the proximal part.4
4. Involucral bracts curling in an S-shape in the distal part.5
- + Involucral bracts not curling in the distal part / straight or slightly deflexed/.8
5. Stem wings up to the apical part. Leaves tender, bristly on the edge. Capitula in clusters of 2-4. Perennial up to 120 cm. In woods. Flowering VI-VIII. Forebalkan (*Eastern*), Balkan Range (*Western, Central*), Znepole region, Vitosha region, Belasitsa Mts, Pirin Mts, Rila Mts, Rhodope Mts (*Western, Central*).(-2.5).4. *C. personata* (L.) Jacq.
- + Stem wings below the apical part. Leaves stiff with rigid spines on the edge. Single capitula with peduncles up to 10 cm.6
6. Stem white-fibrous, wings up to 7mm wide, apical spine up to 5 mm. Leaves densely hairy above, greyish-tomentose beneath, with 6-8 pairs of lobes, each with an apical spine up to 3 mm. Pappus 10-13 mm. Annual or biennial up to 70 cm. Dry grassland. Flowering VII-IX. ? Black Sea coast, ?Northeast Bulgaria, ?Toundzha Hilly Plain.(-0.5).....5. *C. uncinatus* Bieb.
- + Stem sparsely arachnoid-hairy with wings up to 5 mm wide and apical spine up to 2.5 mm. Leaves sparsely hairy above, more densely hairy beneath with 8-10 pairs of lobes, each with an apical spine up to 2 mm. Pappus 13-15 mm.7
7. Capitula 2.5-4 cm in diameter. Annual up to 100 cm. Dry grassland and waste places. Flowering VI-IX. Northeast Bulgaria, Danubian Plain, Sofia region, **West Frontier Mts**, Sredna Gora Mts, Rhodope Mts (*Eastern, Central*), **Thracian Lowland**, Strandzha Mts. (0.5-1).6. *C. hamulosus* Ehrh.

- + Capitula up to 1.3 cm in diameter. Biennial up to 100 cm. Rocky waste places. Flowering VI-VII. Northeast Bulgaria, Forebalkan, Balkan Range (*Eastern*), Valley of the river Strouma, Rhodope Mts, Thracian Lowland, Toundzha Hilly Plain, Strandzha Mts. (0.7-1).7. ⊗ *C. thracicus* (Velen.) Hayek
- 8. Capitula in clusters, without peduncles. 9
- + Capitula solitary with short (up to 2.5 cm) and long (up to 20 cm) peduncles.11
- 9. Stem wings up to 4 mm wide, with an apical spine up to 2 mm. Leaves tender, with short (up to 2 mm) bristles on the edge, lobed or crenate-dentate, sparsely arachnoid-hairy and dark green above, glabrescent beneath. Involucral bracts recurved at apex. Perennial up to 150 cm. Mountain forests. Flowering IV-VIII. Black Sea coast (Northern), Northeast Bulgaria, Danubian Plain, Forebalkan, Vitosha Mts, Rila Mts, **Rhodope Mts (Eastern), Thracian Lowland**, Toundzha Hilly Plain. (1-2). 8. *C. crispus* L.
- + Stem wings up to 14 mm wide, with an apical spine up to 7 mm. Leaves stiff, with an apical spine longer than 2 mm, glabrescent above, with multicellular hairs on the middle vein beneath.10
- 10. Stem wings 3-14 mm wide, with an apical spine up to 7 mm. Capitula solitary with short peduncles or no peduncles. Middle involucral bracts with mid-vein in the distal part. Biennial up to 170 cm. Cultivated ground. Flowering VI-IX. Throughout Bulgaria. (-1.3).9. *C. acanthoides* L.
- + Stem wings 6-9 mm wide, with an apical spine up to 5 mm. Leaves with an apical spine up to 15 mm. Capitula in racemose or thyroid inflorescence. Middle involucral bracts with raised mid-vein throughout its length. Perennial up to 100 cm. Grassland places. Flowering VII-VIII. Balkan Range (*Northern*), Znepole region, **Slavyanka Mts, Rila Mts, ? Rhodope Mts (Eastern), Osogovo Mts**. (1.5-2).10. ⊗ *C. armatus* Boiss. & Heldr. (*C. tmoleus* subsp.)
- 11. Involucral bracts linear, sharp on the apical part. Leaves glabrescent above, with single hairs beneath, 6-13 pairs of lobes and an apical spine 1-2 mm wide. Annual-Perennial up to 100 cm. Rocky places. Flowering VI-IX. **Slavyanka Mts**, Rhodope Mts (*Western, Central*), **Thracian Lowland** (0.8-2).11. ● *C. rhodopaeus* Velen. (*C. adpressus* subsp.)
- + Involucral bracts style-shape, gradually tapering into a spine.12
- 12. Stem arachnoid-hairy, wings up to 18 mm and an apical spine 1-7 mm. Leaves white-tomentose beneath, the lobes with an apical spine up to 5 mm. Involucral bracts with a raised mid-vein throughout its length, apical spine 0.5-1 mm, the outer usually outspread. Biennial-Perennial up to 125 cm. Grassland places. Flowering VI-VIII. Throughout Bulgaria. (-1)12. ⊗ *C. candicans* Waldst. & Kit. subsp. *globifer* (Velen.) Kazmi
- + Stem subglabrous or very sparsely hairy, wings up to 4 mm and apical spine up to 2 mm. Leaves green beneath, glabrous or very sparsely hairy, the lobes with an apical spine 1-3 mm. 13
- 13. Stem wings below. Leave lobes with 8-10 pairs. Involucral bracts straight or deflexed. Perennial up to 80 cm. Grassland places. Flowering VII-IX. Balkan Range (*Western, Central*), **Vitosha Mts**, West Frontier Mts, **Pirin Mts**, Rila Mts. (1.5-2.5).13. *C. carduelis* (L.) Gren. (*C. alpestris*)
- + Stem with wings throughout its length. Leave lobes with 14-20 pairs. Involucral bracts outspread. Perennial up to 100 cm. Grassland places. Flowering VI - IX. Balkan Range (*Western, Central*), Vitosha Mts, Pirin Mts, Rila Mts, Rhodope Mts (*Western*), Osogovo Mts. (1.5-2.8).14. ⊗ *C. kernerii* Simonkai subsp. *austro-orientalis* Franco (*C. scardicus*).

Legend: ⊗ - Balkan endemic; ● - Bulgarian endemic.

The new floristic regions of some species are in bold. The symbol "?", before the names, marks the non-confirmed habitats.

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