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Chromosome number and ploidy level in seven *Centaurea* species from Croatia

Abstract

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Seven *Centaurea* species from Croatia (*C. alba*, *C. calcitrapa*, *C. cristata*, *C. rhenana*, *C. rupestris*, *C. salonitana* and *C. solstitialis*) belonging to five sections were studied. Chromosome numbers and metaphase plates are presented. All species studied here were found to be either diploid or tetraploid with the exception of *C. salonitana* which presented both ploidy levels: one diploid and one tetraploid population were detected.

1919. *Centaurea alba* L. — 2*n* = 2x = 18 (Fig. 1A).

Ct: Klis, Split, limestones, 43° 33’ 34,97” N, 16° 31’ 34,69” E, 315 m a.s.l., 12 Jul 2016, FNST_DB_2016_CA_10 (FNST – Fac. Natural Sciences Split, DB - Dept. of Biol.).

Centaurea alba L. [Syn.: *C. calva* Reut. ex Nyman, *C. deusta* subsp. *concolor* (DC.) Hayek, *C. globosa* Hort. ex DC., *C. haynaldiiformis* Prodan, *C. nitida* Lam., *C. strobilacea* Scop. (The Plant List 2013; Nikolić 2017)], which belongs to section *Phalolepis* (Cass.) DC., is a biennial or perennial European-Mediterranean floral element. It is spread over dry rocky meadows of the Mediterranean, sub-Mediterranean and mountainous regions of southern Europe (Dostál 1976; Nikolić 2017).

The chromosome number 2*n* = 18 reported here confirms the number given by several authors (IPCN 1979; Siljak-Yakovlev 2005; Siljak-Yakovlev & al. 2010), but tetraploid chromosome number (2*n* = 4x = 36) is also reported by Kuzmanov & al. (1986) and Bancheva & Greilhuber (2006). Measured genome sizes of this species are 2C = 1.67 pg (Siljak-Yakovlev & al. 2010) and 2C = 3.58 pg (Bancheva & Greilhuber 2006) which also pointed out the existence of two ploidy levels.

1920. *Centaurea calcitrapa* L. — 2*n* = 2x = 20 (Fig. 1B).

Ct: Rupotine, Klis, Split, limestones, 43° 33’ 29,43’’ N, 16° 30’ 48,66’’ E, 240 m a.s.l., 12 Jul 2016, FNST_DB_2016_CC_9.

Centaurea calcitrapa L. [Syn.: *Calcitrapa calcitrapa* (L.) Hill, *C. hybrida* Sweet, *C. hypophaestum* Gaertn., *C. lanceolata* Lam., *C. myacantha* Cass., *C. phoenicea* Sweet, *C. stellaris* Hill, *C. stellata* Lam., *C. vulgaris* Bernh., *Centaurea adulterina* Moretti ex DC., *C. calcitrapoides* L., *C. carduifolia* Salisb., *C. devauxii* Nyman, *C. horrida* Ten., *C. hybrida* Chaix, *C. macroacantha* Guss., *C. myacantha* DC., *C. penicillata* Delile, *C. trichacantha* Willd. ex Spreng. (The Plant List 2013)], belongs to *Dumulosae* (Hayek) Dostál section. It is biennial plant that belongs to the European-Mediterranean floral element. This species is found in ruderal anthropogenic habitats and it is native to south-eastern Europe and Asia Minor, but also naturalized in Western and Central Europe, Africa, West Asia up to NW India (Dostál 1976; Nikolić 2017).

According to relevant literature (Fedorov 1969; IPCN 1979), this species has a stable chromosome number $2n = 20$ that we also found.

1921. *Centaurea cristata* Bartl. — $2n = 4x = 36$ (Fig. 1C).

Ct: Kaštela, Kozjak, Split, limestones, 43° 33’ 26,48’’ N, 16° 18’ 13,86’’ E, 154 m a.s.l., 12 Jul 2016, FNST_DB_2016_CC_19.

Centaurea cristata Bartl. [Syn.: *Acosta cristata* (Bartl.) Holub, *C. acutiloba* DC., *C. cristata* subsp. *rabenhorstiana* (Sch. Bip.) Nyman, *C. karschiana* Auersw. ex Nyman, *C. rabenhorstiana* Sch. Bip. ex Nyman, *C. scopolii* Vest, *C. spinosociliata* subsp. *cristata* (Bartl.) Dostál (The Plant List 2013)], which belongs to *Arenariae* (Hayek) Dostál section, is biennial Illyrian-Adriatic endemic knapweed. This species is making the sub-Mediterranean and epi-Mediterranean eastern Adriatic dry lawns along the coastal slopes of the Croatian Littoral from the island Krk to the Neretva river in the Mediterranean vegetation zone (Dostál 1976; NKS 2014; Nikolić 2017).

The chromosome count for this taxon $2n = 36$ confirms the data reported by Lovrić (1982).

1922. ***Centaurea rhenana*** Boreau — $2n = 4x = 36$ (Fig. 1D).

Ct: Pasjača, Konavoske Stijene, Konavli, limestones, 42° 34’ 52,81’’ N, 18° 14’ 59,97’’ E, 163 m a.s.l., 25 Jun 2016, FNST_DB_2016_CR_17.

Centaurea rhenana Boreau [Syn.: *Acosta rhenana* (Boreau) Soják, *Acrolophus rhenanus* (Boreau) A. Löve & D. Löve, *Centaurea maculosa* Lam. subsp. *rhenana* (Boreau) Gugler, *C. paniculata* var. *rhenana* (Boreau) Rouy, *C. stoebe* L., *C. stoebe* L. subsp. *stoebe*, *C. stoebe* subsp. *maculosa* (Lam.) Hayek, *C. stoebe* subsp. *rhenana* (Boreau) Schinz & Thell.], belongs to *Maculosae* Dostál section and is a biennial or perennial plant. Its distribution range is quite wide, across the lawns and rocks of Central and South-Eastern Europe to the central Russia (Dostál 1976; Nikolić 2017).

The tetraploid chromosome number $2n = 4x = 36$, found in this study, confirms previous reports (Fedorov 1969; IPCN 1979; Bancheva & Greilhuber 2006), but diploid individuals are also recorded $2n = 18$, 18+0-2Bs in available literature (IPCN 1979; Bancheva &

Greilhuber 2006). Different 2C values, corresponding to two ploidy levels, were measured for this species: 1.70, 1.76, 1.84, 3.10, 3.16, 3.20 and 3.30 pg (Bennett & Leitch 2012; GSAD 2013). In our study only tetraploid individuals were recorded.

1923. *Centaurea rupestris* L. — 2*n* = 2x = 20 (Fig. 1E).

Ct: Pustinja Blaca, Klis, Split, limestones, 43° 34' 15,17'' N, 16° 28' 38,51'' E, 435 m a.s.l., 12 Jul 2016, FNST_DB_2016_CR_16.

Centaurea rupestris L. [Syn.: *Acrocentron tenuifolium* Cass., *Calcitrapa rupestris* (L.) Sweet, *Centaurea adonidifolia* Rchb., *C. rupestris* subsp. *aculeata* Arcang., *C. saxatilis* Bertol. ex Nyman, *C. variabilis* Bartl. ex Steud., *Colymbada rupestris* (L.) Holub) (The Plant List 2013)], belongs to section *Acrocentron* (Cass.) DC. It is a biennial plant, present on the two shores of the Adriatic and South East Europe, above all in the Carpathian-Danubian region, in the Epi-Mediterranean vegetation zone (Dostál 1976; Zepigi 2008; Nikolić 2017).

The diploid chromosome number 2*n* = 20 has been reported by Siljak (1977), Siljak-Yakovlev (2005) and Van Loon & Kieft (1980), but additionally the somatic number 2*n* = 24 was reported (Fedorov 1969; Van Loon & Kieft 1980). Here we confirm 2*n* = 20 chromosomes. Siljak-Yakovlev & al. (2010) reported genome sizes for the species 2C = 2.33 and 3.50 pg.

1924. *Centaurea salonitana* Vis. — 2*n* = 2x = 20 (Fig. 1F) and 2*n* = 4x = 40.

Ct: Kijevo, Mt. Dinara, limestones, 43° 59' 38,44'' N, 16° 24' 07,49'' E, 447 m a.s.l., 17 Jun 2016, FNST_DB_2016_CS_7. — 2*n* = 2x = 20.

— Žnjan, Split, limestones, 43° 30' 29,24'' N, 16° 29' 36,03'' E, 72 m a.s.l., 16 Jun 2016, FNST_DB_2016_CS_12. — 2*n* = 4x = 40.

Centaurea salonitana Vis. [Syn.: *Acrocentron salonitanum* (Vis.) Á. Löve & D. Löve, *Centaurea centauroides* M. Bieb., *C. collina* var. *macracantha* DC., *C. latifolia* Pers., *C. latisquama* DC., *C. latisquama* subsp. *salonitana* (Vis.) Nyman, *C. liliniea* Velen., *C. neglecta* Besser, *C. reflexa* subsp. *salonitana* (Vis.) Mikheev, *C. salonitana* var. *macracantha* (DC.) Boiss. & Heldr., *C. salonitana* var. *macracantha* DC., *C. salonitana* var. *subinermis* Boiss., *C. stribrnyi* Velen., *C. tatarica* Pall., *Colymbada salonitana* (Vis.) Holub, *Crepula centauroides* (L.) Hill) (The Plant List 2013)], belongs to section *Acrocentron* (Cass.) DC., is a perennial plant, widespread on the lawn sand rocky meadows of South East and Central Europe (Dostál 1976; Nikolić 2017).

We found one diploid (2*n* = 20) and one tetraploid (2*n* = 4x = 40) population. The diploid chromosome number confirms previous reports (Fedorov 1969; Siljak-Yakovlev & Gorenflot 1977; IPCN 1979), as well as the tetraploid number that confirms findings of Siljak-Yakovlev & Gorenflot (1977) and IPCN (1979).

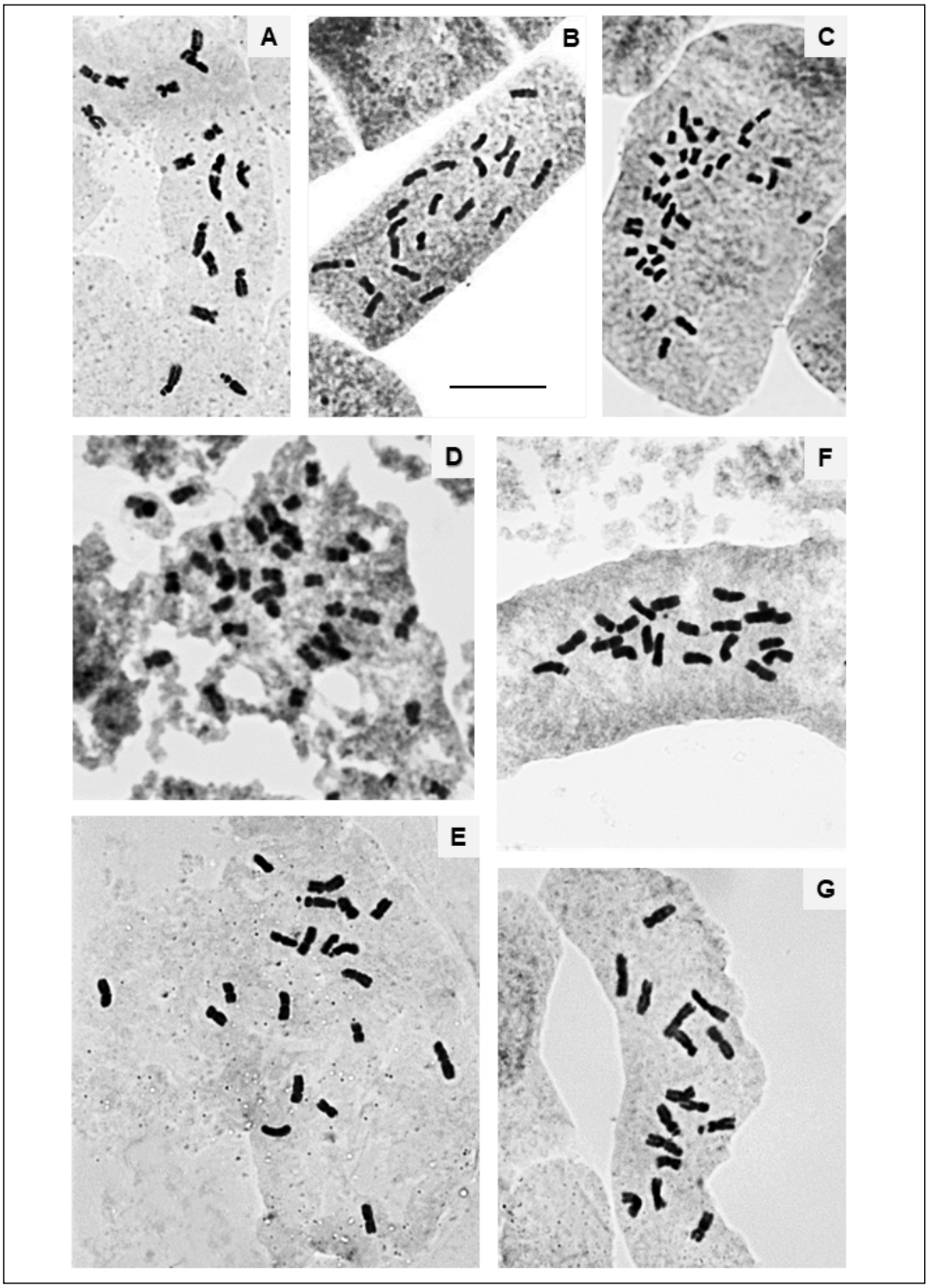

Fig. 1. Mitotic methaphase plates of *Centaurea*: **A**, *C. alba*, 2*n* = 14; **B**, *C. calcitrapa*, 2*n* = 20; **C,** *C. cristata*, 2*n* = 36; **D**, *C. rhenana*, 2*n* = 30; **E**, *C. rupestris*, 2*n* = 20; **F**, *C. salonitana*, 2*n* = 20; **G**, *C. solstitialis*, 2*n* = 16. – Scale bar = 10 μm.

1925. *Centaurea solstitialis* L. — 2*n* = 2x = 16 (Fig. 1G).

Ct: Marjan, Split, limestones, 43° 30' 31,37'' N, 16° 25' 59,18'' E, 64 m a.s.l., 12 Jul 2013, FNST_DB_2013_CS_17.

Centaurea solstitialis L. [Syn.: *Calcitrapa lutea* Delarbre, *C. solstitialis* (L.) Lam., *Centaurea cyanifolia* Poir., *C. parvispina* Láng ex Gugler, *C. pseudosolstitialis* Debeaux, *Cyanus solstitialis* J. Presl & C. Presl, *Leucantha solstitialis* (L.) Á. Löve & D. Löve) (The Plant List 2013)], belongs to *Dumulosae* (Hayek) Dostál section, is annual to biennial, spread on dry open habitats of southern Europe, but expanded and naturalized in parts of Central Europe. It belongs to the South-European floral element (Dostál 1976; Nikolić 2017).

Different authors (Fedorov 1969; IPCN 1979; Bennett & Leitch 2012) counted the same chromosome number (2*n* = 16), but also 2*n* = 18 can be found in the literature (IPCN 1979). Bancheva & Greilhuber (2006) estimated genome size for *C. solstitialis* 2C = 1.74 pg and Carev & al. (2017) reported higher value of 2C = 1.95 pg.

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