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## Chromosome numbers of adventive species in the flora of the Republic of Altai. Post VII

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**Summary.** Chromosome numbers ( $2n$ ) of 13 adventive plant species from the families Apiaceae, Asteraceae, Boraginaceae, Brassicaceae, Caryophyllaceae, Cucurbitaceae, Fabaceae, Lamiaceae, Onagraceae, Polygonaceae, and Solanaceae are reported based on the material collected in the Republic of Altai. To determine chromosome number (ploidy level), the method of direct counting in metaphase on root meristem was used. Among species studied, chromosome numbers for *Foeniculum vulgare* ( $2n = 22$ ) were first examined for Russian Federation; for *Trifolium campestre* ( $2n = 14$ ) – first for Siberia; for *Rumex acetosella* ( $2n = 28$ ) – for West Siberia; *Calendula officinalis* ( $2n = 32$ ), *Centaurea cyanus* ( $2n = 24$ ), *Echium vulgare* ( $2n = 32$ ), *Lepidium ruderales* ( $2n = 32$ ), *Arenaria serpyllifolia* ( $2n = 40$ ), *Echinocystis lobata* ( $2n = 32$ ), *Epilobium pseudorubescens* ( $2n = 36$ ) were first studied for the Republic of Altai. General distribution and the history of floristic findings of these species in the Republic of Altai are given. Previously published data on chromosome numbers from Russia are cited.

## Числа хромосом адвентивных видов во флоре Республики Алтай: сообщение 7

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**Ключевые слова:** инвазивные виды, расселение видов, числа хромосом, Apiaceae, Asteraceae, Boraginaceae, Brassicaceae, Caryophyllaceae, Cucurbitaceae, Fabaceae, Lamiaceae, Onagraceae, Polygonaceae, Solanaceae.

**Аннотация.** Приводятся данные о числах хромосом ( $2n$ ) для 13 адвентивных видов из семейств Apiaceae, Asteraceae, Boraginaceae, Brassicaceae, Caryophyllaceae, Cucurbitaceae, Fabaceae, Lamiaceae, Onagraceae, Polygonaceae, Solanaceae, полученные на материале из Республики Алтай. Для определения чисел хромосом (уровня пloidности) использован метод прямого подсчета в метафазе корневой меристемы. Впервые для России определено число хромосом у *Foeniculum vulgare* ( $2n = 22$ ); впервые для Сибири – у *Trifolium campestre* ( $2n = 14$ ); впервые для Западной Сибири – у *Rumex acetosella* ( $2n = 28$ ); впервые для Республики Алтай – у *Calendula officinalis* ( $2n = 32$ ), *Centaurea cyanus* ( $2n = 24$ ), *Echium vulgare* ( $2n = 32$ ), *Lepidium ruderales* ( $2n = 32$ ), *Arenaria serpyllifolia* ( $2n = 40$ ), *Echinocystis lobata* ( $2n = 32$ ), *Epilobium pseudorubescens* ( $2n = 36$ ). Для всех исследованных видов приводятся сведения по общему распространению, истории расселения на территории Республики Алтай, а также литературные данные по числам хромосом с территории России.

We continue the karyological study of adventive species in the flora of southern Siberia on the material from the Republic of Altai (Lomonosova et al., 2018; Zykova et al., 2018, 2020, 2021a, b, 2023a). The chromosome numbers of 13 adventive species were studied, six of which are invasive on the territory of the republic: *Echium vulgare* L., *Echinocystis lobata* (Michx.) Torr. et A. Gray, *Epilobium pseudorubescens* A. K. Skvortsov, *Rumex acetosella* L., *Elsholtzia ciliata* (Thunb.) Hyl., *Lepidium ruderales* L. (Zykova, 2023). Information is provided on the distribution of the species on the territory of the Republic of Altai. For three species, the chromosome number was determined for the first time on material from the territory of Western Siberia, for one – from the territory of the Russian Federation. Latin names of plants are given according to the “Catalogue of Life” (Bánki, 2023). The chromosome numbers were determined by direct counting in metaphase on root meristem squash preparations. The method was described in our previous article (Lomonosova et al., 2018). Metaphase plates were observed under 100× magnification by the Axioscope 40 (Karl Zeiss, Axio Lab) and photographed by the AxiCam MRC 5 digital camera (AxioVision 4.8 software). The herbarium specimens (vouchers) are deposited in the Herbarium of the Central Siberian Botanical Garden SB RAS (NS).

#### Apiaceae

##### *Foeniculum vulgare* Mill., $2n = 22$

“Russian Federation, the Republic of Altai, Gorno-Altaysk city, wasteland in the area of the «Goluboy Altay» cinema, on a pebble. 12 VIII 2021. E. Yu. Zykova”, Z954–1521 (NS0041416).

Biennial or perennial. Mediterranean species. Cultivated as an aromatic and medicinal plant, it is found in anthropogenically disturbed habitats. One population has been discovered in the Republic of Altai, expanding over 4 years.

This is the first report of the chromosome number on the material collected outside of crops for the Russian Federation.

Diploid ( $2x$ ),  $x = 11$ .

#### Asteraceae

##### *Calendula officinalis* L., $2n = 32$

“Russian Federation, the Republic of Altai, Gorno-Altaysk city, Shosseynaya street, wasteland. 22 VIII 2017. E. Yu. Zykova”, Z488–6717 (NS0050694).

Annual. Mediterranean species widely cultivated all around the world. In the Republic of Altai it is

common outside culture in the northern regions (Zykova, 2015).

The chromosome number is given for the first time for the Republic of Altai. The same number is determined for the Primorye Territory (Probatova, 2014, and references therein) and for the Novosibirsk Region (Zykova et al., 2023b).

Tetraploid ( $4x$ ),  $x = 8$ .

##### *Centaurea cyanus* L., $2n = 24$

“Russian Federation, the Republic of Altai, Gorno-Altaysk city, vicinity of the republican hospital, abandoned manor. 12 VIII 2018. E. Yu. Zykova”, E64–2118 (NS0050693) (Fig. 1A).

Annual. Circumboreal species. Cultivated as an ornamental, noted in crops, on fallow lands, near roads in most regions of the Republic of Altai (Zykova, 2015).

The chromosome number is given for the first time for the Republic of Altai. The same chromosome number was revealed in collections from the Primorye Territory (Probatova, Seledets, 2017), Novosibirsk (Krasnikov, 1991), Moscow and Leningrad Regions, and from the Republic of Crimea (Agapova et al., 1990, and references therein).

Diploid ( $2x$ ),  $x = 12$ .

#### Boraginaceae

##### *Echium vulgare* L., $2n = 32$

“Russian Federation, the Republic of Altai, Gorno-Altaysk city, between the stops «Ploshchad» and «Ruchey», embankment of the Mayma River, on pebbles. 4 VIII 2021. E. Yu. Zykova”, Z956–1121 (NS0050696).

Biennial or perennial. A European-Asian Minor species with a cosmopolitan secondary range. An invasive species in the flora of Siberia (Zykova, 2016). On the territory of the Republic of Altai it was first discovered in the 1930s on the Seminsky Pass (Krylov, 1937), now widely spread, is one of the most common invasive species here (Zykova, 2023).

The chromosome number is given for the first time for the Republic of Altai. The same chromosome number was reported from the Krasnoyarsk (Stepanov, Muratova, 1995) and the Perm (Agapova et al., 1990, and references therein) Territories, and from the Republic of Dagestan (Probatova, Krivenko, 2022). The number  $2n = 16$  was registered in material from the Irkutsk Region (Chepinoga, 2014, and references therein) and from the Primorye Territory (Probatova, 2014, and references therein).

Tetraploid ( $4x$ ),  $x = 8$ .

**Brassicaceae*****Lepidium ruderales* L.,  $2n = 32$** 

“Russian Federation, the Republic of Altai, Mayma district, Kyzyl-Ozek village, near the roads. 9 VIII 2013. E. Yu. Zykova”, Z20–7513 (NS0050695).

Annual. Eurasian species, settled in most regions of Siberia. The first location in the Republic of Altai was discovered in 1984 in the village of Ust-Koksa (Artemov, Korolyuk, 1999), and is currently an invasive species in the Republic of Altai (Zykova, 2023).

The chromosome number is given for the first time for the Republic of Altai. The same chromosome number was known for the Irkutsk (Chepinoga, 2014, and references therein), the Novosibirsk (Krasnikov, Lomonosova, 1990), the Sakhalin (Probatova et al., 2007, and references therein) Regions, and for the Stavropol Territory (Agapova et al., 1990, and references therein). Chromosome number  $2n = 16$  was mentioned for the Irkutsk (Chepinoga, 2014, and references therein) and the Sakhalin (Probatova et al., 2017a) Regions, the Primorye (Probatova, 2014, and references therein) and the Stavropol (Agapova et al., 1990, and references therein) Territories.

Tetraploid ( $4x$ ),  $x = 8$ .

**Caryophyllaceae*****Arenaria serpyllifolia* L. (*A. uralensis* Pall. ex Spreng., *A. viscida* Haller.),  $2n = 40$** 

“Russian Federation, the Republic of Altai, Chermal district, Chermal village, pebble bank of the Chermal River. 29 VII 2012. E. Yu. Zykova”, E85–3012 (NS0050706); “Russian Federation, the Republic of Altai, Chermal district, Chermal village, wasteland near the bridge. 14 VII 2013. E. Yu. Zykova”, E88–4613 (NS0050705); “Russian Federation, the Republic of Altai, Mayma district, vicinity of Rybalka village, wasteland on the territory of the Altai Valley base. 18 VIII 2015. E. Yu. Zykova”, E85–5215 (NS0050704).

Annual. A species with a Holarctic range. It is found in disturbed habitats and on pebbles in most regions of Western Siberia. In the Republic of Altai, the distribution pattern of the species needs to be studied more precisely. In any case, in recent years the species has been very actively spreading throughout the regions of the republic. Thus, in the 1930s, only three localities of the species were known – in Gorno-Altaysk, Aleksandrovka and Anos (Krylov, 1931). To date, according to our data, the species is common in Gorno-Altaysk, and Mayma, Choya, Turochak, Chermal, Shebalino districts, and was found in the Ulagan district.

The chromosome number is given for the first time for the Republic of Altai. The same chromosome number was known for the Novosibirsk Region (Zykova et al., 2023c). The number  $2n = 20$  was registered in material from the Primorye Territory (Probatova et al., 2019),  $2n = 30$  – from the Stavropol Territory (Agapova et al., 1990, and references therein).

Tetraploid ( $4x$ ),  $x = 10$ .

**Cucurbitaceae*****Echinocystis lobata* (Michx.) Torr. et A. Gray.,  $2n = 32$** 

“Russian Federation, the Republic of Altai, Gorno-Altaysk city, «Stroiteley» street, wasteland. 12 VIII 2021. E. Yu. Zykova”, E118–1623 (NS0050691).

Annual. North American ornamental species, settled in Eurasia. Invasive species in Russia (Morozova, Vinogradova, 2018). In the Republic of Altai it is one of the most active species, settled in the northern and penetrated into the central regions; found in weedy places, in damp ravines and along river banks, forms thickets (Zykova, 2023).

The chromosome number is given for the first time for the Republic of Altai. The same number was identified for the Primorye Territory (Probatova, 2014, and references therein).  $2n = 16$  was determined for the Krasnoyarsk Territory (Stepanov, 1994).

Tetraploid ( $4x$ ),  $x = 8$ .

**Fabaceae*****Trifolium campestre* Schreb.,  $2n = 14$** 

“Russian Federation, the Republic of Altai, Turochak district, Verkh-Biysk–Turochak highway, side of the road. 8 V 2016. E. Yu. Zykova”, E53–2716 (NS0049981).

Annual. European-Caucasian-Asian Minor species. Rare in Siberia. In the Republic of Altai, it was discovered in 2016 on the Verkh-Biysk – Turochak highway in the Turochak district, to date it is known only sporadically in the Choya and the Mayma districts (Zykova et al., 2019).

This is the first report of the chromosome number from Siberia. The same chromosome number was known in collections from the Primorye Territory (Probatova, 2014, and references therein) and from the Krasnodar and the Stavropol Territories, the Republic of Crimea, the Kabardino-Balkarian Republic, the Republic of Dagestan, the Republic of North Ossetia – Alania (Magulaev, 1987).

Diploid ( $2x$ ),  $x = 7$ .



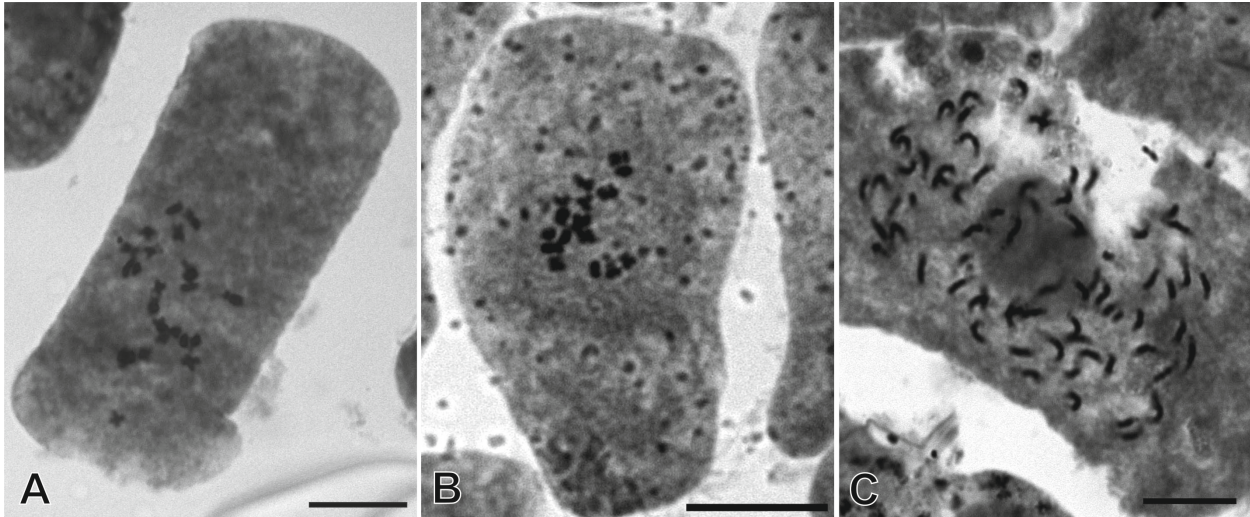


Fig. 1. Mitotic metaphases: A – *Centaurea cyanus*,  $2n = 24$ ; B – *Elsholtzia ciliata*,  $2n = 16$ ; C – *Solanum nigrum*,  $2n = 72$ ; Scale = 10  $\mu\text{m}$ .

#### Lamiaceae

##### *Elsholtzia ciliata* (Thunb.) Hyl., $2n = 16$

“Russian Federation, the Republic of Altai, Turochak district, Altai State Reserve, Baygazan cordon, weed on the estate. 14 VIII 2017. E. Yu. Zykova”, Z572–5217 (NS0050692) (Fig. 1B).

Annual. An East Asian species distributed throughout the Holarctic. It has been known in the Republic of Altai since the 1930s. (Krylov, 1937; Khomutova et al., 1938). To date, it has spread throughout all inhabited areas of the Republic of Altai and is an invasive species here (Zykova, 2023).

The same chromosome number was reported from the Novosibirsk (Zykova, Pankova, 2021), the Irkutsk (Chepinoga, 2014, and references therein), the Amur (Probatova et al., 2006) Regions, and from the Krasnoyarsk (Stepanov, 1994) and the Primorye (Probatova, 2014, and references therein) Territories, as well as for the Chermal district of the Republic of Altai (Probatova et al., 2013).

Diploid ( $2x$ ),  $x = 8$ .

#### Onagraceae

##### *Epilobium pseudorubescens* A. K. Skvortsov, $2n = 36$

“Russian Federation, the Republic of Altai, Mayma district, vicinity of Kysyl-Ozek village, quarry at a closed landfill. 15 VIII 2018. E. Yu. Zykova”, E41–2418 (NS0050701); “Russian Federation, the Republic of Altai, Gorno-Altaysk city, near the hippodrome, wasteland. 18 VIII 2018. E. Yu. Zykova”, E40–2718 (NS0050699).

Biennial. North American species spreading throughout the Holarctic. In the European part

of Russia, it is one of the most aggressive invasive species (Vinogradova et al., 2010), invasive species in Siberia (Buko, 2016). In the Republic of Altai it was discovered in 1985 in the village of Veselaya Seika, Choya district (Ebel, 2013). The species has now spread throughout the northern regions of the republic as an invasive species (Zykova, 2023).

The chromosome number is given for the first time for the Republic of Altai. The same number is determined for the Tomsk (Probatova et al., 2016) and the Novosibirsk (Zykova, Pankova, 2021) Regions and for the Republic of Tatarstan (Probatova et al., 2022).

Tetraploid ( $4x$ ),  $x = 9$ .

#### Polygonaceae

##### *Rumex acetosella* L., $2n = 28$

“Russian Federation, the Republic of Altai, Turochak district, vicinity of Turochak village, wasteland. 07 VIII 2015. E. Yu. Zykova”, Z207–3815 (NS0050004).

Perennial. Holarctic species. It has been known in the Republic of Altai since the mid-20th century (Kuminova, 1960). Currently, it is an invasive species in the northern and central regions of the republic (Zykova, 2023).

This is the first report of the chromosome number for Western Siberia. Diploid ( $2n = 14$ ) was revealed in collections from the Sakhalin Region (Probatova et al., 2007, and references therein). Tetraploid ( $2n = 28$ ) was reported from the Republic of Buryatia (Probatova et al. 2017b). Hexaploid ( $2n = 42$ ) was known in collections from the Irkutsk Region, the Republic of Buryatia, the Trans-Baikal

Territory (Chepinoga, 2014, and references therein), the Leningrad Region and the Kamchatka Territory (Agapova et al., 1993, and references therein).

Tetraploid ( $4x$ ),  $x = 7$ .

### Solanaceae

#### *Hyoscyamus niger* L., $2n = 34$

“Russian Federation, the Republic of Altai, Turochak district, vicinity of Turochak village, wasteland. 07 VIII 2015. E. Yu. Zykova”, E68–3815 (NS0050698); “Russian Federation, the Republic of Altai, Gorno-Altaysk city, embankment of the Mayma River between the stops «Rodnik» and «Tkatsky». 30 VI 2022. E. Yu. Zykova”, E46–3722 (NS0050697).

Biennial. Eurasian species with a cosmopolitan secondary range. A common weed in the Republic of Altai, more often found in the central and southeastern regions (Zykova, 2015).

The same number was determined for the Novosibirsk Region (Krasnikov, 1991; Zykova et al., 2022), the Republic of Tyva, the Kabardino-Balkarian and the Chechen Republics (Agapova et al., 1993, and references therein), the Trans-Baikal (Chepinoga, 2014, and references therein) and the Primorye (Probatova, 2014, and references therein) Territories, as well as for the Ust-Kan district the Republic of Altai (Krivenko et al., 2013).

Diploid ( $2x$ ),  $x = 17$ .

#### *Solanum nigrum* L., $2n = 72$

“Russian Federation, the Republic of Altai, Mayma district, Manzherok village, side of the road. 30 VI 2016. E. Yu. Zykova”, Z177–1716 (NS0050703) (Fig. 1C).

Annual. Holarctic species. It has been known in the Republic of Altai since the 1930s (Khomutova

et al., 1938; Krylov, 1939). To date, it is common in all regions of the republic, with the exception of the southeastern ones (Zykova, 2015).

The number of chromosomes  $2n = 72$  was determined for the first time using material from the Republic of Altai. The same number was determined for the Moscow, the Sverdlovsk (Gerasimenko, Reznikova, 1968), the Irkutsk (Probatova et al., 2015) Regions and in the Primorye Territory (Probatova, 2014, and references therein).  $2n = 60$  was indicated in the Stavropol Territory and the Chechen Republic (Agapova et al., 1993, and references therein);  $2n = 48$  – in the Novosibirsk Region (Zykova et al., 2022) and the Republic of Altai (Zykova et al., 2021a).

Hexaploid ( $6x$ ),  $x = 12$ .

### Conclusion

The chromosome numbers in 13 adventive species found in the flora of the Republic of Altai were studied. Six of them are invasive on the territory of the republic, in between *Echium vulgare*, *Echinocystis lobata*, *Epilobium pseudorubescens*, *Lepidium ruderale*, *Rumex acetosella* are polyploids and *Elsholtzia ciliata* is diploid. Among the remaining alien species, *Arenaria serpyllifolia*, *Calendula officinalis*, *Solanum nigrum* are polyploids, *Centaurea cyanus*, *Foeniculum vulgare*, *Hyoscyamus niger*, *Trifolium campestre* are diploids. Thus, the most of the studies alien species are polyploids.

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