



Chromosome numbers in some vascular plants from the highlands of south-east Altai, Republic of Altai, Russia

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ABSTRACT

The paper provides the chromosome numbers ($2n$) for ten species and one subspecies of vascular plants from the families Asteraceae, Brassicaceae, Caryophyllaceae, Ranunculaceae, and Valerianaceae in highlands of the Kuray Range (South-Eastern Altai). Most of these species are endemic or rare. The species *Leiospora excaeva* (C.A. Mey.) F. Dvorak ($2n=14$) was studied for the first time. For *Minuartia verna* (L.) Hiern. ($2n=24$) and *Pulsatilla bungeana* C.A. Mey. ex Ledeb. ($2n=16$) we give the chromosome numbers first for Siberia; for *Erigeron uniflorus* L. subsp. *eriacalyx* (Ledeb.) Á. Löve & D. Löve ($2n=18$), *Packera heterophylla* (Fisch.) E. Wiebe ($2n=46$), *Pulsatilla turczaninowii* Kryl. & Serg. ($2n=16$) and *Valeriana petrophila* Bunge ($2n=14$), we give the chromosome numbers for the first time from West Siberia. *Crepis chrysantha* (Ledeb.) Turcz. ($2n=16$) is a new cytotype for West Siberia. For *Dracocephalum imberbe* Bunge, we confirm the previously described cytomixis. For each species we give both their distribution areas and previous chromosome number data.

Keywords: chromosome numbers, vascular plants, endemic species, rare plants, South-Eastern Altai, Kuraiskii Range, Republic of Altai, West Siberia, Russia

РЕЗЮМЕ

Королюк Е.А., Анькова Т.В. Числа хромосом некоторых сосудистых растений из высокогорий Юго-Восточного Алтая, Республика Алтай, Россия. Приводятся числа хромосом ($2n$) для 10 видов и 1 подвида сосудистых растений (Asteraceae, Brassicaceae, Caryophyllaceae, Ranunculaceae, Valerianaceae) из труднодоступных высокогорий Курайского хребта (Юго-Восточный Алтай), большинство видов эндемичные и редкие. Впервые для науки исследован вид *Leiospora excaeva* (C.A. Mey.) F. Dvorak ($2n=14$). Для видов *Minuartia verna* (L.) Hiern. ($2n=24$), *Pulsatilla bungeana* C.A. Mey. ex Ledeb. ($2n=16$) числа хромосом приводятся впервые для Сибири; *Erigeron uniflorus* L. subsp. *eriacalyx* (Ledeb.) Á. Löve & D. Löve ($2n=18$), *Packera heterophylla* (Fisch.) E. Wiebe ($2n=46$), *Pulsatilla turczaninowii* Kryl. & Serg. ($2n=16$) и *Valeriana petrophila* Bunge ($2n=14$) – впервые для Западной Сибири. *Crepis chrysantha* (Ledeb.) Turcz. ($2n=16$) – новый цитотип для Западной Сибири. У *Dracocephalum imberbe* Bunge подтверждено, описанное ранее явление цитомиксиса. Для каждого вида указан ареал и приведены данные по числам хромосом.

Ключевые слова: числа хромосом, сосудистые растения, эндемичные виды, редкие растения, Юго-Восточный Алтай, Курайский хребет, Республика Алтай, Россия

We studied the chromosome numbers ($2n$) on ten species and one subspecies of vascular plants, from the families Asteraceae, Brassicaceae, Caryophyllaceae, Ranunculaceae and Valerianaceae in the Kuraiskii Range, South-Eastern Altai (the Republic of Altai). We collected the seeds and herbarium material *in situ*. The chromosome numbers were determined according to the standard approach: the karyological analysis is made on root meristem squash preparations from seedlings. Seeds are sprouted in Petri dishes on wet sterile sand at 27°C and light regime providing 16 hours of daylight and eight hours of darkness. The germs are treated in 0.2 % colchicine for two hours and then fixed in a mixture of ethanol-acetic acid (3:1). The chromosomes are stained with aceto-haematoxyline according to Smirnov (1968). Slides were examined under Axioscop-40 microscope. We conducted the

chromosome analyses on 5–10 slides under 100× magnification. The herbarium samples are stored at the Herbarium of the Central Siberian Botanical Garden SB RAS (NS).

We collected the samples from three ecotopes at the same geographical location: Republic of Altai, Ulaganskii Raion, 9 km east of Aktash settlement, the Kuraiskii Range, 50°19'N, 87°44'E. 2613 m alt., 25 Jul 2017. Coll. A.Yu. Korolyuk, E.A. Korolyuk. (NS).

After description of the general geographic distribution (“distribution”) of each species, we provide a herbarium sample’s label with the number of ecotope: **1** – herb tundra, **2** – the roadside and **3** – tundra on rock debris. The number of the sample is given for each case (e.g. 1: no. 159):

ASTERACEAE

Aster alpinus L., 2n=36 (Fig. 1A)

Distribution: Eurasia, West America. Boreal-montane. **1:** no. 519. The species was studied from different parts of its distribution range, there are records of chromosome numbers 2n=18, 27, 36 (Goldblatt & Johnson 1979+, Agapova et al. 1990, Rice et al. 2015). The previous record from Altai was 2n=18 (Krogulevich & Rostovtseva 1984, Krasnikov 1985), while our data confirm the previously stated 2n=36 in alpine populations of Altai (Sokolovskaya & Strelkova 1938, 1948; Krogulevich & Rostovtseva 1984). Tetraploid (4x), x=9. Variable ploidy.

Crepis chrysantha (Ledeb.) Turcz., 2n=16 (Fig. 1B)

Distribution: East Europe, Asia. Mountain tundras. **1:** no. 549. Polymorphic species. There was only one record 2n=8 in Altai population from the Seminskii Range (Pulkina 1988), and there are also diploid records (2n=8) for North Urals, East Kazakhstan, East Siberia, Chukotka and the Far East (Goldblatt & Johnson 1979+, Agapova et al. 1990, Rice et al. 2015+). In West Sayan populations S.V. Pulkina (1988) revealed 2n=8+1B.

On the samples from West Sayan, Tyva and Chukotka the tetraploids (2n=16) have been found (Krogulevich 1978, Zhukova 1980, 1982, Krogulevich & Rostovtseva 1984). The sample of *Crepis bokkaidoensis* Babč. from Sakhalin Island re-identified later by N.S. Probatova et al. (2007) as *C. chrysantha*, was also tetraploid. We found tetraploid cytotype of *C. chrysantha* which is new for West Siberia. Tetraploid (4x), x=4. Variable ploidy.

Crepis multicaulis Ledeb., 2n=10 (Fig. 1C)

Distribution: Europe, Middle and Central Asia. Montane. **1:** no. 546. In Altai, 2n=10 was found on populations from the Kozhalyu (Krasnikov 1985) and Yuzhno-Chuiskii (Pulkina 1988) ranges. The same chromosome number was reported by Krogulevich & Rostovtseva (1984) from Tyva, West Sayan. The samples from Scandinavia and Tadjikistan showed the same chromosome number as well (Goldblatt & Johnson 1979+, Astanova 1989, Rice et al. 2015+). Diploid (2x), x=5.

Erigeron uniflorus L. subsp. *ericalyx* (Ledeb.) Á. Löve & D. Löve (*Erigeron ericalyx* (Ledeb.) Vierh.), 2n=18 (Fig. 2A)

Distribution: the subspecies is common in the alpine regions of Europe, Siberian and Mongolian highlands. Tundras and alpine belts of the mountains. **1:** no. 516. For Asian part of the distribution range, the diploid chromosome number (2n=18) Krogulevich & Rostovtseva (1984), as well as Chepinoga (2014) reported only for East Siberia. In West Siberia, we give the data on chromosome number data for the first time. Diploid (2x), x=9.

Packera heterophylla (Fisch.) E. Wiebe (*Tephrosieris heterophylla* (Fisch.) Konechn., *Senecio resedifolius* Less.), 2n=46

Distribution: Holarctic. Arctic-alpine. **1:** no. 550. For Asian part of the distribution area (West and East Sayan, the Putorana Plateau, Yakutia, and Chukotka Upland), the chromosome numbers are reported: 2n= 28, 46, 80, 90, 92, 114, 138 (Krogulevich & Rostovtseva 1984). We obtained first chromosome number data from West Siberia. It is, most probably, aneuploid. Variable ploidy.

BRASSICACEAE

Leiospora excapa (C.A. Mey.) F. Dvorak (*Parrya excapa* C.A. Mey.), 2n=14 (Figs 1D, 2B)

Distribution: Alpine species, with a narrow distribution area in the Republic of Altai, Tyva and Mongolia (Rybinskaya 1994), **2:** no. 488. We determined the chromosome number in this species for the first time. Diploid (2x), x=7.

CARYOPHYLLACEAE

Minuartia verna (L.) Hiern. (*Arenaria verna* L.), 2n=24

Distribution: Europe, the Caucasus, Middle Asia, Siberia, Mongolia, and the Far East. Widely distributed species. **1:** no. 545. There are records of chromosome number 2n= 24, 26, 48, 78, 120 for this species in populations from Europe, the Caucasus, and the Far East (Goldblatt & Johnson 1979+, Rice et al. 2015). We give the first data on chromosome number for Siberia. Diploid (2x), x=12. Variable ploidy.

LAMIACEAE

Dracocephalum imberbe Bunge, 2n=14 (Figs 1E, 2C)

Distribution: alpine belt of the mountains of South Siberia, Middle Asia, West Mongolia and North-East China. Described from Altai. **3:** no. 515. There are three closely related species growing in Altai: *Dracocephalum grandiflorum* L., *D. altaense* Laxm. and *D. imberbe* Bunge. The only chromosome number known for the first two species is 2n=14 (Sokolovskaya & Strelkova 1938). Besides, some authors combine these species in *D. grandiflorum* L. (Peshkova 1997), while *D. imberbe* has clearly distinguished morphological characteristics and different chromosome numbers reported in literature: 2n=10 (Sokolovskaya & Strelkova 1938, 1948) and n=7 (Krasnoborov et al. 1980) from Altai, but 2n=14 (Budantzev 1986) from Kyrgyzstan.

Rostovtseva (1978) recorded the cytomicis phenomenon in the plants of *D. imberbe* collected from the Kuraiskii Range (Ulaganskii Raion, the Republic of Altai), though the haploid chromosome number from flower buds could not be determined. Later, Krasnoborov et al. (1980) published the data from two populations of close geographic regions of the Republic of Altai: approximately n=7 for Ulaganskii Raion (probably, from the same samples as Rostovtseva examined) and n=7 for Kosh-Agachskii Raion.

There are samples of *D. imberbe* Bunge stored at Krasnoborov Herbarium, which Rostovtseva (1978) cites in her paper on cytomicis though without mentioning the determined chromosome number. This Herbarium contains another sample (Altai, Kosh-Agachskii Raion, western slope of the Kozholyu Range in the valley of the left tributary of the Buguzun River, 2800 m a.s.l., pebble-ped, 14.08.1981) with remark made by A.A. Krasnikov on determined chromosome number 2n=14 (Krasnikov, unpublished data).

In course of examination of 30 root samples, we noticed that in all preparations containing both mitotic plates and cells with easily discerned chromosome number 2n=14 there are rather common cells with the chromosome number ranging from 8 to 20 (Fig. 1F).

Thus, our data redouble previous ones for the samples from Ulaganskii Raion (the Kuraiskii Range) and confirm the phenomenon of mixoploidy in this species.

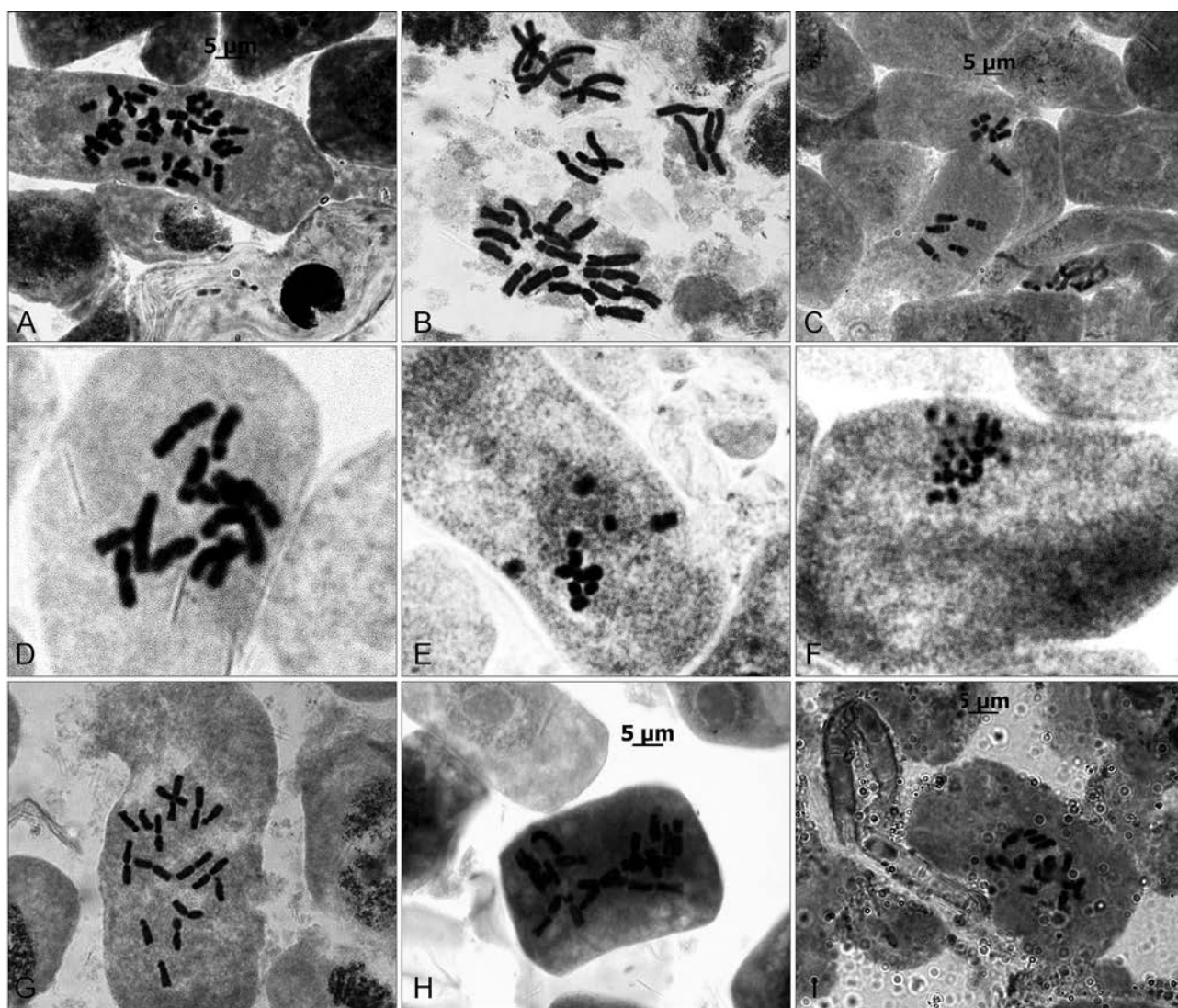


Figure 1 Mitotic metaphases: A – *Aster alpinus*, $2n=36$; B – *Crepis chrysantha*, $2n=16$; C – *Crepis multicaulis*, $2n=10$; D – *Leiospora excarpa*, $2n=14$; E – *Dracocephalum imberbe*, $2n=14$; F – *Dracocephalum imberbe*, $2n \approx 20$; G – *Pulsatilla bungeana*, $2n=16$; H – *Pulsatilla turczaninovi*, $2n=16$, I – *Valeriana petrophila*, $2n=14$. Scale bar – $5 \mu\text{m}$

RANUNCULACEAE

Pulsatilla bungeana C.A. Mey. ex Ledeb., $2n=16$
(Figs 1G, 2D)

Distribution: endemic of South Siberia and Mongolia (Timokhina 1993), **1**: no. 518. On mountains. The European authors (Uellner 1954, Baumberg 1970) state the chromosome number for this species to be $2n=16$ and 32. Besides determining the chromosome number in his summarizing paper, Baumberg provided the karyogram and a high-quality photo of the plate. Unfortunately, the origin of the sample is from horticulture (Erlenbach, Switzerland) and the Botanical Garden of Geneva. Thus, we consider our data on chromosome number to be the first for Siberia. Diploid ($2x$) $x=8$. Variable ploidy.

Pulsatilla turczaninovi Kryl. & Serg., $2n=16$ (Fig. 1H)

Distribution: widely distributed in Asia. Steppe meadows, pine forests edge, on sands. **1**: no. 487. The chromosome number that we state coincides with the records from Tyva, Mongolia and the Far East (Fedorov 1969, Krogulevich &

Rostovtseva 1984; Volkova & Ulanova 1986, Probatova et al. 2004). The chromosome number is the first for West Siberia. Diploid ($2x$), $x=8$.

VALERIANACEAE

Valeriana petrophila Bunge, $2n=14$ (Figs 1I, 2E)

Distribution: alpine belts in the mountains of Altai, Tyva, South Buryatia, and North Mongolia (Kurbatski 1996), **3**: no. 552. The only obtained chromosome number for this species was from Tyva, Mongun-Taiga (Krasnikova et al. 1983): $2n=14$. We determined the chromosome number first for West Siberia. Diploid ($2x$), $x=7$.

CONCLUSION

A gap still exists in cytological data from the alpine flora of Altai. According to recent studies (Krasnoborov & Artemov 2012), the flora of South-East Altai consists of 1365 species. Based on the analysis of cytological data for Altai species and our provisional estimations, we came to the point



Figure 1 Endemic species on the Kuray Range: A – *Erigeron uniflorus* subsp. *eriocalyx*; B – *Leiospora excapa*; C – *Dracocephalum imberbe*; D – *Pulsatilla bungeana*; E – *Valeriana petrophila*

that only about 10 % of South-East Altai flora has been studied. First of all, this is due to the difficulties in sampling in remote areas. From 11 taxa of vascular plants from South-East Altai, we determined the chromosome number of *Leiospora excapa* ($2n=14$) for the first time. For *Minuartia verna* ($2n=24$) and *Pulsatilla bungeana* ($2n=16$) the chromosome numbers are stated for the first time for Siberia. For *Erigeron uniflorus* subsp. *eriocalyx* ($2n=18$), *Packera heterophylla* ($2n=46$), *Pulsatilla turczaninovi* ($2n=16$), and *Valeriana petrophila* ($2n=14$) we discovered the chromosome number for the first time for West Siberia. *Crepis chrysantha* ($2n=16$) is a new cytotype for West Siberia. Among studied taxa, we revealed 5 diploid species, 4 species with variable ploidy ($2x$, $4x$), as well as one aneuploid and one mixoploid species.

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