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## The genus *Trollius* L. (Ranunculaceae) in the flora of the Altai Mountain Country

A.S. Erst<sup>1,2</sup>, A.N. Luferov<sup>3</sup>, V.I. Troschkina<sup>1</sup>, K. Xiang<sup>4,5</sup>, W. Wang<sup>4,5</sup>

<sup>1</sup>Institution of Russian Academy of Sciences, The Central Siberian Botanical Garden, The Siberian Branch of the RF Academy of Sciences, Zolotodolinskaya str., 101; 630090, Novosibirsk, Russia. E-mail: erst\_andrew@yahoo.com

<sup>2</sup>Tomsk State University, Laboratory of structural and molecular analysis of plants of the Biological Institute of TSU, Lenin str., 36; 634050, Tomsk, Russia

<sup>3</sup>I.M. Sechenov First Moscow State Medical University, Pharmaceutical Natural Science Department, Izmailovsky Boulevard, 8, 105043, Moscow, Russia; luferovc@mail.ru

<sup>4</sup>State Key Laboratory of Systematic and Evolutionary Botany, Institute of Botany, Chinese Academy of Sciences, 100093, Beijing, China

<sup>5</sup>University of Chinese Academy of Sciences, Beijing 100049, China

**Abstract.** Information on new characters, that were not previously used for the *Trollius* species identification is presented: consistence and degree of dissection of blade, type of margin, shape of teeth, number of petal veins, shape of nectarostigma, and morphological characters of fruits – type of the pericarp surface. The quantitative and qualitative morphological characters of the species are indicated: number of sepals and petals, distance from the petal base to the nectarostigma, length of the follicle and persistent style, as well as its shape and location. An identification key is proposed, which has been developed taking into account the suggested characters. A synopsis of the genus *Trollius* (Ranunculaceae) of the Altai Mountain Country, including 3 species belonging to 2 sections is given. The synopsis includes nomenclature quotations, information on type specimens, distribution in the region, and general distribution for each species.

**Key words:** *Trollius*, Ranunculaceae, diagnostic characters, Altai Mountain Country.

The genus *Trollius* L. includes c. 35 species (excluding *Hegemone* Bunge ex Ledeb.) distributed in the extratropical regions of the Northern Hemisphere. *Hegemone* is treated as a distinct genus (Schipczinsky, 1937). The common name of some species is "globeflower" (globe flower) or "Trollblume" (Stearn, 1992). The genus is characterized by conspicuous orange- or yellow-colored flowers, similarly colored petals, subscapose habit, and ternate or deeply 3-lobed leaves (Kadota, 1987). *Trollius* is characterized by an unusual floral structure with petals divided into the blade, pit (nectarostigma) and claw (Wang et al., 2010). The length ratio of nectaries to stamens was considered to be one of the most important morphological characters for species delimitation (Schipczinsky, 1937; Siplivinsky, 1972).

A. Doroszevska (1974) divided the genus into seven sections. Sections are mostly natural, but the gaps among them seem to be too small to assume them as distinct ones (Tamura, 1995). In Russia, about 19–20 species are recognized (Luferov et al., 2018). The greatest species diversity is observed in Siberia (12 species: our data). Eleven species of *Trollius* were previously indicated for that region (Friesen, 2003). Many taxa described recently from Russia (Malyshev, 1965, Siplivinsky, 1972, 1973; Stepanov, 1994, 2018) require more detailed investigation and evidence of species independence (Luferov et al., 2018).

The Altai Mountains, sometimes referred to the Altai Mountain Country (AMC), are located in the borderland between Russia, Kazakhstan, China, and Mongolia (Kamelin, 2005). The AMC is situated in the western part of the Altai-Sayan ecoregion and stretches from approximately of N 45° to 54°, and E 80° to 100° as outlined by R.V. Kamelin. This region crosses not only administrative boundaries, but also floristic boundaries, and the region's varied topography, coupled with the intersection of floristic boundaries, has led to a degree of endemism in the Altai flora (Orme et al., 2005).

The aim of this work was to study the taxonomy and characters of the *Trollius* species in the flora of the Altai Mountain Country. Firstly we identified diagnostic morphological characters of the *Trollius* species of the Altai Mountain Country, searched for new characters for the identification of taxa, compiled the key for species identification, and analyzed the distribution of *Trollius* species in the AMC.

### Material and methods

Morphological and geographical methods were used. The specimens deposited in the following Herbaria: V.L. Komarov Botanical Institute (LE), the Main Botanical Garden (MHA), M.V. Lomonosov Moscow State University (MW), Central Siberian Botanical Garden (NS, NSK), Altai State University (ALTB), and Tomsk State University (TK), were examined. Meanwhile, living plants were also collected during 20 expeditions (2000–2018) in the Russian and Chinese Altai (2014, 2016). The photographs in the field were taken with a Nikon D90 camera. The morphological characters were measured using AxioVision 4.8. The flowering and fruiting periods and habitats are given as cited on the collector's labels. Data on chromosome numbers are presented by the Chromosome Counts Database, CCDB (Rice et al., 2015).

In this study, we consider the Altai Mountain Country within its botanical-geographic borders, and follow R.V. Kamelin (2005) in dividing the AMC into floristic provinces and regions. These are: *Altai province* (regions: A1 – Northern Altai, A2 – North-Eastern Altai, A3 – Central Altai, A4 – Tchulyshman, A5 – Abakan-Dzhebash, A6 – Khemchik), *Altai-Dzungarian province* (regions: KAD1 – North-Western Altai, KAD2 – Kalbinsky, KAD3 – Tarbagatai, KAD4 – Saur, KAD5 – Zaisan, KAD6 – Bukhtarma, KAD7 – Markakol-Kanas, KAD8 – Kara-Irtysh, KAD9 – Altai-Dzungarian), and *Tuvian-Mongolian province* (regions: ZM1 – Chuya-Khobdo, ZM2 – Tsagan-Gol, ZM3 – Khobdo-Tonkhil; UM – South-Mongolian).

## Results and discussions

We recognize three species of the genus *Trollius* within the AMC: *T. asiaticus* L., *T. altaicus* C.A. Mey, and *T. dschungaricus* Regel. Some important characters can be used to distinguish all three species (Figure 1, 2; Table 1). The margin of blades and the shape of teeth are significant characters for *T. altaicus* and *T. dschungaricus*. *Trollius altaicus* is characterized by short teeth, arcuate-convex along the edge, and acute or slightly obtuse at the apex. In contrast to *T. altaicus*, *T. dschungaricus* is distinguished by small pointed teeth. An important character crucial for species identification is sepal dimorphism (the shape of the sepal can differ in one and the same flower). *Trollius dschungaricus* and *T. altaicus* exhibit this character, whereas *T. asiaticus* has identical sepals. The most significant character for identification of the taxa is the length of the persistent style. *Trollius altaicus* has the longest persistent style, which distinguishes it from two other species.



Figure 1. Species of the genus *Trollius* L. from Altai Mountain Country

A, B – flower of *T. asiaticus* L.; C, D – flower of *T. altaicus* C.A. Mey.; E – follicles of *T. asiaticus* L.; F – basal leaf of *T. asiaticus* L.; G – follicles of *T. altaicus* C.A. Mey.; H – basal leaf of *T. altaicus* C.A. Mey.; I, J – flower of *T. dschungaricus* Regel; K – follicles of *T. dschungaricus* Regel; L – basal leaf of *T. dschungaricus* Regel.

Photos: A, B – by V. Troshkina; C, D – by V. Saveliev & A. Raspopov; E – by V. Remorov; F – by P. Kosachev; G, H – by T. Rib; I – photo by A. Ebel; J, L – by B. Kryzhatyuk, K – by A. Hamitov.

*Trollius asiaticus* grows in the wide range of habitats, and thus exhibits the morphological variability. Despite this, species is characterized by the constant features, such as thin, not fleshy consistence of blade of the leaf, rhombic shape of the basal leaf segments, spaced lobes of segments, oblong-triangular acute at the apex teeth with straight or slightly arcuate edges, sepals equal to petals, and very short persistent styles of follicles (in two other species, persistent styles are much longer).

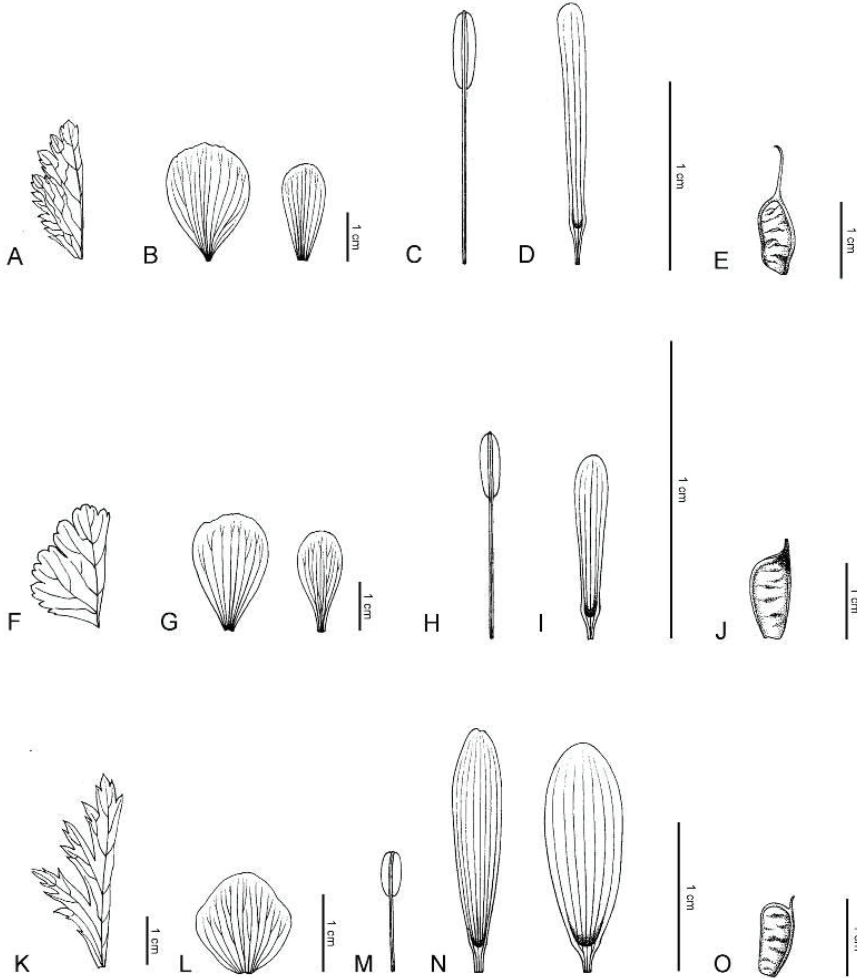


Figure 2. Leaf blade segments, sepals, stamens, petals and follicles of *Trollius* species:  
A-E – *Trollius altaicus* C.A. Mey; F-J – *T. dschungaricus* Regel; K-O – *T. asiaticus* L.  
(Figure by N. Prydak)

Interestingly, there are plants that combine diagnostic characters of *T. altaicus* and *T. asiaticus* leaves: lobes and teeth at the margin can sometimes be both straight and arcuate-convex on lateral sides, and the apex is pointed or acute. For *T. dschungaricus*, yellowish styles and stigmas are most characteristic, but sometimes they are dark-purple.

Table 1

Taxonomically significant characters of *Trollius* species from the AMC

Characters	<i>T. altaicus</i>	<i>T. dschungaricus</i>	<i>T. asiaticus</i>
Number of basal leaf segments (lobes in <i>T. dschungaricus</i> )	5	3–5	5
Shape of the leaf blade segments (lobes in <i>T. dschungaricus</i> )	Broadly rhombic	Broadly obovate, reniform	Rhombic
Leaf blade margins	Lobes of the leaf segments close or with unequally serrate-dentate margins overlapped. Teeth usually short, with arcuate-convex edges, acute at the apex, less often slightly obtuse	Blade margin slightly incised into short crenate-dentate lobes: teeth small, acute or rounded	Lobes of the leaf segments fan-like with clearly visible grooves between them, margins unequally serrate-dentate. Teeth oblong-triangular with straight or slightly arcuate edges, pointed at the apex, less often acute
Leaf blade consistence	Thin, not fleshy	Thick, slightly fleshy	Thin, not fleshy
Length of the basal leaf petiole, cm	4–25(35)	4–10(15)	4–35(45)
Flower diam, cm	2.5–4	3.5–6	3–5
Number of sepals	10–15	5–20	10–20
Sepal shape	Outer sepals broadly obovate or reniform; inner ones – rhombiform or narrowly obovate, with cuneate base and tapering to the apex	Outer sepals broadly obovate or reniform; inner ones – rhombiform or narrowly obovate, with cuneate base and tapering to the apex	Broadly elliptical or obovate
Sepal length, mm	12–19	17–29	14–24
Sepal width, mm	12–25 (outer sepals), 7–18 (inner sepals)	12–32	12–28
Sepal color	Yellow or yellow-orange	Yellow or pale-yellow; occasionally slightly reddish on the outside	Orange or reddish-orange
Number of petals	8–16(19)	8–14	18–30(40)
Petal shape	Linear	Obovate or spatulate	Oblong-elliptic
Petal length, mm	9–18	5–8	12–24
Petal width, mm	0.8–1.2	1.5–2	2.5–4(6)
Shape of the petal apex	Rounded, less often truncated or with a small notch	Rounded or truncated, less often with a small notch	Rounded, less often acute
Number of petal veins	3–5	3 (below nectarostigma) – 5 (above nectarostigma)	(3)7–17

Table 1. Continued

Characters	<i>T. altaicus</i>	<i>T. dschungaricus</i>	<i>T. asiaticus</i>
Colour of petals	Orange or yellow-orange	Yellow	Orange or orange-red
Length ratio of petal to sepal	Petals 2–3 times shorter than sepals	Petals 4–7 times shorter than sepals	Petals somewhat shorter or almost equal to sepals
Length ratio of petal to stamen	Petals 1–4 mm longer than stamens, less often almost equal to them	Petals equal or 1–3 mm shorter than stamens	Petals 2–3 times longer than stamens
Nectarostigma shape	Narrowly-elliptical	Narrowly-elliptical	Broadly-elliptical or obovate
Distance from the petal base to nectarostigma, mm	1–1.5	0.8–1	2–3
Colour of styles and stigmas	Black-purple or reddish-violet	Yellowish or dark purple	Yellowish
Follicle surface	Transverse veins sharply protruding	Almost smooth with hardly visible veins	Veins slightly protruding
Follicle length, mm	12–17	9–12	8–11
Persistent style length, mm	2–3	1.8–2.2	0.5–1
Persistent style shape and its location	Thin, erect or curved outwards at the base, curved to the fruit center at the apex	Erect or arcuate curved outwards	Arcuate curved inwards or erect, deflected outwards

Interestingly, there are plants that combine diagnostic characters of *T. altaicus* and *T. asiaticus* leaves: lobes and teeth at the margin can sometimes be both straight and arcuate-convex on lateral sides, and the apex is pointed or acute. For *T. dschungaricus*, yellowish styles and stigmas are most characteristic, but sometimes they are dark-purple. It can be assumed that this combination of characters indicates possible hybridization between different species in contact zones. It is important to note that the length of follicles and persistent styles are very different at the different stages of development due to the features of fruit morphogenesis. Three species exhibit elongated persistent styles at the initial stage of development, but during fruiting the length of the follicle increases more than the length of the persistent style (except for *T. altaicus*). The identification of plants collected at different phenological phases can be erroneous if this is not taken into account.

In three species studied, the flower buds and initial stages of the flower blooming are often characterized by various colors of sepals and petals: from pale yellow, dark yellow, and greenish to yellow-orange with tints of pink, reddish, and sometimes violet. These morphological characters are of an important diagnostic value and are used in this study to compile the identification key for the species studied.



The considered combinations of structural characters typical of different species are important for species identification. The causes of the morphological variability can only be clarified by further studies using different methods.

According to A. Doroszewska (1974), species of the genus *Trollius* from the Altai Mountain Country belong to two sections: *Trollius* (*T. altaicus* C.A. Mey., *T. dschungaricus* Regel), and *Longipetala* Dorosz. (*T. asiaticus* L.). The former is characterized by petals elongated, convex, thickened, shorter than sepals (Doroszewska, 1974), whereas the latter is distinguished by petals linear, flat, thin, longer than sepals. *Trollius altaicus* and *T. dschungaricus* belong to the same group, but exhibit a number of important differences. *Trollius altaicus* is mainly characterized by 5 segments of basal leaves (*T. dschungaricus* is distinguished by 3–5-lobed leaf blade), thin, not fleshy leaf blade consistence, often with the glossy surface (*T. dschungaricus* is distinguished by the thick, slightly fleshy blade, often with the glossy surface).

Molecular-phylogenetic studies do not cover all groups and most species (Despres et al., 2003; Wang et al., 2010). L. Despres et al. (2003) considered *T. altaicus* and *T. asiaticus* as belonging to the same clade and different sub-clades of the molecular-phylogenetic tree. W. Wang et al. (2010) analyzed *T. asiaticus* only; *T. dschungaricus* and *T. altaicus* were not investigated using molecular-phylogenetic methods. Since all three species were poorly investigated by molecular methods, it is difficult to consider their taxonomic relationship and affiliation with certain groups.

### Key to the *Trollius* species

1. Petals 18–40, 1.5–2 times longer than stamens and almost equal to or slightly shorter than sepals. Nectarostigma broadly-ovate or obovate, 2–3 mm from the petal base. Petal veins (3)7–17. Sepals are monomorphic, broadly elliptic or obovate. Persistent style 0.5–1 mm long. Leaf lobes fan-shaped, with clearly visible grooves between them, margins unequally serrate-dentate. Teeth oblong-triangular with straight or slightly arcuate edges, pointed at the apex, less often acute ..... ***T. asiaticus***
- + Petals 8–16(19), about the same length as stamens or slightly longer than stamens and more than 2 times shorter than sepals. Nectarostigma narrowly ovate, 0.8–1.5 mm from the petal base. Petal veins 3–5. Sepals dimorphic: outer – broadly obovate or reniform; inner– rhombiform or narrowly ovate, with a cuneiform base, narrowed to the apex. Persistent styles longer. Leaf blades of a different structure ..... 2
2. Leaf blades thin, not fleshy, dissected into 5 broadly rhombic segments with oblong-lanceolate, close and often overlapping lobes, their margins unequally serrate-dentate. Teeth usually short, with arcuate convex edge, acute at the apex, less often slightly obtuse. Petals 9–18 mm long, linear, longer than pistils or equal to them. Styles and stigmas black and purple, violet or reddish. Follicles 12–17 mm long. Persistent styles 2–3 mm long ..... ***T. altaicus***
- + Leaf blades thick, slightly fleshy, triquinate; lobes broadly obovate or reniform, slightly incised along the edge into short crenate-dentate segments: teeth with small pointed tips, less often rounded. Petals 5–8 mm long, obovate or spatulate, with a rounded apex and slightly curved inwards edges, usually shorter than pistils. Stiles and stigmas yellowish or dark-purple. Follicles 9–12 mm long. Persistent styles 1.8–2.2 mm long ..... ***T. dschungaricus***

## Sinopsis for the *Trollius* genus of the AMC

**Subgen. 1. *Trollius*** – Flowering shoots apical. The inflorescence cymose or flowers solitary. Basal leaves (or just a leaf) arranged in rosettes. Stem leaves sessile or petiolate. Rhizomes branching and ascending.

Type: *T. europaeus* L.

**Sect. *Trollius***, 1974, Monogr. Bot., 41: 159. – Sect. *Eutrollius* Prantl in Engler u. Prantl, 1891, Nat. Pflanzenf., 3(2): 56, p.p. – Petals elongated, convex, thickened, shorter than sepals (Doroszewska, 1974).

Type: *T. europeus* L.

1. ***Trollius altaicus*** C.A. Mey., 1831, Verz. Pfl. Cauc.: 200; Krylov, 1931, Fl. Zap. Sib., 5: 1122; Schipcz, 1937 in Fl. USSR, 7: 45; Gamajun., 1961, in Fl. Kazakhst., 4: 14; id., 1969, Ill. opred. rast. Kazakhst.: 365; Pachom., 1972, in Opred. rast. Sred. Azii, 3: 144; Revushkin, 1988, Vys. fl. Alt.: 64; Grubov, 1982, in Opred. sosud. rast. Mongolii: 108; Friesen, 1993, in Fl. Sib., 6: 104; Gubanov, 1996, Konsp. fl. Vneshn. Mong. (sosud. rast.): 51; Liangqian, Tamura, 2001, in Fl. China, 6: 140; Borodina-Grabovskaja, 2001, in Pl. Centr. Asia, 12: 18. – *T. caucasicus* C.A. Mey. non Steven, 1830, in Ledeb. Fl. Alt., 2: 301.

Lectotype (Siplivinsky, 1972: 168): "Altai, in pratis subalpinis legit Dr. Bunge" (LE!). A.E. Grabovskaya-Borodina (2018: 233) published the following syntypes: Western Siberia, Russia: "In pratis subalpinis, Altai [fl.], Bunge, Herb. Meyer" (LE); Kazakhstan: "In pratis subalpinis, Altai [fl.], Bunge, Herb. Meyer" (LE); "R[iddersk], 1 V [1826], [fl.], № 57, Herb. Ledebour" (LE); "R[iddersk], 18 V [1826], [fl.], № 206, Herb. Ledebour" (LE); "ad Schilgan fluv. 12 VI [1826], [fr.], № 390, Herb. Ledebour" (LE).

**Description:** Perennial herbs 15–60 cm high, to 80–100 cm at fruiting. Stem straight, simple or branched, smooth. Basal leaves with petioles 4–25(35) cm. Leaf blade ones or less dissected. Lower cauline leaves petiolate, upper ones sessile, or all cauline leaves sessile. Pedicle 1–12 cm, elongating to 25 cm at fruiting. Flowers 2.5–4 cm in diam., open (Figure 1C, D). Sepals orange 10–15, 11–18 mm long, outer: broadly ovate or cordate, oval and tapering to the center (Figure 2B); sometimes finely dentate and greenish at the apex. Petals 10–16(19), orange or yellow-orange, 9–18 mm long, 0.8–1.2 mm wide, linear, rounded at the apex, less often truncated or with 3.5–6 × 6.5–11 cm, base cordate, palmately 5-sect, segments broadly rhombic, 3-fid; terminal segments with unequally serrate-dentate margins (Figure 1H). Teeth usually short, with arcuate convex edge, acute at the apex, rarely slightly obtuse (Figure 2A). Cauline leaves 2–4, similar to the basal a small notch, 2–3 times shorter than the sepals (Figure 2D). Stamens, including anthers, 8–15 mm long. Anthers 2.5–3.5 mm long (Figure 2C). Nectarostigma narrowly ovate, 0.8–1.5 mm from the petal base. Styles and stigmas black and purple, reddish and violet. Fruit a globose head of numerous follicles, each 12–17 mm long. Persistent style thin, erect or curved outwards at the base, curved inward at the apex, 2–3 mm long (Figures 1G, 2E). Seeds ellipsoid-globose, black, slightly glossy.

**Chromosome number:**  $2n=16$  (out of the AMC) (Doroczewska, 1967; Rostovseva et al., 1981).

**Habitat:** Alpine and subalpine meadows, the upper part of the forest belt; up to 2200 m.

**Phenology:** Flowering May – June; fruiting June – July.

**Distribution:** A1, A2, A4–A7, KAD1, KAD2 (Ubinsky District), KAD3, KAD4, KAD5, ZM2, ZM3.

**General distribution:** China (Nei Mongol, Xinjiang), Kazakhstan (Almaty Region, East Kazakhstan Region, Jambyl Region), Kyrgyzstan (Chuy Region, Issyk-Kul



Region, Talas Region), Mongolia (Bayan-Ölgii Province), Russia (Altai Republic, Altai Krai, Tuva Republic) (Krylov, 1931; Siplivinskiy, 1972; Borodina-Grabovskaya, 2001; Liangqian, Tamura, 2001).

2. *T. dschungaricus* Regel, 1880, Acta Horti Petropol., 7: 383; Karamysheva, 1992, Fl. Tarb.: 54; Liangqian, Tamura, 2001, in Fl. China, 6: 138; Borodina-Grabovskaja, 2001, in Pl. Centr. Asia, 12: 19. – *T. europaeus* L. var. *songoricus* Regel, 1870, in Bull. Nat. Mosc., 43, 1: 243.

Lectotype (Siplivinsky, 1972: 169): [Kazakhstan] "Am 10 Mai auf den Gebirgen um das Fort Wernoje an den Quellen des Grossen Almaty-Flusses (Sewerzow)" (LE!).

Description: Perennial herbs 5–40 cm high, to 60–70 cm at fruiting. Stem simple or slightly ascending, or branched, with 1–3 flowers, smooth. Basal leaves with petioles 4–10(15) cm long. Leaf blade 1.5–4.5 × 2–7.5 cm, base cordate, palmately 3–5-sect, slightly incised into short crenate-dentate lobes at margins (Figure 1L). Teeth acute or rounded (Figure 2F). Cauline leaves 2–4, similar to the basal ones or more dissected and smaller in size. Lower cauline leaves petiolate, upper ones sessile. Pedicle 1–15 cm, elongating to 20 cm at fruiting. Flowers 3.5–6 cm in diam., open (Figure 1I, J). Sepals yellow or pale yellow, sometimes slightly reddish on the outside, 17–29 mm long, 12–32 mm wide, 5–20 mm wide, broadly obovate or elliptic (Figure 2G). Petals 8–14, yellow, 5–8 mm long, 1.5–2 mm wide, ovate or reniform, shorter than the sepals, equal to or shorter than the stamens (Figure 2H, I). Stamens, including anthers, 8–12 mm long. Anthers 2.5–3 mm long. Nectarostigma narrowly elliptic, 0.8–1 mm from the petal base. Styles and stigmas yellowish or dark purple. Fruit a globose head of numerous follicles, each 9–12 mm long (Figure 1K). Persistent style erect or arcuate curved outwards, 1.8–2.2 mm long (Figure 2J). Seeds round, smooth-angular, brown-black, slightly glossy.

Chromosome number:  $2n = 16$  (out of the AMC) (Doroczewska, 1967; Zhukova, 1967).

Habitat: Wet meadows, sedge bogs, wetted habitats in a strip of spruce forest and among juniper, along mountain streams, subalpine meadows, on peaty soil, near glacial moraines and near snow spots in the middle and upper mountain belt; up to 2500 m.

Phenology: Flowering July – August; fruiting August – September.

Distribution: KAD5 (Tarbagatay Ridge).

General distribution: Kazakhstan (Almaty Region, East Kazakhstan Region), Kyrgyzstan (Issyk-Kul Region, Chuy Region, Osh Region), Uzbekistan (Andijan Region, Fergana Region, Namangan Region, Tashkent Region), China (Xinjiang), Mongolia (Bayan-Ölgii Province, Govi-Altai Province) (Siplivinskiy, 1972; Borodina-Grabovskaya, 2001; Liangqian, Tamura, 2001).

Sect. 2. *Longipetala* Dorosz., 1974, Monogr. Bot. (Warszawa), 41: 159. – Sect. *Eutrollius* Prantl, in Engler u. Prantl, 1891, Nat. Pflanzenf., 3(2): 56, p.p. – Petals linear, flat, thin, longer than sepals or nearly equal to them (Doroczewska, 1974; Luferov, 2004).

Type: *T. asiaticus* L.

3. *T. asiaticus* L., 1753, Sp. Pl.: 557; DC., 1824, Prodr., 1: 46; C.A. Mey., 1830, in Ledeb. Fl. Alt., 1: 301; Ledeb., 1842, in Fl. Ross., 1: 73; Krylov, 1931, Fl. Zap. Sib., 5: 1121; Schipcz., 1937, in Fl. USSR, 7: 49; Gamajun., 1961, in Fl. Kazakhst., 4: 15; Pachom., 1972, in Opred. rast. Sred. Azii., 3: 144; Dorosz., 1974, Monogr. Bot., 41: 64; Grubov, 1982, in Opred. sosud. rast. Mongolii: 108; Lomon., 1984, in Opr. Rast. Tuv. ASSR: 34; Revushkin, 1988, Vys. fl. Alt.: 64; Friesen, 1993, in Fl. Sib., 6: 106; Gubanov, 1996, Konsp. fl. Vneshn. Mong.

(sosud. rast.): 51; Liangqian, Tamura, 2001, in Fl. China, 6: 141; Borodina-Grabovskaja, 2001, in Pl. Centr. Asia, 12: 19. – *Trollius sertiflorus* Salisb., 1807, Trans. Linn. Soc. London, 8: 303. – *T. sajanensis* (Malysch.) Sipliv., 1972, Novosti Sist. Vyssh. Rast., 9: 168. – *T. bargusinensis* Sipliv., 1973, Novosti Sist. Vyssh. Rast., 10: 358. – *T. vitalii* Stepanov, 1994, Florogenet. Analiz, 1: 101, p.p. – *T. kolonok* Stepanov, 2018, Systematic notes, 117: 41, p.p.

**Lectotype** (Siplivinsky, 1972: 168): "In Sibiria" (LINN).

**Description:** Perennial herbs 5–90 cm high. Stem straight, simple or branched, with 1–3 flowers, grooved. Basal leaves with petioles 4–35(45) cm. Leaf blade  $4.5 \times 8.5$  cm, base reniform, palmately 5-sect, segments rhombic, 3-fid, fan-like lobes with clearly visible grooves between them, with unequally serrate-dentate margins (Figure 1F). Teeth often oblong-triangular, with straight or slightly arcuate edges, pointed at the apex, less often acute (Figure 2K). Cauline leaves 2–6, similar to the basal ones, or smaller. Lower cauline leaves petiolate, upper ones sessile. Pedicle 1–10 cm, elongating to 15 cm at fruiting. Flowers 3–5 cm in diam., open (Fig. 1A, B). Sepals 10–20, orange or reddish-orange, 14–24 mm long, broadly elliptical or obovate (Figure 2L). Petals 18–40, orange or orange-red, 12–24 mm long, 2.5–4 (6) mm wide, oblong-elliptical, rounded at the apex, slightly shorter than or almost equal to the sepals (Figure 2M, N). Stamens, including anthers, 8–12 mm long. Anthers 2.5–3 mm long. Nectarostigma broadly elliptic or obovate, 2–3 mm from the petal base. Styles and stigmas yellowish. Fruit a dense globose head of numerous follicles, 8–11 mm long including the persistent style (Figures 1E, 2O). Persistent style arcuate curved inwards or erect, deflected outwards, 0.5–1 mm long. Seeds rounded, 3-edged, black, glossy.

**Chromosome number:**  $2n = 16$  (out of the AMC) (Doroczewska, 1967; Zhukova, 1967).

**Habitat:** Wet meadows, forest glades, alpine and subalpine meadows in the upper and middle mountain belt., up to 2800 m.

**Phenology:** Flowering June – August; fruiting August – September.

**Distribution:** A1 (Baschelaksky Ridge), Anui River, A2 (Teletskoye Lake), A3-A6, KAD1, KAD3-KAD5, ZM1, ZM2, ZM3.

**General distribution:** China (Xinjiang), Kazakhstan (Almaty Region, East Kazakhstan Region), Kyrgyzstan (Chuy Region, Issyk-Kul Region, Talas Region), Mongolia (Bayan-Ölgii Province, Govi-Altai Province, Zavkhan Province, Uvs Province, Khövsgöl Province, Selenge Province), Russia (Altai Krai, Altai Republic, Buryatia Republic, Irkutsk Oblast, Kemerovo Oblast, Khakassia Republic, Krasnoyarsk Krai, Novosibirsk Oblast, Omsk Oblast, Tomsk Oblast, Tyumen Oblast, Tuva Republic) (Krylov, 1931; Igoshina, 1968; Siplivinskiy, 1972; Borodina-Grabovskaya, 2001; Liangqian, Tamura, 2001).

## Conclusion

The study of morphological characters of the *Trollius* species growing in the Altai Mountain Country allowed us to propose new characters of the leaves and flowers that were not previously used for the species identification: consistence of blade and degree of its dissection, type of margin, shape of teeth, number of petal veins, shape of nectarostigma, venation of follicles, and shape and direction of persistent style. The quantitative differences of the species are specified: length of the basal leaf petiole, number of sepals and petals, distance from the petal base to the nectarostigma, and length of persistent style. The suggested key based on a combination of vegetative and generative morphological characters allows us to

identify species more accurately. As a result of the study, three species of *Trollius* were identified for the Altai Mountain Country: *T. altaicus*, *T. asiaticus*, and *T. dschungaricus*; intermediate morphological forms, apparently of a hybrid origin, are detected.

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## Род *Trollius* L. (Ranunculaceae) во флоре Алтайской горной страны

А.С. Эрст<sup>1,2</sup>, А.Н. Луферов<sup>3</sup>, В.И. Трошкина<sup>1</sup>, К. Ксианг<sup>4,5</sup>,  
В. Ванг<sup>4,5</sup>

<sup>1</sup>Центральный Сибирский ботанический сад СО РАН, Новосибирск, Россия;  
erst\_andrew@yahoo.com

<sup>2</sup>Томский государственный университет, Томск, Россия

<sup>3</sup>Первый Московский государственный медицинский университет им.  
И.М. Сеченова, Москва, Россия; luferovc@mail.ru

<sup>4</sup>Институт Ботаники Китайской академии наук, Пекин, Китай

<sup>5</sup>Университет Китайской академии наук, Пекин, Китай.

**Аннотация.** В статье представлены сведения о новых признаках, которые ранее не использовались для идентификации видов *Trollius*: текстура и степень рассечения пластинки, зубчатость и форма зубцов, число жилок лепестка, форма нектаростигмы, морфологические признаки плодов — тип поверхности околоплодника (наличие резко выступающих жилок у *T. altaicus*; слегка выступающие жилки у *T. asiaticus*, гладкая поверхность у *T. dschungaricus*). Указаны количественные морфологические характеристики видов: число чашелистиков и лепестков, расстояние от основания лепестка до нектаростигмы, длина листовок, их форма и расположение. Предложен идентификационный ключ, разработанный с учетом предложенных признаков, приведен конспект рода *Trollius* (Ranunculaceae) Алтайской горной страны, включающий 3 вида, относящиеся к 2 секциям. Конспект включает номенклатурные цитаты, информацию о типовых образцах, распространении в регионе и об общем распространении каждого вида.

**Ключевые слова:** *Trollius*, Ranunculaceae, диагностические признаки, Алтайская горная страна.

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