Floral finds in the city of Abakan (Republic of Khakassia, Russian Federation)

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Abstract. Abakan is a city district, the capital of a constituent entity of the Russian Federation of the Republic of Khakassia, with a population of 171.2 thousand people. On botanical and geographical zoning of L M Cherepnin Abakan is located in the Priabakanskaya valley steppe (S1) in the central part of the Khakass-Minusinsk depression at a height of 250 m above the sea level at the mouth of the Abakan river. Despite the fact that the territory of the Republic of Khakassia is studied well from the botanical point of view, there is not enough information about the current state, structure and species composition of the flora of the city of Abakan, which constituted the basis for in-depth studies of its vegetation cover. The aim of the work was to identify new and rare plant species in the flora of the city of Abakan. Floristic collections in the city were carried out from 2016 to 2018 by the method of model section of the urbanized landscape. As a result of the expeditionary research of 11 model sections, new plant species for the Republic of Khakassia (Centaurea ruthenica, Galium coriaceum, Myosotis sparsiflora, Oxytropis candidans, Peucedanum morisonii, Sagittaria trifolia, Silene turgida) and the city of Abakan were found and identified for the first time in the administrative boundaries of Abakan (Aquilegia grandulosa, Batrachium peltatum, Potamogeton crispus, Scirpus radicans, Viola canina). Habitats and model sections with the coordinates of the collection are specified, the boundaries of the ranges of species in the regions are marked.

1. Introduction

The city of Abakan is located in the central part of the Khakass-Minusinsk depression at an altitude of 250 m above sea level at the mouth of the Abakan River. By botanical and geographical zoning of L M Cherepnin [1] the city is located in the Priabakansky steppe region (S1); and according to the floristic zoning of Siberia by L I Malyshev [2] it is located in the working floristic area (FA) of the Republic of Khakassia.

There was practically no focused floristic research in the city of Abakan. Since the mid-twentieth century a number of outstanding Siberian botanists from Siberian scientific and educational institutions have been involved in the study of the Khakassia plant cover: Tomsk State University (Tomsk), Central Siberian Botanical Garden, Siberian Branch of the Academy of Sciences of the USSR (Novosibirsk, CSBG), Krasnoyarsk State Pedagogical Institute (Krasnoyarsk, KSPI) – V V Reverdatto, L M Cherepnin, A V Kuminova, A V Polozhiy, I M Krasnoborov et al. [3]. But most of them were carried out in the city of Abakan. L M Cherepnin collected interesting plants in the city of Abakan in 1942 along the way in his expedition around Khakassia. The outstanding work of L M Cherepnin [4], which has not lost its relevance up to the present, lists geobotanical research routes in the territory of Khakassia.
According to the literary and herbarium data, Honored Worker of the Russian Federation I M Krasnoborov and associate professor of KSU T M Zorkina studied the flora of the city [5]. I M Krasnoborov consulted at the Khakass University and assisted in the identification of some plant species in the city of Abakan, which are still kept in the HGU Herbarium, T M Zorkina collected and identified herbarium material of about 250 species on Samokhval Mount, located in the city, and made geobotanical descriptions [6].

Much of the city, which houses about sixty percent of modern buildings, was occupied by swampy swamps [7]. The city feature extends from the south and east along the river. Abakan, from the west it is delimited by the Tasheba River, and from the north by a dam, built to protect the city from flooding, which causes the presence of a large number of hygrophilic plants. A major role in shaping the vegetation cover of cities has been played and now continues to be played by conscious human activity aimed at optimizing the urban environment - the human habitat [8]. As a result, in parks and on avenues, landscaping is carried out with species atypical for this territory.

A characteristic feature of the urban flora, which distinguishes it from the natural flora, is its great dynamism and inconstancy. Its composition and the total number of species can vary over fairly short periods of time. At the same time, the younger the neighbourhood is, the more unstable is its flora. This is facilitated by such factors as the expansion of buildings, the demolition of old buildings, the development of industry and transport. A targeted floristic study in Abakan was conducted by us from 2016 to 2018. The aim of the work was to identify new and rare plant species in the flora of Abakan city.

2. Materials and research methods

The material for the work is based on the outline of the flora of Abakan city, compiled on the basis of the collection of higher plants of the Herbarium named after L M Cherepnin KRAS named after V P Astafiev collected during the inventory of the flora of the city and rare species. Field work was carried out by the method of model sections (MS) of the urbanized landscape, supplemented by route surveys [9]. As a result, the territory of the city was divided into relatively equal economic and geographical zones of 250 x 250 m with pronounced environmental and visual isolation. Trial areas were established within the administrative boundaries of the city; they were allocated on the basis of phytocenotic diversity and peculiarities of anthropogenic load. As part of the MS there are areas of natural habitats that are within the city (mountain Samokhval, Park of Culture and Rest near the Tasheba River, etc.), and man-made habitats with disturbed vegetation: man-made - the territory of an industrial enterprise, railway station, garden-dacha area, areas Eastern and Southern Dams, habitats of residential areas (residential urban development and the private sector) and habitats of artificial plantations (Victory Park and Komsomolsky Park). Most of the territories of the MS were visited repeatedly and at different times of the growing season. In addition, the literature data and data of the Herbals of the KRAS named after V P Astafiev and Krasnoyarsk State University (HGU). Quoted samples are stored in the Herbarium named after L M Cherepnin of Krasnoyarsk State Pedagogical University named after V P Astafiev. Types are arranged in the order of the Latin alphabet. The names of the species and the authors are given in accordance with the electronic database of the nomenclature of plants - http://www.ipni.org/ipni/plantnamesearchpage.do. In the work, MSs are given in abbreviated form: Mn - residential area of the Ministry of Railways, Gs - Samokhval mountain, Yud - South dam, Hb - Eastern dam, Od - Orbitov dachas, Pk - Park of Culture and Rest.

3. Results and discussion

Currently, an urgent task for the Republic of Khakassia is the preservation of all growing plant species. With the development of economic activity in the city of Abakan for many decades, the environment has been subjected to a strong anthropogenic impact. The most vulnerable elements of regional floras are rare and endangered plant species. According to the latest data, over 1,670 species of higher plants grow on the territory of Khakassia, of which 85 species are endemic to the Altai-Sayan mountainous country and 28 are endemic to the Khakassian steppes [10]. However, in order to take timely measures
to conserve the species, it is necessary to know about their presence in the region, habitats, the state of populations, and limiting factors [11]. Therefore, field surveys are so necessary to identify the flora, as a result of which we have found and identified new and rare plant species in the city of Abakan.

3.1. New species for the Republic of Khakassia

3.1.1. Centaurea ruthenica Lam. In the city of Abakan, it was gathered once on the southern slope of Samokhval Mount (Gs), latitude 53°70’83″ North, longitude 91°55’91″ East. It is the European-Central Asian species, in the territory of Siberia, it has been separated from the main part of the range by its location in Western Siberia from the Barnaul floristic region and the Altai Republic [12]. The identified location specifies the northern limit of the species distribution in Asia and it is the most eastern one.

3.1.2. Galium coriaceum Bunge. Single charges are made on Samokhval Mount (Gs), latitude 53°70’83″ North, longitude 91°55’91″ East. It is Altai-Sayan-Tuvin endemic [13], it is widespread in the Gorno-Altai floristic region (Altai Republic), the Upper Yenisei floristic region (Us river, Krasnoyarsk region) and in the Tyva Republic. Our find is the only one for Khakassia at the northern boundary of the Central Siberian area.

3.1.3. Myosotis sparsiflora J. C. Mikan ex Pohl. It was noticed once in the city of Abakan on the Southern dam (Yud), latitude 53°70’82″ North, longitude 91°47’43″ East. The area spreads in the Western Palearctic, on the territory of Siberia and has a sporadic distribution, mainly in cities [14]. We cite the only location in the Republic of Khakassia, where the species inhabits, obviously, as an invasive plant. This find complements the only known location in Central Siberia (Yeniseisk) and clarifies information on its distribution in the eastern part of the range.

3.1.4. Oxytropis candicans (Pall.) DC. It was found in the city of Abakan on the bank of the Southern Dam (Hb), latitude 53°70’82″ North, longitude 91°47’43″ East. It is endemic of Eastern Siberia [15]. It is extremely rare in the Krasnoyarsk Territory, the Irkutsk Region, Buryatia, Chita Region and Yakutia. And it was first noted in Khakassia. The location of the species is the only one on the left bank of the Yenisei.

3.1.5. Peucedanum morisonii Bess. ex Spreng. It was gathered on the Eastern dam (A), latitude 53°72’73″ North, longitude 91°48’82″ East, Southern dam (Yud), latitude 53°70’82″ North, longitude 91°47’43″ East, in the Park of Culture and Rest (Pk), latitude 53°72’53″ North, longitude 91°47’85″ East. It is the West Siberian-Kazakh species, which grows mainly on the plains of Western Siberia, Northern and Eastern Kazakhstan [16]. Locations in Central Siberia are somewhat far from the main part of the range. Our findings complement the information on the distribution of the species on the eastern frontiers within the Siberian part of the range.

3.1.6. Sagittaria trifolia L. It was found on the shore of a reservoir on the Eastern Dam (Hb), latitude 53°72’73″ North, longitude 91°48’82″ East. It is extremely rare. In the “Flora of Siberia” for Khakassia, the location in the vicinity of the city of Minusinsk is indicated [17]. This point is outside of Khakassia and belongs to the Krasnoyarsk Territory. In Siberia, the species has a significant range disjunction; in Eastern Siberia, it is known from Buryatia and the Chita region. This is the first reliable find, literature data and herbarium collections (HGU, KRAS) from the territory of Khakassia are absent. The South Palearctic species is located on the northern boundary of the range.

3.1.7. Silene turgida M. Bieb. ex Bunge. It was found on a rocky slope near the river in the Park of Culture and Recreation (Pk), latitude 53°72’53″ North, longitude 91°47’85″ East. The Mongol-Altai endemic is mainly distributed in the Gorno-Altai floristic region and the Tyva Republic. In the Altai Territory, the only location in the Upper Yenisei working district (2 reliable locations) [18]. It is included
into the Red Book of the Krasnoyarsk Territory as a vulnerable, shrinking in number from individual locations [19]. The identified single location in Khakassia clarifies the northern limit of the species distribution.

3.2. New species for the city of Abakan

3.2.1. *Aquilegia grandulosa* Fisch. ex Link. Single herbarium collections found on the river bank in the Park of Culture and Rest (Pk), latitude 53°72′53″ North, longitude 91°47′43″ East. The plant grows in Altai, Krasnoyarsk and Trans-Baikal Territories, the Irkutsk Region, Altai, Buryatia, Tuva, Khakassia, Yakutia, China, and Kazakhstan [20]. On the territory of Khakassia, the localities of the species are noted in Askiza, Ordzhonikidzhevsky, Tashtypsky and Shirinsky districts [21]. For the city of Abakan, the identified location is obviously alien.

3.2.2. *Batrachium peltatum* (Schrank) C. Presl. It was found on the territory of South Dam (Yud), latitude 53°70′82″ North, longitude 91°47′43″ East. In some places it is abundant. It is palearctic boreal nemoral species. It is widely distributed throughout Siberia, reaching the Kolyma Federal region [22]. The catalog of flora of the Republic of Khakassia shows the location of this species in most areas [21]. It grows in Khakass steppes: region of God lake (Popov and Degtyarev), Bateni village on the Yenisei river (Reverdatto); valley of the Abakan river; Toguzhekov street, floodplain of the Tasheba River (Reverdatto, Golubintsev, etc.) [23]. This is where one can find the first one for the city of Abakan.

3.2.3. *Potamogeton crispus* L. It was found in the Park of Culture and Rest (Pk), latitude 53°72′53″ North, longitude 91°47′43″ East. In the Republic of Khakassia, the only location is noted in Shirinsky District [21]. Our find, first noted in the city of Abakan, complements the few known locations in Central Siberia.

3.2.4. *Scirpus radicans* Schkuhr. It grows along the banks of the reservoir in the Park of Culture and Rest (Pk), latitude 53°72′53″ North, longitude 91°47′43″ East. It is Eurasian boreal-nemoral species. It is distributed mainly in southern Siberia, very rarely found in its northern part, reaching the Republic of Yakutia - the environs of Vilyuisk in the Vilyuisko-Verkhnelensky FR and the settlement of Khara-Aldan in the Aldan FR. In Central Siberia it is rare; a few collections are known only from the Upper Yenisei FR [24] and the adjacent Shirinsky district of Khakassia [21].

3.2.5. *Viola canina* L. It grows on the rocky banks of the river in the Park of Culture and Rest (Pk), latitude 53°72′53″ North, longitude 91°47′43″ East. It is Eurosiberian boreal meadow-forest species. In Central Siberia, locations are known in the Tungussky FR [25] and the Upper Yenisei FR [26]. In the Republic of Khakassia it is noted in Ust-Abakan, Askiz and Tashtyp districts [21]. Our find is the first in the city of Abakan, complements the information on the distribution of the species, specifying the Siberian part of the range.

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