History of floristic studies in Abakan

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Abstract. Abakan is a capital of the subject of the Russian Federation, the Republic of Khakassia. The aim of the paper is to identify the history of botanical research on the territory of Abakan in the XX-XXI centuries. The floristic studies were carried out by advanced botanists, scientists of educational institutions (Tomsk State University, Krasnoyarsk State Pedagogical University named after V.P. Astafiev, Khakass State University named after N.F. Katanov) and scientific institutions of Siberia (Central Siberian Botanical Garden of SB RAS, etc.). The historical information collected from publications, route information provided by flora researchers, herbar labels, field diaries and herbarium reports is arranged in chronological order. The early history of the vegetation cover study of Krasnoyarsk Territory and Khakassia (from 1627 to 1954) is described in detail in the work of L.M. Cherepnina, further it is described in the works of N.N. Tupitsyna and others. In the XXI century the floristic studies were continued by representatives of the three scientific schools. The Tomsk school (TSU) is presented by A.L. Ebel, A.I. Pyak and others, the Novosibirsk school (TSSBS SB RAS) is presented by D.N. Shaulo and others and the Krasnoyarsk school (KSPU named after V.P. Astafiev) is presented by E.M. Antipova, T.M. Zorkina, O.P. Chebotareva. This school has a leading role in a special study of the Abakan flora.

1. History of Abakan

One of the actual and priority areas in modern botany remains the study of the biological diversity in cities and towns, in particular the floristic diversity of land plants, i.e., urbanoflor [1, 2].

Abakan is a city in Southern Siberia, an urban district, a capital city of the subject of the Russian Federation, the Republic of Khakassia. The city grew from a small ulus, which later became Ust-Abakananskoye village. Since 1882, it was a center of a foreign council or steppe duma. In 1859, only 183 people lived in Ust-Abakanskoye village. Until the October Revolution, there were only two streets: Naberezhnaya and Abakanorskaya; there was no any industrial enterprise; there was the only handicraft tannery, which processed up to 700 leathers per year. The main occupation of the population was cattle breeding. Due to the beginning of the Abakan-Achinsk railway line construction in 1914, the village was incentive for development. The October Revolution changed the life of the Khakass people radically. On November 14, 1923, the resolution on the formation of the Khakass national district with a center in Ust-Abakananskoe village was adopted. On May 25, 1925 Ust-Abakananskoe village became an administrative center of the Khakassky district. The Civil War interrupted the further construction of the railway, and only after the final victory over the interventionists it became possible to complete the railway to Ust-Abakananskoe. On November 23, 1925, the grand opening of the Abakan railway station took place. By this time, Vokzalnaya and Pushkina streets were found in the area of the railway station.
On October 20, 1930, the Khakass Autonomous Region was found; Ust-Abakan was renamed to Abakan on January 20, 1931.

Abakan received a status of a city and it has 10.6 thousand people. Abakan in these years did not yet have an urban appearance and consisted of several small villages. The formation of the modern city began only after the World War II. Modern Abakan is a scientific and cultural center of Khakassia.

The city is located in the center of the southern part of the Minusinsk hollow. The Khakass-Minusinsk hollow has a shape of a bowl; its lines are the Kuznetsk Alatau mountains in the west, the Western Sayan ridges in the south, and the Eastern Sayan ridges in the north and east. The Yenisei River crosses the hollow almost in the middle from the south to the north, and, one of its largest inflows, the Abakan River, flows into the Yenisei in the center of the hollow. The Abakan River, born in the mountains of the Western Sayan, at the confluence of the Greater and Lesser Abakan, originating on the northern slopes of the Western Sayan and Altai Mountains, flows into the Krasnoyarsk reservoir at the foot of Mount Samokhval. The river Abakan in its upper stretches flows through a narrow, taiga-covered valley; near Bolshoi Monok village, the valley expands sharply, passing into the Khakass-Minusinsk hollow. Here the Abakan channel is divided into numerous sleeves. The river has mainly snow and rain nutrition. The ice is from the second half of November to the end of April. A capital of Khakassia, Abakan is located at the place where the river flows into the Yenisei (the Krasnoyarsk reservoir). The height of the mouth is 243.6 m above the sea level. It is 514 km long (from the source of the Bolshoi Abakan), the basin area is 32,000 km². The city is located at the confluence of the Yenisei and Abakan rivers, 3,390 km east of Moscow and 400 km south of Krasnoyarsk.

Abakan has a compact structure of the city center and an extended structure of summer cottages and homestead type houses, which area in the city significantly exceeds the territory of the city center. In the north, the city borders on the airport and settlements of the Ust-Abakan region, which are adjacent to the city line, in the west it borders with the industrial zone and the railway. In the south and southwest there is also a railway, military corps, homestead type houses and further the Abakan river; in the north-east is the floodplain of the Yenisei River, in the southeast is mountainous terrain and large areas of homestead type houses, as well as an industrial and warehouse zone of the port and city cemeteries. The city line extends from the south and east along the Abakan river, partially passes in the region of the Sogrinsky industrial hub and summer cottages along the Yenisei River, from the west it is delimited by the Tasheba River and the buildings of the Abakan HEC, and from the north a dam built to protect the city from flooding and the territory of the Abakan airport, a part of which (without a runway) is a part of the city. The total land area of the city is 11,238 ha. A significant part of the territory is occupied by lands occupied by gardening unities (23.1%), residential and public-business buildings (18.8%) and industrial enterprises (10.7%). There are large energy enterprises in the city.

Abakan is known for its cultural and scientific centers. Gardens, squares and boulevards occupy 1/3 of the city. The most significant are “Komsomolsky”, “Preobrazhensky” parks, “Recreation” park, “Victory park”, “Orlenok” children's park, “Chernogorsky” park and “Pushkinsky” square.

The zonal type of vegetation is steppes [3], forest and meadow communities also form the basis of the city’s vegetation cover, but the natural vegetation in the city is fragmented. Wetland, shrubby, solonchak, weed vegetation significantly complete the phytocenotic diversity of the urban environment.

2. Survey of botanic studies
The aim of the paper is to identify the history of the botanical search on the territory of the city Abakan of the Republic of Khakassia in the XX-XXI centuries.

The studies were carried out within the administrative boundaries of the city. The field works were carried out by the model separation (MS) method of the urbanized landscape, supplemented by route surveys [4,5].

The historical materials were obtained in the study of monographs and publications of botanists on the flora and vegetation of Khakassia [6, 7, 8], data on herbarium labels of Herbaria named after L.M. Cherepnina (KRAS) and Khakass State University (HGU), as well as data from floristic reports for Siberia, Krasnoyarsk Territory and Khakassia: “Flora of the southern part of the Krasnoyarsk Territory”
[9]; "Plants of the south of the Krasnoyarsk Territory" [10]; “Flora of Siberia” [11]; Catalog of flora of the Republic of Khakassia [12]; Woody plants of Asian Russia [13]; List of higher plants of the Altai-Sayan ecoregion [14] and others.

The history of the study of vegetation in the southern part of Krasnoyarsk Territory (including Khakassia) from 1627 to 1954 was described by L.M. Cherepnin [15]. Until now, the material presented in this first work is actual and allows us to continue the history of the floristic study of various territories from the second half of the 20th century. The history of floristic studies of Central Siberia of this time period is described in detail in the works of N.N. Tupitsyna and others [6, 16].

Since the middle of the twentieth century the study of the Khakassia vegetation cover is carried out by a number of outstanding botanists of the leading scientific and educational institutions of Siberia: Tomsk State University (Tomsk), Central Siberian Botanical Garden of the Siberian Branch of the USSR Academy of Sciences (Novosibirsk, TsSBS), Krasnoyarsk State Pedagogical Institute (Krasnoyarsk, KSPI) - V. V. Reverdatto, L. M. Cherepnin, A. V. Kuminova, A. V. Position, I. M. Krasnoborov and others [16-23]. They worked for many years and set up their botanical schools. Most of the herbarium materials were collected by researchers in the regions of Khakassia (Bogradsky, Shiriinsky, Altai, Ust-Abakansky, etc.). The detailed floristic studies within the city of Abakan were not carried out, although a lot of botanists visited the city on their way and collected rare plants.

L.M. Cherepnin conducted the first studies of the vegetation cover of the city of Abakan in 1942. In [15] he listed the subsequent expedition routes of 1948, 1949, passed mainly through the city of Abakan to various regions of the Minusinsk hollow, while the city was not the subject of research. In 1948, he participated in geobotanical expeditions that began and ended in Abakan, for example, in the Priabakan steppes together with V. V. Reverdatto, A. Samoilova, A. Skvortsova; to the Ulenskaya hollow together with V. S. Fedorova, A. Samoilova, A. Koroleva, A. Skvortsova; as a part of the Yuzhny Yenisei integrated expedition to study meadows, urine and vegetation of saline habitats together with A. Samoilova, A. Skvortsova; geobotanical research together with T. K. Nekoshnova, soil scientist M. V. Kirillov; departure to the Uybat, Iuso-Shirin steppe through the city of Abakan. In 1949 L. M. Cherepnin continues to work in the Yuzhny Yenisei integrated expedition, leaving Abakan on routes to the right-bank part of the Minusinsk hollow in Shushenskoye, Minusinsk, Ermakovskoe, Karatuzskoe, lake Kuzylkul, the river Amyl, Lake Tagar, Jirim steppe, etc., visiting some intermediate towns, together with V. A. Yeskova.

In 1951 the expedition of V. V. Reverdatto together with G. V. Krylov and N. D. Gradoboev along the routes of the Khakass field shelterbelts included a visit to the city of Abakan.

I. M. Krasnoborov visited Abakan, traveling on expeditions to study the high mountains flora of the Western Sayan. He together with B. Bobonakov, A. N. Vasiliev and others visited Abakan on an expedition to the river Ona basin in 1967-1968, studying the regions of Khakassia, he, together with V. M. Hanminchun and E. A. Ershovoy arrived to the city Abakan. In 1970 he together with M. N. Lomonosova at traveling to the ridge Joysky and in 1999, he was traveling to the lake Itkul together with E. S. Ankipovich and O. O. Lipatkina. Later, he was invited to KhSU to give lectures on the systematics of plants, as well as on final exams of students as chairman of the commission. At the same time, he held consultations and assisted in identifying some difficult groups of plants found in the city of Abakan, which are stored in the herbarium of KhSU. These are species of the Apiaceae family (Kadeniathamia L. - doubtful cadence, 07/09/1997; Peucedanumvaginatum Ledebe. - vaginal henfoot, 07/11/1996), Saliceaeae (Salixsylvestres Wimm. - wooded willow, 11/27/1997 L. sili; three-stamens, June 16, 1995), Polygonaceae (Rumexcrispus L. - curly sorrel, January 14, 2001); Ranunculaceae (Pulsatillamultifida (G.Pritz.) Juz. - cross-section lumbago, 06/20/2002; Pulsatillatenuiloba (Turcz.) Juz. - cross-section lumbago, 05/10/1999).

For many years (1995-2008), Candidate of Biological Sciences, Associate Professor of KhSU T. M. Zorkina studied the flora and vegetation of Khakassia and the south of Krasnoyarsk Territory. [17]. She paid special attention to halophytic vegetation [18], since the time of Reverdatto [19], A. P. Samoilova [20], L. M. Cherepnina [9], A. V. Kuminova [21] halophytic flora and vegetation has not been studied by anyone. She collected a huge herbarium material (KhGU, KRAS) and wrote a large number of
publications (over 200) on the flora and vegetation [22] of this region. In addition to geobotanical research and mapping of vegetation in the regions of Khakassia, she studied the flora and vegetation directly of the city Abakan. She collected herbarium material of about 250 species on Mount Samokhval, located within the city [23].

In the 1990s and 2000s, the botanists of Abakan visited the botanists of various scientific institutions and universities of Siberia, carrying out various projects to study the vegetation cover of Khakassia and Tuva.

In 1996, E.S. Ankipovich’s expedition started from Abakan together with D.N. Shaulo and A.I. Shmakov to the city Kyzyl and back to Abakan. Since 1996, the research on the vegetation cover of Khakassia has been conducted by the team of the South Siberian Botanical Garden (USBS) of Altai State University (AltSU) under the supervision of a corresponding member of RAS R.V. Kamelin and Professor A.I. Shmakova. This year, E.S. Ankipovich together with D.N. Shaulo started their studies from Abakan.

In 1997, I.D. Shaulo, E.S. Ankipovich, S.V. Smirnov, D.A. Durnikin, P.A. Golyakov, members of the USBS expedition visited the city. In 2005, the USBS expedition took place (A.A. Kechaykin, M.S. Ivanova, G.A. Zvoznikov, V. Zabelin, I. Mazko, I. Evdokimov, P. Tatyunin) together with German botanists (N. Friesen, G. Hurka, B. Neufeld).

In 2001 V.E. Skvortsov (Moscow State University) together with O.V. Grigoryeva, S.V. Goryunova, A.M. Ermolchik, T.B. Ermak, S.V. Lavrinenko, N.N. Lashchinsky (senior), N.S. Liksakova visited Abakan in the expedition to the Abakan Range [6]. Pastinacasativa L. was discovered in the city of Khakassia for the first time. [24]. In 2001-2003 E.G. Lagunova visited Abakan when performing dissertation work on the flora of the floodplain of the river Abakan and its inflows [25].

Since 1990 up to the present, A.L. Ebel, professor of the Department of Botany of TSU has been exploring the flora of Khakassia. In 2002, he visited the city Abakan on the way to Tuva together with A.I. Pyak and others. In 2016, he visited the city Abakan in the expedition investigated the structure of alien plants in Khakassia. According to floristic notes, he found some invasive and weed species in Abakan: Hordeum jubatum L. 
- “Republic of Khakassia, Abakan, roadside. August 4, 2002 N.R. Emer”; (TK); Panicum miliaceum L. subsp. ruderale (Kitag.) Tzvel. 
- “The Republic of Khakassia, okr. Abakan, roadside. July 22, 2002 N.R. Emer”: Malvamauritiana L. 
- “Republic of Khakassia, okr. Abakan, roadside, July 23, 2002 N.R. Emer” (MK) [30]; Atriplextatarica L. : : Abakan, st. Askizskaya, between the sidewalk and the fence (massively). 53°40′46″ S.S. 91°22′08″ E.L. 27 VII 2016”[26].

M.A. Myadelets, a postgraduate student of the Central Statistical Bureau of the SB RAS came to Abakan when studying the biodiversity of the labiate in the flora of Khakassia (2002–2008).

3. Current studies

In 2016, an employee of Siberian Federal University, Professor N.V. Stepanov was herbarizing in the vicinity of Abakan.

In regional floristic reports, Abakan is mentioned only in some cases. In “Flora of the southern part of Krasnoyarsk Territory” [9], two species were noted, i.e., Setariaglaucus (L.) P.B. and Poatibetica MunroexStapf. While working with the materials on “Siberian Flora”, a circum-boreal (by origin it is from Eurasian desert-steppe) species of Atriplexsagittata Borkh, a rare in herbarium specy for Khakassia and Abakan, was discovered by M.N. Lomonosova [27]. It shows a tendency to expand its range [28]. Nowadays, this quinoa is quite widespread in some regions of Siberia, where it is an invasive species [29, 30, 31]. In “Flora of Siberia” noted that sedges Carexstenophylla Wahlend [32] was located in Krasny Abakan village. Nowadays it is the territory of the city Abakan. The only location of Eleocharislingei (Meinsch.) B. Fedtsch was in moist and marshy salt meadows in Khakassia [33].

In 2017, a new species for the flora of Khakassia, Galinsogaparviflora Cav, was registered in Abakan. (Asteraceae) [29]: “Russia, Republic of Khakassia, Abakan, okr. g. railway station, weed, near the sidewalk, 256 m above sea level 53°42’55.1″ S.S. 91°26’29.8″ E.L. 22 VII 2017. D. Shaulo” (NS, ALTB). - Xenophyte, ephemero phyte. A one-year plant with a primary habitat in Central America, spreading
throughout the globe in regions with a temperate and subtropical climate [30]. In Siberia, the species was discovered at the end of the 20th century. Nowadays, the isolated locations are known in Tomsk [29] and Novosibirsk [13] regions, Altai Territory, Republics of Altai and Tyva. As invasive and potentially invasive plant, it was noted in Kemerovo and Omsk regions, the Republic of Buryatia, and Krasnoyarsk Territory [32]. It is a new species in the flora of Khakassia.

The students of KhSU also study the urban flora during summer field practices, but herbarium materials are negligible, so the city’s flora is poorly represented in the Herbarium. So I.M. Bukinich, a student of KhSU named after Katanova studied the coastal and aquatic vegetation of Abakan in 2004.

We have been conducting a focused floristic study in the city Abakan since 2016. The field work was carried out using a of model separation (MS) method of an urban landscape supplemented by route surveys [18]. As a result, the territory of the city was divided into relatively equal economic and geographical zones of 250 x 250 m with the exact environmental and visual isolation. The similar land plots were laid within the administrative boundaries of the city, allocated on the basis of phytocenotic diversity and the characteristics of the anthropogenic load. As a part of the MS, there are areas of natural habitats located in the urban area (Mount Samokhval, “Recreation Park” near the Tasheba River, etc.), and anthropogenic habitats with disturbed vegetation, so-called a technogenic territory with the industrial enterprise, railway station, garden and summer cottage area, areas East and South Dykes, territories of the residential area (urban housing and a private sector) and territories of artificial plantings (“Victory” park and “Komsomolsky” park). The most of the MS territories were visited repeatedly and at different times during the growing season. Floristic gatherings in the city were held from 2016 to 2018 by a model precipitation method (MS) of the urbanized landscape. As a result of expeditionary studies of 11 MVs, new and rare plant species were found and identified for the Republic of Khakassia and directly the city of Abakan within the administrative boundaries of Abakan. For each species, the habitat and the MV with collection coordinates were indicated.

The representatives of three scientific botanical schools, Tomsk school, based at TSU by P.N. Krylov, then developed by V.V. Reverdatto and A.V. Position; Novosibirsk, found in TsBSB SB RAS V.V. Reverdatto, K.A. Sobolevskaya and A.V. Kuminova, later developed by I.M. Krasnoborov, Krasnoyarsk school, created L.M. Cherepnin in KSPU. They studied the flora of Abakan varying degrees.

In the 21st century floristic studies are being continued by representatives of the noted scientific schools: TSU - A.L. Ebel, A.I. Pyak and others; TsBSB SB RAS - D.N. Shaulo and others, KhSU named after N.F. Katanova - E.S. Ankipovich; USSU AltSU employees under the direction of A.I. Shmakova; SFU - N.V. Stepanova. The leading role in a special study of the flora of Abakan belongs to E.M. Antipova, T.M. Zorkina and O.P. Chebotareva.

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