

Genus *Allium* in CSBG Digital Herbarium

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Abstract. Two herbarium collections (NS and NSK) of the Central Siberian Botanical Garden SB RAS keep about 740,000 specimens of vascular plants, collected in Siberia, Russian Far East, Europe, Asia and North America. Genus *Allium* s. lat. Is presented by 6224 herbarium sheets, all of them were scanned using international standards: at a resolution of 600 dpi, the barcode for each specimen, 24-color scale and scale bar. Images and metadata are stored at the CSBG SB RAS Digital Herbarium, generated by ScanWizard Botany and MiVapp Botany software (Microtek, Taiwan). Datasets were published via IPT at the Global Biodiversity Information Facility portal (gbif.org). In total 207 species of the genus *Allium* are placed in the CSBG Digital Herbarium, which includes representatives from 13 subgenera and 49 sections of the genus. 35 type specimens of 18 species and subspecies of the genus *Allium* are hosted in CSBG Herbarium collections.

1 Introduction

For the taxonomic treatment it is necessary to study worldwide herbarium collections. The value and universality of herbarium specimens are recognized in most countries, where national and large regional herbariums are actively developing and improving [1, 2]. According to the data in Index Herbariorum as of 15 December 2019, there are 3324 active herbaria in the world, containing 392,353,689 specimens [3].

Historically at state moment, there are two herbarium collections at the Central Siberian Botanical Garden, Siberian Branch of the Russian Academy of Sciences (CSBG SB RAS): herbarium named after I.M. Krasnoborov (NS) and herbarium named after M.G. Popov (NSK). The first herbarium collection at the CSBG SB RAS was organized in 1946 on the base of herbarium sheets transferred from Medical and Biological Institute (Novosibirsk). The main additions to collection were made in 1970-1980 years by Siberian researchers, whose scientific works deal with territories of southern part of Krasnoyarskiy krai, Khakassia and Tuva. Tuva plants collection in CSBG SB RAS herbarium is the largest in the world and counts about 80,000 herbarium sheets. Since 1980 the collection was replenished by plants from West Siberia: Altai, Novosibirsk, Omsk and Kemerovo regions. Nowadays NS herbarium divided into divisions: Siberia, Tuva, Far East, European part of ex-USSR, Middle Asia, Caucasus, North America, Foreign Europe and Foreign Asia.

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In 1978 Herbarium collection named after M.G. Popov with divisions of northern part of Krasnoyarskiy krai, West Siberia, Central Siberia, East Siberia, Europe, Asia and America was transferred from Irkutsk to CSBG SB RAS. NS and NSK collections contain about 800,000 herbarium specimens of vascular plants (740,000 specimens), mosses, lichens and fungi sampled in Siberia, Russian Far East, Europe, Asia and North America [4].

In 2017 a new research group USU-Herbarium was organized in CSBG with the purpose of digitization and management of herbarium specimens in the NS and NSK collections. The digitization was started from Primulaceae [5], Amaryllidaceae, Geraniaceae [6], Iridaceae for the project "Flora of Russia" and data was published as datasets at the Global Biodiversity Information Facility (gbif.org). The genus *Allium* L. is one of the largest genera in the family Amaryllidaceae. It comprises over 1000 species, and the number is still increasing. In the APG III classification system, *Allium* is placed in the family Amaryllidaceae, subfamily Allioideae (formerly the family Alliaceae). In some of the older classification systems, *Allium* was placed in Liliaceae. The new intergeneric classification system, based on molecular sequence data, subdivided the genus into 15 subgenera and more than seventy sections [7]. In more recent years nine further *Allium* sections were proposed [8].

The aim of this work is to present to the general public an extensive collection of one of the largest genera in the petaloid monocotyledons, stored in the Herbariums CSBG (NS and NSK).

2 Materials and Methods

All digitized herbarium specimens of genus *Allium* have been placed in the Digital herbarium CSBG SB RAS (<http://herb.csbg.nsc.ru:8081>) and most of them were examined by N. Friesen [9, 10]. Digitization of herbarium specimens was initially undertaken for type specimens [11] with a customized *HerbScan* unit, which consisted of a flatbed scanner (*Epson Expression 10000XL*) modified for inverted use. Images and metadata for 22 *Allium* type specimens preserved at the NSK are currently available on the *Virtual Herbaria* web site at the University of Vienna, Austria (<http://herbarium.univie.ac.at/database>) and 12 of them in JSTOR (<https://plants.jstor.org>). A new research group *USU-Herbarium* was organized in the CSBG in the end of 2017 with the purpose of digitization and management of herbarium specimens in NS and NSK collections. Currently digitization of samples is carried out using two *ObjectScan 1600* scanners. Each workstation consists of an *ObjectScan 1600* scanner, *ScanWizard_Botany* software and *MiVapp_Botany* archive management system software (*Microtek*, Taiwan). This integrated workstation is characterized by on-top scan design for full-frame focus, a maximum of 1600 dpi (equal to 1 Gigabyte pixels), color CCD, Optical Character Recognition (OCR) for specimen label and ID barcode, and image archive and privileged-account cloud management system. Specimens were scanned using international standards: with the resolution of 600 dpi, a barcode for each specimen, and a 24-color scale and scale bar. The CSBG Digital Herbarium taxonomic database is compatible with the international resource, Catalogue of Life (<http://www.catalogueoflife.org>), where an updated list of taxa is published every month [12]. Originally, only 12,8% of labels had collection point coordinates when digitizing samples. Irina Khan was specially engaged in search of coordinates using different resources on the Internet. These coordinates are entered in the Digital Herbarium by Evgeniya Gatilova. Now we have more than 85% of samples with coordinates and maps of areas can be viewed at gbif.org.

3 Results

Label metadata analysis has yielded the following results. In total 6224 samples from 207 species of the genus *Allium* are placed in the CSBS Digital Herbarium [13, 14]. In the M.G. Popov Herbarium (NSK) there are 106 species of the genus *Allium*, including *Allium neriniflorum* (Herb.) G.Don. In Krasnoborov Herbarium (NS) 204 species of *Allium* are represented.

3.1 Type specimens

The typhotecary stores 22 type specimens from NSK’s herbarium of the genus *Allium* [15]. There are holotypes for two taxa: *Allium rupestristepposum* N. Friesen (NSK0000019) and *A. montibaicalense* N. Friesen (NSK0000015). There are isotypes for 19 taxa *A. altynolicum* N. Friesen (NSK0000007), *A. anisopodium* Ledeb. (NSK0000027), *A. burjaticum* N. Friesen (NSK0000008, NSK0000009), *A. chamarense* M. M. Ivanova (NSK0000010 и NSK0000011), *A. dauricum* N. Friesen (NSK0000022), *A. malyshevii* N. Friesen (NSK0000023), *A. montibaicalense* N. Friesen (NSK0000016, NSK0000017, NSK0000018), *A. rupestristepposum* N. Friesen (NSK0000020, NSK0000021), *A. vodopjanovae* N. Friesen (NSK0000012, NSK0000013, NSK0000014, NSK0000024, NSK0000025, NSK0000026) and one isolectotype *A. amblyophyllum* Kar. et Kir. (NSK0000028).

In Herbaria NS there are 13 type specimens of the genus *Allium*: *A. lutescens* Vved. (NS0000087), *A. dolichomischum* Vved. (NS0000084), *A. transvestiens* Vved. (NS0000090), *A. grumm-grshimailoi* Kamelin et Namz. (NS0000085, NS0000086), *A. senescens* L. subsp. *glaucum* (Schrad.) Friesen (NS0000088, NS0000089), *A. shevockii* McNeal (NS0016169) and *A. nevskianum* Vved. ex Wendelbo (NS0015725), *A. schischkinii* Sobolevsk. (NS0014707, NS0014709, NS0014710, NS0014711).

3.2 Historical analysis

In Herbarium collection the earliest specimens are the collections of Karelin and Kirilov, for 1840-1841. There are 18 specimens from Kazakstan (Dzungaria and Dzungarian Alatau): *Allium azureum* Ledeb. (NSK0031212), *A. amblyophyllum* Kar. et Kir. (NSK0000028, isolectotype); *A. atrosanguineum* Schrenk (NS0015736, NSK0031187), *A. caeruleum* Pall. (NS0015783), *A. flavidum* Ledeb. (NSK0031229), *A. hymenorhizum* Ledeb. (NS0015841, NS0015843), *A. monadelphum* Less. ex Kunth (NS0015858, NS0015859, NS0015860), *A. pallasii* Murray (NS0015877), *A. platyspathum* Schrenk (NS0015884, NS0015886), *A. polyphyllum* Kar. et Kir. (NSK0031203), *A. robustum* Kar. et Kir. (NS0015890), *A. subtilissimum* Ledeb. (NS0015947), *A. tulipifolium* Ledeb. (NSK0031217).

The total amount of specimen for the 19th century is 34 herbarium samples, including samples of Tauscher D.A.J., Freyn J., Dichtl S.J., Winter H., Krylov P.N., Haussknecht C., Michno P., Nelson A., Lipsky V., Blumberg M., Fedchenko B., Litvinov D., Nelson E., Koch E. and Palibin I.V. The latest specimens are of I.N. Pospelov 23.08.2013, Taimyr; S.V. Soloviev, A.M. Samdan 12.08.2013 Altai.

The collection of onion in the Herbarium CSBG was supplemented by 1200 collectors, the most active of which collected more than 200 specimens: N. Friesen (660 specimens), I. M. Krasnoborov (412), D. N. Shauro (330), M. N. Lomonosova. (238), G.A. Peshkova (232), V.M. Hanminchun (223).

3.3 Geographic analysis

Except Russia (5641 samples), 10 countries of the former USSR are presented: Kazakhstan - 151; Tajikistan - 42; Turkmenistan - 30; Uzbekistan - 20; Kyrgyzstan - 19; Ukraine - 16; Azerbaijan - 14; Georgia - 9; Belarus - 3; Armenia - 1 and 15 foreign countries: Mongolia - 146; USA - 51; China - 15; Moldova - 11; Romania - 10; Hungary - 5, Germany - 5, Canada - 5, Austria - 3, Bulgaria - 3, Japan - 2, Slovakia - 1, Turkey - 1, France - 1, Croatia - 1.

Russia is represented by 42 subjects of the Federation. The largest number of samples is represented by the Republic of Tyva (1504), the Republic of Altai (1144), the Republic of Buryatia (774), the Irkutsk region (442), Republic of Khakassia (396), Krasnoyarsk krai (326), Transbaikalia krai (288), Novosibirsk region (172), Altai krai (171), Republic of Sakha Yakutia (152), Kemerovo region (58). The geographical map of *Allium* occurrences for NS and NSK collections was placed in the dataset at gbif.org [13].

3.4 Taxonomic review

Since the Herbaria of CSBG are Siberian, more than 95% of all of the collections of the species of the genus *Allium* are from Siberia, which is confirmed the number of samples of the most common onions in the Herbaria CSBG [13]. However, the onions collection in Herbaria NS and NSK contains representatives from 13 of the 15 described subgenera and more than 200 species from 49 sections and 80 sections of new classification of the genus *Allium* [7, 8, 16]. Among them are: subgenus *Allium* (sections *Allium*, *Avulsea*, *Brevidentia*, *Caerulea*, *Codonoprasum*, *Costulata*, *Eremoprasum*, *Minuta*, *Pallasia*, *Scorodon*), subgenus *Amerallium* (sections *Amerallium*, *Arctoprasum*, *Briseis*, *Caulorhizideum*, *Lophioprasum*, *Narkissoprasum*), subgenus *Anguinum* (section *Anguinum*), subgenus *Butomissa* (sections *Butomissa* and *Austromontana*), subgenus *Caloscordum* (section *Caloscordum*), subgenus *Cepa* (sections *Annuloprasum*, *Cepa*, *Condensatum*, *Sacculiferum*, *Schoenoprasum*), subgenus *Melanocrommyum* (sections *Acanthoprasum*, *Acmopetala*, *Decipientia*, *Kaloprasum*, *Megaloprasum*, *Miniprasum*, *Popovia*, *Procerallium*, *Pseudoprasum*, and *Regeloprasum*), subgenus *Microscordum* (section *Microscordum*), subgenus *Nectaroscordum* (section *Nectaroscordum*), subgenus *Polyprason* (sections *Daghestanica*, *Falcatifolia*, *Oreiprasum* and *Scorodon*), subgenus *Porphyroprason* (section *Porphyroprason*), subgenus *Reticulobulbosa* (sections *Campanulata*, *Reticulobulbosa* and *Scabriscapa*), subgenus *Rhizirideum* (sections *Eduardia*, *Rhisomatosa*, *Rhizirideum* and *Tenuissima*). The full list of *Allium* species and metrics are published in the dataset at gbif.org [13].

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