



Geranium (Geraniaceae) in the digital herbarium of the Central Siberian Botanical Garden SB RAS

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Manuscript received: 15.06.2022
Review completed: 28.09.2022
Accepted for publication: 18.10.2022
Published online: 27.10.2022

ABSTRACT

During the inventory of the I.M. Krasnoborov (NS) and the M.G. Popov (NSK) herbaria collections, a total of 2793 specimens of the genus *Geranium* were digitised and placed into CSBG SB RAS Digital herbarium. There were 1500 herbarium sheets in the NS and 1293 specimens in the NSK, 94 taxa in total, containing species, subspecies, variations and forms. The results of digitisation were published as a dataset in the Global Biodiversity Information Facility (GBIF). A short history of the taxonomic study of *Geranium* collections is given and type specimens of 6 *Geranium* taxa stored in NS and NSK herbaria are cited.

Keywords: biodiversity, digital herbarium, GBIF, NS, NSK herbarium collections, taxonomy, type specimens, vascular plants

РЕЗЮМЕ

Ковтонюк Н.К., Трошкина В.И. Род *Geranium* (Geraniaceae) в Цифровом гербарии Центрального Сибирского ботанического сада СО РАН. В ходе инвентаризации коллекций гербариев NS и NSK в общей сложности 2793 экземпляра рода *Geranium* были оцифрованы и помещены в Цифровой гербарий ЦСБС СО РАН. В гербарии И.М. Красноборова (NS) насчитывалось 1500 гербарных листов, а в гербарии М.Г. Попова (NSK) – 1293 экземпляра, всего 94 таксона, включая виды, подвиды, вариации и формы. Результаты оцифровки были опубликованы в виде набора данных в Глобальном информационном фонде по биоразнообразию (GBIF). Описана краткая история таксономического изучения коллекций герани, приведены типовые образцы для 6 таксонов *Geranium*, хранящихся в гербариях NS и NSK.

Ключевые слова: биоразнообразие, цифровой гербарий, GBIF, гербарные коллекции NS, NSK, таксономия, типовые образцы, сосудистые растения

The first herbarium at the Central Siberian Botanical Garden, Siberian Branch of the Russian Academy of Sciences (CSBG) was founded in Novosibirsk in 1946. Currently this herbarium collection is named after I.M. Krasnoborov (NS). In 1978, an herbarium collection from Irkutsk was transferred to CSBG with L.I. Malyshev and the staff of his department. This herbarium collection is named after M.G. Popov (NSK). So, historically, there are two herbaria forming the consortium in CSBG with their own acronyms NS, NSK and registrations in the Index Herbariorum (Thiers 2022). The collections contain about 800000 herbarium specimens of vascular plants, mosses, lichens and fungi sampled in Siberia, the Russian Far East, Europe, Asia and America.

The family Geraniaceae Juss. has 800 species from ca. 11 genera (APG IV 2016), three of which are represented in the CSBG Digital herbarium (*Geranium* Tourn ex L. – 2793 specimens, *Erodium* L'Hér. – 132 and *Pelargonium* L. – 1). *Geranium* is one of the largest genera of the family Geraniaceae containing about 430 perennial herbaceous species distributed over the world, mainly in Eurasia, North Africa, North and South America and Australia (Yeo 1984, Bobrov 1949, Peshkova 1996, Aedo et al. 1998, Troshkina 2018). *Geranium* species grow in forest, meadow-forest, meadow, steppe, and meadow-steppe communities. Some of them are weedy and semi-weedy such as *G. sibiricum* L., *G. pyrenaicum*

L., *G. pusillum* L. and *G. rotundifolium* L. In Asiatic Russia 40 taxa of *Geranium* are recorded, 26 of them known in Siberia (Bobrov 1949, Peshkova 1996, Lomonosova 2000, 2007, Peshkova & Ovchinnikova 2012, Troshkina 2016, 2019, Troshkina & Lashchinskii 2021) and 21 found in the Russian Far East (Bobrov 1949, Tsirenova 2007).

The CSBG Digital Herbarium (2022) was started in 2018 by digitising one taxonomic group at a time, genus by genus (Kovtonyuk et al. 2018, 2020). Currently, completely digitised herbarium specimens of the genera *Allium* L. (6253 specimens), *Hedysarum* L. (2007), *Iris* (1490), *Medicago* L. (1066), *Rhododendron* (1387), family Primulaceae (5214), Geraniaceae (2926), and all ferns (7758), as well as 1367 type specimens of vascular plants are completely digitised and stored in the NS and NSK collections. The results of digitisation were published in 14 open access datasets in the Global Biodiversity Information Facility (GBIF 2022) using the Integrated Publishing Toolkit (IPT) installed on the CSBG server.

Our primary goal is to create a database and digitise the collections at NS and NSK to make them web-accessible for researchers and to provide open online access to the CSBG Digital Herbarium as a worldwide data resource for the study of biodiversity. The purpose of this publication is to make the *Geranium* data available.

MATERIAL AND METHODS

There are 2793 *Geranium* specimens in the herbarium collections of the CSBG, 1500 of them in NS and 1293 in NSK collections. All herbarium specimens were digitised using two customized scanners, ObjectScan 1600, according to international standards, at 600 dpi, with a barcode, 24-color scale and spatial scale bar. Images and metadata are stored in the CSBG Digital herbarium generated by ScanWizard Botany and MiVapp Botany 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 systems. Specimen label information is recognized and automatically saved under an herbarium code and specimen serial number in XML format through ScanWizard-Botany. MiVapp Botany is a web-server system and a specimen image authentication database aiming for an efficient and integrated multi-functional platform. After hierarchical login-based image quality and metadata profile validation by experts, MiVapp-Botany can quickly update the system and make verified specimens accessible for users (Microtek 2022). The digitised specimens of the genus *Geranium* were published as a dataset (Kovtonyuk et al. 2021) on the GBIF.org portal. Names of taxa conform to the World Checklist of Vascular Plants (WCVP 2022).

RESULTS AND DISCUSSION

All digitised specimens of the genus *Geranium* stored in the NS and NSK herbarium collections were deposited in CSBG Digital herbarium (<http://herb.csbg.nsc.ru:8081>). Scientific name (family, genus), locality (country name, administrative area), specimens ID (barcodes), collection date, names of collectors, ecology and revision label were recorded for each specimen. The dataset consists of 2784 specimens of Geraniaceae collected between 1841 and 2021 (Kovtonyuk et al. 2021). The registration of Geraniaceae specimens in the NS and NSK herbaria per year are shown in Figure 1 with the maximum gatherings while preparing the “Flora of USSR”, published between 1934 and 1964, the “Flora of Central Siberia” in 1979 and the “Flora of Siberia” between 1987 and 2003.

Most of the *Geranium* specimens were collected in Russia (2537) but also in 25 countries (Fig. 2) or were sent from other herbarium collections as duplicates: Mongolia

(48 specimens), U.S.A. (30), Kazakhstan (30), Tajikistan (24), Ukraine (17), Georgia (12), Armenia (11), Kyrgyzstan (8), China (7), Japan (7), Poland (7), Czechia (7), Canada (5), Azerbaijan (4), Moldova (3), Turkey (3), Romania (2), Germany (2), Bulgaria (2), Finland (2), Mexico (2), Sweden (1), Latvia (1), Turkmenistan (1) and Uzbekistan (1).

Several species of *Geranium* are endemic and sub-endemic in various areas, for example *G. affine* Ledeb. (NS0022642, NS0022643, NS0024898, NSK0063753, NSK0065366) and *G. laetum* Ledeb. (34 specimens in NS and NSK) are subendemic species of the Altai Mountains and *G. schrenkianum* Trautv. ex A.K. Becker. (NS0024930, NS0024931, NSK0065351, NSK0065372) is endemic for Kazakhstan. Specimens of all these species are stored in NS and NSK herbarium collections. Moreover, there are 7 specimens of *Erodium tataricum* Willd. (Geraniaceae) in the I.M. Krasnoborov herbarium (NS0022636 – NS0022641, NS0000575). *E. tataricum* is listed in the Red Data Book of the Russian Federation (Lomonosova 2008) with status 3a: rare species, endemic of the steppes of Khakassia.

The taxonomic study of the genus *Geranium* in the NS and NSK collections began with the oldest herbarium specimen, *G. schrenkianum* (Fig. 3), collected by G.S. Karelin and I.P. Kiriloff in 1841 (NSK0065351). On the herbarium label of this specimen is written: “1328. *Geranium dissectum* L. var. ... In herbidiis ad fl. Lepsa ad radicem montium Alatau. leg. Karelin et Kiriloff a. 1841. Soc. Imp. Nat. Cur. Mosqu” and signed “Reliq Ledebour” which means “The rest at Ledebour”. In addition to the label on the herbarium sheet there are 2 labels with annotations: on the first is written: “Ger. gracile Schrenk”, on the second: *G. schrenkianum* Trautv. The second was written by E.G. Bobrov, the author of the *Geranium* treatment for “Flora of USSR” (1949). We agree with Bobrov’s determination. *Geranium gracile* was described by A.G. Schrenk (1845) but the name, *Geranium gracile* Ledeb. ex Nordm. was already published in 1837. Then in 1882 the replacement name, *Geranium schrenkianum* Trautv. ex A.K. Becker was published. (Trautvetter 1882: 53).

The main collectors of the genus *Geranium* in the NS and NSK herbaria are: D.N. Shaulo (150 samples), I.M. Krasnoborov (139), G.A. Peshkova (112), A.V. Kuminova (98), M.N. Lomonosova (70), and L.I. Malyshev (69). There are also collections from such famous botanists as A.L. Takhtajan, P.N. Krylov, L.P. Sergievskaya, M.G. Popov, V.N. Sukachev, S.S. Kharkevich, V.M. Khanminchun, D.P. Syreyschikov, B.A. Fedchenko, R.E. Krogulevich, A.K. Skvortsov,

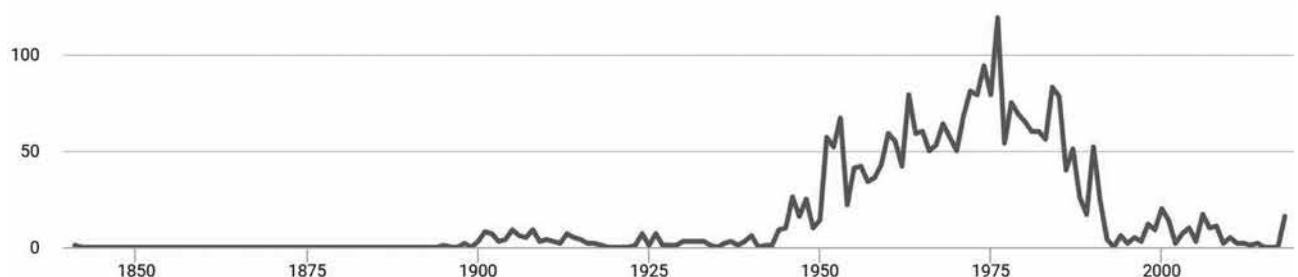


Figure 1 The registration of Geraniaceae specimens at NS and NSK herbaria per year between 1841 and 2021



Figure 2 Distribution map of Geraniaceae specimens deposited at NS and NSK herbaria

D.I. Litvinov, V.I. Grubov, A.A. Yunatov, I.Yu. Koropachinsky, V.I. Vereshchagin, V.P. Sedelnikov, K.A. Sobolevskaya, A.A. Chepurnov, and N.S. Vodopyanova. The last sample of *Geranium* placed in CSBG Digital Herbarium was collected by V.I. Troshkina, in Altai Territory, in 2021, it is *G. sibiricum*. (NSK0091425, NSK0091426).

NS and NSK herbaria keep the type specimens of 6 *Geranium* taxa names:

Geranium igoshinae Troshkina – Chelyabinsk Region, Verkhneuralsk District, 10 km north of the village Arsin-

skiy, 53.89742 N 59.86025 E, meadow steppe, 02.06.2012, A.Y. Korolyuk – holotype (NSK0000707), isotypes (NSK0000706, NSK0000708).

Geranium malyshevii Troshkina – Republic of Buryatia, East Sayan, Tunkinskij Range, Sagan-Shuluta river, M-47-10, forest belt, h = 1900 m a. s., among high grasses. [51°43'55"N 100°53'38"E]. 31.07.1975, No.196, R.E. Krogulevich. 2n = 28. Det. R.E. Krogulevich – holotype (NSK0000775).

Geranium pamiricum Ikonn. – Republic of Tajikistan, Pamir, in valle fl. Murgab (ad ripam sinistram), 10 km infra pagum Murgab, in pratulis caricoso-kobresiosis. 3600 m.s.m. [38°10'15"N 73°57'8"E]. 08.10.1968. Leg et det. Ikonnikov – isotype (NS0000215).

Geranium pseudosibiricum J. Mäyer var. *subuschkanense* (Popov) Peshkova – [Irkutsk Region]. Ripa boreali-occidentalis Baicalensis, promontorium Sagan-Marjan, declive stepposum [54°5'24"N 108°17'24"E]. 01.07.1955. Popov M.G., Prochorov V. – lectotype (NSK000335), isolectotype (NSK000334).

Geranium pseudosibiricum J. Mäyer var. *uschkanense* (Popov) Peshkova – [Republic of Buryatia]. Lacus Baical, insula Boljschoj Uschkanij. [53°51'0"N 108°37'60"E]. 14.07.1952. Popov M.G. – holotype (NSK0000337).

Geranium pseudosibiricum J. Mäyer f. *album* Troshkina – Russia, Republic of Altai, Onguday District, Seminsky pass, edge of Siberian pine forest, grass-geranium meadow, 51°02'43"N 85°36'56"E, alt. 1710 m a. s. l., 5.07.2020, V.I. Troshkina – holotype NSK0000913; isotype (NSK0000915).

CONCLUSION

NS and NSK collections have herbarium specimens from the last 180 years. CSBG Digital Herbarium is an open data resource for the study of worldwide biodiversity, keeps more than 74000 specimens and may also be used for the creation of regional flora checklists such as “Flora of Russia” and “Atlas of Russian flora”. All digitised specimens have good quality images, information from herbarium labels, and more than 82 % *Geranium* specimens have geolocation data.

ACKNOWLEDGEMENTS

The study was carried out within the framework of the State Assignment of the Central Siberian Botanical Garden, SB RAS (AAAA-A21-121011290024-5). The authors are grateful to I. Han, E. Gatilova, I. Deyun, S. Krasnikova and L. Lukmanova for their help



Figure 3 Herbarium sheet and label of *Geranium schrenkianum* Trautv. ex. A.K. Becker (NSK0065351)

in herbarium digitization NS and NSK collections (USU 440537). We thank Dr. Irina Belyaeva (UK) for consultations on nomenclature, Dr. Keith Chamberlain (UK) for useful linguistic corrections and our reviewers for their comments.

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