PLANT GERMPLASM COLLECTION REPORT

Collection of Reduced-Maintenance Turf and Forage Germplasm in Russia

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Summary: Plant germplasm from Russia is poorly represented in genebanks of the U.S. and has potential to expand existing germplasm for the improvement of turf for tolerance to drought, mowing, and low temperatures. As a result, the USDA Germplasm Exploration Fund supported a project to collection seed of possible turf species (*Poa, Festuca, Agrostis,* and *Koeleria*) in northwestern Russia that have potential for reduced-maintenance turf applications in the western U.S. When opportunities arose, we also made seed collections of various grass and legume species that have potential for forage or conservation applications. A total of 170 collections covering a wide diversity of grass and legume species were made throughout Ivanovo, Novgorod, Tver, Vladimir, Vologda, and Yaraslavl Oblasts of northwestern Russia.

Participants from the U.S. and Ukraine arrived in St. Petersburg on 6 August 2007. On 7 August 2007, we began a 27-day collection trip to northwestern Russia. Our collection route took us from St. Petersburg to V. Novogorod, Shimsk, St. Russa, Valdai, Rorovichi, Pestovo, Ustuzna, Cherepovets, Rybinsk, Yaroslavl, Kostroma, Ivanovo, Vladimir, Pereyaslavl Zalessky, Zagorsk, Kaliazin, and Tver. We returned to St. Petersburg on 2 September 2007. At the N.I. Vavilov Research Institute of Plant Industry (VIR) in St. Petersburg, we cleaned, weighed, and divided

our seed collections with portions going to Russia, Ukraine, and the U.S. Seed collections were inspected by officials at the Federal Service for Veterinary and Phytosanitary Surveillance of the Russian Federation in St. Petersburg and given approval for export. The Ukrainian portion of the seed and herbarium specimens was hand-carried as luggage back to the Ustimovskaya Research Station at Ustimovka, Ukraine. The U.S. portion of the seed collections was delivered to Homeland Security inspectors at the Los Angeles International Airport and sent to the USDA Plant Germplasm Quarantine Center in Beltsville, Maryland for processing. The seed collections were subsequently sent to Logan, UT for final cleaning and preparation of passport data. The cleaned seed and accompanying passport data will be sent to the Western Plant Introduction Station in Pullman, WA, where they will be incorporated into the U.S. National Plant Germplasm System. These collections will be available for research to scientists around the world and evaluated in breeding programs at the USDA-ARS Forage and Range Research Lab for potential use in reduced-maintenance turf, forage, and conservation applications in the western U.S.

Recommendations: VIR has a new Director (Dr. Nickolai Dzyubenko) who is very interested in promoting joint germplasm collection expeditions and collaborative germplasm-related research. U.S. scientists should be encouraged to establish cooperative interactions with scientists at VIR. Russia is a huge country, and there is a need for additional germplasm collections from Russia and adjoining countries in Central Asia for grass and legume germplasm for reduced-maintenance turf, forage, and conservation applications. Collection of this germplasm from this unique part of the world would insure its preservation and availability for future generations.

Acknowledgments: The success of our trip was directly attributable to the collective efforts of individual team members. Dr. Vladimir Chapurin (leader of the expedition) did an excellent job of planning, organizing, and facilitating all aspects of our trip. Appreciation is extended to Drs. Victor Kir'yan, Leonid Malyshev, and Tamara Buravtseva who contributed to team efforts in many ways including seed collection, taxonomic identification, logistical preparations, driving, cooking, and seed cleaning.

Technical Report

Introduction

Background: Russia is the largest country in the world with an area that covers about one eight of the global land area or about 1.8 times greater than the U.S. Its territory encompasses eight natural zones that include vast steppe areas, arctic deserts and tundra, taiga, broad-leaved forests, and steppe areas. Russia has more than 11,000 species of vascular plants, which constitutes about 8 % of the global vascular plant flora. Russia has about 22 % of the world's forested area or about 764 million hectares (equal to about 1.9 billion acres). Russia's vast natural resources are of global importance, both ecologically and economically.

The climate of Russia is continental with long, cold winters and brief summers. Summer and winter temperatures vary widely in Russia and precipitation is relatively low. Annual precipitation decreases from about 640-760 mm in the European region of Russia to less than 50

mm in parts of Central Asia. The tundra has long winters, with summers lasting one or two months, and receives from 8 to 12 months of snow or rain. The far northern forest, like most of the country, has long severe winters, short summers, and extremely short springs and autumns. Precipitation is generally low but falls throughout the year, varying from 530 mm at Moscow to 200-250 mm in eastern Siberia. The steppe region of Russia has very cold winters and hot, dry summers.

Trip Details

Targeted species: Species of *Poa, Agrostis, Festuca, Koeleria,* and *Puccinellia* from northwestern Russia's flora have potential for reduced-maintenance turf and were targeted for collection on this collection trip. Accessions of these targeted genera in northwestern Russia have been exposed to heavy grazing pressure for thousands of years and, therefore, likely have developed tolerance to grazing, which would make them ideal candidates for clipping tolerance traits. Because of the long grazing history of northwestern Russia and the large heterogeneity of habitats within this area, grass collections may hold particular promise for characteristics required for low-maintenance turf applications. These characteristics include seedling establishment, production, and persistence of high quality turf under conditions of cold temperatures, low fertility, clipping, and other adverse conditions.

Objectives: The primary objective of our trip was to collect seed of grasses in genera of *Poa, Agrostis, Festuca, Koeleria,* and *Puccinellia,* which are known to have potential for reduced-maintenance turf applications. Another objective of our trip was to collect seed of various grass and legume species with potential for forage or conservation applications.

Logistical Arrangements: Dr. Vladimir Chapurin of VIR was the leader of our expedition. Dr. Chapurin is one of the most experienced germplasm collectors at VIR and is a specialist in perennial forage legumes with an emphasis on red clover. He has participated in and led numerous germplasm expeditions in Russia and Central Asia. About six months prior to our trip, preparation of a non-funded, five-year cooperative agreement was necessary to formalize joint germplasm collection activities between VIR and ARS. In addition, Dr. Chapurin arranged with the VIR Foreign Relations Department (headed by Dr. Sergey Alexanian) for official invitation letters from the Russian Ministry of Foreign Affairs for obtaining our Russian visas. The morning after arriving in St. Petersburg, Drs. Johnson and Kir'yan registered with the Russian police for permission to travel in the Russian countryside.

We brought along the necessary collecting equipment and supplies including seed envelopes, global positioning system (GPS), and other miscellaneous supplies. In addition, we purchased various collecting, camping, and cooking gear in St. Petersburg prior to our trip. During the collection trip, the five expedition participants traveled in a four-wheel drive UAZ van and camped in tents. All food expenses were shared equally among participants. On returning to St. Petersburg, VIR provided lodging at one of their apartments located on Sapernyi Street. Procedures outlined in materials provided by Dr. Karen Williams were followed concerning seed export permits, Phytosanitary Certificate, and other importation documentation required for Homeland Security officials in the U.S.

Collection Itinerary and Route (Figure 1)

5-6 August 2007: I flew to St. Petersburg and was met by Dr. Vladimir Chapurin at the St. Petersburg International Airport. I stayed overnight at a small hotel in Pushkin to avoid heavy traffic congestion in St. Petersburg the next morning. Dr. Victor Kir'yan from the Ukraine arrived earlier that day and stayed at the same hotel.

7 August: Dr. Kir'yan and I filled out necessary forms, and Dr. Chapurin took our passports and completed forms to the Russian police for registration. We then picked up Drs. Tamara Buravtseva and Leonid Malyshev. We stopped by a huge grocery store on the outskirts of St. Petersburg to purchase our primary food provisions for the trip. We then traveled southeast from St. Petersburg.

8-15 August: We began our collections along the Volkhov River northeast of Novgorod. We spent the next eight days making collections throughout Novgorod Oblast and traveling through the cities of Novgorod, Borovichi, and Pestovo. The elevation gradually increased from about 20 to 141 m during this portion of the collection trip, and most of the collections were made in previously abandoned crop fields. Turf grass collections were made for the following genera: *Agrostis, Festuca*, and *Poa*. We were surprised to see *Dactlyis glomerata* growing in these areas, which typically experience extremely low winter temperatures and have considerable snow accumulation; these collections may hold promise for cold tolerance.

16-19 August: During this portion of the trip, we traveled through the cities of Ustyuzhna, Cherepovets, and Rybinsk circling around the north and east side of Rybinsk Reservoir. This area was dominated by pine/birch forests (*Pinus sylvestris*/*Betula pubescens*) and ranged in elevation from 110 to 140 m. Few under story species were found in pine/birch forests; most collections were made in cleared areas, abandoned croplands, or power-line corridors. Turf genera collected in this area included: *Agrostis, Festuca, Koeleria, Phleum,* and *Poa.* Interesting collections of *Dactylis glomerata* continued to be made as well as collections of other forage species including *Trifolium hybridum* and *Bromus inermis*.

20 August-1 Sept.: Collections of *Agrostis, Festuca, Koeleria, Phleum,* and *Poa* continued to be made in abandoned fields and power-line corridors throughout the countryside as we traveled on a route that took us through the cities of Yaraslavl, Kostroma, Ivanovo, Vladimir, Rostov, Kalyazin, Kalinin, and Valday. The area is dominated by pine/birch forests and ranged in elevation from 99 to 165 m. The weather turned cold and rainy at the end of the trip.

2 Sept.: We returned to St. Petersburg about 6:00 pm. I was dropped off at the VIR apartment building on Saperyni Street. Accommodations were comfortable with a bathroom and two rooms equipped with a refrigerator and an electric pot for preparing basic meals. There was a small grocery store about a half block from the apartments with easy bus and subway access. My wife (Kathy) arrived earlier that same day from the U.S. and was waiting for me at the apartment.

3-16 September: Collections were cataloged, dried, cleaned, and divided into portions for Russia, U.S., and Ukraine. Seed collections were delivered to the Federal Service for Veterinary

and Phytosanitary Surveillance of the Russian Federation in St. Petersburg for inspection, a Phytosanitary Certificate was issued, and the collections were approved for export. The Ukrainian portion of the seed was hand-carried as luggage by train to the Ukraine by Dr. Victor Kir'yan. After seed processing was completed, I took several days of annual leave to see the beautiful historical sights in and around St. Petersburg.

17 September: I returned to the U.S. and delivered the U.S. portion of the seed collections to Homeland Security inspectors at the Los Angeles International Airport. Our seed collections were sent to the USDA Plant Germplasm Quarantine Center in Beltsville, Maryland for inspection and processing.

Collections: Prior to our collection trip, only ten collections of the targeted taxa from northwestern Russia were available in NPGS. Our collection route traversed more than 4,000 km (Figure 1) and covered a diversity of plant communities in northwestern Russia. We made a total of 170 collections (Table 1) covering a range of grass and legume species throughout the Ivanovo, Novgorod, Tver, Vladimir, Vologda, and Yaraslavl Oblasts of Russia. This included 62 collections of various species that hold promise for reduced-maintenance turf applications including *Poa* (17), *Festuca* (8), *Agrostis* (18), *Phleum* (17), and *Koeleria* (2). Seeds of various forage grasses were collected and included *Bromus* (3), *Festuca* (21), and *Phalaris* (2). Of particular note were collections of *Dactylis glomerata* (19), which may hold promise for cold tolerance. Opportunistic seed collections of various forage legumes were also made including *Lathyrus* (9), *Lotus* (1), *Lupinus* (1), *Medicago* (6), *Melilotus* (11), *Trifolium* (20), and *Vicia* (6).

After processing of the seed collections at the Plant Quarantine Center in Beltsville, Maryland, our collections were shipped to Logan, UT where the seed was given a final cleaning. Small portions of the seed will remain at Logan for evaluation in breeding programs at the USDA-ARS Forage and Range Research Lab and Utah State University for their potential use in reduced-maintenance turf, forage, and conservation applications in the western U.S. The bulk of the U.S. portion of the seed will be sent to the Western Plant Introduction Station in Pullman, WA for incorporation into the U.S. National Plant Germplasm System where these collections will be available for research to scientists around the world. The Russian portion of the seed will be curated at VIR in St. Petersburg. The Ukrainian portion of the seed collection will be curated through the Ustimovskaya Research Station.

Benefits to U.S.: With the expanding human population in the U.S., demand for water is increasing for human consumption, recreational uses, landscaping, and industrial purposes. This is especially true in the western U.S. where water resources are limited due to low precipitation and high evaporative rates. Typical high-input turf species for expansive lawns, parks, and golf courses are becoming increasingly scrutinized for their water and maintenance costs. Water costs are continuing to increase, and water restrictions are being imposed during the hot, dry summer months in many metropolitan areas of the western U.S. As a result, homeowners, golf course managers, and park superintendents are actively looking for ways to reduce water consumption. Xeriscaping is becoming more and more popular and homeowners, park managers, and golf course superintendents are replacing high-input turf species with reduced-maintenance species.

Our collections will expand existing reduced-maintenance turf germplasm by adding germplasm that has tolerance to clipping, low temperatures, and other adverse growing conditions. These collections may add important genetic diversity for response to clipping because plants there have been exposed to intensive grazing by wild and domesticated herbivores for thousands of years and have undergone natural selection so they are likely tolerant to clipping or mowing. As a result, this germplasm from northwestern Russia holds promise for turf improvement programs. Collected materials also have potential for biotechnology applications to improve insect and disease resistance of important crop species. Incorporation of the collected germplasm into the NPGS will allow use by scientists in the U.S. and throughout the world, and will ensure preservation and conservation of this unique germplasm.

Benefits to Russia and Ukraine: Collections of reduced-maintenance turf germplasm from northwestern Russia made on this trip will add important germplasm to the collections of the N.I. Vavilov Institute of Plant Industry (VIR), which is one of the world's premier institutions for curation of seeds of crop species and their wild relatives. These collections will make important germplasm available to Russian scientists in their breeding and improvement programs, which may eventually lead to improved cultivars for reduced-maintenance turf. In addition, our collections will add important germplasm to the Ukrainian Genebank. Close interactions with botanists, forage scientists, and staff from VIR strengthened professional ties between U.S. and Russian scientists. Discussions among personnel during and after our collection trip allowed the exchange of the latest information concerning germplasm collection, preservation, and utilization.

References Consulted

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Richmond, S., M. Elliot, P. Horton, and S. Kokker. 2006. Russia and Belarus. Lonely Planet Publications, Hawthorn, Australia. 792 pp.

Figure 1. Collection route taken in northwestern Russia during 2007.

Table 2. Species and numbers of collections (Russia, Aug.-Sept. 2007)

Agrostis gigantea (16)
Agrostis stolonifera (2)
Alopecurus pratensis (3)
Anthoxanthum odoratum
Briza media
Bromus inermis (3)
Dactylis glomerata (19)
Deschampsia caespitosa
Elytrigia repens (2)
Festuca arundinacea (4)
Festuca ovina
Festuca pratensis (17)
Festuca rubra (6)
Festuca spp.
Koeleria cristata
Koeleria spp.
Lathyrus pratensis (2)
Lathyrus spp.
Lathyrus sylvestris (6)
Lotus corniculatus
Lupinus polyphyllus
Medicago falcata (3)
Medicago lupulina (3)
Melilotus albus (10)
Melilotus officinalis
Phalaris arundinacea (2)
Phleum phleoides
Phleum pratense (16)
Poa pratensis (15)
Poa spp. (2)
Rumex spp.
Trifolium arvense (3)
Trifolium hybridum (3)
Trifolium medium (5)
Trifolium pratense (7)
Trifolium strepens (2)
Vicia cracca (2)
Vicia sativa
Vicia sepium (3)

Total = 170