PLANT GERMPLASM COLLECTION REPORT

Collection of Reduced-Input Turf and Forage Germplasm in the Northern Caucasus Mountains of Russia

U.S. Team Members:

Douglas A. Johnson
USDA-ARS, Forage and Range Res. Lab
Utah State University
Logan, UT 84322-6300
Telephone: 435-797-3067, Fax: 435-797-3075
Email: doug.johnson@ars.usda.gov

Paul G. Johnson
Dept of Plants, Soils, and Climate
Utah State University
Logan, UT 84322-4820
Telephone: 435-797-7039, Fax: 435-797-3376
Email: paul.johnson@usu.edu

Robert J. Soreng
Dept. of Botany NHB MRC-166
National Museum of Natural History
Smithsonian Institution, P.O. Box 37012
Washington, DC 20013-7012
Phone: 202-633-0981, Fax: 202-786-2563
Email: sorengr@si.edu

Russian Team Members:

Nickolai Dzyubenko, Director General
Vavilov Res. Inst. of Plant Industry (VIR)
42 Bolshaya Morskaya Street
190000, St. Petersburg, Russia
Telephone: (7-812) 315-5093
Fax: (7-812) 571-8762
Email: n.dzyubenko@vir.nw.ru

Elena Dzyubenko, Grass Curator
Vavilov Res. Inst. of Plant Industry (VIR)
42 Bolshaya Morskaya Street
190000, St. Petersburg, Russia
Telephone: (7-812) 315-5093
Fax: (7-812) 571-8762
Email: e.dzyubenko@vir.nw.ru

Country Visited/Dates: Russia, 13 July to 25 August 2010

Funding Sources: NPGS Plant Exploration Program and Utah State University

Summary: Plant germplasm from the northern Caucasus Mountains of Russia is poorly represented in U.S. genebanks and has potential to expand existing germplasm for the improvement of turf for tolerance to drought, mowing, and low temperatures. As a result, the NPGS Plant Exploration Program and Utah State University supported a project to collect seed of possible turf species (*Poa, Festuca, Agrostis, Koeleria,* and *Puccinellia*) in the northern Caucasus Mountains of Russia, which have potential for reduced-input turf applications in the western U.S. Opportunistic collections of various grass and legume species that have potential for forage or conservation applications were also made. A total of 291 collections covering a wide diversity of grass and legume species were made throughout the Stavropol, Cabardino-Balkaria, Karachay-Cherkessia, Krasnodarskya, and Adygea regions of Russia at elevations ranging from 47 to 3,100 m.

The three U.S. team members left the U.S on 13 July 2010, arrived in St. Petersburg on 14 July, obtained a police registration for an extended-stay permit in Russia on 15 July, flew to Mineral'nye Vody on 16 July where they were met by Drs. Nickolai and Elena Dzyubenko. Using two VIR vans and help from local botanists, we began our collection in the steppe region near Stavropol, followed by regions in the northern slopes of the Caucasus Mountains near Pyatigorsk, Kislovodsk, Elbrus, Teberda, Apsheronsk, Tuapse, and Sochi. U.S. team members flew back to St. Petersburg from Sochi on 13 August. Seed collections were inspected by officials at the Federal Service for Veterinary and Phytosanitary Surveillance of the Russian Federation in St. Petersburg who issued a Phytosanitary Certificate and approval for export.

The U.S. portion of the seed collections was delivered to Homeland Security inspectors at the Salt Lake City Airport on 25 August 2010 and sent to the USDA Plant Germplasm Quarantine Center in Beltsville, MD for quarantine 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 (NPGS). 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-input turf, forage, and conservation applications in the western U.S.

Recommendations: Dr. Nickolai Dzyubenko (Director General of VIR) 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 VIR scientists. The diverse, expansive land mass in Russia and Central Asia makes this region of the world an important area to add targeted collections of a wide range of crop plants and their wild relatives. Because of Dr. Dzyubenko's support and interest, opportunities exist to collaborate with VIR on making germplasm collections in Russia and countries in Central Asia. Collection of germplasm from this unique part of the world will insure its preservation and availability for future generations.

Acknowledgments: Nickolai and Elena Dzyubenko did an excellent job of planning, organizing, and facilitating all aspects of our trip. Their hard work and preparation insured that our trip was productive, enjoyable, and successful. We also thank Nickolai Dzyubenko and Rashid Abdurashidov (driver from the VIR Experiment Station in Dhagestan) who spent long hours on the road safely driving us to our many collecting sites along our 4,379 km collecting route. Special thanks go to Elena Dzyubenko who not only was a very important scientific member of our team, but also took special care to plan and prepare a wide variety of delicious meals during our trip. Appreciation is also extended to many staff members at VIR in St. Petersburg, Stavropol Botanical Garden, Ecological and Biological Experiment Station of the Komarov Botanical Garden (KBC) at Pyatigorsk, Teberda Wildlife Reserve, VIR Experiment Station at Maikop, and VIR Experiment Station at Adler who made numerous contributions involving arrangements for seed collection, taxonomic identification, logistical preparations, seed cleaning, and cooking. We particularly appreciated the capable assistance of Dr. Dima Schilnikov (young botanist from KBC) who accompanied our team for 13 days in the northern Caucasus Mountains.

Technical Report

Introduction

Background: Russia is the largest country in the world with an area that covers about one eighth 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, and broad-leaved forests. 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.

Summer and winter temperatures vary widely in Russia and so does precipitation. 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 has long, severe winters and short summers with precipitation falling throughout the year and varying from 530 mm in Moscow to 200-250 mm in eastern Siberia. The steppe region of Russia has very cold winters and hot, dry summers.

The Caucasus Mountains extend about 1,000 km (about 680 miles) from the northeastern shore of the Black Sea, trending east-southeast nearly reaching Baku, Azerbaijan on the Caspian Sea. The Caucasus Region covers an area of more than 477,000 km^2 (184,000 $miles^2$) and traverses through the countries of Russia, Georgia, Armenia, and Azerbaijan. About two thirds of the area of the Caucasus Region occurs within the territory of Russia. The Caucus Mountains cover a range in latitude from N 41^o near Baku to N 45^o N near Novorossiysk on the Black Sea, and are between longitudes of about E 38^o to E 50^o. The highest peak in the Caucasus Mountains is Mount Elbrus, which has an elevation of 5,642 m (18,506 feet). The Caucasus Mountains are generally considered the southeast boundary between Europe and Asia, and are composed of granite, crystalline rock, and some volcanic formations. The main minerals of the Caucasus Mountains are coal, copper, lead, manganese, and oil.

The climate of the Caucasus Mountains varies considerably according to elevation, latitude, and location with temperature generally decreasing as elevation increases. For example, mean annual temperature in Sukhumi, Abkhazia at sea level is 15^{o}C, while on the slopes of Mt. Kazbek (elevation of 3,700 m) is -6.1^{o}C. Precipitation increases from east to west in most areas of the Caucasus Mountains with higher elevations generally receiving greater amounts of precipitation than lower elevation areas, except for areas located on the coast of the Black Sea. The minimum annual precipitation in the Caucasus occurs in the Caspian Depression, which receives about 250 mm (10 inches), whereas precipitation can reach more than 1,000 mm (40 inches) in higher elevation areas. Some areas of the Caucasus Mountains can receive snow amounts as high as 5 m (16 feet).

The Caucasus area is comprised of three primary Regions including the Central, Western, and Eastern Caucasus. The northern portion of the Caucasus Region is comprised of the dry steppes of Russia, to the west are the subtropical lowland marshes of the Black Sea, and to the east are the arid, saline lowlands of the Caspian Sea. The central portion of the Caucasus Region includes a variety of broadleaf and coniferous forests, alpine meadows, and glaciers. We targeted the Western and Central Caucasus Regions on this collection trip. Although the flora and vegetation of the Caucasus Mountains have been well studied by Russian botanists, nearly all of these floral treatments are published in Russian. The Caucasus Region has a rich biological diversity with more than 6,350 species that include 155 plant families and 1,286 genera with about 25% of its flora being endemic. In the northern portion of the Caucasus Region, grassland steppe transitions to semi-arid ecosystems and to desert in the east. The vegetation of the Caucasus Region represents a unique mix of floral elements from Europe, Asia, and the dry steppes of Kazakhstan.

In September 2008, Elena Dzyubenko and Doug Johnson visited Professor N.N. Tzvelev, world renowned grass taxonomist at the Komarov Botanical Institute in St. Petersburg, Russia. In discussing possible centers of diversity for turfgrass species, Professor Tzvelev indicated that he thought that the Caucasus Mountain Region was one of the most diverse regions for grass species with high potential for reduced-input turfgrasses. Professor Tzvelev indicated that the Caucasus Mountain Region has 82 species within the most likely candidate genera for reduced-input turfgrass. He further indicated that this region has incredible floristic diversity for turfgrass genera because of its heterogeneous geography, elevation, and climate, which have resulted in considerable speciation.

Trip Details

Targeted species: Species of *Poa, Agrostis, Festuca, Koeleria, Puccinellia,* and possibly other genera from the flora of the Caucasus Mountains have potential for reduced-maintenance turf. Accessions of these targeted genera 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 in this part of Russia and the large heterogeneity of habitats within the targeted collection area, grass collections from there may hold particular promise for characteristics required for reduced-maintenance turf applications. These characteristics include seedling establishment, production, and persistence of high quality turf under conditions of low precipitation and fertility, cold temperatures, salinity, 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, Puccinellia,* and other genera that have potential for reduced-input turf. When opportunities arose, we also collected seed of grass and legume species that have potential for forage or conservation applications.

Logistical Arrangements: Nickolai Dzyubenko and Elena Dzyubenko of VIR were the Russian team members on our expedition. They have led and participated in numerous seed collection expeditions in Russia and Central Asia in the past. Besides his position as Director General of VIR, Nickolai is the Head of VIR's Department of Forage Crops where he is an alfalfa geneticist. Elena is a grass curator in the Department of Forage Crops at VIR. Our trip was conducted under the auspices of a non-funded, five-year cooperative agreement that formalizes joint germplasm collection activities between VIR and ARS. U.S. participants received official letters of invitation from VIR and the Russian Ministry of Foreign Affairs for obtaining visas from the Russian Consulate in Washington, DC. The morning after arriving in St. Petersburg, U.S. participants registered with the Russian police for the necessary permission to travel for an extended period in Russia.

U.S. team members brought along the necessary collecting equipment and supplies including seed envelopes, global positioning system (GPS), vials for collecting leaf samples, and other miscellaneous supplies. During the collection trip, the six expedition participants traveled in a four-wheel drive Russian UAZ van and a Volkswagen van. Participants usually camped in tents with several nights in hotel accommodations. All food expenses were shared equally among participants. On returning to St. Petersburg, VIR provided lodging at rooms at a small hotel 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)

13-14 July 2010: U.S. team members flew to St. Petersburg and were met by Sergey (VIR driver) at the St. Petersburg International Airport. We were driven to VIR's small hotel on Sapernyi Street.

15 July: Team members completed police registration forms and gave their passports to hotel staff for an extended stay (more than 30 days) approval through the Russian Police. We went to an American Express Office where traveler's checks were exchanged for Russian currency to pay for expedition expenses. We visited VIR where we met Mr. Sergey Shuvalov in the Foreign Relations Department who made arrangements for us to visit VIR's N.I. Vavilov Museum. Paul Johnson and Robert Soreng were taken to the VIR Herbarium, and Doug Johnson visited with the staff at VIR's Department of Forage Crops (Drs. Vladimir Chapurin, Leonid Malyshev) and Department of Leguminous Crops (Tamara Buravtseva). U.S. participants returned to Sapernyi Street where they were given their police registrations and passports.

16 July: U.S. participants took a three-hour flight on Rossiya Airlines from St. Petersburg to Mineral'nye Vody, where we were met by Nickolai and Elena Dzyubenko and Rashid Abdurashidov (VIR driver from Dhagestan). After having a celebratory lunch of shashlik near the airport and discussing general logistical plans for our trip, we drove to Stavropol (a city with a population of about 400,000). We went to the Stavropol Botanical Garden (SBG), where we were met by the Director (Dr. Sergey Kozhevnikov). We were given a tour of the facilities and showed an area near the Administrative Building where we setup our tents.

17-19 July: During day trips from Stavropol, we were accompanied by staff of the SBG (Drs. Vassily Hrapach, Ludmilla Grechushkina, Victor Belous, Galina Shevchenko, and Andrei Skripchinsky) and made collections of various grass and legume species from stony, xeric, and mesic steppe environments ranging in elevation from 166 to 663 m. We also made collections in a reconstructed restoration area at the Stavropol Botanical Garden and were presented seed of six collections from turf plots maintained at the SBG. We obtained a total of 56 seed collections from the Stavropol area.

20-25 July: We traveled to Pyatigorsk (a population of about 140,000) and arrived at the

Ecological and Biological Experiment Station of the Komarov Botanical Garden (KBC). Part of the KBC grounds contains a well-managed, commercial tree nursery that is under heavy security. The other portion of KBC is the actual Botanic Garden, which is suffering from a lack of funding. The KBC has a limestone, two-story building that contains offices and labs on the ground floor and living accommodations for the Director's family on the second floor. We were met by Director Anatoliy Miheev, and he invited us to setup our tents in an orchard near the KBC and use one of their labs for processing our collections.

We conducted day trips from KBC in the vicinity of Pyatigorsk. Dr. Dima Schilnikov from KBC accompanied us on several of those trips. Dima is a very capable young taxonomist who lives in Essentucky and has written a book on the plants of the Caucasus Mountains. We used a chairlift to take us to the top of Mashuk Mountain and made seed collections as we hiked down from the top of the chairlift. Other locations where we collected in the Pyartigorsk area included: Bogustan Mountain Range, Beschtau Mountain, Byk Mountain, and Skalisty Khrebet Mountain Range. We made 66 seed collections at elevations ranging from 466 to 1,970 m. We cleaned our accumulated seed collections at KBC on a day that it rained.

26-28 July: We traveled to the base of Cheget Mountain and Mount Elbrus and made collections in the campground in the valley midway between the two peaks. The following day we took the chairlift to the top of Cheget Mountain and made collections as we hiked down the mountain, which ranged from an elevation of 3,100 m to 1,138 m. We were in close proximity to the border between Russia and Georgia. On the following day, we took a gondola in combination with a chairlift up as far as we could go on Mount Elbrus, the highest mountain peak in Europe at 5,642 m. Mount Elbrus is an extremely impressive, rugged mountain that has a permanent icecap that feeds 22 glaciers, which give rise to the Baksan, Kuban, and Malka Rivers. At the chairlift terminus, the site was mainly snow and volcanic boulder fields. Seeds were not mature for collection at the highest sites; we made 26 seed collections at elevations ranging from 2,347 to 3,100 m.

29-31 July: We descended down the highest portion of the Caucasus Mountains along the Baksan River through steppe areas near Karachaevsk, back through Pyatigorsk and eventually to Teberda where we stayed at dormitory facilities at the Teberda National Biosphere Reserve. We were met by the Deputy Director (Dr. Jamal Kemalovich) and Dr. Vladimir Onipchenko (botanist from Moscow University). The Reserve is part of the UNESCO Biosphere Reserve Program, covers 536,000 ha, and has a diverse flora and fauna with more than 2,500 plant species and 219 bird species. We collected near Teberda at elevations ranging from about 1,300 to 1,600 m. On 31 July, we drove to Dombai and took a series of four chairlifts to the top of Musatcheri Mountain with stunning mountain scenery. We hiked down Musatcheri Mountain and made collections at elevations ranging from 1,632 to 2,436 m. We made 43 collections in the Teberda area.

1-2 Aug.: We left Teberda and descended down the Caucasus Mountains to mesic steppe areas with temperatures approaching 40^{o}C. We made a total of 31 seed collections at elevations ranging from 171 to 580 m, including collections along the Little and Big Laba Rivers. We eventually arrived at the VIR Maikop Experiment Station, which was established in 1930. The VIR Maikop Experiment Station covers about 5,000 acres and focuses on research related to onion, pepper, eggplant, cucumber, cabbage, garlic, carrot, tomato, and red beet as well as southern varieties of apple, pear, plum, sweet cherry, and filbert. It has one of the largest fruit tree collections in the world. There is also a quarantine nursery at the Station. We stayed in the upstairs of the first building of the Station, which has a statue of Lenin in the front of the building, and we were allowed to use cooking and bathroom facilities in a guesthouse at the Station. The Director of the VIR Maikop Station is Dr. Anna Guz and the Deputy Director is Dr. Valentine Semynov; they were extremely helpful to our team.

3-6 Aug.: We conducted day trips for collection from the VIR Maikop Experiment Station to areas above the Belaya River, which ranged in elevation from 360 to 671 m. We also made productive seed collections during hikes in the Lago-Naki Nature Reserve located on the scenic, diverse Lago-Naki Plateau located at about 1,800 m elevation. Special permission for collecting seeds in the Lago-Naki Nature Reserve was arranged by the Director of the VIR Maikop Experiment Station. In addition, we cleaned our accumulated seed collections at the VIR Maikop Experiment Station. A total of 48 collections were made during this period.

7-8 Aug.: We drove southwest and ascended the north slope of the Caucasus Mountains on a fine-dust road to the pass and descended to the Black Sea near Tuapse making several seed collections at an elevation of 47 m. The weather by the Black Sea was hot and humid, and vegetation was sub-tropical. We stayed in a small, tightly packed campground near the Black Sea at Shepsi and did a day trip to collect seed at the Golovinski Nature Reserve at an elevation of 100 m. We made 11 collections in this area.

9-13 Aug.: We drove on a slow, winding road through resort/vacation towns along the Black Sea that was crowded with trucks and tourists. Major road construction was also taking place from Sochi to Adler, site of the 2014 Winter Olympics. We arrived at the VIR Adler Experiment Station southwest of Sochi where we checked into hotels on the Black Sea. We were graciously hosted and guided by the Director of the VIR Adler Experiment Station (Mr. Alexander Boiko who was previously director of a large collective farm near Kuban). Plans are to replace the existing old laboratory at the VIR Adler Experiment Station by a new, modern building that would house offices, labs, an auditorium, and guest quarters with funding provided from the Russian Academy of Agricultural Sciences. The VIR Adler Experiment Station conducts research on a wide range of vegetables and production research on kiwi fruit.

We conducted a trip to the Krasna Polyana Nature Reserve, a stunningly beautiful area near Sochi where the 2014 Winter Olympic venues will be held. Krasna Polyana is located against the scenic backdrop of the Caucasus Mountains, which rise to more than 2,000 m in elevation from sea level at the Black Sea just 50 km away. Krasna Polyana is a favorite meeting place and vacation spot for Prime Minister Putin, President Medvedev, and other government officials. Massive highway, light-rail, ski lift, and building construction projects are proceeding in Krasna Polyana to provide transportation between Sochi (site of the Olympic Village) and the new Sochi-Adler International Airport. The highway and light-rail system are being constructed along (and in) the Mzymta River, which runs in the bottom of the relatively steep, narrow main canyon of Krasna Polyana. The river is being channelized, trees are being cleared, pilings are being poured in the river, and the environment is being severely disturbed.

We suspected that security would be tight in Kransna Polyana because it is a border area with Georgia, a meeting/vacation location for high government officials, and a hub of construction activity for the Winter Olympics. Director Boiko received special permission for us to make seed collections in Krasna Polyana. However, when we arrived at the security checkpoint for the best collection area, military security guards would not allow U.S. team members to proceed past the checkpoint. The only seed collections obtained past the checkpoint were donated by Larisa Bagmet and Olga Radchenko from VIR who were there several days earlier. We camped in a lower elevation area in Krasna Polyana and made collections there. The following day, we took newly installed chairlifts and trams to the top of the of the ski area, anticipating that we could hike down the mountain and make seed collections. However, military security personnel did not allow anyone to proceed past the restricted viewing area so we could not hike down the mountain. We obtained a total of 10 seed collections in the vicinity of Sochi/Adler. We cleaned our accumulated seed collections at the VIR Adler Experiment Station, split the collections, prepared the required passport data and seed list, finalized trip expenses, and packed for our return to St. Petersburg.

14-24 August: U.S. team members flew to St. Petersburg and were picked up by Sergey (VIR driver) and taken to the small VIR hotel on Saperyni Street. We brought our seed collections and accompanying seed list with Latin names, Russian names, and seed weights to the VIR Foreign Relations Department who delivered them to the Federal Service for Veterinary and Phytosanitary Surveillance of the Russian Federation in St. Petersburg for inspection. They normally require two weeks to process seed. Paul Johnson returned to the U.S. on 17 August. While in St. Petersburg waiting for the Phytosanitary Certificate, Rob Soreng and Doug Johnson visited with Professor Tzvelev at the Komarov Botanical Institute and discussed the results of the collection trip. We also worked in the herbarium to confirm the identification of several of our collections. Our seed collections were returned on 24 August with the Phytosanitary Certificate.

25 August: Doug Johnson returned to the U.S. and delivered the U.S. portion of the seed collections to Homeland Security inspectors at the Salt Lake City International Airport. The collections were sent to the USDA Plant Germplasm Quarantine Center in Beltsville, MD for inspection and processing. Rob Soreng returned to Washington, DC on the same day with the collected herbarium specimens and dried leaf samples for DNA analysis.

Collections: Prior to our collection trip, only 59 accessions of the targeted taxa were available in NPGS from the entire Caucasus Mountain Region of Russia. Essentially no turfgrass collections were available from NPGS from higher elevation areas in the Russian Caucasus Region. Collections brought back to the U.S. will add important holdings to NPGS and provide a broader representation of genetic diversity within the unique flora of the Caucasus Mountains. Our collection route traversed 4,379 km (Figure 1).

We brought back a total of 291 collections (Table 1) covering a wide range of grass and legume species from the Stavropol, Cabardino-Balkaria, Karachay-Cherkessia, Krasnodarskya, and Adygea Oblasts of Russia ranging in elevations from 47 to 3,100 m. Collections in the following genera hold promise for reduced-maintenance turf applications: *Poa* (67), *Festuca* (21), *Agrostis* (14), *Koeleria* (5), *Puccinellia* (3), *Trisetum* (2), and *Catabrosella* (1). Seeds of various forage grasses were also collected: *Schedonorus* (17), *Bromus* (14), *Phleum* (7), *Festuca* (5), *Agropyron* (4), *Thinopyron* (2), *Bothriochloa* (2), and *Pseudoroegneria* (1). Of particular note were collections of *Dactylis glomerata* (15), which may hold promise for cold tolerance. Opportunistic seed collections of various forage legumes were also made including *Trifolium* (12), *Galega* (8), *Onobrychis* (8), *Astragalus* (6), *Medicago* (6), *Vicia* (3), *Coronilla* (2), *Hedysarum* (1), *Lathyrus* (1), *Lotus* (1), and *Melilotus* (1).

After processing at the Plant Quarantine Center in Beltsville, MD, our seed 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 NPGS 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.

Doug Johnson and Paul Johnson will cooperatively evaluate the collections for reduced-maintenance turf applications at sites in northern Utah. Accessions were started in the greenhouse during the winter of 2011 and transplanted at two field sites during the spring of 2011. These evaluations include three replications of five-plant plots at each site with 1.0-m spacing between rows and 0.5-m spacing between plants within a row. Plants will be established during 2011, and data collection will commence in 2012. Plots will be evaluated for turf quality, spread, and greenness under conditions of 50% evapo-transpiration (ET) and 50 kg/ha N. Throughout the growing season of 2012 and 2013, a standardized light box will be placed above plots to evaluate accessions for density, cover, and greenness. In addition, individual plots will be given a qualitative visual rating for relative vigor and turf quality several times during the season.

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 high water and maintenance costs. Water costs are increasing and will likely continue to increase in the future. In addition, 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 also is becoming more popular and homeowners, park managers, and golf course superintendents are replacing high-input turf species with reduced-maintenance species.

Our collections from the Caucasus Mountain Region will expand existing reduced-maintenance turf germplasm by adding germplasm that has tolerance to clipping, low temperatures, and other adverse growing conditions. Also, ecotypic diversity for response to clipping is likely extensive in many of these collections because plants in the Caucasus Mountains have been exposed to intensive grazing by wild and domesticated herbivores for thousands of years and likely have been genetically modified through natural selection. As a result, collections could be particularly tolerant to clipping or mowing, which would be beneficial for incorporation into turf and forage improvement programs in the western U.S. The collections also provide additional genetic material of species not well represented in NPGS, which may be useful in elucidating genetic relationships in the collected species, especially for *Poa* and *Festuca*. Incorporation of the collected germplasm into NPGS will allow their use by scientists in the U.S. and throughout the world, and will ensure preservation and conservation of this unique germplasm.

Benefits to Russia: These collections will also add important germplasm to the genebank 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 of reduced-maintenance turf and forage species. Close interactions with botanists, forage scientists, and staff from VIR provided opportunities for strengthened professional ties between U.S. and Russian scientists. Exchange of information among personnel during and after the collection trip will assist in transferring the latest information and technology concerning plant breeding and selection, germplasm collection and preservation, and germplasm enhancement.

References Consulted

Czerepanov, S.K. 1995. Vascular plants of Russia and adjacent states (the former USSR). Cambridge Univ. Press. 528 pp.

Fedorov, A. 1987. Volume 6: Flora of Russia. Nauka Publishers, Leningrad. 992 pp.

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

Contacts

N.I.Vavilov Research Institute of Plant Industry
42 Bolshaya Morskaya Street
190000, St. Petersburg, Russia
Phone: 812-315-5093
Fax: (7-812) 117-8762
Email: vir@vir.nw.ru
Dr. Nikolay Dzyubenko (Director)
Dr. Elena Dzyubenko (Grass Curator)
Dr. Sergey Alexanian (Head of the Foreign Relations Department)
Mr. Sergey Shuvalov (Foreign Relations Specialist)

Stavropol Botanical Garden
478 Lenin Street
Stavropol, Russia 355029
Phone: (865-2) 56-03-71
Email: sbs@stavmail.ru
Dr. Sergey Kozhevnikov (Director)

Dr. Ludmila Grechushkina (Grass Specialist)
Dr. Galina Shevchenko (Senior Researcher)
Dr. Vasiliy Hrapach (Researcher)
Dr. Victor Belous (Botanist at Stavropol State Univ.)

Pyatigorsk Ecological and Biological Experiment Station of the Komarov Botanical Garden
Pyatigorsk, 357532, Russia
Dr. Anatoliy Miheev (Director)
Dr. Dima Schilnikov (Botanist, email: demons2002@rambler.ru)

Teberda National Biosphere Reserve
1 Baduksky Pereulok
Karachaevo, Karachay-Cherkessia
369210, Teberda, Russia
Phone/Fax: (7-878-22) 51-261
Email: teberda@mail.svkchr.ru
Dr. Jamal Kemalovich (Deputy Director)
Dr. Vladimir Onipchenko (Visiting Botanist from Moscow University)

VIR Maikop Experiment Station
1 Nauchnaya Street
Shuntuk, Maikop Region, Adygeya Republic
385746, Russia
Phone: (877-77) 5-64-32
Email: mosvir@pochta.ru
Dr. Anna Guz (Director)
Dr. Valentine Semynov (Deputy Director)

VIR Adler Experiment Station
95 Lenin Street
Sochi, Adler Region, Krasnodar Territory
354340, Russia
Phone: (862-2) 40-03-34
Email: aos.vir.@mail.ru
Mr. Alexander Boiko (Director)

Komarov Botanical Institute
2 Professor Popov Street
Saint Petersburg, 197376, Russia
Phone: (7-812) 53-11-974
Email: vdorofeyev@yandex.ru
Dr. N. N. Tzvelev (Grass Taxonomist)
Dr. Volodya Dorofeyev (Deputy Director)

Figure 1. Collection route taken in the Caucasus Mountains of Russia (2010).

Table 1. Species and numbers of collections made in Caucasus Mountain Region of Russia.

Agropyron cristatum (3)
Agropyron fragile
Agrostis capillaris (7)
Agrostis gigantea
Agrostis stolonifera (5)
Agrostis vinealis
Alcea rugosa
Alopecurus glacialis
Alopecurus ponticus
Alopecurus textilis
Anthyllis vulneraria
Astragalus cicer
Astragalus danicus
Astragalus demetrii
Astragalus falcatus
Astragalus galegiformis
Astragalus oreades
Avenula adzharica (2)
Avenula pubescens
Bothriochloa ischaemum (2)
Brachypodium rupestre (8)
Brachypodium sylvaticum (4)
Briza eliator (2)
Bromus benekenii (2)
Bromus erectus
Bromus riparius (6)
Bromus variegatus (5)
Calamagrostis arundinacea (3)
Calaphaca volgarica
Catabrosa aquatica
Catabrosella variegata
Coronilla coronata
Coronilla varia
Cynodon dactylon
Cynosurus cristatus
Dactyilis glomerata (15)
Deschampsia cespitosa (2)
Drymochloa drymeja (2)
Festuca breistrofferi
Festuca brunnescens
Festuca ovina
Festuca rubra (4)
Festuca rupicola (7)
Festuca sp. (2)
Festuca valesiaca (7)
Festuca varia (3)
Galega officinalis
Galega orientalis (7)
Hedysarum biebersteinii
Holcus lanatus
Hordelymus europaeus
Hordeum violaceum (2)
Koeleria eriostachya
Koeleria pyramidata (4)
Lathyrus tuberosus
Lolium perenne (11)
Lotus caucasicus (4)
Lotus sp.
Medicago cancellata
Medicago falcata (5)
Melica transsilvanica
Melilotus alba
Milium effusum (2)
Nardus stricta (2)
Onobrychis inermis (2)
Onobrychis ruprechtii
Onobrychis sp.
Onobrychis tanaiticus (2)
Onobrychis vassilchenko (2)
Orobus aureus
Phleum alpinum
Phleum paniculatum
Phleum phleoides (6)
Piptatherum virescens
Poa alpina (4)
Poa annua (2)
Poa badensis (5)
Poa bulbosa
Poa compressa (9)
Poa iberica (4)
Poa longifolia
Poa nemoralis (8)
Poa palustris
Poa pratensis (31)
Poa trivialis
Pseudoroegneria stipifolia
Puccinellia distans (3)
Schedonorus arundinaceus (6)
Schedonorus giganteus (3)
Schedonorus pratensis (8)
Sesleria alba
Thinopyrum intermedium (2)
Trifolium alpestre
Trifolium arvense
Trifolium canescens (2)
Trifolium fragiferum (2)
Trifolium pratense (3)
Trifolium repens (3)
Trisetum flavescens
Trisetum teberdense
Vicia abbreviata
Vicia grossheimii
Vicia tenuifolia
Unknown (legume)

Total = 291 seed collections