Collection of Wild *Beta* Section *Corollinae* in the Former Soviet Union

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ABSTRACT

Wild *Beta* species are relatives of the cultivated forms of *Beta vulgaris* L. (sugarbeet) and are continually at risk of being destroyed in natural habitats. This is particularly true concerning *Beta* species of section *Corollinae* in the Caucasus Mountain region of the former Soviet Union where a joint exploration was undertaken to collect representative populations of species of the section. Wild *Beta* species were not as easily located as expected due to many factors such as land use, accessibility, and suitable habitat. However, a few populations of the species of section *Corollinae* were collected. This germplasm was the first to be collected in the Caucasus region in over 50 years. The seed has been deposited in the USDA-ARS National Plant Germplasm System *Beta* collection with a duplicate collection at the Centre for Genetic Resources (CGN), Wageningen, The Netherlands. The germplasm will be an important addition to the collections and will help ensure the preservation of these species. Evaluation will be necessary to determine their potential value.

Additional Key Words: germplasm, genebank, wild beet, genetic resource, *Beta corolliflora, B. lomatagona, B. macrorhiza.*

The objectives of genetic resources conservation are the collection, maintenance, and regeneration of the genetic variation of a taxon to ensure its existence and availability in the long term (Astly, 1992). The collection of wild relatives of crop species recently has received increased attention largely due to the concerns about destruction of natural habitat. This is particularly true for *Beta* species of the section *Corollinae* in the Caucasus Mountain region of the former Soviet Union.

Species relationships in the genus *Beta* are divided into four sections: *Beta, Corollinae, Nanae* and *Procumbentes* (Letschert et al., 1994). Within section *Corollinae,* from three to six species have been classified (Letschert, 1993). Initially, the species *B. lomatogona* Fisch. & Mey., *B. trigyna* Wald. and Kit., and *B. macrorhiza* Stev. were recognized on morphological grounds. There is good reason to regard all apomictic beets of section *Corollinae,* described as *B. trigyna* (4X to 6X), as allopolyploid hybrids. The taxonomic position of these apomictics and hybrids is still unresolved (Letschert, 1993). The taxonomy of this paper follows Buttler (1977), who recognized the section *Corollinae* as consisting of three species: *B. corolliflora* Zoss. ex Buttler, *B. lomatogona,* and *B. macrorhiza.* Species of section *Corollinae* are perennial and develop a large tap root. The distribution of the section is continental occurring from Central Europe and the Balkans to Anatolia, the Caucasus, southern Russia, and Iran at higher elevations. The species occur mainly as weeds in arable land (Buttler, 1977). *B. lomatogona* grows along the edges of wheat and barley fields, while *B. corolliflora* is found more often within arable fields rather than along their margins (Buttler, 1977). *B. macrorhiza* is typically a species of roadsides and ruderal habitats, with long, woody, and fibrous roots (Buttler, 1977). Some roots of *B. lomatogona* have been reported to have a sugar concentration up to 30% (Scheibe, 1934), but most are in the 3 to 15% range (Zossimovitch, 1940). Krasochkin (1959) reported that the high sugar concentrations (>20) are erroneous values.

All species in this section are cold and winter hardy, as well as drought tolerant (Zossimovitch, 1940). Tolerance to saline soils also has been observed in *B. lomatogona* (Scheibe, 1934). Resistance to curly top, a devastating virus of sugarbeet in the western U.S., has been identified in *B. corolliflora* (Savitsky, 1969) and *B. macrorhiza* (Coons, 1975). The seed balls of species of this section are very hard and difficult to germinate (Zossimovich, 1940). Germination problems and the perennial nature of the species need to be considered when hybridizing with cultivated sugarbeet. More importantly, nonhomology of chromosome pairing between the species of this

section and cultivated sugarbeet adds to the difficulty of obtaining interspecific hybrids and gene transfer (Van Geyt et al., 1990).

Due to the need to fill a gap in the wild *Beta* germplasm collection and preserve valuable germplasm, and considering the destruction of valuable habitat of the species, a cooperative exploration was conducted to collect wild *Beta* species of the section *Corollinae* from the Caucasus region of the former Soviet Union.

MATERIALS AND METHODS

The *Beta* section *Corollinae* exploration took place August 19 to September 9, 1990. It was a cooperative endeavor among the USDA-Agricultural Research Service, National Plant Germplasm System, the N.I. Vavilov All-Union Research Institute of Plant Industry (VIR), Leningrad (St. Petersburg, Russia), and the Centre for Genetic Resources (CGN), Wageningen, The Netherlands. The exploration involved travel in the former Soviet Republics of Armenia, Azerbaijan, and Russia (Daghestan). Seed was collected from as many plants as possible in each population. Seed was bulked into one accession sample per population. No rootstocks were collected for propagation purposes. Herbarium specimens were collected and deposited at Fargo, North Dakota. The seed samples are stored at the USDA-ARS, Western Regional Plant Introduction Station (WRPIS), Pullman, Washington, where they will be maintained and distributed. Duplicate and some individual collections (Table 1) will be maintained at CGN, Wageningen, The Netherlands.

All populations collected were from the known geographical range of the species. General species distribution maps were used to locate populations (Zossimovitch, 1940). Species populations were collected as they were encountered. Passport data (i.e., location, latitude, longitude, altitude), population size (estimated number and size), population uniformity, soil type, and habitat were recorded.

RESULTS AND DISCUSSION

The accessions collected during the exploration are listed in Table 1. They are all perennial and represent the recognized species of the section as defined by Buttler (1977).

Collection in the Republic of Armenia

The exploration began in the Yerevan region of Armenia (Figure 1). This region is north of Turkey near the southern end of the Caucasus Mountains. The *Corollinae* section of *Beta* was reported to be in this

Table 1. Species, location, population size, soil, and habitat of wild *Beta* of section *Corollinae* collected in the former Soviet Union.

Collection Number	Taxon	PI Number[†]	Location	Republic/ District	Longitude/ Latitude	Altitude (M)	Population Size[‡]	Population Uniformity	Soil	Habitat
BFS/90-03	*Beta corolliflora*	546495	1 km NE Razdan	Armenia Yerevan	44.48°E 40.28°N	1900	60	Uniform	Loam	Rocky slope of grazed pasture
BFS/90-13	*Beta corolliflora*	———	5 km E of Razdan to Sevan	Armenia Razdan	44.49°E 40.30°N	1860	3	Uniform	Loam	Roadside near bushes
BFS/90-18	*Beta corolliflora*	546496	Aragats Monastery Pach Lavunie (Ambest)	Armenia Ashtarakskij	44.14°E 40.25°N	2160	40	Uniform	Loam	Disturbed area by ruins mixed in grassland

Table 1 *(Continued)*

Collection Number	Taxon	PI Number[†]	Location	Republic/ District	Longitude/ Latitude	Altitude (M)	Population Size[‡]	Population Uniformity	Soil	Habitat
BFS/90-20	*Beta lomatogona*	———	0.5 km W. of Norachen before Gladzor	Armenia Talin	43.52°E 40.25°N	1900	1	Uniform	Loam	Wheat field near grasslands
BFS/90-21	*Beta corolliflora*	———	Gladzor	Armenia Jeheknazor	45.22°E 39.48°N	——	3	Uniform	Loam	Shrubs near outskirts of village
BFS/90-32	*Beta macrorhiza*	546497	Dimirkent, 1 km toward Mikra	Daghestan Achtunskij	47.53°E 41.17°N	1200	100	Uniform	Loam	Steep rocky slope of steppe, heavily grazed
BFS/90-49	*Beta macrorhiza*	546498	Duldug 3 km W. of Chirakhchay River	Daghestan Agul	47.49°E 41.45°N	1610	20	Uniform	Loam	Steep slope by river and pasture

[†] Accessions with no PI number assigned did not have enough seed to be shared. The germplasm will be maintained by CGN, The Netherlands.
[‡] Number of plants in the population.

general area (Zossimovitch, 1940). The area surrounding Yerevan is very rocky and mostly used for grazing. Small areas are cleared of rocks to grow small grains such as wheat and barley. The area generally appeared arid. *B. corolliflora* was found growing on rocky slopes in a grazed steppe at 1900 m in the Razdan area. Populations were generally uniform within a location, but varied between locations due to the intensity of agricultural practices, such as grazing.

B. lomatogona was located in the Talin district near Norachen at an elevation of 1900 m. One vegetative plant of *B. lomatogona* was

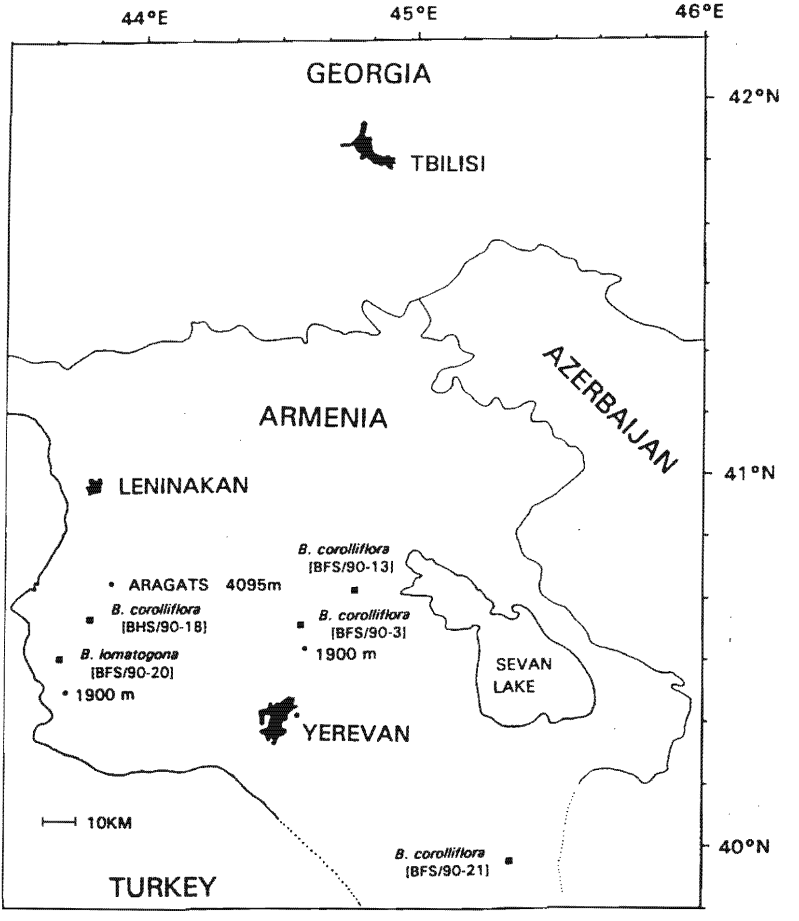

Figure 1. Wild *Beta* exploration collection sites in Armenia of the former Soviet Union.

found in small grain stubble with a seed stalk, but with little seed. Several plants had been present in the field, but the stems and the seed had been harvested with the grain. A search of the surrounding area was unsuccessful in locating additional fruiting plants. The area was very rocky with small cleared areas (< 1 ha) where wild beets had been growing mixed with the grain crop and along the edge of the field.

The area surrounding Lake Sevan was explored because of an earlier report indicating that it was a major center of distribution for the *Corollinae* section (Zossimovitch, 1940). The area was heavily grazed and didn't appear to have many suitable habitats for wild beets (rocky slopes, steppe, and cultivated fields) and, as a result, we were not successful in finding wild beets in the 2 days spent exploring this area.

The area northwest of Lake Sevan near the city of Spitak also was explored. It is characterized by granitic rock. Only one population of *B. corolliflora* was found in this area. This population was one of the largest and most robust. It was located in a remote grassland (steppe) in a rugged area not accessible to livestock, near the ruins of the Aragats Monastery constructed in 1132 AD (Figure 2). Wild beets grow scattered among the ruins; the plants appeared to be typical for *B. corolliflora*. This site was at an elevation of 2160 m.

The limited time spent exploring the area that was considered to be the center of diversity for *Beta* section *Corollinae* presented a cursory overview of the distribution of these taxa. Contrary to our expectations, we were not able to locate many *B. corolliflora* populations in Armenia. Our consensus was that extensive use of the land has led to a considerable genetic erosion of the taxa of section *Corollinae*. However, it should not be concluded that other populations of these taxa do not exist in very remote areas which were not accessible during this exploration due to time limitations and denial of access to specific areas. It is anticipated that, with the location of additional populations, the survival picture may be quite different.

Collection in the Daghestan Region (Republic of Russia)

The Daghestan region is located west of the Caspian Sea and contains parts of the eastern Caucasus Mountains (Figure 3). The topography of Daghestan can be divided into lowlands with rich alluvial soils of clay/loam texture, undulating hills of about 800 m with pastures, grasslands, and small areas of cultivated land, and steeply dissected mountains of 1500-2500 m in elevation. The area between the coast and the mountains was generally cultivated with some vegetable crops, but most recently established as vineyards. The elevation of this coastal plain is close to sea level.

The most suitable habitats for locating wild *Beta* were at higher elevations of the Caucasus Mountains. Two populations of *B. macrorhiza* were found on steep, wet slopes in gravelly soils at elevations above 1200 m (Figure 4). Buttler (1977) reported that this species is found in a specific habitat which is very different from habitats

Figure 2. *Beta corolliflora* (BSF/90-18) (center) in ruins of Aragats Monastery, constructed in 1132 AD, in the Ashtarakskij region of Armenia.

colonized by *B. corolliflora* and *B. lomatogona*. One population of *B. macrorhiza* was scattered over a large area (10,000 m²) of talus within a grassland (steppe). Plants had been grazed but were surviving on the steep slope at an elevation of 1200 m. The plants had good seed set. Another population of *B. macrorhiza* was collected near Duldug along the Chirakhchay River Valley. It occupied areas on a steep talus, as well as along the edge of a small wheat field. Both areas had been heavily grazed. The population was scattered over a 2500 m² area, with plants having good seed set and abundant seeds.

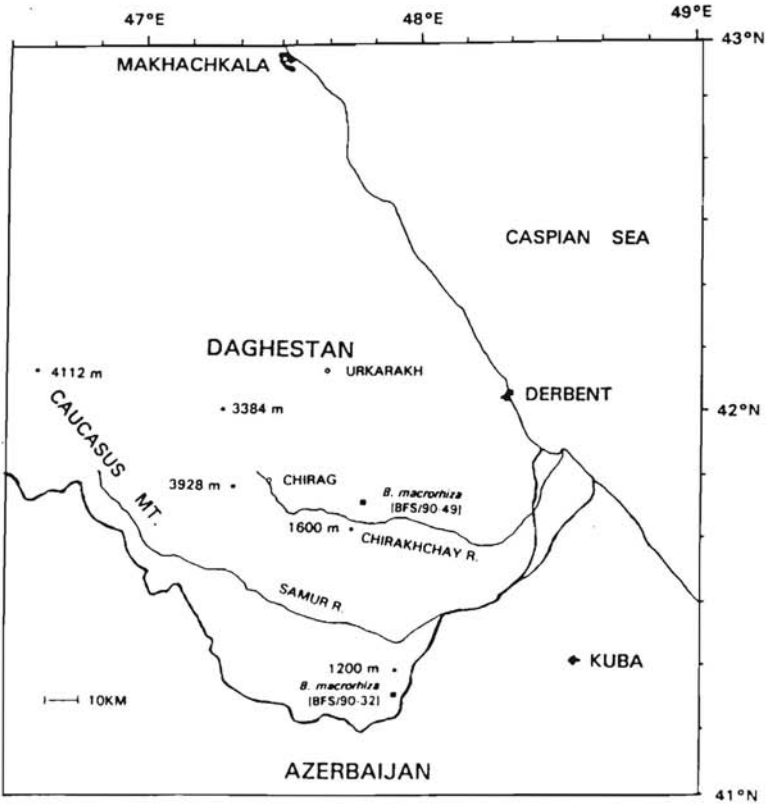

Figure 3. Wild *Beta* exploration collection sites in Daghestan of the former Soviet Union.

The successful location of the limited number of *B. macrorhiza* populations in Daghestan can be attributed to the excellent cooperation with the Derbent Experiment Station, a part of the VIR Institute. Daily excursions were guided by members of the Station who had knowledge of the area and could speak the ethnic dialects of the local

Figure 4. *Beta macrorhiza* (BSF/90-49) in gravelly talus soil in the Agul district of Daghestan, Russia.

villages. This was invaluable since they were able to communicate with local people (especially schoolteachers) who had good knowledge about the local flora. Interaction with local people appears to be essential for explorers from abroad because road maps are outdated and lacking in detail and road signs are scarce. Additional explorations to some remote areas will be necessary to gain a clearer picture concerning the distribution of this species.

Collection in the Kuba Region (Republic of Azerbaijan)

A one-day exploration was undertaken to the eastern side of the Caucasus Mountains in the foothills near Kuba. The topography was much the same as the Daghestan area, with steep rocky slopes which are typical habitats for *B. macrorhiza*. No *B. macrorhiza* populations or other wild *Beta* of section *Corollinae* were located in the limited time spent exploring this area. Several suitable sites could not be reached by vehicle due to the rough terrain and wet roads.

CONCLUSIONS

The present exploration was successful in locating some populations of species of *Beta* section *Corollinae* but did not succeed in expanding our knowledge about their species range. More detailed explorations spending considerably more time in specific areas, many of them remote and limited in access because they are in politically sensitive areas, will be necessary to accomplish this goal. Most of the wild *Beta* populations located in the present exploration were found in locations previously reported in the literature. Future explorations would be greatly aided by access to detailed topographic maps. These maps would allow exploration of potential habitats and expand our knowledge of species ranges. The efficiency of future explorations would be increased by making arrangements for extended stays in remote areas.

Exploration for wild *Beta* in Armenia, Daghestan, and Azerbaijan was difficult due to the mountainous topography and primitive roads. Habitat disturbance was high due to the heavy agricultural pressure, even in remote areas. The exploration proved to be very timely considering the rate of habitat destruction observed in these areas.

Fewer accessions were collected during this exploration than expected. These collections represent the only known wild germplasm of the *Beta* section *Corollinae* to have been collected from the Caucasus Mountain region of the former Soviet Union in over 50 years. These accessions help fill a gap in the wild *Beta* germplasm collection. Evalua-

tion of the collected materials will be needed to determine their potential value. These collections may represent gene pools different from those currently available. The new germplasm may facilitate efforts to improve cultivated sugarbeet by making available new genes from the wild species. The exploration will allow for the preservation of valuable germplasm for future generations. A detailed report of the exploration can be obtained from the senior author.

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LITERATURE CITED

Astley, D. 1992. Preservation of genetic diversity and accession integrity. Field Crops Res. 29:205-224.

Buttler, K. P. 1977. Revision von *Beta* section *Corollinae (Chenopodiaceae)* I. Selbststerile Basisarten. Mitt. Bot. Staatssammlung, München 13:255-336.

Coons, G. H. 1975. Interspecific hybrids between *Beta vulgaris* L. and the wild species of *Beta*. J. Am. Soc. Sugar Beet Technol. 18:281-306.

Krasochkin, V. T. 1959. Review of the species of the genus *(Beta)*. Trudy Prikl. Bot. Genet. Selek. 32:3-36. Technical translation TT-73-52013, Amerind Pub., New Delhi.

Letschert, J. P. W. 1993. *Beta* section *Beta:* biogeographical patterns of variation and taxonomy. Ph.D. Thesis. Wageningen Agric. Univ. Papers 93-1:1-155.

Letschert, J. P. W., W. Lange, L. Frese, and R. G. Van Den Berg. 1994. Taxonomy of *Beta* section *Beta*. J. Sugar Beet Research 31:69-85.

Savitsky, H. 1969. Meiosis in hybrids between *Beta vulgaris* and *Beta corolliflora* and transmission of resistance to curly top virus. Can. J. Genet. Cytol. 11:514-521.

Scheibe, A. 1934. Über die wild Zucherrüben Anatolienc, *Beta lomatogona* F. & M., *B. intermedia* Bunge. und *B. trigyna* W. & K. Angew. Bot. 16:305-349.

Van Geyt, J. P. C., W. Lange, M. Oleo, and T. S. M. DeBock. 1990. Natural variation within the genus *Beta* and its possible use for breeding sugar beet: A review. Euphytica 49:57- 76.

Zossimovitch, V. P. 1940. Wild species and origin of cultivated beets. *In:* Sugar Beet Industry. Vol. I (Biology, Genetics, and Selection of Sugar Beets). Kiev, USSR. pp. 17-89. (Translated by Eugenia Artschwager, April 1943).