Collection of Wild *Beta* Species in Morocco and Spain: Genetic Variation in Collected Plants[1]

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ABSTRACT

Thirty-two accessions of wild *Beta* species (seeds) were collected along the seacoast areas of Morocco, Gran Canaria Island, and the inland and seacoast area near Zaragoza and Tarragona, Spain, from June 25 to July 15, 1990, by T. Masutani and A. Yoshizawa. Passport data of these collections were presented in a previous publication (Masutani and Yoshizawa, 1991). Multiplication, agricultural, and botanical investigations of these collections started in 1992. Genetic variation among the collections was noted in seed morphology, plant type, and 13 isozyme loci.

Additional Key Words: Plant distribution, isozyme loci

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Collection sites were at intervals of at least 20 km. In almost all cases, fully matured seeds were collected. For each collection, notes were recorded on location, site characteristics, morphological and ecological characteristics, growing status, growing stage, and population size. Seed characteristics, morphological characteristics, chromosome number, self compatibility, and isozyme loci of the plants from the original seeds were investigated.

The actual collecting periods between June 25 and July 15, 1990, were three days along the Mediterranean seacoast of Morocco (east of Tanger), five days along the Atlantic seacoast of Morocco, two days in Gran Canaria Island, and two days in Spain proper. Collections included *Beta macrocarpa* and *B. vulgaris* subsp. *maritima.* Most of the populations from Morocco were prostrate and multigerm. Only one multigerm population with erect type was found. No monogerm *Beta* plants were found (Table 1).

Gran Canaria Island was divided into two parts for collecting. The southern part is a flat seacoast and the soil dry. Only monogerm *Beta* plants of the species *B. patellaris* were collected in the southern part. Monogerm populations composed of two or three species *(B. patellaris, B. procumbens,* and/or *B. webbiana)* and prostrate multigerm populations (tetraploid *B. macrocarpa)* were obtained on the northern part of the island, which is higher in altitude and wetter than the southern part. Only erect multigerm populations *(B. vulgaris* subsp. *maritima)* were collected in Spain.

Although almost all *Beta* plants observed were dead or at the end of their growing stage during the exploration, a few populations collected on the Atlantic seacoast of Morocco and at high altitudes of Gran Canaria Island included juvenile plants. Prostrate multigerm *Beta* plants on the seacoast of Morocco and the northern part of Gran Canaria Island were rare.

Seed weight and germ number per seed ball of the collected seeds varied among and within species. Seed weight of the collections from the seacoast of Spain was heavier than those from inland Spain. Isozyme analysis also showed differences between these two groups. Isozyme variation was examined for 16 populations collected from Morocco and Spain. Thirteen loci *(Ak1, Aco1, Aco2, Gdh2, Idh1, Lap, Mdh1, Pgi2, Pgm1, Pgm2, Pgd1, Pgd2, and Skdh2)* were tested, of which *Lap* and *Pgm1* were highly polymorphic both among and within collections. Genetic diversity (He) was 0.66 for Lap and 0.46 for Pgm1. Gst, a measure of the proportion of total variation accounted for by differentiation among collections, ranged from 0.01 for *Pgd2* to 0.76 for *Pgm2,* with an average of 0.40. This Gst was partly due to Collection Number 1 *(B. macrocarpa).* This popula-

Table 1. Description of sites and collections.

No	Site		Growing	Population	Plant	Germ[6]	Seed	Germ	Collecting
	Altitude (m)	Distance[2] (km)	Stage[3]	Size[4]	Posture[5]		Weight (g/100)	No	Area[7]
1	60	20.0	7-9	3	Pros.	Mult	4.17	2.9	Morocco, M.
2	3	0.2	9	30-50	Pros.	Mult	2.55	3.2	Morocco, A.
3	5	1.0	9	30-50	Pros.	Mult	2.73	2.8	Morocco, A.
4	1	0.02	5-6	1	Pros.	Mult	2.20	2.8	Morocco, A.
5	60	10.0	8-9	20-30	Erect	Mult	1.18	2.1	Morocco, A.
6[1]	60	10.0	5-6	Mass	Erect	Mult	3.52	3.3	Morocco, A.
7	50	1.0	8-9	10	Pros.	Mult	1.57	2.5	Morocco, A.
8	90	0.5	5-6	2-3	Pros.	Mult	1.70	2.1	Morocco, A.
9	130	0.5	-	2-3	Pros.	Mult	2.18	2.5	Morocco, A.
10	20	0.1	4-9	20-30	Pros.	Mult	2.32	3.3	Morocco, A.
11	1	0.05	1-9	Mass	Pros.	Mult	1.06	1.7	Morocco, A.
12	118	30.0	7-9	4	Pros.	Mult	1.61	3.8	Morocco, A.
13	123	37.0	7-9	2	Pros.	Mult	0.92	2.0	Morocco, A.
14	10	10.0	9	4	Pros.	Mult	0.89	2.9	Morocco, A.
15	20	10.0	9	-	Pros.	Mult	1.59	3.1	Morocco, A.
16	155	7.0	9	20-30	Pros.	Mono	1.54	1.0	Gran Canaria, N.

[1]Bolting fodderbeet plants to compare with number 5 collected in same neighborhood.
[2]Distance from seacoast.
[3]1 = Young Seedlings, 2 = Vegetative stage, 3 = Reproductive stage, 4 = Flowering stage, 5 = Seed setting, 6 = Mature seed, 7 = End of growth, but leaves still alive, 8 = Plants dead, 9 = Dead and dried up.
[4]Number of plants in a population. Mass = More than 100 plants.
[5]Pros. = Prostrate.
[6]Mult = Multigerm, Mono = Monogerm.
[7]M. = Mediterranean seacoast, A. = Atlantic seacoast, N. = Northern part, S. = Southern part, I. = Inland area near Zaragoza, Mt. = Mediterranean seacoast near Tarragona.

Table 1. (Continued)

No	Site		Growing	Population	Plant	Germ[6]	Seed	Germ	Collecting
	Altitude (m)	Distance[2] (km)	Stage[3]	Size[4]	Posture[5]		Weight (g/100)	No	Area[7]
17	3	0.5	9	50-60	Pros.	Mono	1.30	1.0	Gran Canaria, S.
18	5	0.5	9	Mass	Pros.	Mono	2.02	1.0	Gran Canaria, S.
19	10	0.5	7-9	Mass	Pros.	Mono	1.28	1.0	Gran Canaria, S.
20	3	0.3	9	Mass	Pros.	Mono	1.92	1.0	Gran Canaria, N.
21	312	6.0	9	2-3	Pros.	Mult	2.05	2.8	Gran Canaria, N.
22	312	6.0	9	5-6	Pros.	Mono	0.87	1.0	Gran Canaria, N.
23	230	7.0	9	4	Pros.	Mult	2.05	3.9	Gran Canaria, N.
24	230	7.0	9	Mass	Pros.	Mono	1.65	1.0	Gran Canaria, N.
25	360	0.05	6	3	Pros.	Mono	1.02	1.0	Gran Canaria, N.
26	530	0.01	6	2-3	Pros.	Mono	1.31	1.0	Gran Canaria, N.
27	80	2.0	7	Mass	Erect	Mult	0.69	1.0	Gran Canaria, N.
28	451	176.0	6	4	Erect	Mult	1.51	2.8	Spain, I.
29	430	170.0	6	Mass	Erect	Mult	0.72	2.1	Spain, I.
30	430	163.0	6	50	Erect	Mult	1.53	2.8	Spain, I.
31	2	0.02	6	Mass	Erect	Mult	2.34	3.2	Spain, Mt.
32	50	0.1	6	-	Erect	Mult	2.23	3.3	Spain, Mt.

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tion possessed the alleles *Ak1-2, Gdh2-1, Lap-1, Mdh1-1, Pgm1-4, Pgm2-2,* and *Skdh2-3,* which were not observed or rare in the *B. vulgaris* subsp. *maritima* populations.

Geographical differentiation was recognized between collections from Morocco and those from Spain. The collections from Spain possessed the alleles *Ak1-1* and *Ak1-2,* whereas, those from Morocco had the alleles *Lap-4* and *Lap-5,* but not the alleles *Ak1-1* and *Ak1-2.* In addition, collections from inland areas (Numbers 28 and 30) and those from seacoast areas (Numbers 31 and 32) in Spain differed in allele frequency for *Gdh2* and *Pgm1.*

The differentiation between neighboring populations was also observed in Morocco. Collection number 5, the only erect type in Morocco, was different in the frequency of the alleles *Pgm1-3* and *Skdh2-4* from the populations collected in neighboring seacoast areas (Numbers 2, 3 and 4). These results suggest that genetic differentiation has proceeded not only between different regions but also between neighboring populations in spite of wind pollination. This may be due to genetic drift resulting from small population size and/or phenological topographical isolation.

Average genetic diversity was 0.10 ± 0.04 in Morocco (except number 1) and 0.18 ± 0.06 in Spain. Isozyme diversity in Morocco was lower than that estimated in the other regions (0.13 - 0.28) (Letschert, 1993).

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