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Variations of Several Morphological Characters of *Petunia axillaris* in Uruguay

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Summary

Petunia axillaris seedlings from 102 localities in Uruguay were examined for the range of morphological variations. When three floral characters and seven vegetative characters that are horticulturally important were measured, they varied significantly between the two subspecies *axillaris* and *parodii*, except for plant height and leaf length. Cluster analyses of variations of characters, relative to the population locality, revealed that plant height and width and number of lateral stems segregated into six growth forms: upright, medium, compact, lax, small prostrate, and large prostrate. These growth forms seemed to represent ecotypical groups rather than taxonomical. The relationship between the growth forms and the environment of native habitats are discussed. In addition, we noted the growth forms that have horticultural potentials and their application to breeding.

Key Words: cluster analysis, growth form, *Petunia*, subsp. *axillaris*, subsp. *parodii*.

Introduction

Garden petunias are considered to be progenies of the artificial interspecific hybrid between *Petunia axillaris* (Lam.) Britton, Sterns et Poggenb. (=*P. nyctaginiflora* Juss.) having large white flower in the genus and *P. integrifolia* (Hook.) Schinz et Thell. (=*P. violacea* Lindl.) having medium-sized reddish purple flower (Paxton, 1836; Sink, 1984). *Petunia parodii* Steere and *P. inflata* R. E. Fr. are also suspected to have contributed as the parents (Sink, 1984), but they are now treated as subspecies of *P. axillaris* and *P. integrifolia*, respectively (Cabrera, 1977; Wijsman, 1982).

Petunia axillaris was initially collected in Uruguay (Montevideo) by Philibert de Commerson, a French plant hunter (Lamarck, 1793). The first collecting record of *P. integrifolia* was also in Río Negro, Uruguay by James Baird (Hooker, 1831). Just after the introduction of *P. integrifolia* into England, artificial hybrids between the two species were recorded and on sale at almost every nursery around London (Paxton, 1836). Therefore, Uruguay may be the most important country to seek the origin of parental species of garden petunias.

In *Petunia axillaris*, three geographical subspecies, subsp. *axillaris*, subsp. *parodii* (Steere) Cabrera, and subsp. *subandina* T. Ando are currently recognized (Ando, 1996). We studied the distribution of *P. axillaris* in Uruguay by using discriminant functions, obtained by the morphological characters of vegetative and floral organs, and concluded that the two subspecies occur separately in Uruguay. Subsp. *axillaris* occurs south of the Río Negro which flows through Uruguay from northeast to southwest; subsp. *parodii* occurs north of the river (Ando et al., 1994, 1995). In a detailed study, the occurrence of intermediate forms between the two subspecies along the Río Negro and the other regions was also examined (Kokubun et al., 1997).

To calculate the discriminant functions, a few characters as possible were chosen to distinguish most efficiently the two subspecies from each other. Thus, several other characters with less taxonomical importance, such as plant height and width, leaf shape, and corolla lobe shape and thickness were eliminated, although of horticultural value, because they did not contribute to the discrimination process. Classifying wild populations according to some of these characters give an opportunity to explore horticulturally important traits such as large corolla and different growth habits. In this paper, we focused on those horticultural characters, and examined the range of variations prevailing in the Uruguayan native *Petunia axillaris* and its relationship with the infraspecific classification and the environment of native habitats.

Materials and Methods

Plant material

Seeds were collected randomly from wild populations from 1988 to 1992 in a total of 102 localities in Uruguay. Only the abbreviations of the collections will be referred to in this study. For a full description of

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localities, see Appendix 2 in Ando et al. (1994) and Appendix 2 in Kokubun et al. (1997).

The infraspecific status of each population was determined according to Kokubun et al. (1997), in which four infraspecific groups were classified by discriminant functions obtained by the several floral characters of live plants; subsp. *axillaris*, subsp. *parodii*, intermediate form closer to subsp. *axillaris* (intermediate A), and intermediate form closer to subsp. *parodii* (intermediate P). In all maps presented here, this infraspecific status is illustrated.

The seeds were germinated in January 1993 in a growth chamber at 25 ℃ under constant light from cool-white fluorescent lamps. After germination, they were transferred to an unheated, unshaded glass greenhouse and grown by the standard technique for garden petunias. At least 10 individual plants from respective localities were eventually transplanted to 13.5 cm plastic pots filled with a mixture of loam: composted wood bark: perlite (7: 2: 1, v/v/v). The pots were placed on a wire mesh bench at 30 x 36 cm spacing. Plants that began to spread were rearranged so that their growth was not hindered.

Floral character measurement

Three morphological characters of the trumpet-like flowers of horticultural importance, corolla limb diameter (corolla diameter), corolla lobe tip angle (tip angle), corolla lobe thickness (corolla thickness), were measured at full anthesis. To calculate the mean value of each character for a given locality, one flower was selected from each individual and a total of 10 flowers per locality were measured.

The corolla thickness was measured with a digital caliper from a fresh flower. To prepare the flowers for the tip angle measurement, the corolla tube was excised, the remaining corolla limb was carefully flattend on paper with the top lobe clearly marked, and pressed in a herbarium press. When the corolla became dry, the tip angle was measured by drawing two lines from the tip of the top lobe tangential to both shoulders of that lobe (Fig. 1).

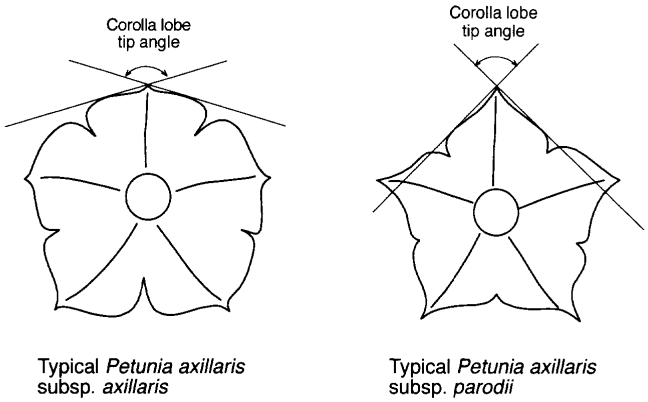

Fig. 1. Typical corolla shape and diameter of *Petunia axillaris* subsp. *axillaris* and subsp. *parodii*, with the definition of corolla lobe tip angle.

Vegetative character measurements

The longest leaf on the main axis, its length, width, and thickness of the leaf blade on each individual were measured at anthesis of the first flower, whether the flower was on the main axis or a lateral branch.

Simultaneously, plant height, plant width, number of lateral branches more than 50 mm long, and the number of days elapsed from seed sowing to anthesis of the first flower were measured. Only the plant height and the width were measured; the plant width/height ratio was calculated to quantify the growth form.

Analysis of variance

Analysis of variance (ANOVA) was performed using the ONEWAY procedure of the SPSS statistics program package (SPSS, Inc.) to compare mean values of each character among the two subspecies and of two intermediates, A and P. When a significant difference was detected, Scheffe's multiple range test was used to compare the means among the infraspecific taxa.

Another ANOVA was performed after cluster analyses described below were made. It compared values of characters used in the cluster analysis among the major clusters detected. Scheffe's multiple range test was also employed.

Cluster analysis

The growth forms of all populations were classified according to cluster analysis of three most relevant vegetative characters that affect the growth form: plant height, plant width, and number of lateral branches at anthesis of the first flower. The analysis was carried out with the CLUSTER procedure of the SPSS statistics program package (SPSS, Inc.). The matrix was calculated using squared Euclid's distance and the amalgamation method by UPGMA.

Because the scale of the number of lateral branches was different from the others, all three characters were standardized to make the average 0.0 and the standard deviation 1.0 before the cluster analysis.

Results

Table 1 lists the mean values of all characters measured for each population with the classification of infraspecific taxa according to Kokubun et al. (1997) for a subsequent closer examination of the data.

Floral characters

When the infraspecific classification of the two subspecies (A and P in Table 1) and two intermediate forms (MA and MP in Table 1) was used as a factor (Table 2), the ANOVA revealed that all floral characters were significantly different among the infraspecific classifications with the F probability lower than 0.1%. All floral characters were significantly different between subsp. *axillaris* and subsp. *parodii* by Scheffe's multiple range

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Table 1. Measurements of floral and vegetative characters of *Petunia axillaris* occurring in Uruguay and classification by discriminant and cluster analyses.

Locality (Poulation code)	Classification after Kokubun et al. (1997)	Corolla limb diameter (mm)	Corolla limb thickness (mm)	Corolla lobe tip angle (degree)	Leaf length (mm)	Leaf width (mm)	Leaf thickness (mm)	Plant height (mm)	Plant width (mm)	Ratio width /height	Number of branches	Days to flower	Group by cluster analysis
Artigas													
U27	P[z]	43.0	0.05	117	78.0	25.0	0.62	270	228	0.8	3.5	115	medium
U28	P	44.8	0.05	118	78.0	20.0	0.45	121	506	4.2	4.0	133	large prostrate
U31	P	46.9	0.05	113	83.1	26.8	0.56	244	344	1.4	4.7	118	medium
U32	P	54.1	0.05	111	93.2	28.9	0.55	429	210	0.5	2.3	118	upright
U34	P	51.5	0.06	115	96.7	25.2	0.56	390	260	0.7	3.0	121	upright
U35	P	49.5	0.05	103	70.5	25.5	0.46	311	263	0.9	1.8	122	medium
U37	P	48.4	0.05	116	89.2	20.8	0.48	386	424	1.1	3.9	122	lax
U38	P	39.8	0.06	112	87.9	23.8	0.59	326	222	0.7	3.9	115	medium
U217	P	49.4	0.05	112	74.5	21.3	0.50	405	166	0.4	1.6	121	upright
U220	P	48.1	0.05	121	61.6	22.1	0.58	41	603	14.8	6.7	147	large prostrate
Canelones													
U175	A	52.1	0.09	149	83.7	19.7	0.65	332	152	0.5	0.3	124	upright
U242	A	55.0	0.09	136	76.1	19.4	0.66	312	210	0.7	2.2	128	medium
Cerro Largo													
U55	A	50.4	0.06	157	78.8	22.9	0.61	369	158	0.4	0.2	116	upright
U258	A	43.5	0.06	143	85.3	21.0	0.61	149	429	2.9	6.9	143	large prostrate
Colonia													
U90	A	47.2	0.07	141	91.3	20.8	0.61	413	172	0.4	2.8	118	upright
U91	A	50.0	0.08	144	89.8	26.0	0.58	433	159	0.4	1.3	116	upright
U92	A	50.4	0.08	141	91.2	25.3	0.64	338	168	0.5	0.8	119	upright
U93	A	50.0	0.08	137	93.6	23.0	0.64	370	173	0.5	0.7	122	upright
U98	A	48.1	0.08	147	83.0	21.9	0.62	366	167	0.5	2.0	120	upright
U99	MA	47.9	0.08	150	83.1	18.6	0.67	323	152	0.5	0.9	119	upright
U100	MA	49.1	0.07	151	87.0	24.0	0.66	391	163	0.4	2.0	126	upright
U101	A	53.3	0.09	144	87.8	22.0	0.56	331	197	0.6	1.2	125	upright
U102	MA	46.7	0.08	141	91.0	18.4	0.53	341	181	0.5	2.4	126	upright
U108	A	45.8	0.08	155	91.0	18.1	0.76	230	210	0.9	1.4	127	medium
U173	P	46.3	0.06	128	75.7	21.3	0.62	213	228	1.1	3.4	116	medium
U199	A	44.9	0.08	150	95.3	21.0	0.56	402	223	0.6	1.6	128	upright
U200	MA	48.9	0.06	129	89.8	23.0	0.56	254	230	0.9	2.4	119	medium
Durazno													
U5	MA	50.7	0.08	148	91.4	22.3	0.60	415	175	0.4	0.3	123	upright
U159	P	46.5	0.06	128	92.9	24.1	0.56	265	249	0.9	2.8	116	medium
Florida													
U2	A	50.2	0.07	138	74.1	17.8	0.61	271	276	1.0	3.6	130	medium
U3	A	45.3	0.06	150	70.9	14.6	0.65	153	305	2.0	6.1	128	small prostrate
U110	A	46.0	0.08	159	74.4	19.6	0.57	205	289	1.4	2.9	128	medium
U113	A	46.1	0.08	149	61.4	19.6	0.65	222	255	1.2	3.0	129	medium
Flores													
U240	MA	40.6	0.06	155	57.0	12.3	0.57	109	513	4.7	6.0	140	large prostrate

test (Table 2). The flowers were large with thick limb and a wide tip angle in subsp. *axillaris*, whereas the flowers were small with thin limb and a narrow tip angle in subsp. *parodii*.

Fig. 2 shows the distribution of schematic corolla shapes of plants from each locality; the shape and size of the symbols approximate the frontal view of an actual corolla. The shape of the symbols represents the tip angle, which segregated into four classes, represented by four different shapes on the map. The maximum tip angle was 172 ° with the population code U152 (subsp. *axillaris*, Maldonado), and the minimum angle was 103 ° in U35 (subsp. *parodii*, Artigas).

Although the size of the symbols in Fig. 2 is proportional to the corolla diameter, the diameter is presented again in Fig. 3 in a more uniform way to facilitate the visual comparison of diameters. The maximum corolla diameter was 55.6 mm in U25 (subsp. *axillaris*, San

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Table 1. (continued)

Lavalleja													
U49	A	50.2	0.08	148	89.5	22.3	0.62	393	193	0.5	1.0	124	upright
U58	A	41.3	0.06	127	52.6	8.2	0.48	94	271	2.9	6.6	132	small prostrate
U76	A	48.4	0.07	145	90.0	16.2	0.47	262	290	1.1	1.0	127	medium
U79	A	49.4	0.08	145	84.4	17.9	0.69	267	260	1.0	3.3	123	medium
U80	A	48.9	0.07	145	89.8	20.8	0.62	344	201	0.6	1.0	135	upright
U83	A	44.7	0.08	144	87.3	21.3	0.67	304	247	0.8	4.7	119	medium
U141	A	48.1	0.08	147	85.3	22.7	0.63	244	196	0.8	2.0	124	medium
U143	A	48.6	0.08	142	90.9	22.5	0.62	289	189	0.7	0.8	118	medium
U147	A	48.6	0.08	155	77.6	17.2	0.59	236	244	1.0	1.9	126	medium
U204	A	50.6	0.08	146	83.4	20.9	0.58	370	178	0.5	0.9	123	upright
U253	A	49.6	0.09	148	78.1	21.8	0.68	297	164	0.6	2.2	121	medium
Maldonado													
U61	A	51.9	0.08	148	80.9	18.0	0.67	241	277	1.2	2.4	129	medium
U63	A	52.4	0.09	144	88.0	22.1	0.65	312	174	0.6	0.7	130	upright
U65	A	50.6	0.09	150	81.2	20.4	0.66	224	328	1.5	3.5	132	medium
U151	A	50.9	0.10	156	82.0	16.4	0.91	201	305	1.5	2.8	136	medium
U152	A	48.9	0.10	171	64.5	17.6	1.00	72	155	2.2	5.1	132	compact
U177	A	54.2	0.10	153	66.2	19.2	0.91	106	170	1.6	1.4	122	compact
U178	A	54.0	0.10	163	67.2	19.6	0.82	169	143	0.9	1.0	125	compact
U245	A	47.9	0.09	151	76.3	18.4	0.65	320	173	0.5	0.9	130	upright
Montevide													
U1	A	51.4	0.07	149	82.2	23.8	0.66	327	173	0.5	0.8	114	upright
U157	A	47.7	0.09	149	86.9	22.3	0.67	291	212	0.7	2.5	122	medium
Paysandú													
U124	P	45.0	0.06	120	74.3	20.8	0.56	271	188	0.7	3.0	123	medium
U126	P	47.7	0.05	115	72.4	21.0	0.65	224	211	0.9	3.4	116	medium
U195	P	42.2	0.05	127	86.0	23.7	0.49	284	222	0.8	2.6	129	medium
U197	P	42.6	0.06	118	83.5	21.0	0.52	162	383	2.4	5.8	131	large prostrate
U198	P	47.0	0.05	116	75.6	25.8	0.50	170	286	1.7	5.6	131	medium
U238	MP	45.6	0.05	114	84.4	25.2	0.55	162	357	2.2	3.6	119	large prostrate
U267	P	45.5	0.05	123	75.4	26.4	0.54	72	659	9.2	4.7	139	large prostrate
Río Negro													
U162	MP	49.7	0.06	120	90.3	33.5	0.52	366	210	0.6	1.4	111	upright
U163	MP	48.9	0.06	120	86.0	25.7	0.53	339	266	0.8	2.0	117	medium
U262	A	52.1	0.07	124	82.0	19.8	0.63	394	169	0.4	1.4	122	upright
Rocha													
U67	A	51.4	0.09	146	77.2	19.8	0.83	286	147	0.5	0.3	119	upright
U68	A	53.3	0.08	158	65.3	19.3	0.93	57	399	7.0	4.3	132	large prostrate
U71	A	51.3	0.08	143	86.0	24.0	0.56	209	231	1.1	1.7	128	medium
U73	A	47.7	0.08	148	82.9	20.3	0.64	367	154	0.4	1.3	120	upright
U156	A	49.9	0.08	155	84.3	21.0	0.61	267	259	1.0	3.2	127	medium
U179	A	52.0	0.09	148	79.7	22.8	0.63	316	204	0.6	1.3	129	medium
U181	A	49.1	0.08	144	92.1	20.7	0.63	355	234	0.7	2.2	121	upright
U182	A	49.3	0.09	146	83.8	18.8	0.64	287	237	0.8	2.7	127	medium
U183	A	49.0	0.09	159	79.6	19.2	0.63	254	208	0.8	1.6	126	medium
U184	A	51.3	0.09	148	77.2	21.6	0.70	265	141	0.5	0.5	120	upright
U185	A	48.0	0.09	139	78.9	21.3	0.56	310	237	0.8	2.3	121	medium
Salto													
U26	P	45.0	0.04	124	89.6	23.4	0.42	280	338	1.2	2.8	122	medium
U224	P	46.8	0.05	125	68.2	23.3	0.56	297	229	0.8	1.6	122	medium
U225	P	46.1	0.05	109	71.1	22.0	0.54	280	192	0.7	2.5	120	medium
U228	P	44.2	0.06	113	78.4	17.4	0.44	284	346	1.2	4.7	142	medium
U232	P	42.4	0.05	124	73.3	24.2	0.51	157	392	2.5	3.4	124	large prostrate
U271	P	47.2	0.06	111	68.3	18.2	0.54	83	563	6.8	6.7	142	large prostrate

José); the minimum diameter was 39.5 mm in U105 and U169 (intermediate A, Soriano).

The height of symbols in Fig. 3 represents the corolla thickness; the maximum corolla thickness was 0.10 mm in U151 (subsp. *axillaris*, Maldonado), and the minimum thickness was 0.04 mm in U26 (subsp. *parodii*, Salto).

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Table 1. (continued)

San José													
U25	A	55.6	0.08	135	95.3	20.3	0.56	410	224	0.6	2.3	128	upright
U85	A	47.8	0.07	143	81.3	20.5	0.63	248	196	0.8	4.8	119	medium
U87	A	50.8	0.08	156	81.5	19.5	0.63	330	154	0.5	0.5	126	upright
U88	A	52.1	0.08	149	90.0	22.2	0.63	387	154	0.4	0.5	126	upright
U89	A	46.4	0.08	147	86.8	20.3	0.58	276	227	0.8	1.8	121	medium
U96	A	50.6	0.08	158	94.7	23.9	0.56	482	162	0.3	0.2	125	upright
U97	A	50.2	0.07	150	79.7	21.0	0.65	397	172	0.4	1.7	121	upright
U174	A	47.2	0.07	143	68.4	19.4	0.67	182	313	1.7	3.8	122	medium
Soriano													
U104	MA	42.0	0.06	126	79.0	18.4	0.57	162	327	2.0	5.8	122	small prostrate
U105	MA	39.5	0.07	164	64.2	16.7	0.56	131	266	2.0	6.3	121	small prostrate
U166	MP	44.1	0.05	118	88.5	24.9	0.61	285	260	0.9	3.1	109	medium
U169	MA	39.5	0.06	132	63.7	15.0	0.69	174	287	1.7	5.5	124	small prostrate
U170	MA	40.2	0.06	124	62.3	14.5	0.84	130	351	2.7	8.0	125	small prostrate
U171	MA	40.4	0.07	142	57.0	14.2	0.70	106	413	3.9	9.6	125	small prostrate
U201	A	49.5	0.08	142	91.7	22.9	0.62	405	206	0.5	1.7	117	upright
Tacuarembó													
U19	P	43.1	0.06	116	101.5	26.3	0.53	298	292	1.0	3.3	140	medium
U20	P	48.6	0.05	116	90.5	24.2	0.48	376	232	0.6	2.0	118	upright
U121	MP	46.1	0.05	128	85.0	25.6	0.73	173	253	1.5	3.3	127	medium
Treinta y Tres													
U187	A	47.2	0.08	143	74.5	20.1	0.53	384	127	0.3	0.0	125	upright
U188	MA	49.6	0.06	139	75.5	20.0	0.58	170	239	1.4	4.7	120	medium

[z] A: subsp. *axillaris*
P: subsp. *parodii*
MA: intermediate close to subsp. *axillaris*
MP: intermediate close to subsp. *parodii*

Table 2. Floral character measurements of *Petunia axillaris* subsp. *axillaris*, subsp. *parodii*, and their intermediate forms.

Taxon[z]	Number of localities	Corolla limb diameter (mm)			Corolla lobe thickness (mm)			Corolla lobe tip angle (degree)		
		Mean	SD[y]	CV[x]	Mean	SD	CV	Mean	SD	CV
Petunia axillaris subsp. *axillaris*	59	49.5	2.77	0.06 a*	0.080	0.009	0.12 a	147	7.85	0.05 a
Intermediate A	12	44.6	4.36	0.10 b	0.067	0.008	0.12 b	142	11.9	0.08 a
Intermediate P	5	46.9	2.10	0.04 ab	0.055	0.006	0.10 bc	120	4.52	0.04 b
Petunia axillaris subsp. *parodii*	26	46.2	3.06	0.07 b	0.052	0.005	0.10 c	117	6.16	0.05 b
All	102	47.9	3.59	0.07	0.070	0.015	0.21	138	15.6	0.11

[z] Determination of subspecies and intermediates after Kokubun et al.(1997), intermediate A: the intermediate from closer to subsp. *axillaris*, intermediate P: intermediate form closer to subsp. *parodii*.
[y] Standard deviation, square root[Σ (value - mean)^2/(n - 1)].
[x] Coefficent of variation, SD/mean.
* Mean separation by Scheffe's multiple range test(P=0.05). No significant difference between groups with a same letter.

Leaf characters

The leaf length had small CV values (less than 0.18) and was not significantly different among subspecies and intermediate forms, but the leaf was significantly narrow and thick in subsp. *axillaris* and was wide and

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thin in subsp. *parodii* (Table 3).

Leaf characters of the plants from respective localities, e.g., leaf thickness of the longest leaf on each plant and its width are represented as symbols in Fig. 4. Therefore, these symbols may be regarded as schematic cross sections of the leaves. The maximum leaf width was 34 mm in U162 (intermediate P, Río Negro), the minimum width was 8 mm in U58 (subsp. *axillaris*, Lavalleja), the maximum leaf thickness was 1.00 mm in U152 (subsp. *axillaris*, Maldonado), and the minimum thickness was 0.42 mm in U26 (subsp. *parodii*, Salto).

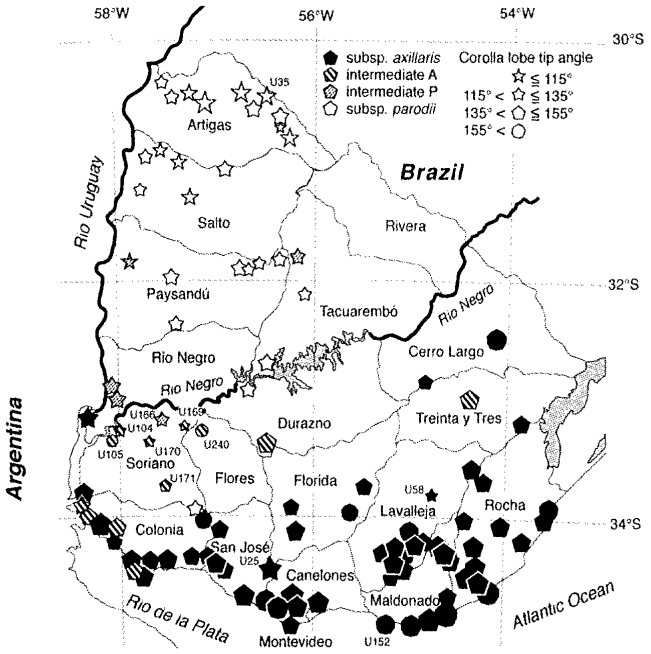

Fig. 2. Morphological variations in corolla limb shapes within *Petunia axillaris* in Uruguay. The size of symbols represents the corolla limb diameter and the shape represents corolla lobe tip angle of which there are 4 classes. Determination of subspecies and intermediates is after Kokubun et al. (1997), intermediate A: the intermediate form close to subsp. *axillaris*, intermediate P: the intermediate form close to subsp. *parodii*.

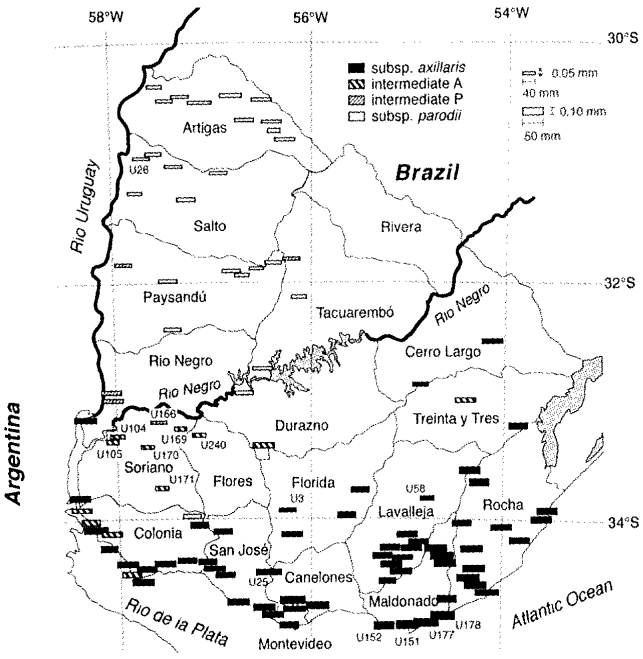

Fig. 3. Corolla limb diameter and lobe thickness of *Petunia axillaris* in Uruguay. The width of symbols represents the corolla limb diameter and their height the corolla limb thickness. Determination of subspecies and intermediates is after Kokubun et al. (1997), intermediate A: the intermediate form close to subsp. *axillaris*, intermediate P: the intermediate form close to subsp. *parodii*.

Table 3. Leaf character measurements of *Petunia axillaris* subsp. *axillaris*, subsp. *parodii*, and their intermediate forms.

Taxon[z]	Number of localities	Leaf blabe length (mm) of the longest leaf			Leaf blabe width (mm) of the longest leaf			Leaf blabe thickness (mm) of the longest leaf		
		Mean	SD[y]	CV[x]	Mean	SD	CV	Mean	SD	CV
Petunia axillaris subsp. *axillaris*	59	81.8	9.0	0.11	20.4	2.69	0.13 a*	0.65	0.10	0.15 a
Intermediate A	12	75.1	13.6	0.18	18.1	3.58	0.20 a	0.63	0.08	0.13 a
Intermediate P	5	86.8	2.5	0.03	27.0	3.27	0.12 b	0.59	0.08	0.13 ab
Petunia axillaris subsp. *parodii*	26	80.4	10.0	0.12	23.2	2.69	0.12 b	0.53	0.06	0.11 b
All	102	80.9	9.9	0.12	21.1	3.51	0.17	0.61	0.10	0.17

[z] Determination of subspecies and intermediates after Kokubun et al.(1997), intermediate A: the intermediate from closer to subsp. *axillaris*, intermediate P: intermediate from closer to subsp. *parodii*.

[y] Standard deviation, square root[Σ (value - mean)^2/(n - 1)].

[x] Coefficent of variation, SD/mean.

* Mean separation by Scheffe's multiple range test(P=0.05). No significant difference between groups with a same letter. Note that this analysis was not done for the leaf length because there was no significant differences among the taxa by F-test.

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Plant characters

The ANOVA of vegetative characters of the above plants, using the infraspecific classification (two subspecies and two intermediates) as factor, revealed that all characters, except for plant height, were significantly different with the F probability less than 0.1% (Table 4). The plant width, plant width / height ratio, and the number of lateral branches were significantly different between subsp. *axillaris* and subsp. *parodii* by Scheffe's multiple range test; the plant was narrow and had fewer lateral branches in subsp. *axillaris*, whereas it was wide and had more lateral branches in subsp. *parodii*. However, the days to anthesis did not differ between them.

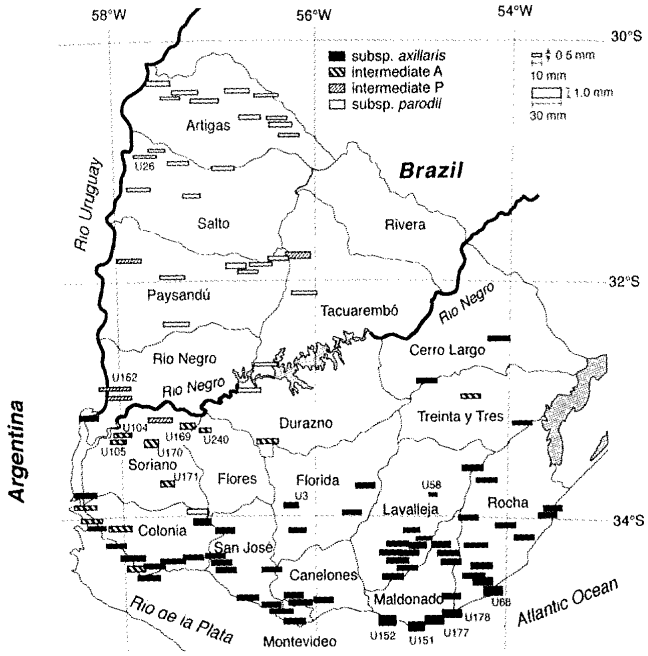

Fig. 4. Morphological variation of leaf characters of *Petunia axillaris* in Uruguay. The height of symbols represents leaf thickness of the longest leaf, whereas its width represents relative width of the same leaf. Determination of subspecies and intermediates is after Kokubun et al. (1997), intermediate A: the intermediate form close to subsp. *axillaris*, intermediate P: the intermediate form close to subsp. *parodii*.

The schematic growth forms that represent plant height and width for each locality are represented as symbols on the map in Fig. 5. The plant heights and widths were recorded at anthesis of the first flower. The maximum plant height was 482 mm in U96 (subsp. *axillaris*, San Joseé), the minimum height was 41 mm in U220 (subsp. *parodii*, Artigas), the maximum plant width was 659 mm in U267 (subsp. *parodii*, Paysandú), and the minimum width was 127 mm in U187 (subsp. *axillaris*, Treinta y Tres).

Growth forms

The dendrogram derived from cluster analysis of plant height and width and number of lateral branches that influence growth form shows that the *Petunia axillaris* populations in Uruguay can be classified into major clusters from one to six (Fig. 6). Out of 102 populations, 81 were classified into either cluster 1 (36 populations) or cluster 2 (45 populations) as the dominant growth forms in Uruguay, while the small clusters 3 to 6 have different growth characteristics.

Comparison of the three plant characters among the

Table 4. Vegetative character measurements of *Petunia axillaris* subsp. *axillaris*, subsp. *parodii*, and their intermediate forms.

Taxon[z]	Number of localities	Plant height (mm) at the anthesis of the first flower			Plant width (mm) at the anthesis of the first flower			Ratio plant width /plant height			Number of lateral branches more than 50 mm long			Days from sowing to anthesis of the first flower		
		Mean	SD[y]	CV[x]	Mean	SD	CV	Mean	SD	CV	Mean	SD	CV	Mean	SD	CV
Petunia axillaris subsp. *axillaris*	59	290	92	0.32	214	62	0.29 b*	1.05	1.03	0.97 b	1.1	1.0	0.97 b	125	5.5	0.04 a
Intermediate A	12	225	109	0.48	275	106	0.38 ab	1.82	1.48	0.81 ab	2.6	2.1	0.81 a	122	3.0	0.02 ab
Intermediate P	5	265	84	0.32	269	48	0.18 ab	1.41	0.90	0.64 ab	1.5	0.5	0.30 b	116	7.1	0.06 b
Petunia axillaris subsp. *parodii*	26	255	102	0.40	317	133	0.42 a	2.53	3.65	1.44 a	1.9	0.9	0.50 a	123	7.5	0.06 ab
All	102	272	100	0.37	250	101	0.40	1.54	2.14	1.39	1.5	1.3	0.86	123	6.2	0.05

[z] Determination of subspecies and intermediates after Kokubun et al.(1997), intermediate A: the intermediate form closer to subsp. *axillaris*, intermediate P: intermediate form closer to subsp. *parodii*.

[y] Standard deviation, square root[Σ (value − mean)^2/(n − 1)].

[x] Coefficent of variation, SD/mean.

* Mean separation by Scheffe's multiple range test(P=0.05). No significant difference between groups with a same letter. Note that this analysis was not done for the plant height because there was no significant differences among the taxa by F-test.

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above six clusters by Scheffe's multiple range test revealed that all three characters were significantly different between clusters 1 and 2, clusters 1 and 5, and clusters 1 and 6 (Table 5).

By comparing the mean values in each cluster derived by cluster analysis and visual inspection of live plants, we labeled the growth forms for the respective clusters 1 to 6 as upright, medium, compact, lax, small prostrate, and large prostrate.

The results of the cluster analysis for each population with their names are listed in Table 1 and it is shown on the map in Fig. 7.

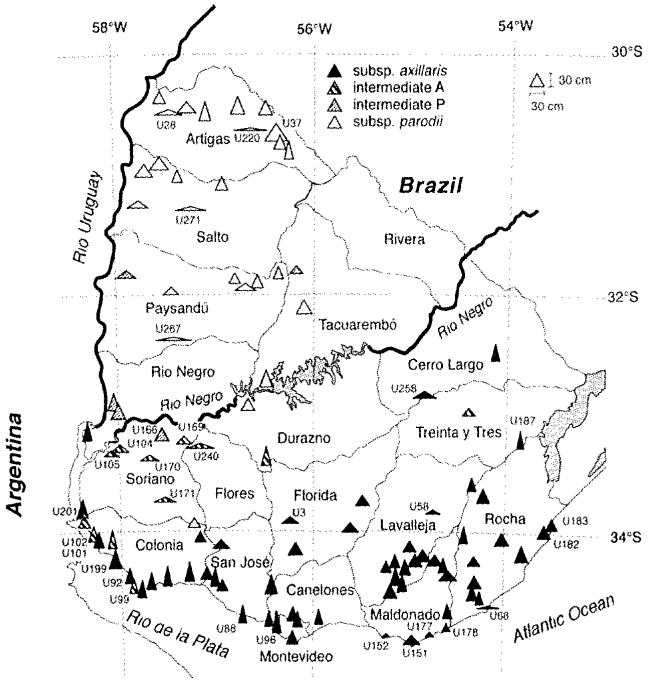

Fig. 5. Schematic growth form of *Petunia axillaris* in Uruguay. The height of symbols represents the plant height at the anthesis of the first flower, whereas the width of symbols represents the relative width of the plant. Determination of subspecies and intermediates is after Kokubun et al. (1997), intermediate A: the intermediate form close to subsp. *axillaris*, intermediate P: the intermediate form close to subsp. *parodii*.

Cluster 1: upright form

Members of cluster 1 with 36 populations are characterized by their tallness, the mean plant height being 367 mm, is second to plants in cluster 4 with a mean height of 386 mm in one population (Table 5). The plants, although upright and tall, are narrow, the mean width being only 179 mm, and have the smallest number of lateral branches per plant (0.4). Because of their erect, strong main axis with few lateral branches, they are classified as an upright form.

Cluster 2: medium form

This cluster with 45 populations is characterized by the medium values of the three characters. The plant height was significantly smaller than the cluster 1 (upright form), smaller than the cluster 4 (lax) but without statistical significance, and significantly larger than the remaining clusters (Table 5). The mean plant width of 248 mm is larger than those of clusters 1 and 3 with width of 179 and 156 mm, respectively. The number of lateral branches in this cluster is 1.6, which is significantly larger than those of cluster 1 (upright form) and 3 (compact form), but was significantly smaller than those of the clusters 5 (small prostrate form) and 6 (large prostrate form).

Cluster 3: compact form

This cluster is characterized by its significantly small plant height, being shorter than the upright and medium forms. Its plant width is narrower than those of clusters 4, 5, and 6 (lax, small prostrate, and large prostrate forms, respectively) (Table 5). The number of lateral branches was equal to that of clusters 1 and 4 (upright and lax forms) but significantly smaller than those of clusters 2, 5 and 6 (medium, small prostrate, and large prostrate forms). The growth form resembles that of modern *Petunia* cultivars, therefore we called it compact.

Table 5. Comparison of plant height, plant width, and number of lateral branches by groups assigned by cluster analysis.

Cluster	Growth form	Number of localities	Plant height (mm)			Plant width (mm)			Number of lateral brancges		
			Mean	SD[z]	MS[y]	Mean	SD	MS	Mean	SD	MS
1	upright	36	367	43.9	a	179	29.6	d	0.4	0.35	d
2	medium	45	260	43.0	b	248	44.2	c	1.6	0.68	c
3	compact	3	116	49.2	c	156	13.5	cd	0.6	0.59	d
4	lax	1	386	-[x]	ab	424	-	b	2.4	-	abcd
5	small prostrate	7	136	29.3	c	317	52.0	b	4.5	0.89	ab
6	large prostrate	10	111	45.9	c	480	104	a	3.0	0.81	b
	Total	102	273	99.7		250	101		1.5	1.3	

[z] Standard deviation, square root[Σ (value - mean)^2/(n - 1)].

[y] Mean separation, no significant difference between same letter by Scheffe's multiple range test(P=0.05).

[x] SD cannot be calculated because there is only one case in this cluster.

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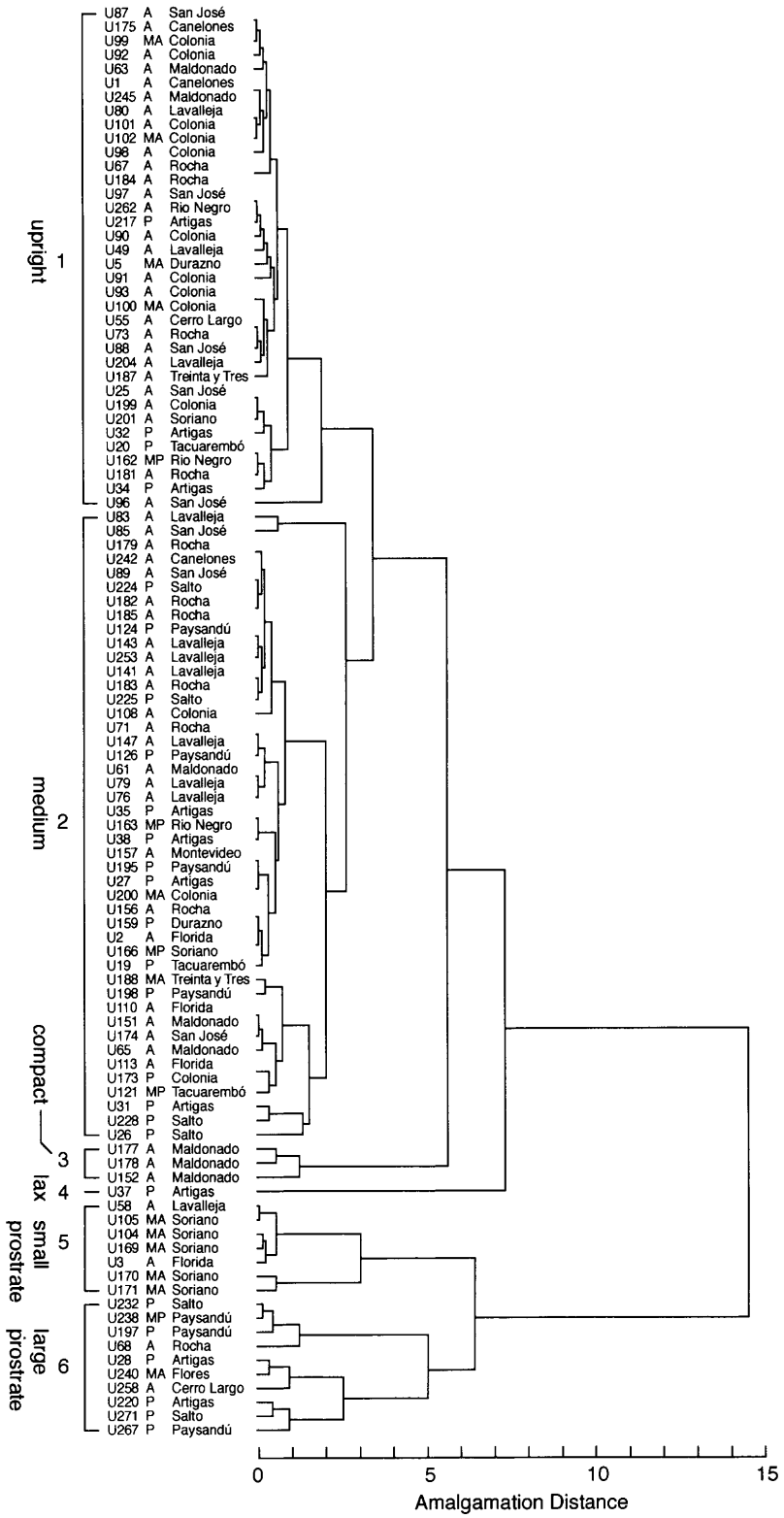

Fig. 6. Dendrogram produced by the cluster analysis of plant height, plant width, and number of lateral branches. Squared Euclid's distance was used to calculate distance matrix, and UPGMA was used to calculate amalgamation schedule. The amalgamation distance of less than 1.0 is not drawn to the scale. The numbers to the left of the figure are major clusters designated as growth form groups. Each population is represented by herbarium code, infraspecific taxon as determined in Kokubun et al. (1997), and the name of department. Infraspecific taxa: A = subsp. *axillaris*, P = subsp. *parodii*, MA = intermediate close to subsp. *axillaris*, MP = intermediate close to subsp. *parodii*.

Cluster 4: lax form

Members of this cluster are characterized by their large size in height, width, and medium number of lateral branches. The term "lax" fit this form (Table 5).

Cluster 5: small prostrate form

Members of this cluster as well as cluster 6 (large

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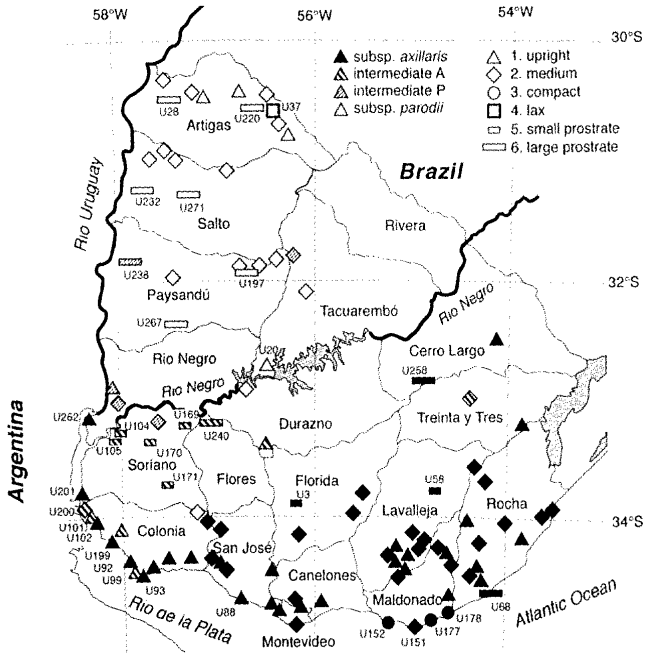

Fig. 7. Growth form of *Petunia axillaris* in Uruguay as determined by cluster analysis of plant height and width, and the number of lateral branches. Six symbols represent the major cluster detected in Fig. 6. Determination of subspecies and intermediates is after Kokubun et al. (1997), intermediate A: the intermediate form close to subsp. *axillaris*, intermediate P: the intermediate form close to subsp. *parodii*.

prostrate form) have a short main axis so that they are significantly short, compared with clusters 1 and 2 (upright and medium forms). Plants in clusters 5 and 6 have significantly large numbers of lateral branches, as compared with those of clusters 1 to 3 (upright, medium and compact forms). The lateral branches are somewhat prostrate and relatively short. The branches start to grow horizontally and remain so, or rise slightly as they elongate. This lateral branching habit results in intermediate plant width.

Cluster 6: large prostrate form

The plant height and number of lateral branches in this cluster are similar to those of cluster 5 (small prostrate form), but the plant width is significantly greater than that of cluster 5. The main axis resembles that of cluster 5, but lateral branches grow horizontally far beyond the edge of the pots and could cover a large area.

Discussion

Stability and variability of characters

The stability of the morphological characters measured in this study needs to be addressed. Although our data were collected in a single growing season, we have grown some of these plants repeatedly in different years. In every year these morphological characters seemed reasonably stable, especially for the growth forms, such as the compact and large prostrate (Fig. 7). Therefore, we are confident that these morphological traits are genetically stable and reproducible.

Most floral characters had CV values lower than or equal to 0.1, that is, they were consistent within the 4 infraspecific classifications (Table 2). Corolla lobe thickness was an exception with a relatively high CV value ranging between 0.10 and 0.12.

CV values of plant characters were mostly larger than 0.3 (Table 4), with the values of the ratio plant width/plant height exceeding 1.0. The numbers of days, from sowing to anthesis, were constant and did not vary among the infraspecific taxa.

Leaf length, width, and thickness had CV values of 0.11 to 0.20 (0.03 for the leaf length of intermediate P) (Table 3); therefore, they were more consistent than the whole plant character but less so than the floral characters.

Floral character

The corolla shape, as viewed from the front, was not possible to measure objectively, but the tip angle seemed to be a good quantitative character to express that form. The tip angle was significantly large in subsp. *axillaris* and small in subsp. *parodii* (Table 2); the former has rounded corolla lobes, whereas the latter has pointed ones (Fig. 2). Hence, the corolla of the typical subsp. *axillaris* with its large tip angle visually appears to be more rounded, whereas that of the typical subsp. *parodii* is more star-like (Fig. 1).

Because the corolla limb diameter of subsp. *axillaris* was significantly larger than that of subsp. *parodii* (Table 2), this morphological character was chosen as a variable in two of the six relevant functions in our discriminant analyses of floral morphology (Kokubun et al., 1997).

The corolla tended to be larger in populations growing in the southeastern departments than in the northern departments. However, the concentration of localities with small flowered plants in middle western departments of Soriano and Flores is conspicuous (Figs. 2, 3). Six were classified as intermediate A (Soriano: U104, U105, U169, U170, U171; Flores: U240) and one was intermediate P (Soriano: U166) in the previous study (Kokubun et al., 1997). The mean corolla diameter of plants from these seven localities is 41 ± 1.5 mm, whereas that from all other localities is 49 ± 3.1 mm; the difference was significant at 0.1% level by the t-test.

A population determined as typical subsp. *axillaris* in Lavalleja (U58) has a small corolla diameter of 41 mm (Figs. 2, 3) and an exceptionally narrow tip angle (Fig. 2). The discriminant analysis (Kokubun et al., 1997) placed the population in the subsp. *axillaris* probably because the corolla tube length was 43 mm in this population, just slightly shorter than the 55 mm of the seven populations from Flores and Soriano Departments.

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The above eight populations were also characterized by their small prostrate form, with thin, zigzagging lateral branches which placed them in a special form of *P. axillaris* occurring in central Uruguay.

The corolla was thick in subsp. *axillaris* and thin in subsp. *parodii* (Table 2). The thickest corollas were found in U151, U152, U177, and U178 which thrive along the shore of the Atlantic Ocean in Maldonado (Fig. 3). These populations were also distinguishable by their unique compact form and thick leaves.

Leaf characters

Although the leaf lengths did not differ, leaf width was significantly different between subsp. *axillaris* and subsp. *parodii*, it being narrower in the former than in the latter (Table 3).

The leaf thickness was also significantly different between the two subspecies; subsp. *axillaris* had thicker leaf than subsp. *parodii* (Table 3). The five populations of subsp. *axillaris*, U68, U151, U152, U177, and U178 with extremely thick leaf are distributed along the Atlantic coast (Fig. 4).

Growth form

Our analyses detected dominant growth forms of the two subspecies of *Petunia axillaris* in Uruguay. The 36 populations were classified as upright form, the second most dominant cluster (Fig. 6). Among them, 27 and 4 populations had been predicted as subsp. *axillaris* and intermediate A, respectively, in a previous paper (Kokubun et al., 1997). This dominant form of subsp. *axillaris* in Uruguay is distributed abundantly in Colonia department (10 populations) all along the Río de la Plata, San José department (5), and southern half of its distribution area such as in Rocha (4), Lavalleja (3) and inland Maldonado (2) departments (Fig. 7, Table 1). The plants continued to elongate after the first measurement, reaching a height often exceeding one meter.

The distribution of the most dominant cluster, medium form, is rather complicated because it includes both subsp. *axillaris* (25 populations) and subsp. *parodii* (15) (Fig. 6, Table 1). This form seems to be distributed randomly within the subsp. *parodii* range such as in Artigas (4 populations), Salto (4), Paysandu (4) and Tacuarembó (2) and also in most of the subsp. *axillaris* range. This form of subsp. *axillaris* is also represented among the inland populations of subsp. *axillaris* in Florida (3 populations) and San José (3) (Fig. 7).

Although Steere (1931) stated in the original description of *Petunia parodii* (=*P. axillaris* subsp. *parodii*) from Formosa Province of Argentina that *P. parodii* is larger and more erect than *P. axillaris* (=*P. axillaris* subsp. *axillaris*), Uruguayan subsp. *parodii* is characterized by the significantly wider growth form than that of subsp. *axillaris* (Table 4).

Large prostrate form

The following 10 populations were classified as large prostrate form: U28 and U220 (Artigas), U232 and U271 (Salto), U197, U238 and U267 (Paysandú), U240 (Flores), U258 (Cerro Largo), and U68 (Rocha) (Figs. 6, 7). Within this form, seven populations were classified as subsp. *parodii*, one intermediate A (U240), and two subsp. *axillaris* (U68 and U258). All populations are located inland, except U68.

All these subsp. *parodii* were located on the banks of arroyos (small streams that can be dry for an extended period). However, the arroyo bank is also a common habitat of *Petunia axillaris* in Uruguay. We did not notice any particular characteristics about these seven localities that led to the development of the large prostrate growth form.

These members have a low growth habit with a mean height of 111 mm but not compact. Its lateral branches extend to form a robust plant with a mean width at the anthesis of the first flower of merely 480 mm (Table 5). Ultimately the plant grows to a width exceeding one meter in diameter.

Artigas department

Except for U20 in Tacuarembó along the Río Negro river, the remaining populations of subsp. *parodii* which are classified as upright form occur in Artigas (3 populations) (Fig. 7). Artigas is the closest department to Formosa Province of Argentina from which the type of subsp. *parodii* came. The type plant is larger and more erect than subsp. *axillaris* in the original description (Steere, 1931). The upright forms in Artigas may be related to the upright subsp. *parodii* indigenous to Argentina rather than to the upright subsp. *axillaris* which occurs in southern Uruguay. Further research will be necessary before a conclusion can be made.

The growth form of *Petunia axillaris* occurring in Artigas seems to be unique. In addition to the above populations with exceptionally upright form, the two populations U28 and U220 (Fig. 7) are also classified as large prostrate form. Furthermore, the lax form U37 (Fig. 7) that is characterized by tall, wide plants (Table 5) is endemic to this department. These evidence suggest that a great diversity in the growth form exists in this department.

Growth forms of subsp. axillaris

Differences in the growth form among the populations on the shores of the Río de la Plata and the Atlantic Ocean are apparent although the habitats appear similar. The Río de la Plata does not seem much different from the Atlantic Ocean, because its width exceeds 40 km and one cannot see the other side of the river.

Sandy beaches and dunes along rivers and the Atlantic ocean are preferred habitats of numerous populations of *Petunia axillaris*. They exhibited a large variation in

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growth forms, most typical of subsp. *axillaris* with some intermediate A populations in Colonia (Fig. 7). These populations were categorized into three groups as follows:

a) upright Río de la Plata bank

The members of the upright Río de la Plata group are endemic along the banks of Río de la Plata, namely, Río Negro (U262), Soriano (U201), Colonia (U92, U93, U99, U101, U102, U199, U200), and San José (U88). They were classified as the upright form by the cluster analysis (Fig. 6) except U200; this region seems to be ' the center' of the upright form (Fig. 7).

Previously the disjunctive distribution of subsp. *axillaris* and subsp. *parodii* in Uruguay was the subject of many discussions (Ando et al., 1994, 1995, 1998; Kokubun et al., 1997). In our discriminant analysis of floral morphology derived from herbarium specimens (Ando et al., 1994), the classfication of many specimens collected from this region was inconsistent, resulting in both subsp. *axillaris* and subsp. *parodii* occurring concomitantly. Subsequent analysis of floral organs using live plants (Kokubun et al., 1997), categorized most populations among the 21 populations in Colonia and San José into subsp. *axillaris*, but four populations intermediate forms closer to subsp. *axillaris* (intermediate A) (Fig. 7). Therefore, we have concluded that genetic introgression of subsp. *parodii* into subsp. *axillaris* exists.

Although the floral character of the intermediate form (intermediate A) in this region seemed to be influenced by subsp. *parodii* gene, the vegetative growth is definitely that of the upright subsp. *axillaris* (Fig. 7). Although three populations of subsp. *parodii* in Artigas were classified as upright, they are far from this region, being separated from Colonia by the departments of Salto, Paysandú, Río Negro, and Soriano, where different growth forms, such as small prostrate, large prostrate and medium forms persist. Therefore, it may be preferable to consider that the upright form is the result of the environmental force, which induced the subsp. *axillaris*, not subsp. *parodii*, with its upright form to evolve initially along the Río de la Plata.

b) compact Atlantic coast

The second group, compact Atlantic coast, which derived from the cluster analysis (Figs. 6, 7), consists of U152, U177, and U178 in Maldonado. It represents a typical subsp. *axillaris* being less than 15 cm tall and 17 cm wide (Table 1) and having extremely thick corolla limb and leaves (Figs. 3, 4).

According to Map 3 in Daroczi et al. (1990), the Atlantic Ocean and the Río de la Plata are divided at Punta del Este, which is the southernmost point in Maldonado near where U151 is found (Fig. 7). Therefore, U152 belongs to the Río de la Plata bank population. The site is ecologically the same as the Atlantic coast because the vegetation is common to both U152 and other Atlantic coast localities. The plants grow in the cracks of rock (U152) and on the sand dunes (U177, U178). Their compactness seemed to be the result of environmental stress at the time of the field survey, but cultivating the plants under controlled conditions proved that this trait is genetic.

c) large prostrate Atlantic coast

The large prostrate Atlantic coast, consisting of one population in Rocha (U68) that was 6 cm tall and 40 cm wide at the anthesis of the first flower (Table 1), eventually attaining the width exceeding 1 m. It is the sole population located along the Atlantic coast which is classified as the large prostrate form by the cluster analysis (Fig. 6).

Among these three groups, b) and c) on the Atlantic coast the leaves are characteristically 0.8 to 1.0 mm thick and 17.6 to 19.6 mm wide (Fig. 4). The thick leaves may be an adaptation to the dry environment and a defense against the wind carrying sand particles that can severely abrade the plants. The group b) also had the thickest corolla lobes in all plants studied (Fig. 3).

The difference in growth forms among the three waterfront groups is striking. If there is any immediate difference in the environment among the three groups, it would be the salt concentration in the irrigation water, which would affect the osmotic pressure in the root zone.

The difference in growth habits between the second and the third groups cannot be explained easily because the environment of b) and c) groups appear sufficiently similar. The evolutionary mechanism involved in differentiating these two groups within a similar environment is worthy of further investigation.

Small prostrate form

We consider the growth forms revealed by the cluster analysis based on three plant characters as ecotypes or simple vegetative variation; we do not find them taxonomically significant with possible exception of the small prostrate form.

For example, all the river and sea shore populations of subsp. *axillaris* in the previous section had similar floral morphology, except for corolla thickness, while the growth form greatly varied among them. In the subsp. *parodii*, a variety of growth forms exists in the department of Artigas (Fig. 6) but we could not find any ecological significance for the large prostrate form. Therefore, these can hardly be ecotypical or taxonomical groups.

However, the small prostrate form shares several general morphological characters that are distinguishable in the typical subsp. *axillaris*, subsp. *parodii*, and the other forms of *P. axillaris*.

Populations of small prostrate form are primarily found in the Soriano department and fit into intermediate A (U104, U105, U169, U170, U171), but also extend farther east to Florida (U3) and Lavalleja (U58) which are otherwise classified as subsp. *axillaris*.

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Although classified as the large prostrate form, U240 (Flores) and U258 (Cerro Largo) appear to be similar to the plants of the small prostrate form (Fig. 7).

This population with characteristically small corolla, small leaves (Figs. 2, 3 and 4), and thin, zigzagging stems is detected easily by visual inspection. The stem character is rare.

This area around Soriano emerged in the first live plant analysis (Ando et al., 1995) as having inconsistently predictable populations by the discriminant functions. Because we suspected that these populations might be the result of introgression between the two subspecies, we studied the inheritance of floral characters between typical subsp. *axillaris* and subsp. *parodii*. However, the artificial crossing did not produce plants similar to these populations (Kokubun et al., 1999).

The native habitats in these eight localities in Soriano, Florida and Lavalleja are on or among rocky outcroppings; thus, the small prostrate form of *P. axillaris* is apparently a saxatile plant. The drier condition in such habitat may have led to their demunitive size. On the other hand, the small prostrate form can be interpreted as an ecotype associated with rocky outcroppings.

The distribution range of this growth form seems to be restricted to central Uruguay and a discontinuity of morphology seems to be present. However, there is not enough data to conclude if the small prostrate form is indeed an infraspecific taxon because much of Flores, Durazno and northern Florida still needs to be surveyed.

Early breeding of garden petunia and wild variation

The descriptions of earlier petunia hybrids and cultivars in the early 19th century depict tall, lax plants. Loudon (1834) noted a hybrid ("*Petunia willmoreana*") between *P. nyctaginiflora* (=*P. axillaris*) and *P. phoenicea* D. Don ex Loudon (=*P. integrifolia*) that attained a height of 7 ft. (2 m). Cultivation techniques from that era included training the petunia against a trellis or wire frame (Loudon, 1840) and frequent stopping of shoots (Paxton, 1844). These were probably because taller forms of *P. axillaris* were used in the earlier crossings. The other parent, *P. integrifolia*, grows long lateral branches that sprawl on the ground becoming 6 to 10 inches (15-25 cm) tall (Hooker, 1831).

One aim of breeding of garden petunias has been to attain a compact growth form because they are economical to propagate, grow, and market. The objective could be achieved easily if horticulturally acceptable compact types such as U152, U177, and U178 (Fig. 5) found in this study are used as a germplasm source.

Our analysis of growth forms successfully identified some special forms, such as compact, small prostrate, and large prostrate. This classification has immediate use for breeding of new petunia cultivars, e.g., the recent trend toward prostrate type petunia (Rader, 1993) can be expedited by using the large prostrate form found throughout the range of *P. axillaris*, such as U68, U220, and U240 (Fig. 7) as parents.

The garden petunias today have the corolla shape that is similar to subsp. *axillaris* with a wide range of the corolla limb diameter, although their corolla lobes are not as pronounced as in the wild subsp. *axillaris*. Our data indicate that a considerable variation of corolla shape exists (Fig. 2) between subsp. *axillaris* and subsp. *parodii*, which was previously noted by Steere (1931, see Plate 34). Despite certain disadvantages, such as thinner corolla limb (Table 2) and disproportionately long corolla tube (Ando et al., 1995; Kokubun et al., 1997; Steere, 1931), introducing *parodii* genes into new cultivars may create a new corolla shape.

Although we tried to cover a wide range of *Petunia* species both geographically and morphologically, we have examined only a part of it. We did not, for example, expect those compact populations of *P. axillaris* in Maldonado, such as U152, U177, and U178 (Fig. 5). These have rather large, substantially thick corolla (Fig. 3), which may offer an advantage as a breeding material. There must be more unique forms like these waiting to be discovered by future plant explorers.

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ウルグアイ産 *Petunia axillaris* の形態的変異

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摘　要

南米ウルグアイの102地点から採集した *Petunia axillaris* の種子より植物を育て，園芸的に重要と考えられる3つの花器形質と7つの栄養器官形質を計測し，その変異幅を調査して，有用と考えられる形質の集中する地域を抽出した．両形質の多くについて，亜種 *axillaris*，亜種 *parodii* および2種の中間型の間に有意差がみられた．各群落は株の高さ，株の幅，開花時の側枝数の3形質を用いたクラスター分析により次の6つの形態型に分類できた．1) 直立・高性，2) 中間型，3) コンパクト，4) 粗放，5) 小型・ほふく性，6) 大型・ほふく性．これらの形態型と自生地の環境，特に河岸，海岸の群落について考察し，また種内分類群との関連についても述べた．さらに園芸的に利用可能と思われる形質をもつ群落とその育種における有用性について考察した．

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