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Exploration and Collection of Ornamental Germplasm Native to Argentina

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ABSTRACT

Many of the herbaceous ornamentals under cultivation, or their progenitor species, are endemic to South America and these taxa represent a valuable resource for future breeding programs. Argentina has contributed with an important number of ornamental varieties developed from native germplasm. For example varieties derivates from genera such as *Petunia*, *Glandularia*, *Portulaca*, *Alstroemeria*, *Calceolaria* and *Calibrachoa* have been successful and are broadly cultivated around the world. Since 1999, the breeding working group of the Floriculture Institute (INTA-Argentina) has successfully addressed various techniques for the domestication, characterization and breeding of ornamental plants from native species. This work begins with the exploration and collection of native plants and finishes with the development of new varieties. According to latest estimates, the vascular flora of Argentina comprises a total of 248 families, 1927 genera and 9690 species, including 45 endemic genera and 1906 species. Among them, there are many herbs, shrubs and trees with many colorful flowers and these are worthy of being cultivated in our gardens. In this manuscript, we will present the plant explorations methods, planning, organization and logistic and our experience in these topics, emphasizing in ornamental potential of subtropical flora of Argentina.

Keywords: accessions, biodiversity, flora, floriculture, genetic, variability

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INTRODUCTION

The use of wild species is a method designed to introduce additional germplasm into cultivated varieties (Stalker 1980). This situation is common in the international market of ornamental plants, which is very dynamic and avid for new varieties. In addition, consumers' demand for new crops is stimulated by the saturation of the market by traditional crops (Vonk Noordegraaf 1987). Therefore, breeders are constantly producing new varieties to satisfy consumers' needs (Chin and Tay 2007). For example, since the main aims of the Japanese market are to produce diversity and novelty Japanese companies present 350 new varieties each year. This obliges breeders to search for new sources of variability (Tay 2006). In South America, the supply of species and varieties is very limited, especially under the heading of cut flowers and foliage. Because South America and China are the least explored areas with a large floristic diversity, international seed companies are particularly interested in developing new products from the flora of these areas (Boyle 1991). In economic terms, Kate and Laird (1999) estimated that the value of products derived as a result of the use of biological diversity is $ 800 billion per year.

Many of the herbaceous ornamentals under cultivation, or their progenitor species, are endemic to South America and represent a valuable resource for future breeding programs. Despite the large diversity of floricultural crops present in the market, many of these crops have been developed from a narrow germplasm base (Boyle 1991). Although the flora of Argentina has contributed with an important number of ornamental varieties developed from native germplasm, these resources have never been exploited. Besides, new cultivars of existing species are often derived from new wild collected species. The increase in sales of petunia plants following the incorporation of new species in breeding programs is a good example of a program that resulted in the enhancement of garden performance as well as of the spreading/trailing habits of plants such as 'Wave' and 'Surfinia' (Corr 2003).

Since 1999, the breeding working group of the Floriculture Institute of INTA Castelar, Argentina, has successfully

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Invited Review

used various techniques for the domestication, characterization and breeding of ornamental plants from native species (Suarez *et al.* 2003). This aim of our work is to explore and collect native plants with the aim to develop new varieties.

In this manuscript, we present the ornamental germplasm potential of Argentina and the collection methodology for the genetic variability as the essence of breeding inputs for our programs.

Exploration and collection

Exploration and collection activities require the integration of many disciplines such as: botany, taxonomy, cytology, genetics, breeding and ecology, which greatly increases the probability of success (Stalker 1980). Plant explorations demand advanced planning, organization and logistics. A strategy is needed to determine "*what kind*" of target resources will be collected and also "*where*" and "*when*" the collection will take place (Nagamine and Nakagahara 1989).

The planning of a mission frequently starts with a detailed survey of the published floras and herbarium specimens available so as to establish the genetic variability, geographical accessibility, the microenvironment of target sites and the possible exploration route (Chapman 1989).

The selection of the most appropriate season of exploration, which varies according to the target, is also extremely important. When the target is variability, the best season is the fruit stage, whereas when the target is *in situ* selection, the best season for collection is when the desired feature can be identified.

In addition, the goal of the collection trip should be determined by the method of collection and its success depends largely on the sampling method (Nagamine and Nakagahara1989). Two different selection criteria were identified:

1) *Specific unique genotype*: this criterion allows collecting plants which have some particular morphological, phenological or physiological feature/s. In this case, the best is to collect asexual propagules due to their specific phenotype. During the collection trips, plants, bulbs and/or cuttings are collected and then kept in hermetic nylon bags at low temperatures (4°C).

2) *Genetic diversity*: to collect enough genetic variability from wild populations, it is quite important to know about the geographical area of diversity. In this case, the most appropriate propagules to collect are seeds. The sufficient sample size is related to the number of plants and seeds per plant to be sampled in the population. In predominantly self-pollinated populations goodness of sampling is primarily determined by the number of plants rather than by the number of seeds per plant. However, a few plants per population may be enough if the plants are not highly selfing. Mature seeds have to be kept in paper envelopes at room temperature, while immature seeds have to be kept at low temperatures during shipment until sowing.

On the other hand, it is important to make herbarium material to accompany the accessions. However, the species can be cultivated in greenhouse conditions and taxonomically identified later.

In addition, documentation and a code system are necessary to accompany accessions. The code system developed at the Floriculture system of INTA Castelar has numbers and a letter. The numbers refer to the date of collection, starting with the year and followed by the month and day, whereas the letter refers to the site of collection and a number relative to the accessions in each collection place. For example, code "20100512B5" corresponds to the fifth accession in the second spot "B" on May 12th 2010.

The collection forms are essential to document collected accessions. The passport data are the most basic information and should be completed during the collection trip. Records must be precise enough to enable visiting the spot for re-collection. In the Floriculture Institute, we have developed two forms: the place information form (PIF) and the taxa information form (TIF). The PIF includes geographical position (GPS), other taxa included in the population, and environment characteristics (soil, topography, etc). The TIF includes the name, genus and family of the accession, phenology stage, ornamental characteristics, and any other information that the collector considers important to be used in the breeding strategy.

The geography and potential ornamental genera in Argentina

The geography of Argentina is varied and includes large fertile plains located a few meters above sea level, plateaus, mountains and the Andes mountain range, with altitudes of over 6000 m.a.s.l (Cabrera 1976). As expected, in such a wide and varied territory, there are numerous types of climates, from subtropical to cold, as well as many types of soils. As a result, there are also many types of vegetation, adapted to different environmental conditions, such as the jungles of the north or the arid grasslands of Patagonia. According to latest estimates, the vascular flora of Argentina comprises a total of 248 families, 1927 genera and 9690 species, including 45 endemic genera and 1906 species (Zuloaga and Morrone 1999). Among them, there are many herbs, shrubs and trees with many colorful flowers, which are worthy of being cultivated in gardens.

Since 1999, we have visited many regions of Argentina and collected more than 3000 accessions. Although germplasm collections have been carried out all over the country, the most important areas as ornamental resources for our breeding programs were found to be the Northwest and Northeast regions, which have contributed to more than 70% of the genera that we are currently developing.

The following section describes the ornamental potential of the flora of Argentina. To this end, we have divided the country into seven regions: Northwest, Northeast, Chaco, Pampa, Central Hills, Central West Mountains and Patagonia, and will describe their agro-ecological characteristics and their genetic contribution to our breeding programs.

Northeast region

The Northeast region, known as Mesopotamia, includes the provinces of Misiones, Corrientes and Entre Ríos. It is subhumid, is covered by green vegetation and is an area of high biodiversity. The landscape and its characteristics are dominated by two main rivers, the Paraná River and the Uruguay River, as well as by many streams. The flora of the Mesopotamia includes rainy forests in the northern province of Misiones, with abundant rainfall throughout the year (1500-2000 mm) and an annual average temperature of 20°C. In the northwest corner of this region, you can find "The Iguazú Falls" (**Fig. 1A**). To the south, rainfall and temperature decrease and the forest disappears and extends only to form galleries in the banks of rivers and streams. The south of this region is covered with open forests, palm forests and rich grasslands. In the center of the province of Corrientes, the most important aquatic environment of South America, "Los Esteros del Iberá", represents an interesting spot of great biodiversity.

The flora of the Mesopotamia is also represented by many species of large trees, many of which have very valuable timber, such as *Araucaria angustifolia* (**Fig. 1B**), *Handroanthus* spp. (syn=*Tabebuia*) and *Aspidosperma polineurum*. Many species of climbing plants, bromeliads, orchids and ferns grow on these trees. In the south, there are open forests of *Acacia* and *Prosopis* and broad meadows composed of numerous genera of herbaceous plants of many families with ornamental value such as: Verbenaceae, Asteraceae, Fabaceae, Lamiaceae, Solanaceae, Convolvulaceae, Plantaginacea, Scrophulariaceae, Amaranthaceae and Poaceae. In places with sandy soils, there are vast forests formed by the palm *Butia yatay* (**Fig. 1C**), which is a pro-

Fig. 1 Some environments, common species with ornamental value from the northeast region and commercial variety of *Nierembergia*. (**A**) Iguazú falls with *Syagrus romanzoffiana*; (**B**) Landscape of the northeastern of the Misiones province with *Araucaria angustifolia*; (**C**) *Butia yatay* population in Entre Ríos province; (**D**) *Nierembergia scoparia*; (**E**) *Nierembergia linariaefolia*; (**F**) Comercial variety "Luna" of *Nierembergia*. (Bars: 1 cm).

Table 1 Species with ornamental potential from Northeast region, which were collected by the Floriculture Institute.

Family	Genera	Species	Nº of accessions collected	Collected propagule [*1]	Potential ornamental use[*2]
Solanaceae	*Petunia*	*P. integrifolia*, *P. axilaris*	12	CT, SD	PT
	Calibrachoa	*C. excellens*, *C. ovalifolia*, *C. pygmaea*, *C. humilis*, *C. missionica*, *C. caesia*	60	CT	PT
	Nierembergia	*N. aristata*, *N. linariaefolia*, *N. veitichii*, *N. graveolens*	54	CT	PT
Amaranthaceae	*Gomphrena*	*Gonmphrena* sp.	6	PT	CF
Acantaceae	*Ruellia*	*R. bulbifera*, *R. gemiflora*	9	SD	PP
Asteraceae	*Eupatorium*	*E. cabrerae*, *E. missionum*, *E. bupleuriflorum*	15	SD	CF
	Vernonia	*Vernonia* sp.	5	SD	CF
Bignoniaceae	*Tecoma*	*T. stans*	10	CT	PP
	Handroanthus	*H. heptaphyllus*	28	GF	PP
	Jacaranda	*J. puberula*, *J. micrantha*	15	GF	PP
Boraginaceae	*Heliotropium*	*H. phylocoides*	13	CT	PP
Fabaceae	*Senna*	*S. scabriuscula*	10	SD	PP
	Sesbania	*S. punicea*	6	SD	PP
Convolvulaceae	*Evolvulus*	*E. sericeus*, *E. glomeratus*, *E. arizonicus*	16	CT, SD	PP
	Convolvulus	*Convolvulus* sp.	8	CT	PP
Malvaceae	*Cienfuegosia*	*C. sulfurea*	3	CT	PP
Passifloraceae	*Passiflora*	*P. chrysophylla*, *P. edulis*, *P. coerulea*	6	CT	PP
Onagraceae	*Ludwigia*	*L. grandiflora*, *L. hassleriana*	9	SD, PT	
Portulacaceae	*Portulaca*	*P. cryptopetala*	4	CT, SD	PP
Scrophulariaceae	*Angelonia*	*A. hassleriana*	5	SD	PP
	Bacopa	*B. hirsuta*	15	CT	CF
	Mecardonia	*M. procumbens*	10	CT	PP
	Scoparia	*S. montevidensis*, *S. dulcis*, *S. plebeja*, *S. hassleriana*	25	CT	PP
Verbenaceae	*Glandularia*	*G. tenera*, *G. peruviana*	27	CT	CF
	Verbena	*V. rigida*, *V. bonariaensis*, *V. intermedia*	16	CT	CF

*[1] PT = plant; SD = seed; CT = cutting; GF = grafting
*[2] PP = pot plant potential use; CF = cut flower potential use

Fig. 2 Most frequently species of *Calibrachoa* in the northeast region. (**A**) *Calibrachoa excellens*; (**B**) *Calibrachoa ovalifolia*; (**C**) *Calibrachoa missionica*; (**D**) *Calibrachoa linearis*; (**E**) *Calibrachoa caesia*; (**F**) *Calibrachoa humilis*. (Bars: 1 cm).

tected species in the El Palmar National Park (Martínez-Crovetto and Piccinini 1950).

Table 1 shows the herbaceous genera collected in this region that have been included in breeding programs. Among these, *Nierembergi*a, whose germplasm collection was established in 1999, is one of the most important ones. (**Fig. 1D-E**). More than twenty collection trips have been made and more than 300 accessions have been collected and characterized in greenhouse conditions. Two varieties of *N. linariaefolia* have been recorded in Argentina: Luna INTA-JICA (**Fig. 1F**) and Estrella INTA-JICA (Soto *et al.* 2003a). Intraspecific crossing was first used as a breeding tool to look for genetic variability. The relationship among *Nierembergia* species revealed by phylogenetic analysis allowed starting an interspecific hybridization strategy (Soto *et al*. 2005). Successful work in interspecific hybridization between *N. scoparia* x *N. ericoides* has been reported as a source of genetic variation (Soto *et al.* 2009). In addition, style-pollen relationship and embryology studies in interspecific combination have shown new potential hybridization among *Nierembergia* species from this region (Soto 2007).

Another important genus from this region is *Calibrachoa*. **Fig. 2** shows some *Calibrachoa* species included in our breeding program. This program is focused on favorable ornamental characteristics such as compact-shape plants, color variability and high temperature tolerance (Facciuto *et al.* 2009a). Intraspecific and interspecific crossings have been performed to combine favorable characteristics. The selected clones have shown good field and pot performance and many of them are cultivated by local farmers.

Although most efforts have been associated with *Nierembergia* and *Calibrachoa*, many other species from these areas have been characterized, and most of them such as *Evolvulus*, *Portulaca*, *Mecardonia*, *Glandularia*, *Ludwigia*, *Petunia* and *Turnera*, have shown good performance for pot plants (**Fig. 3**).

Also, woody plant varieties have been developed from native flora; a breeding program of *Handroanthus* was initiated in order to produce flowering ornamental pot plants (**Fig. 4A**). The primary goal of this program was to obtain compact-shape plants that blossom after a short-period of cultivation (Facciuto *et al.* 2008). The morpho-phenological characterization followed by intraspecific hybridization and selection has allowed obtaining genotypes with high ornamental value, especially genotypes of *H. heptaphyllus* that blossom in the first year of cultivation. Then, successful work in interspecific hybridization between pink and yellow species has been reported as a source of genetic variation (Facciuto *et al.* 2009). Last year, the first variety from this genus, 'Sorpresa INTA', was recorded in Argentina. This variety is currently being cultivated by local farmers (**Fig. 4B**).

Recently, we have started to work in the selection of genera appropriate to be used as cut flowers. This region has so far shown a good potential with genera such as: *Senecio* (**Fig. 5A**), *Verbena* (**Fig. 5B**), *Sinningia* (**Fig. 5C**), *Vernonia*, *Pavonia* (**Fig. 5D**), *Gomphrena*, *Angelonia*, *Desmodium*, *Eupatorium* and *Polygala*, which have been characterized in greenhouse conditions.

Northwest region

This region includes the provinces of Salta, Jujuy, Tucumán and Catamarca, and is one of the most important regions to collect germplasm with ornamental potential. This is a mountainous area with rains during the summer and highly variable rainfall which depends on the orientation of the slopes. This region shows different biomes. On the eastern slopes, between 350 – 3000 m.a.s.l., rain is abundant (up to

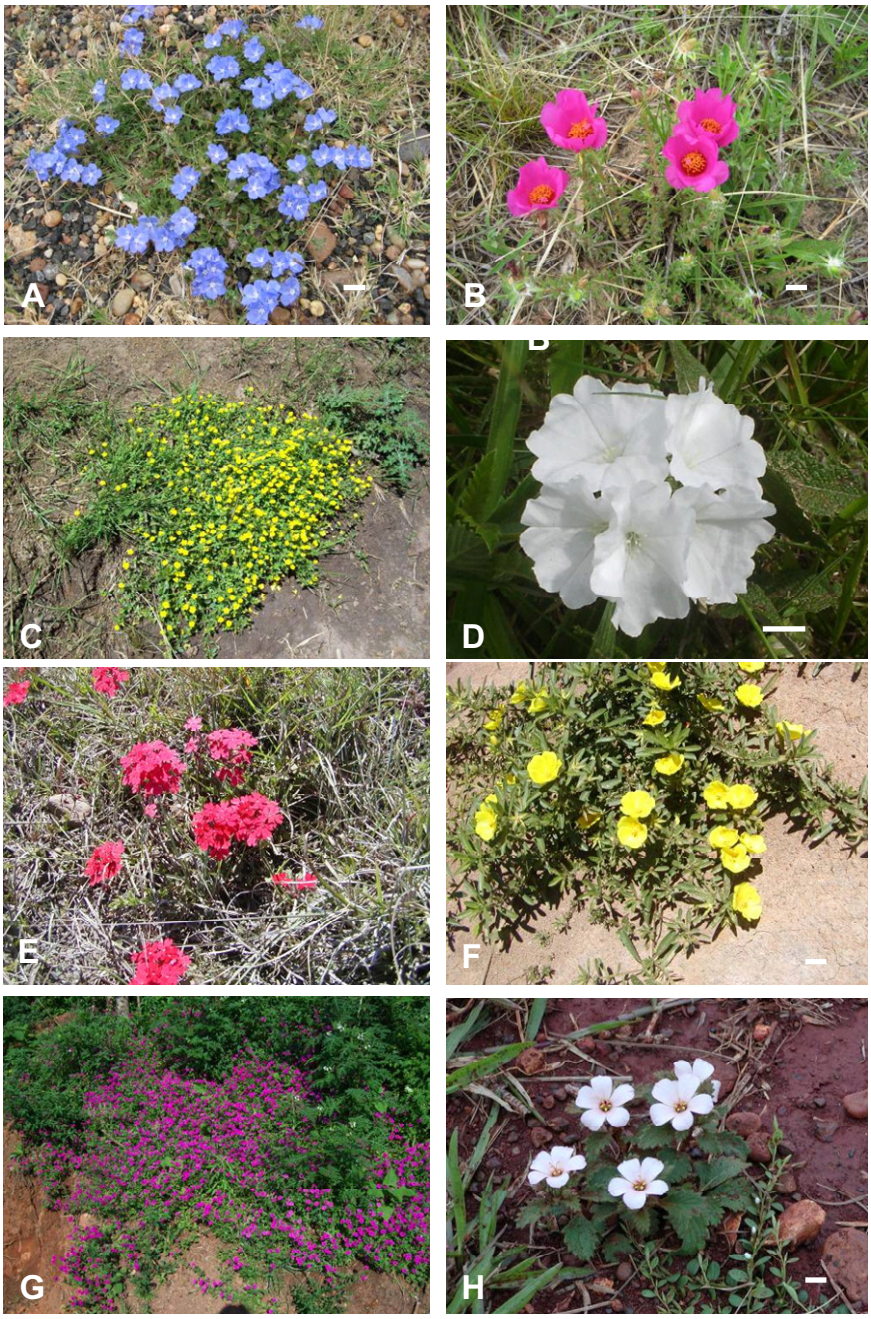

Fig. 3 Some species with ornamental value in the northeast region. (**A**) *Evolvulus glomeratus*; (**B**) *Portulaca grandiflora*; (**C**) *Mecardonia procumbens* var. *tenella*; (**D**) *Varronia paucidentata*; (**E**) *Glandularia peruviana*; (**F**) *Ludwigia peploides*; (**G**) *Petunia inflata*; (**H**) *Turnera sidoides*. (Bars: 1 cm).

Fig. 4 Species with ornamental value. (**A**) *Handroanthus heptaphyllus*; (**B**) ornamental commercial variety.

2500 mm annually), which allows great forests to grow. These forests are known as Yungas (**Fig. 6A**) (Cabrera 1976). The main trees in these forests are: *Tipuana tipu*, *Amburana caerensis*, *Jacaranda mimosifolia*, *Cedrela angustifolia*, *Ceiba insignis*, *Handroanthus* spp., *Anadenanthera macrocarpa*, *Alnus jorullensis*, *Podocarpus parlatorei* and several species of Mirtaceaea, among others (**Fig. 6B**). Abundant climbing plants, bromeliads, orchids and ferns are present in humid areas of this region. Between 2500-3000 m.a.s.l., above the Yungas, there are very rich humid

Fig. 5 Some species with ornamental value from the northeast region. (**A**) *Senecio icoglossus*; (**B**) *Verbena* sp.; (**C**) *Sinningia elatior*; (**D**) *Pavonia missionum*. (Bars: 1 cm).

Fig. 6 Some environments of the region. (**A**) View of the Yungas; (**B**) Mirtaceae Jungle.

Table 2 Species with ornamental potential from Northwest region, which were colleted by the Floriculture Institute.

Family	Genera	Species	N° of accession collected	Collected propagule *[1]	Potential ornamental use*[2]
Bignoniaceae	*Tecoma*	*T. stans*, *T. garrocha*, *T. tenuifolia*	43	CT	PP
	Handroanthus	*H. impetiginosus*, *H. aureus*	36	GF	PP
	Jacaranda	*J. cuspidifolia*, *J mimosifolia*	16	GF	PP
Acantaceae	*Ruellia*	*R. macrosolen*, *R. brevifolia*, *R. cillatiflora*, *R. coerulea*	5	SD	PP
Asteraceae	*Eupatorium*	*E. arnottianum*, *E. saltense*, *E. tanacetifolium*, *E. odoratum*, *E. hookerianum*	13	SD	CF
	Flaveria	*F. bidentis*	3	SD	PP
	Stevia	*S. gilliesii*, *S. yaconensis*, *S. potrerensis*	7	SD	CF
Gesneriaceae	*Seemannia*	*S. gymnostoma*, *S. nematanthodes*	7	PT	PP
Convolvulaceae	*Evolvulus*	*E. sericeus*, *E. arizonicus*	5	CT, SD	PP
	Ipomoeae	*I. alba*, *I. indica*, *I. rubriflora*	6	CT	PP
Rubiaceae	*Manettia*	*M. cordifolia*	3	CT, SD	PP
Passifloraceae	*Passiflora*	*P. misera*, *P. umbilicata*	4	CT	PP
Solanaceae	*Petunia*	*P. axilaris*	3	CT, SD	PP
	Nierembergia	*N. aristata*, *N. linariaefolia*	15	CT	PP
Verbenaceae	*Glandularia*	*G. platenses*, *G. peruviana*, *G. cheitmaniana*, *G. incisa*, *G. scrobiculata*, *G. lilloana*	46	CT	PP
	Verbena	*V. hispida*	5	CT	CF

*[1] PT = plant; SD = seed; CT = cutting; GF = grafting
*[2] PP = pot plant potential use; CF = cut flower potential use

grasslands, where several species of *Begonia* (**Fig. 7A-C**) and many other genera with beautiful flowers like *Cosmos*, *Gentianella*, *Zinnia*, and *Salvia*, grow (**Fig. 7D-H**). To the east of the Yungas, the landscape is similar to the arid Chaco plain, with forests of *Schinopsis* spp. In the west, annual rainfall ranges from 100 to 300 mm, and the landscape is a desert with some fertile valleys between the mountains, such as the Quebrada de Humahuaca and the Valles Calchaquíes (**Fig 8A-B**). Also, high mountains with peaks of the Andes that reach 6000 m.a.s.l. characterize the

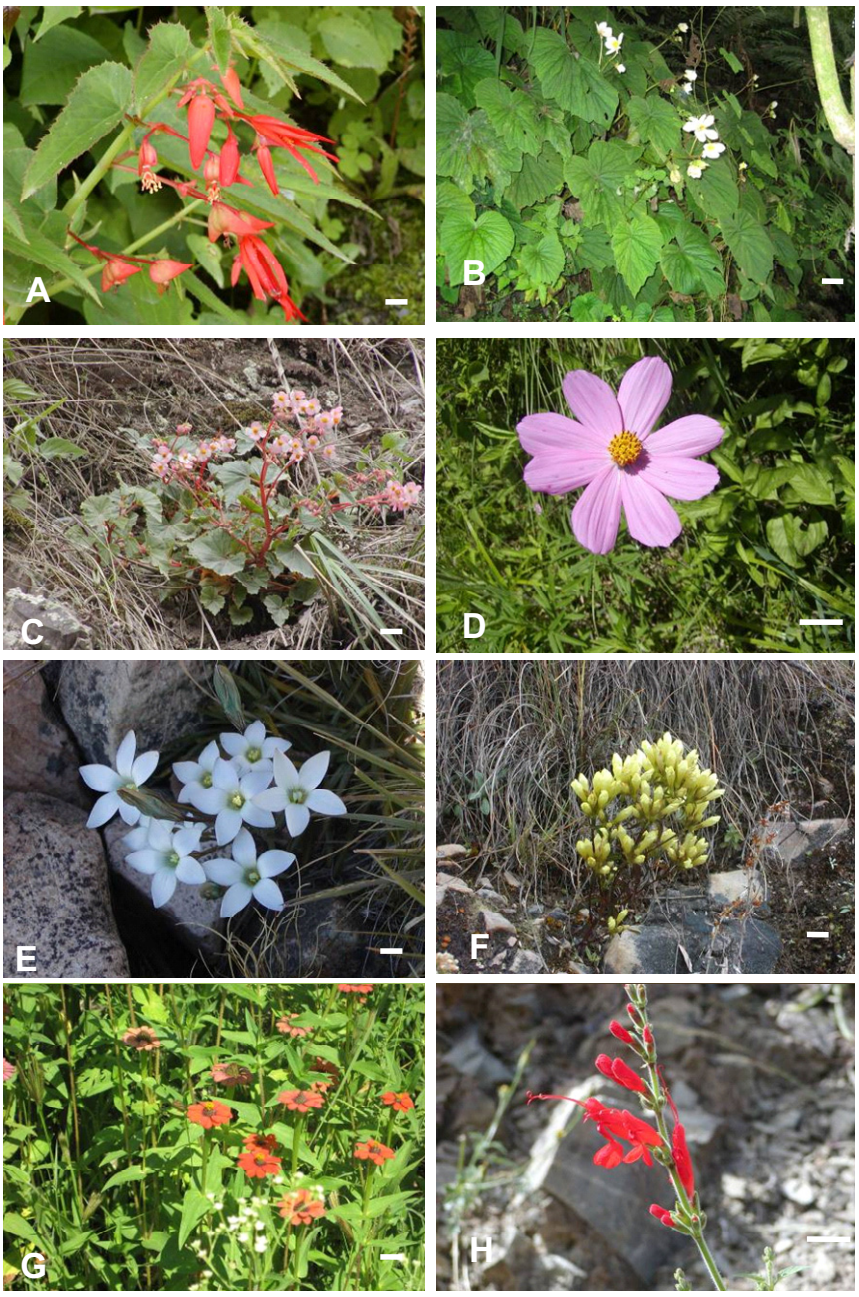

Fig. 7 Common species with beautiful flowers from the northwest region. (**A**) *Begonia boliviensis*; (**B**) *Begonia micranthera*; (**C**) *Begonia* sp.; (**D**) *Cosmos peucedanifolius*; (**E**) *Gentianella anthosphaera*; (**F**) *G. multiflora*; (**G**) *Zinnia peruviana*; (**H**) *Salvia exserta*. (Bars: 1 cm).

region. This diversity of biomes makes the region an important source of genetic resources.

Table 2 shows the species with ornamental potential from the Northwest region collected by the Floriculture Institute.

Bignoniaceae breeding has been addressed using genetic resources from this region. Interesting work in the genus *Tecoma* was initiated and a clone selected for pot use derived from crosses between *T. garrocha* and *T. stanns* ('Victoria INTA-JICA') has been recorded in Argentina (**Fig. 8D**). A breeding program of *Jacaranda* is also being conducted and successful interspecific hybrids between *J. mimosifolia* and *J. cuspidifolia* have been obtained with good performance as pot plants.

The Northwest region has also contributed with many other species of different genera such as: *Fuschia*, *Mutisia*, *Seemannia* and *Manettia* (**Fig. 9**). Most of them have been collected and characterized in greenhouse conditions, and shown good potential for growing in pots. Besides, this region has shown good potential to collect genera suitable to be cultivated as cut flowers such as: *Flaveria*, *Eupatorium*, *Grindelia*, *Gomphrena*, *Verbena* and *Stevia*, which have started to be characterized and domesticated in greenhouse conditions.

Chaco

This region includes the provinces of Formosa, Chaco, Santiago del Estero and Santa Fe. All these provinces are part of an extensive phytogeographic area known as "Gran Chaco". The "Gran Chaco" is mostly an alluvial plain sedimentary environment shared with Paraguay and Bolivia. It extends between 17° to 33° S and 65° to 58° W (Cabrera and Willink 1973), and offers high soil fertility and topography favorable for agricultural development. However, it also presents some challenging aspects. The "Gran Chaco" has one of the highest temperatures in the continent with an arid or sub-arid climate in the west and a sub-humid climate in the east (550 - 1500 mm annual rainfall) (**Fig. 10A**), with a six-month dry season and enough fresh groundwater available in only about one third of the region, and the rest with very salty aquifers.

The most characteristic trees of this region are the "quebrachos" (*Schinopsis* spp.) (**Fig. 10B**). Formerly, the region

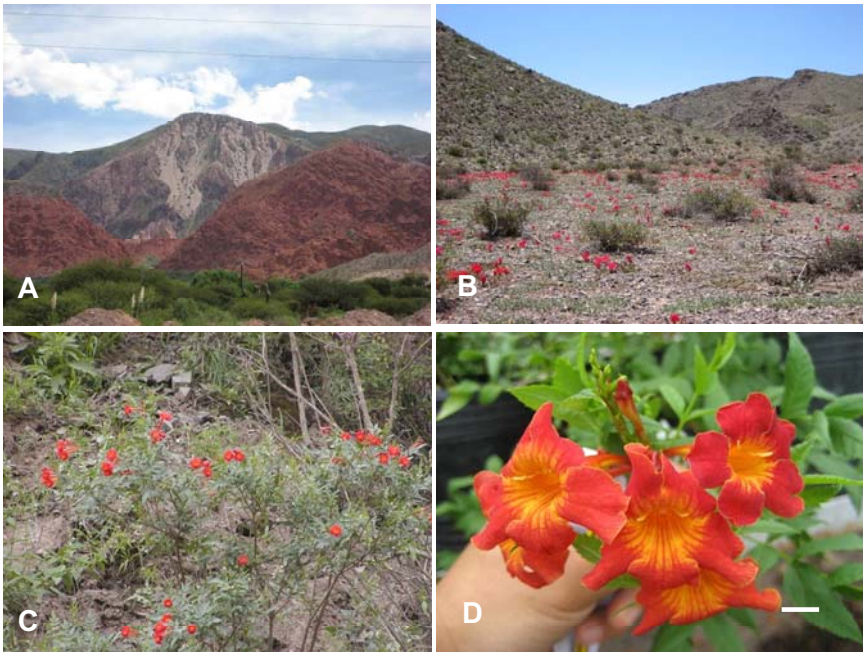

Fig. 8 Environments of the mountains of northwest region and some genotypes of *Tecom.*: (**A**) Northwest arid landscape; (**B**) Steppe with *Portulaca* sp.; (**C**) *Tecoma tenuiflora*; (**D**) commercial variety 'Victoria' of *Tecoma*. (Bars: 1 cm).

Fig. 9 Common species with ornamental value from the northwest region. (**A**) *Fuchsia boliviana*; (**B**) *Nierembergia veitchii*; (**C**) *Seemannia gymnostoma*; (**D**) *Manettia cordifolia*. (Bars: 1 cm).

had great *Schinopsis* forests, but they were reduced due to human activity. Many species of thorn shrubs, cactuses and thorny terrestrial bromeliads grow on the basis of these forests. In some places, the forest opens and grasses are abundant. These mixed grasslands within the forest are called "abras". Plants of this environment are adapted to tolerate periods of high temperatures and drought, important features to select for breeding. The most important herbaceous genera of this region are: *Pavonia*, *Habranthus*, *Gomphrena* and *Desmodium* (**Fig. 10C-F**) and *Portulaca*, among others.

Pampa

This region includes the provinces of Buenos Aires and La Pampa. The Pampas are vast plains which are interrupted only by the low Ventana and Tandil hills, with a height of 1300 m.a.s.l. and 500 m.a.s.l., respectively. The climate is mild, winters are cool to mild, and summers are very warm. Annual rainfall ranges from 600 mm to 1.200 mm. Rainfall is fairly uniform throughout the year but is a little heavier during the summer. Annual rainfall is heavier near the coast and decreases gradually further inland. Rain during late spring and summer usually arrives in the form of brief heavy showers.

The dominant vegetation types are grassy prairies with numerous Poaceae species (**Fig. 11A**). Some of them, such as several *Stipa* species and the "pampas grass" (*Cortaderia selloana*), are emblematic species of the Pampas. In the province of Buenos Aires, trees are very rare, with *Celtis tala* growing naturally, forming small isolated woods in the pasture (Cabrera and Zardini 1979). To the west, in the province of La Pampa, shrubs and trees are more frequent and there are forests of *Prosopis caldenia* (caldén).

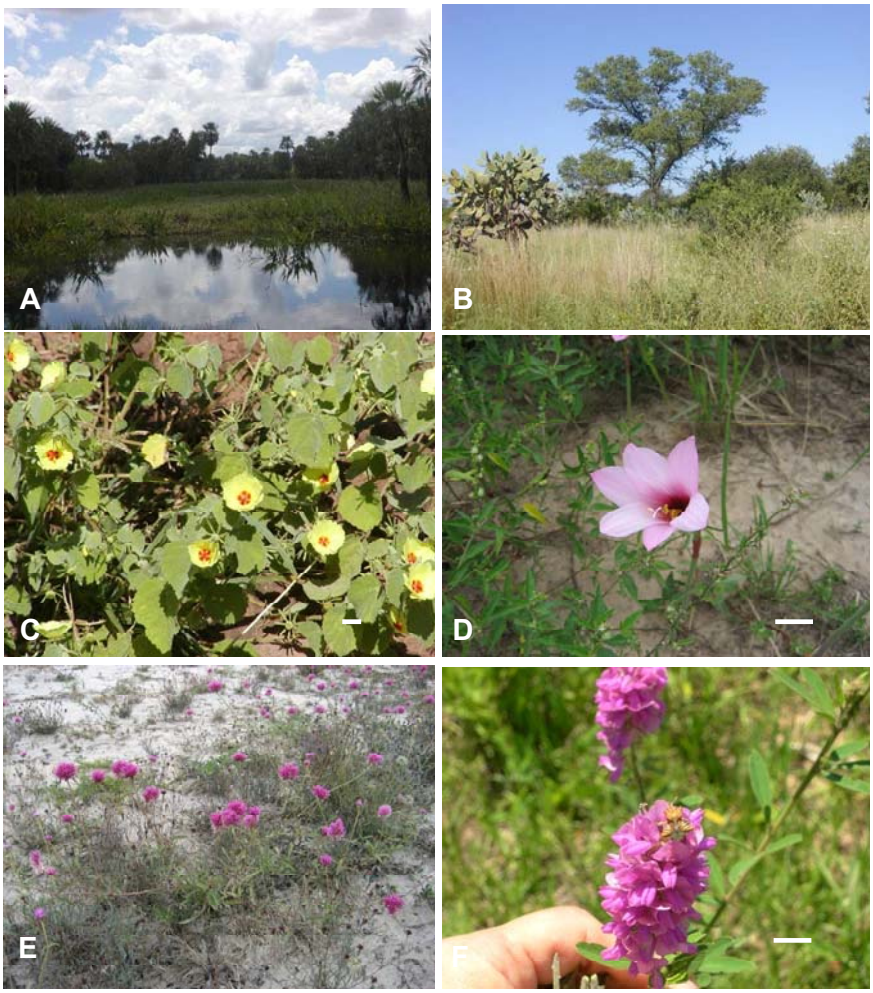

Fig. 10 Some typical environments and common species with colorful flowers from the chaco region. (**A**) Dry chaco landscape with *Schinopsis lorentzii*; (**B**) Humid chaco landscape; (**C**) *Pavonia argentina*; (**D**) *Habranthus pedunculosus*; (**E**) *Gomphrena perennis*; (**F**) *Desmodium* sp. (Bars: 1 cm).

In this region, there are some species with good ornamental potential. Among them, there are several bulbous plants of the genera *Habranthus*, *Rhodophiala* (**Fig. 11B**) and *Zephyranthes*. These species have been collected and characterized in greenhouse conditions, showing a good potential for growing in pots or for using in xerogardens. Other interesting plants of this region are several species of *Verbena*, *Petunia*, *Alstroemeria* and *Lantana* (**Fig. 11C-F**). Asteraceae, such as the genera *Baccharis*, *Eupatorium*, *Vernonia* and *Senecio,* are also present. On the other hand, many species suitable for cultivation in artificial ponds, such as *Eichhornia*, *Nymphoides*, *Limnobium*, *Salvinia*, *Pistia* and *Sagittaria*, grow in the abundant small lakes of the east of the Pampa region (Cabrera and Fabris 1948).

Central hills

This region includes the provinces of Córdoba and San Luis. The physiography of the southeast of this region is similar to the Pampas region, with vast and fertile plains covered by grasses. To the north, it is similar to the Chaco region, with *Schinopsis* forests and thorny bushes, whereas to the west, this region is characterized by hills with abundant waterways (**Fig. 12A**). The climate is characterized by mild winters and hot summers. Annual rainfall ranges from 500 mm to 800 mm. Rains occur mainly in spring and periods of drought are common. In the highest mountains, winter snow accumulation brings water to the rivers and streams during spring. Here, the natural vegetation consists of small trees or shrubs, mostly of the genera *Prosopis*, *Acacia*, *Geoffroea*, *Fagara*, and *Schinus*. Among herbaceous plants, *Glandularia*, *Evolvulus* (**Fig. 12B**), many Asteraceae (**Fig. 12C**) and Poaceae are present. It is important to mention that this region is the center of distribution of *Nierembergia* (Solanaceae), which is included in our breeding programs mentioned in the northeast region (**Fig. 12D-F**).

Central West mountains

This region includes the provinces of La Rioja, Mendoza and San Juan. This region lies at the foot of the Andes. Annual rainfall ranges from 200 mm to 500 mm. Rains are frequent during winter and spring. The average annual temperature is close to 15º C, winters are cold with frequent snow in some places and summers are mild. The soil is arid and crossed by several rivers (**Fig. 13A**). Most of the rivers are fed by the thawing of snow on the mountain peaks, and their volume of water increases considerably in spring. The Desaguadero River, which is the main collector, receives waters from the Bermejo, Vinchina and Salado rivers before reaching the Colorado River.

The vegetation of this region is represented by arid steppe grassland with species of *Festuca*, *Poa* and *Stipa*, and low bushes such as *Larrea*, *Senna* (**Fig. 13B**), *Cercidium* and *Prosopis*. Also, several species of herbaceous plants such as *Perezia ciliosa* with fine blue flowers, *Calceolaria glacialis*, *Geranium sessiliflorum*, *Adesmia* spp. and several others grow either protected under the grasses or sheltered by the rocks. To the west, the mountains grow in height, the climate is colder and the vegetation is less conspicuous, being reduced to very compact small shrubs. However, some of the species growing here, such as *Schizanthus*, *Hypseocharis* and *Oenothera*, possess very attractive flowers (**Fig. 13C-E**). Some bulbous species of the genera *Habranthus*, *Phycella* and *Rhodophiala* are also common (**Fig. 13F**).

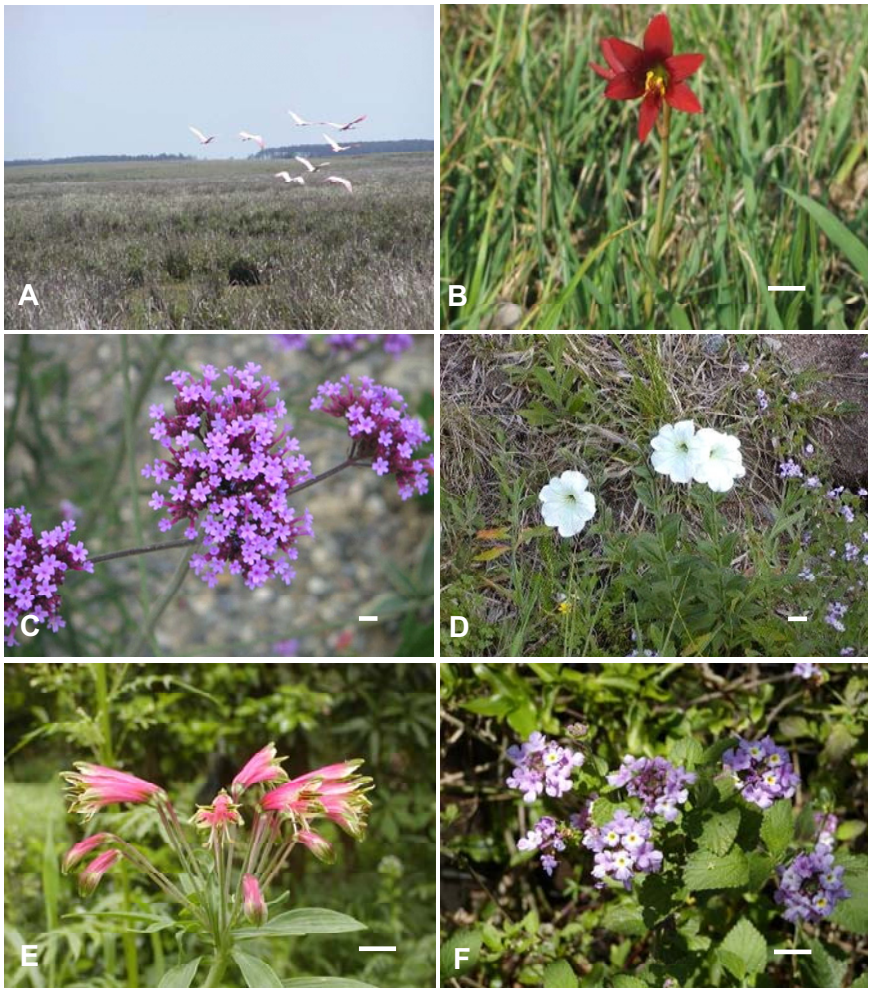

Fig. 11 Typical environment and some species with beautiful flowers in the pampa region. (**A**) Pampa landscape; (**B**) *Rodophialla bifida*; (**C**) *Verbena bonariensis*; (**D**) *Petunia axillaris* subsp. *axillaris*; (**E**) *Alstroemeria psittacina*; (**F**) *Lantana megapotamica*. (Bars: 1 cm).

Patagonia

This region is bordered in the north by the Colorado River and comprises the southernmost portion of the Andes Mountains to the west, and plateaus and low plains to the east. It includes the provinces of Río Negro, Neuquén, Chubut, Santa Cruz and Tierra del Fuego. The climate is temperate in the north and cold in the south. Rainfall increases markedly from east to west and occurs during the winter, and snow is very abundant. Part of Argentine Patagonia is a plain covered with an enormous bed of shingle and almost bare of vegetation. In the east, Patagonia is a desert where annual rainfall ranges from 150 to 500 mm. Here, the steppe vegetation is characteristic, consisting mainly of coarse grasses and small shrubs. In the west, on the Andes, the environment changes due to more abundant rainfall, which ranges from 800 to 2000 mm in some places and up to 4000 mm in others (Correa 1998). The rains occur mainly in winter, and snow accumulation brings water to the rivers and streams during spring. Here, forests, valleys and lakes are a feature of the landscape (**Fig. 14A**). Some species typical of Patagonia are *Austrocedrus chilensis*, *Fitzroya cupressoides* (alerce), *Podocarpus nubigenus*, *Pilgerodendron uviferum*, *Luma apiculata* and *Eucryphia cordifolia*. The dominant species in these forests are *Nothofagus*, and six species are distributed along the slopes of the Andes. Another species typical of this area is the *Araucaria araucana*, which is a large-sized conifer which grows in the north of these forests. Also, many species of shrubs, ferns and herbs are part of this flora. Among the shrubs of this region, the most typical are those of the genera *Berberis* (**Fig. 14B**), *Fuschia*, *Chuquea*, *Fabiana* and *Embothrium coccineum*, with conspicuous red flowers (**Fig. 14C**). Among herbs, many have beautiful flowers, such as several species of *Viola* and terrestrial orchids such as *Chloraea* (**Fig. 14D**), but the most popular is the *Alstroemeria aurantiaca*.

Although these forests are very rich in biodiversity, many of the plants that grow here are difficult to grow elsewhere. The species that has been successful is *Alstroemeria*, of which there are many commercial varieties for cut flowers. Genera such as *Anatrophylum*, *Tropaeolum*, *Calceolaria* and *Ouricia*, have been collected and cultivated, but the results obtained are not very promising (**Fig. 13E, 13F**).

CONCLUSIONS

Native genetic resources provide variability, which is the essence of our breeding programs. Plant breeders' success will be deficient without an adequate germplasm collection. In this context, many of the species native to Argentina have features that make them interesting to be used as ornamental plants. Exploration trips have allowed us to acquire great field experience and knowledge on the variability of the flora of Argentina suitable for floriculture. The Floriculture Institute has recorded four commercial varieties in Argentina (two of *Nierembergia*, one of *Handroanthus* and one of *Tecoma*). Besides, new varieties of *Mecardonia*, *Calibrachoa*, *Glandularia* and *Passiflora* have been developed in our breeding programs. These works suggest that Argentina offers great potential to bring new forms or species into a market that is continually demanding "new products" and it is a good alternative for the purpose of incorporating variability in breeding programs.

Fig. 12 Typical landscape and common species with colorful flowers in the central hills region. (**A**) Central hills landscape; (**B**) *Evolvulus arizonicus*; (**C**) *Hysterionica jasionoides*; (**D**) *Nierembergia linariaefolia* (with lilac flowers) and *Oxalis* sp.; (**E**) *Nierembergia linariaefolia*; (**F**) *Nierembergia aristata*. (Bars: 1 cm).

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Fig. 13 Some typical environments and some species with ornamental value in the central west mountain region. (**A**) Mountain landscape; (**B**) *Senna aphylla*; (**C**) *Schizanthus hookeri*; (**D**) *Hypseocharis pimpinellifolius*; (**E**) *Oenothera* sp; (**F**) *Rodophiala mendocina.* (Bars: 1 cm).

Fig. 14 Typical environment and common species with colorful flowers in the Patagonia region. (**A**) Andean Patagonian landscape; (**B**) *Berberis* sp.; (**C**) *Embothrium coccineum*; (**D**) *Chlorea alpina*; (**E**) *Calceolarea* sp.; (**F**) *Ourisia* sp. (Bars: 1 cm).