MEDITERRANEAN PLANTS FROM CHILE FOR DISPLAYS AT LONGWOOD GARDENS

by

Rodney Todd Eason

A thesis submitted to the Faculty of The University of Delaware in partial fulfillment of the requirements for the degree of Masters of Science in Public Horticulture

Spring 2002

MEDITERRANEAN PLANTS FROM CHILE FOR DISPLAYS AT LONGWOOD GARDENS

by

Rodney Todd Eason

Approved by _____

James E. Swasey, PhD.
Longwood Graduate Program Coordinator,
Chairman of Thesis Research Committee

_____

Robin Morgan, PhD.
Dean of College of Agriculture and Natural Resources

_____

Conrado M. Gempesaw II, PhD.
Vice Provost of Academic Programs and Planning

ACKNOWLEDGMENTS

My extreme gratitude goes to Longwood Gardens, Longwood Graduate Program Executive Committee, and The University of Delaware. Thanks to my committee members Tomasz Aniśko, Mark Bridgen, and James Swasey for all of their feedback and support during the research process.

I must express appreciation to all who helped with this thesis by providing time and/or support: Ann Cook, Iris Gestram, Daniel Hinkley, Fernanda Larrain, Eduardo Olate, Frederick Roberts, William Simeral, and Jerry Stites.

Respectfully, I want to acknowledge my classmates, Melissa Butler, Kelly Roderick, Shannon Still, and Cindy Tejral and our benevolent overseer, Geraldine Zuka.

Gratitude also goes to my wife, Carrie Z. Eason and our son, Alexander Todd Eason for their patience, support, and smiles.

In memory of Irwin F. Zablocky and J.C. Raulston

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

MEDITERRANEAN PLANTS FROM CHILE
FOR DISPLAYS AT LONGWOOD GARDENS

The goal of this thesis research was to determine if plants from central Chile have potential as display plants at Longwood Gardens.

A literature review was completed to select target plants from Chile. A list of plants with potential to complement the displays at Longwood was made by analyzing descriptions, watercolor illustrations, and color photographs. The author selected 92 plants from central Chile that had potential for evaluation based upon literature descriptions. The target list was distributed to members of Longwood Gardens' Research Steering Committee and a survey on plant characteristics was distributed to Longwood's Plant Evaluation Committee. The responses were assimilated to determine selection preferences. Subsequently, the author planned an exploration to observe the target list *in-situ* in Chile. During the exploration, 56 targeted plants were observed. Plants were documented as recommended or not recommended for display in Longwood Gardens.

The thesis presents 40 plants for consideration as display plants for Longwood Gardens. Twenty-six of these plants are on the original target list. The additional 14 plants come from observations made during the Chilean expedition. The remaining 66 target list plants are not recommended for display either because not enough information was obtained or the plants were not observed.

Longwood should participate in future explorations to Chile in order to acquire potential display plants and observe plants not seen during the thesis research expedition.

Chapter 1

INTRODUCTION

Longwood Gardens in Kennett Square, Pennsylvania is a display garden. Longwood Gardens' conservatories allow visitors to observe year-round displays of plants grown out of season and plants not adaptable to the climate of the Mid-Atlantic region of the United States. The conservatories' displays consist of plants from around the world.

The Orangery, East Conservatory, Garden Walk, Acacia Passage, Silver Garden, and Mediterranean House all utilize mediterranean plants within the Longwood conservatory complex. Environmental systems are implemented to grow the plants successfully by modifying temperature, moisture, light, and humidity. Unlike the tropical climate represented in the Tropical Terrace, Cascade Garden, Banana House, Orchid House, and Palm House of Longwood's conservatories, mediterranean plants can grow successfully with less water and more pronounced variations in high and low temperatures (Dallman, 1998). With concern for water and fuel conservation, further incorporating mediterranean display plants in conservatory displays would conserve vital resources. Most plants from mediterranean regions of the world would grow unsuccessfully in permanent outdoor displays at Longwood Gardens. The plants' failure would be due to one or all of the following: the cold, dry winters, the humid, hot summers, the clay soils that prevail along the eastern United States seaboard, or pests not naturally occurring where the plants are native.

The goal of this thesis is to determine if plants from mediterranean, or central, Chile have potential as display plants in Longwood Gardens. Mediterranean Chile has a diverse native flora that have potential to complement and enhance Longwood Gardens' displays by contributing combinations of colors, forms, and textures not seen in plants currently being grown. Of the 32,457 plants in Longwood's plant records database, 116 list nativity as Chile, 56 of which are active, or living, accessions. Other areas with mediterranean regions; Australia, California, the Mediterranean Basin, and South Africa, have plants in Longwood Gardens' plant records database. Compared to 116 Chilean accessions, there are 538 from Australia, 241 from California, 149 from the Mediterranean Basin, and 1,055 from South Africa. Fewer Chilean plants are accessioned at Longwood Gardens than from other areas with mediterranean climates.

Chapter 2

RESEARCH METHODOLOGY

The researcher reviewed literature to become familiar with Chilean plants. The initial literature review included 23 sources. These sources included: previous Longwood Graduate Program theses on plant research, research methodology, Chilean flora, and mediterranean regions. The researcher found from the initial review that the Chilean region with the most potential for containing display plants was the central region. A subsequent review focused on the plants from the central region of Chile. A list of plants with potential to complement the displays at Longwood was based on descriptions, botanical illustrations, and color photographs. The original list contained 94 plants. The basis of information used in compiling the plant list came from: *Arboles Nativos de Chile* (Zegers, 1997), *Arbustos Nativos de Chile* (Zegers and Garcia, 1997), *Flora Silvestre de Chile* (Zizka and Grau, 1992), *Flora Silvestre de Chile: Zona Central* (Hoffmann, 1995), *Index of Garden Plants* (Griffiths, 1995), and *Plant Life in The World's Mediterranean Climates* (Dallman, 1998). Three plants were later removed. *Berberis actinacantha* Martius was removed after Dr. Tomasz Aniśko, Curator of Longwood Gardens, reviewed the list and stated that *Berberis* spp. could not be imported because of a United States Department of Agriculture restriction. *Echium vulgare* L. was also removed after Dr. Aniśko's review of the list. He had observed the plant and did not think it would add to Longwood's displays. *Crinodendron patagua* Mol. was removed after determining the plant grew at elevations far

outside of the mediterranean region. *Fascicularia bicolor* (Ruiz & Pav.) Mez. was later added to the target list after reading about the species' ornamental characteristics in additional literature. This final list contained 92 plants, which are listed in Appendix A (Page 94). The author's selected list relied on personal knowledge of Longwood's plant selection. On several occasions, the researcher attended Plant Evaluation Committee meetings to observe how members selected plants. Based upon personal observations, plants with large, long-lasting flowers are used extensively at Longwood Gardens. Also used as characteristics for selecting potential plants were: large inflorescence size as related to plant size, inflorescence colors that were not muted, and leaf colors that were of one shade. Specific colors, textures, and forms of plants were not used as characteristics for determining target plants. Based upon personal observations, overall color, texture, and form of a plant are important qualities of display plants at Longwood Gardens.

The plant list was distributed to Longwood Gardens' Research Steering Committee. Members of the committee recommended that the list be sent to Longwood's Planning and Design Specialist, Plant Physiologist/Propagator, Floriculturist, Production Foreman, and Research Horticulturist for comments. The selected staff responded with seven plants desired for trial. These plants were: *Alstroemeria spathulata* Presl., *Aristolochia chilensis* Bridges *ex.* Lindl., *Drimys winteri* Forst. & Forst., *Escallonia rubra* (Ruiz & Pav.) Pers., *Lupinus arboreus* L., *Tropaeolum azureum* Miers ex. Colla., and *Tropaeolum tricolor* Sw.

The author sent the Chilean plant list to five individuals, who were not members of either committee, with advanced knowledge of the Chilean flora. The individuals were

identified by personal recommendations or mentioned during the literature reviews. Comments were received from one individual who had participated in two Chilean plant expeditions. These comments listed plants as advisable, inadvisable, or not sure of the plant. The brevity of the individual's comments was not enough to change the target list.

The researcher developed and distributed a survey to Longwood's Plant Evaluation Committee. The survey was reviewed and declared exempt from a human subjects review by the University of Delaware's Human Subjects Review Board because all responses were anonymous. The Plant Evaluation Committee decided which plants should be trialed or utilized for displays at Longwood Gardens. The following was an observation of how plants were selected by the evaluation committee. Members evaluate plants in a subjective format. The members view each plant and determine whether a plant should be used for display at Longwood. They base their determination on each plant's characteristics and if these characteristics could complement a display in Longwood Gardens.

The survey questioned the committee members on selection preferences for display plant characteristics. Respondents answered questions related to preferences of plant textures, colors, sizes, forms, fruiting characteristics, cultural requirements, seasons of interest, life cycles, production cycles, and display uses. Questions pertaining to size were answered with English measurement units. These units were the commonly accepted units of measurement at Longwood Gardens. The responses were assimilated to determine selection preferences and are presented in the RESULTS chapter.

An exploration to Chile was organized from 15 through 28 October 2001, to target plants on the final, compiled list, and to collect germplasm. The researcher obtained a permit to collect germplasm from Corporación Nacional Forestal (CONAF) in Chile. Contacting a secretary at CONAF, via facsimile, began the process of obtaining the permit. She forwarded the request to the issuing authority. The permit was delivered within three weeks of the request.

In addition to the author, the participants in the exploration were Dr. Tomasz Aniśko from Longwood Gardens, Dr. Mark Bridgen from Cornell University, and Mr. Eduardo Olate, from Universidad Pontificia Catolica. Mr. Olate also served as in-country guide. Books used to plan the exploration's itinerary were: *Rough Guide: Chile* (Graham, *et al.*, 1999) and *Flora Silvestre de Chile: zona central* (Hoffmann, 1995). Mr. Olate, a native Chilean, edited the itinerary.

The exploration traversed the central valley of Chile between Concepcion, to the south of Santiago, and La Serena, to the north. The exploration was two weeks in duration and covered approximately 3,500 km of roads. Field notes, global positioning coordinates, and photographic slides were recorded for most observed plants.

The researcher selected plants that had the possibility of becoming display plants at Longwood. Plants were classified as either recommended or not recommended for display. Plants recommended for display had one or more desirable characteristics with little or no undesirable characteristics. Plants not recommended for display had undesirable characteristics and little or no desirable characteristics. Also, a plant was listed as not

recommended for display if it was not observed during the expedition. Some plants not included in the target list, but found in Chile, should be trialed for display. These plants were included in the DISCUSSION chapter of the thesis.

After the plant expedition, the plants recommended for Longwood display were researched in the Longwood plant records database to see if the plants were already growing in the Gardens. The plant records database showed which plants had been accessioned at Longwood Gardens. If a plant grew in Longwood Gardens and was still alive, it was termed an active accession. Any plant that had been grown in Longwood Gardens but was dead or lost was termed an inactive accession. The researchers' recommended display plants were cross-referenced with the plant records database to ensure that future collection trips would not focus on collecting plants already growing in Longwood. The next chapter, INTRODUCTION TO MEDITERRANEAN CLIMATES, will describe the environments in which mediterranean plants grow.

Chapter 3

INTRODUCTION TO MEDITERRANEAN CLIMATES

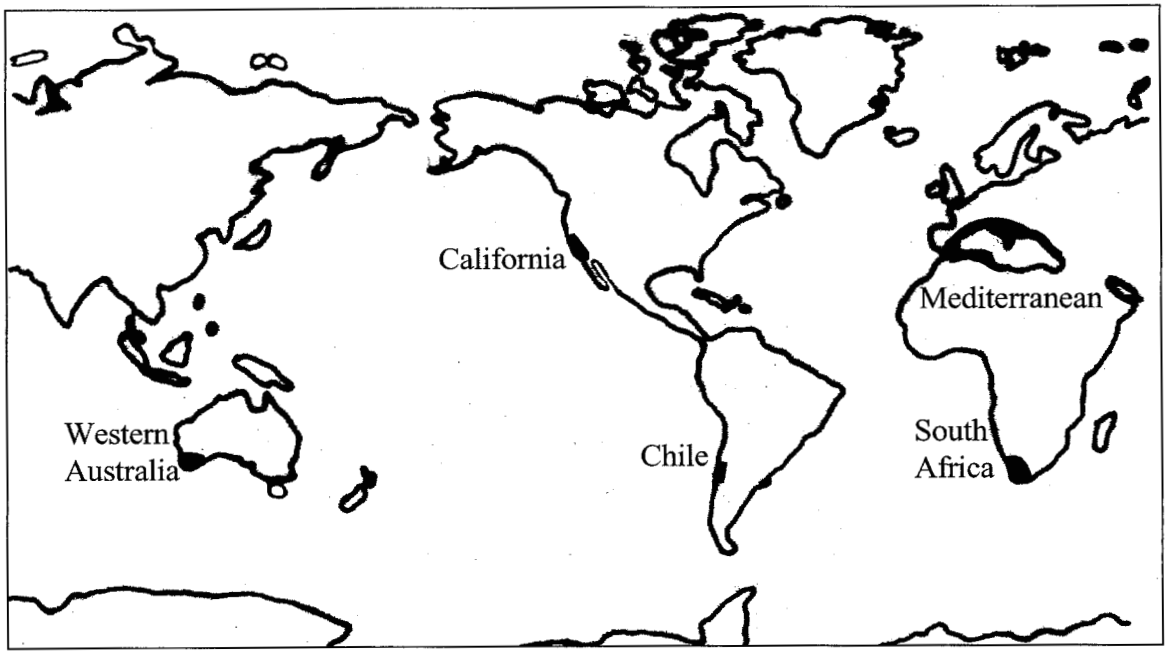


Figure 3.01. Mediterranean climates of the world (based on Dallman, 1998)

Mediterranean regions (Figure 3.01) are characterized by their climate, soils, and flora (Dallman, 1998). The climates of mediterranean regions have hot, dry summers and warm, moist winters (Strahler and Strahler, 1989). Due to the hot and dry summers in these regions, most of these regions give rise to wildfires (Dallman, 1998). The flora of these regions have developed reproductive adaptations to fire. The one region that historically has not had seasonal fires is the mediterranean area of Chile (Arroyo, *et al.*, 1995). Researchers have not determined why Chile does not have the wildfires present.

The soils of mediterranean regions are classified in the Xeralf suborder of Alfisols (Strahler and Strahler, 1989). Alfisols are soils of moist climates that have a B-horizon with accumulated silicate clay minerals. These clay minerals have a moderate capacity to hold base cations such as calcium and magnesium. These clay minerals cause Alfisols to have a high base status. The A-horizon has lost some of its original bases, clay minerals, and sesquioxides by the process of eluviation.

Mediterranean plants have developed adaptations of leaf structure, food and water storage, life cycles, root structure, and spiny stems in order to survive. The flora typically have glaucous and hirsute, or sclerophyll, foliage that allow for efficient water retention, reduced transpiration, and cold tolerance during infrequent periods when the temperature recedes near 0° C and below (Dallman, 1998). Drought-deciduous plants drop most or all of their leaves during periods of summer drought. There are some plants that have seasonally dimorphic leaves. One set of soft, drought-sensitive leaves are produced during the winter and spring. The first set of leaves is replaced in the summer by smaller leaves with a greater resistance to drought. Bulbs and other geophytes grow in mediterranean regions because they can retain water and food underground during droughts. Annuals survive in mediterranean regions by reproducing and setting seed before the onset of droughts. Roots of mediterranean plants have two methods for obtaining water. Seedling plants rapidly develop a taproot to obtain moisture in the soil while older plants form a dense mat to absorb water available after rainfalls. Stems can have spines to deter fauna from eating leaves.

Besides Chile, these regions are located in southwestern Australia, southwestern South Africa, western and central California, and countries around the Mediterranean Sea in Europe, Asia, and Africa (Dallman, 1998).

Further information about the mediterranean region upon which plants were focused for the thesis will be presented in the next chapter, MEDITERRANEAN CHILE.

Chapter 4

MEDITERRANEAN CHILE

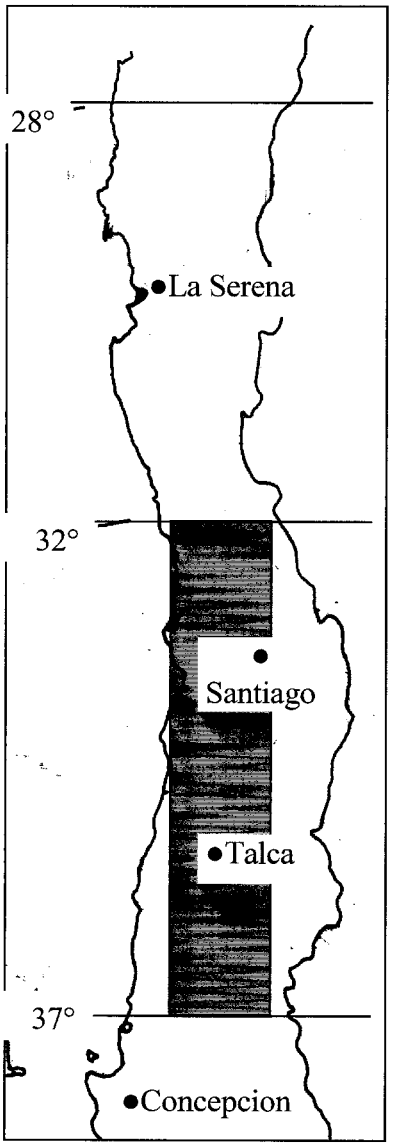


Figure 4.01. Mediterranean Chile represented by shading (Dallman, 1995)

The mediterranean region of Chile (Figure 4.01, 4.02) occurs between 32° and 37° south latitude (Hoffman, 1995). This area on Figure 4.01 is between La Serena and Concepcion. North of this area is semi-desert leading to the Atacama desert at the Chile-Peru border. The semi-desert differs from the mediterranean area by having

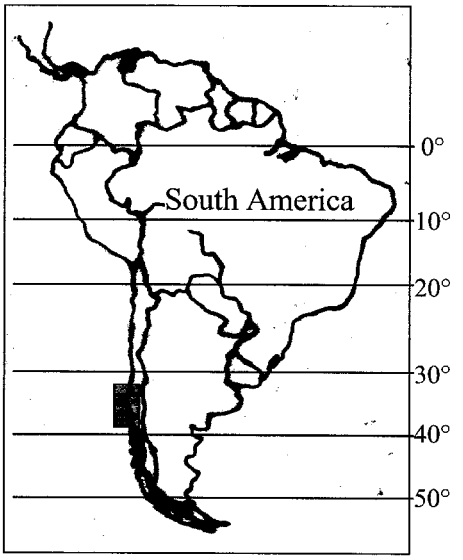
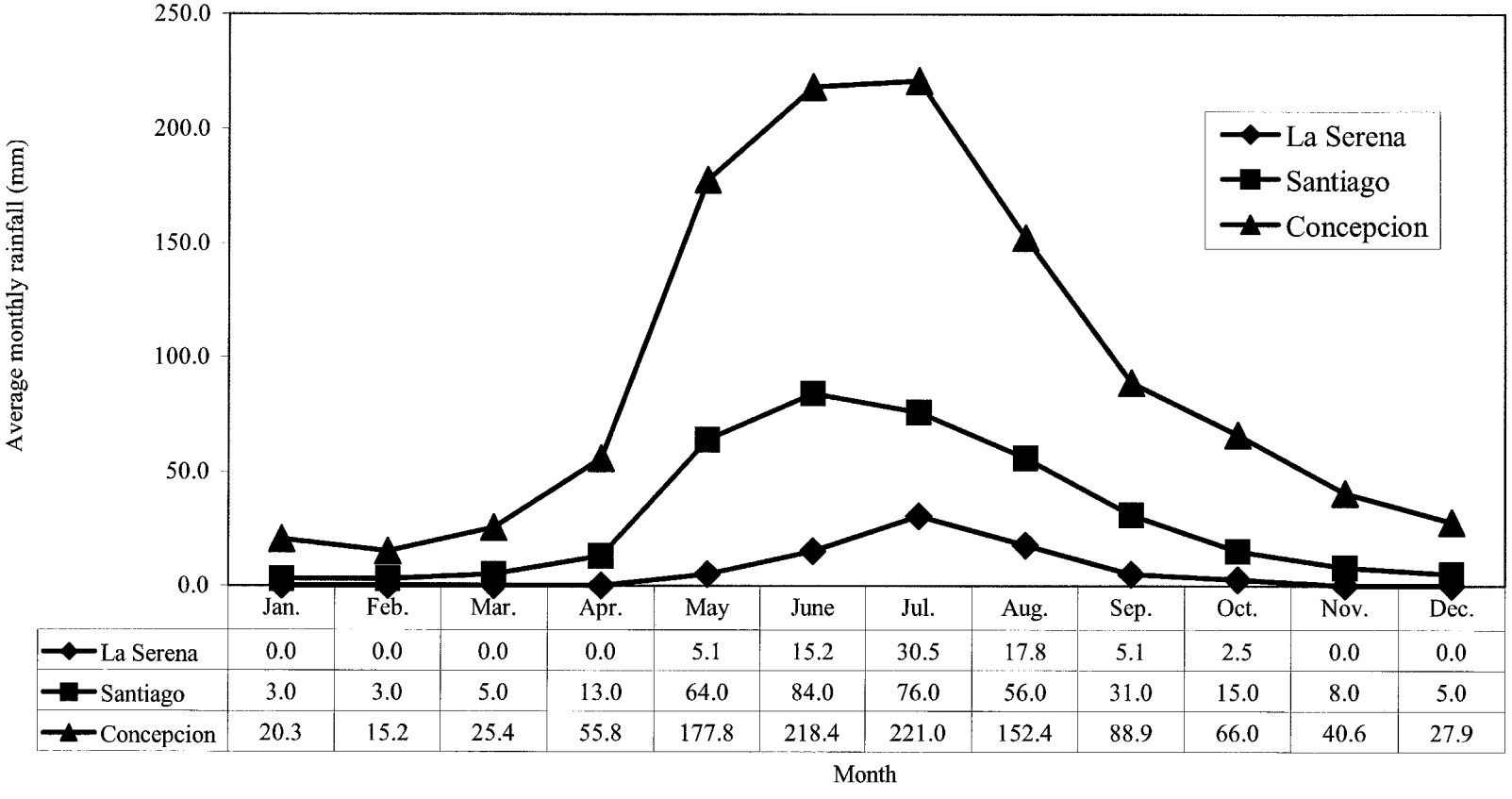


Figure 4.02. South America with shaded area from Fig. 4.01 (Rand McNally, 1970)

warmer temperatures and less rainfall. South of the mediterranean area is the beginning of a temperate rainforest, which differs by having cooler temperatures and increased rainfall. The western boundary of the mediterranean region is the Pacific Ocean. Along the Pacific Ocean is a series of hills known as the Coastal Ranges. The highest point of the coastal range, 600 m above sea level, is at Parque Nacional Fray Jorge, 110 km south of La Serena (Graham, 1998). The hills of the Coastal Ranges block moist winds from blowing into the central valley of Chile. The eastern boundary of the mediterranean region is the Andean Mountains. The Andes reach heights near 7,000 m in elevation above sea level (Graham, 1998).

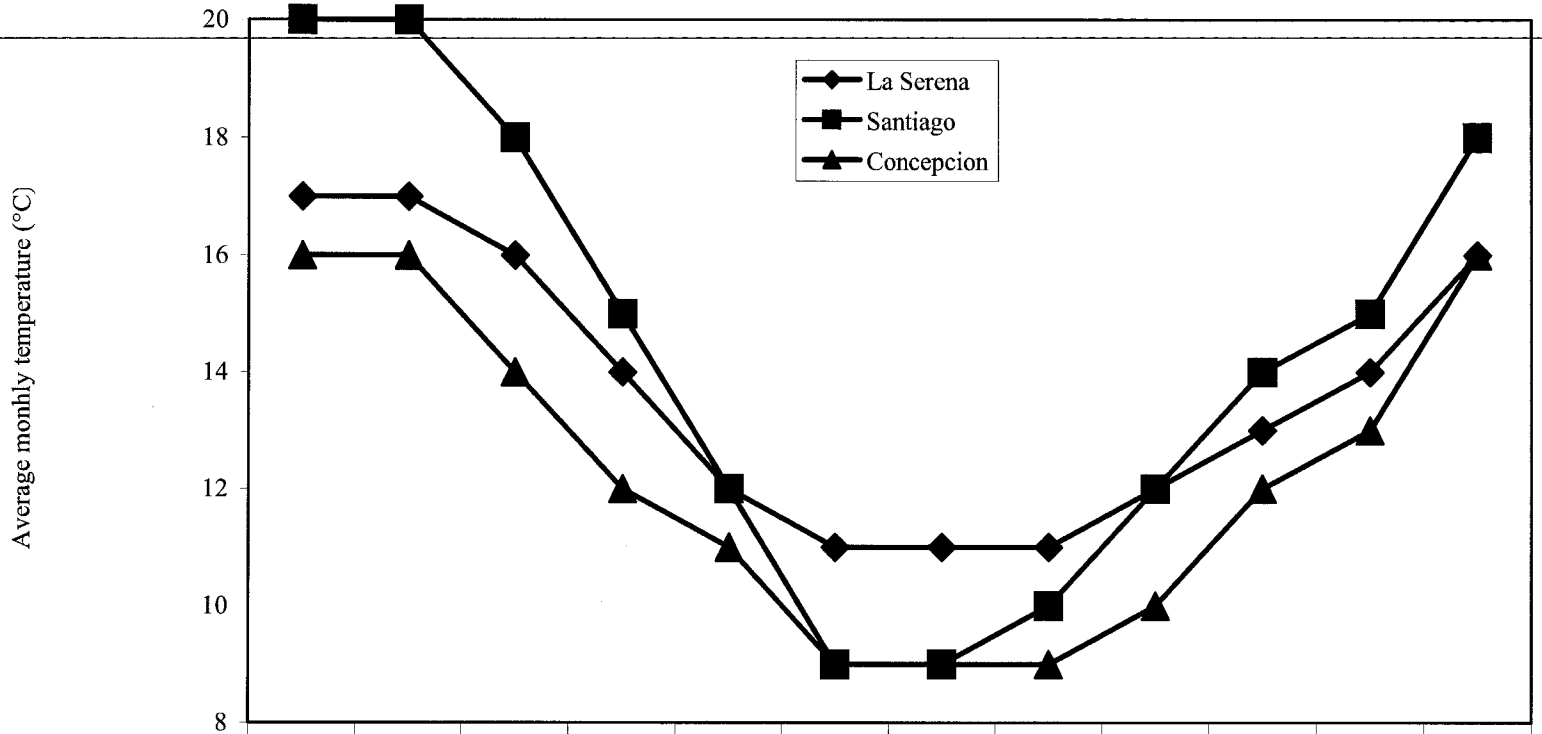
The temperature and rainfall vary significantly from the southern to the northern part of central Chile (Figure 4.03, 4.04). The entire region has moderate temperatures with monthly averages between 9 degrees Celsius in winter and 20 degrees Celsius in summer. Concepcion, being at the southern limit of central Chile, has the lowest average monthly temperatures during the year, between 9 and 16 degrees Celsius. La Serena, on the northern limit of central Chile, has the highest average monthly temperatures, between 11 and 17 degrees Celsius. Santiago, centrally located in mediterranean Chile, lies inland from the Pacific Ocean. Santiago is warmer than Concepcion and La Serena in the summer because it lies inland from the Coastal Ranges. The Coastal Ranges divert the Pacific winds from moderating the temperatures of Santiago during the summer months. Concepcion and La Serena's temperatures are moderated by their proximity to the Pacific Ocean. Winds from the Pacific moderate the temperatures of Concepcion and La Serena in



	Jan.	Feb.	Mar.	Apr.	May	June	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
La Serena	0.0	0.0	0.0	0.0	5.1	15.2	30.5	17.8	5.1	2.5	0.0	0.0
Santiago	3.0	3.0	5.0	13.0	64.0	84.0	76.0	56.0	31.0	15.0	8.0	5.0
Concepcion	20.3	15.2	25.4	55.8	177.8	218.4	221.0	152.4	88.9	66.0	40.6	27.9

Figure 4.03. Comparison of average monthly rainfall; La Serena, Santiago, and Concepcion, 1979-98 (Graham et al., 1998, Pearson, 2002.a, b).

Average monthly rainfall in mm compared between three cities in central Chile. La Serena is at the northern limit of central Chile. Santiago is in the center of central Chile. Concepcion is at the southern limit of central Chile.



	Jan.	Feb.	Mar.	Apr.	May	June	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
La Serena	17	17	16	14	12	11	11	11	12	13	14	16
Santiago	20	20	18	15	12	9	9	10	12	14	15	18
Concepcion	16	16	14	12	11	9	9	9	10	12	13	16

Month

Figure 4.04. Comparison of average monthly temperatures; La Serena, Santiago, and Concepcion, 1979-98 (Graham et al., 1998, Pearson, 2002.a, b).

Graph depicts average monthly temperature in three cities of central Chile. La Serena is at the northern limit of central Chile. Santiago is in the center of central Chile. Concepcion is at the southern limit of central Chile.

the winter by blowing in moist air, warmed from ocean currents. Concepcion receives the most moisture of the three cities with a yearly average of 1,110 mm (Graham, 1998, Pearson, 2002.a). Concepcion receives more rainfall because it lies within the transition between the mediterranean and temperate rainforest regions of Chile. La Serena receives the least rainfall of the three cities with a yearly average of 76.2 mm (Graham, 1998, Pearson, 2002.b). La Serena receives less rainfall because it lies within the transition between the mediterranean and desert regions of Chile.

The plants of central Chile, while not adapted to fire as in other mediterranean climates, have a significant number of species with underground storage systems. These systems: lignotubers, tubers, and bulbs, allow woody and herbaceous plants to survive periods without rainfall. After rains drench soils in spring, plants emerge, flower, and reproduce before summer droughts.

Elevation and orientation also play roles in determining where mediterranean plants grow (Dallman, 1998). Mediterranean plants grow at elevations less than 1500 m in central Chile. Along the Pacific Ocean, hills at or about 600 m in altitude have a cloud forest around their peaks. The clouds are formed as the moist winds rise and cool. These hills produce rain shadows on their eastern sides.

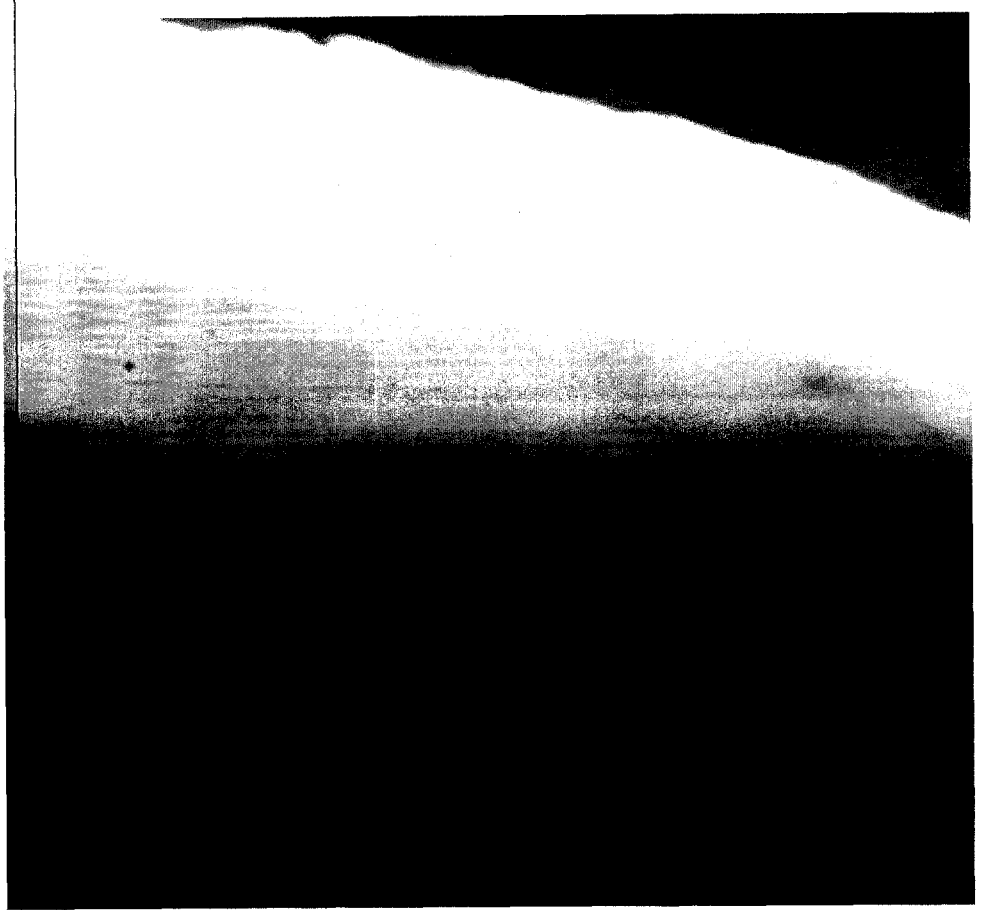


Figure 4.05. Clouds over Pacific coastal range
near Parque Nacional Fray Jorge

As evidenced in Fray Jorge National Park and in Figure 4.05, the moist, coastal air rises above the coastal range, cools, and produces a cloud forest environment while the lands to the east are arid. Plants growing on the windward sides and along the tops of the hills have larger, thinner leaves because more efficient moisture retention is not as important as it is in the arid land to the east.

The plants on the leeward sides have sclerophyll foliage because moisture is dissipated from the air.

One of the first documented plant expeditions in Chile was by a Spanish explorer, Fernando de Magallanes, in the sixteenth century (Grau and Zizka, 1992). Canelo, *Drimys winteri* Forst. & Forst., was collected by him and his crew with hope that parts of the plant would help combat scurvy. Vitamin C, contained in the bark and leaves at levels higher than orange or lemon fruits, could help combat scurvy (Montenegro, 2000). A Catholic priest from France, Louis Feuillee conducted an expedition at the request of King Louis XIV dedicated to documenting cities and ecologies of Chile and Peru in 1709 and then again in 1711. Among the plants he documented was the strawberry, *Fragaria chiloensis* Duchesne (Darrow, unpublished). Juan Ignacio Molina, a Jesuit scholar, attempted to make Europeans aware of the flora of Chile after 1782, when Jesuits were expelled from Chile. Molina fled to Italy, where he wrote a volume on the natural history of Chile in 1782 entitled *Saggio sulla storia naturale del Chili.* This volume included descriptions of Chile's native flora.

A major Chilean expedition was made between 1778 and 1788. King Carlos III of Spain elected Hipolito Ruiz and Jose Antonio Pavon to conduct the "Royal Botanical Expedition" (Schultes and Jaramillo-Arango, 1998). Many species were documented and described by the pair, including the Chilean national flower, *Lapageria rosea* Ruiz & Pav. Their herbarium collections served as the basis for their three volume flora of Chile and Peru, *Flora peruviana et chilensis*,

written between 1798 and 1802. German botanists Eduard Poeppig and Stephan Endlicher between 1835 and 1845 conducted the next major description of the Chilean flora (Zizka and Grau, 1992). In their book, *Reisen in Chile, Perú und auf dem Amazonenstrome*, published in 1834, they provided taxonomic descriptions of many Chilean plants that had never been described before. Their most notable discovery was documentation of *Amaryllis* (Williams, unpublished). A few years after Poeppig and Endlicher published their studies; a Frenchman by the name of Claude Gay began his studies in Chile. Between 1842 and 1867, Gay published 28 volumes called *Political and Physical History of Chile*. Eight of the 28 volumes were devoted to the flora of Chile. To compile the volumes on Chilean flora, Gay collaborated with reknowned French botanists like Achille Richard, Emile Desvaux, Joseph Decaisne, and Jules Remy. Together, they documented 1,320 species of plants. Other botanists that documented the Chilean flora in the nineteenth century were German botanists Rudolph Amandus Philippi and Karl Reiche. In the twentieth century, a major contributor to the documentation of the Chilean flora was Carlos Munoz Pizarro. As Director of the Museum of Natural History in Santiago, Pizarro initiated studies on the native Chilean flora and methods of protection. These early floristic works, though remarkable for their time, lack total taxonomic and geographic coverage and use nomenclature not currently accepted (Arroyo *et al.*, 1995).

Modern books on Chilean plants attempt to fill the gaps left by the earlier researchers. Today, naturalists like Adriana Hoffmann with her volume *Flora*

silvestre de Chile: zona central (1995) and Gloria Montenegro's volume *Chile nuestra flora útil* (2000), continue the tradition of documenting and conserving the mediterranean region's flora. Plant explorers such as Daniel Hinkley and Roy Lancaster are increasing the introduction of plants from Chile to North America and Great Britain, respectively (Hinkley, 2001, Baxter *et al.*, 1998).

Chapter 5

RESULTS

In this chapter, data are presented on a survey distributed to all 14 members of Longwood Gardens' Plant Evaluation Committee and a listing of plants observed in Chile that the author recommends for trial at Longwood. The first section indicates survey responses. The survey responses are represented by a 100% response rate. The survey results show that the Plant Evaluation Committee uses a majority of the given selection criteria when selecting a plant. These results do not assist the researcher in narrowing the list of target plants represented in Appendix B. Any of the target plants have criteria indicated as desirable in the survey results.

The second section, Target plants recommended for display, describes the physical characteristics of 26 plants the researcher finds would be possible display plants at Longwood Gardens.

Survey responses

The following data represents a compilation of survey responses from Longwood Gardens' Plant Evaluation Committee. The percentages indicate importance of a characteristic to the 14 respondents. Each figure caption includes the original question in italics.

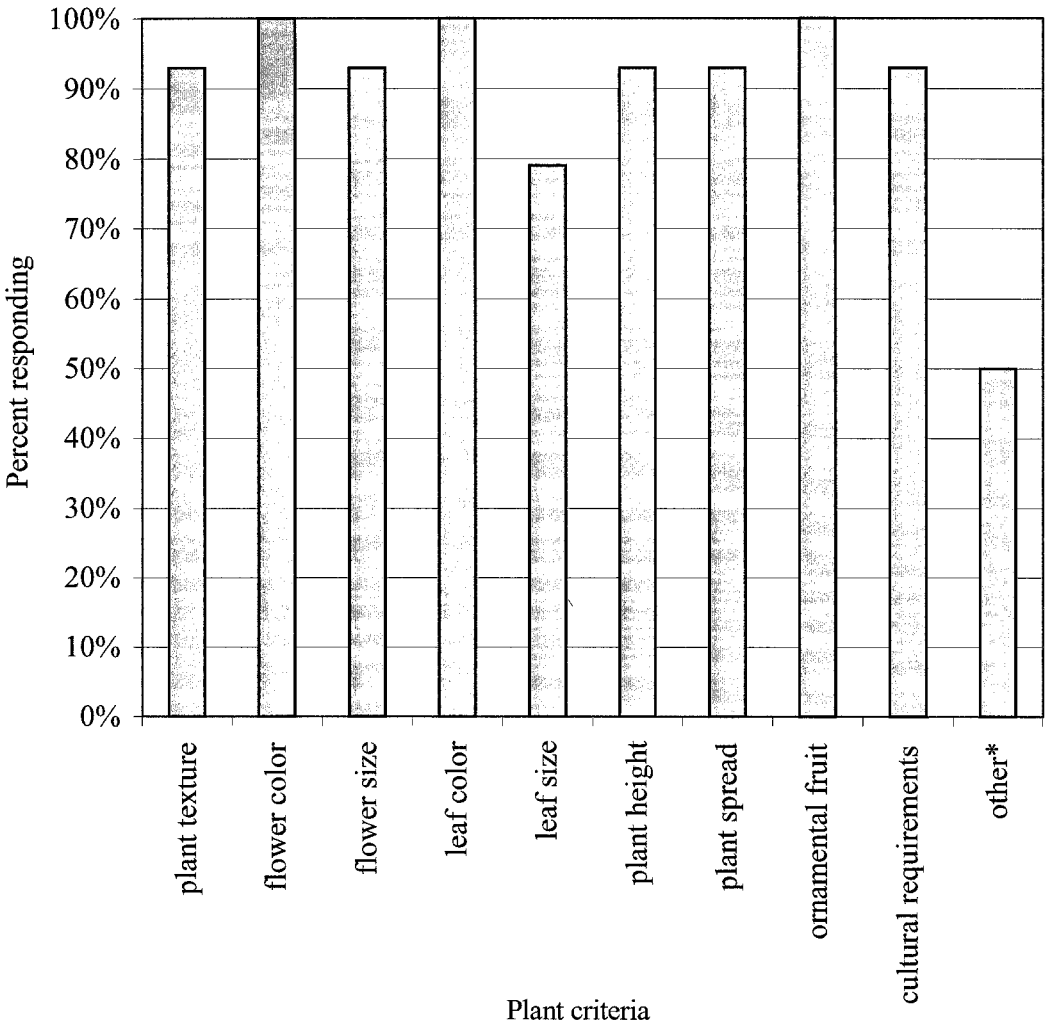


Figure 5.01. Results to question 1. *Of the following criteria, which do you consider when selecting a plant: (check all that apply).*

For question 1 (Figure 5.01), the responses ranged from 50 to 100 percent. The most responded criteria were: flower color, leaf color, and ornamental fruit. The least responded criterion was: other. Characteristics listed in other*: *Invasiveness, leaf shape, nativity, timing, flower duration, pest resistance, attractive*

stems or bark, flower timing, maintenance requirements, plant toughness, something different from already there, timing

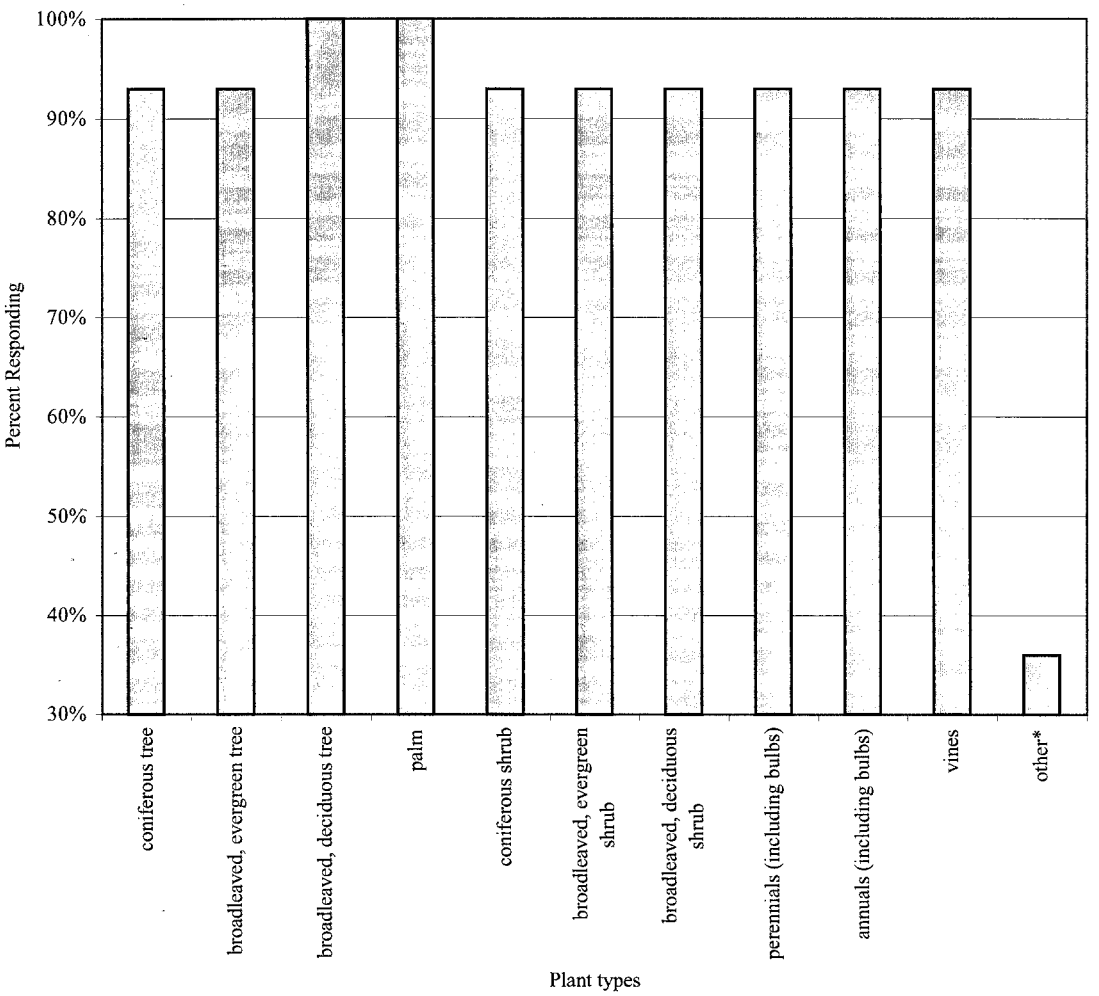


Figure 5.02. Results to question 2. *Of the following types of plants, which do you consider useful to displays at Longwood Gardens? (check all that apply)*

The responses for question 2 ranged from 36 to 100 percent (Figure 5.02). The most responded types were broadleaved, deciduous tree and palm. The least

responded criterion was other. Characteristics listed in other*: *Ground covers, aquatics, tropicals, orchids, ferns, and epiphytes*

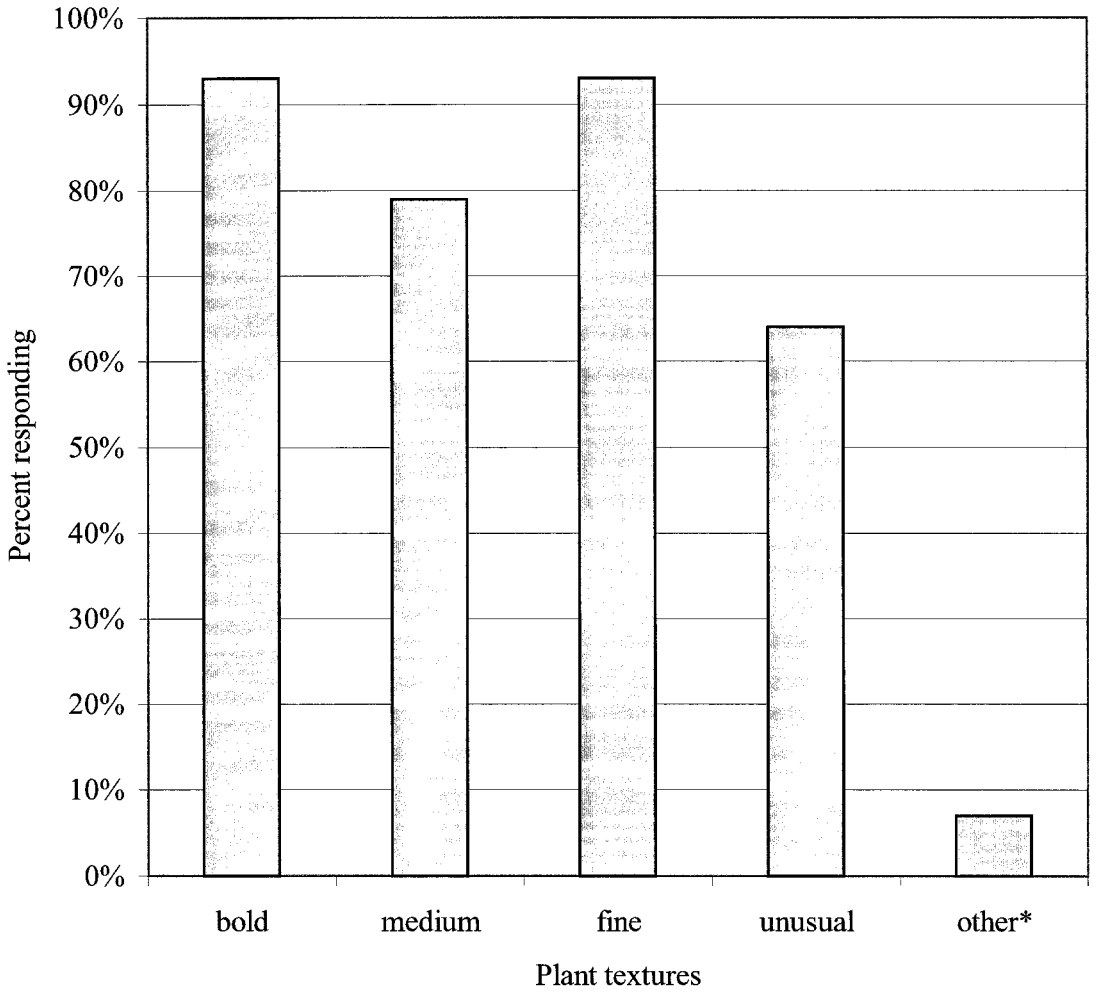


Figure 5.03. Results to question 3. *Of the following plant textures, which do you use in Longwood's displays? (check all that apply)*

The responses ranged for question 3 from 7 to 93 percent (Figure 5.03). The most responded textures were bold and fine. The least responded criterion was other. Characteristics listed in other*: a*ll*

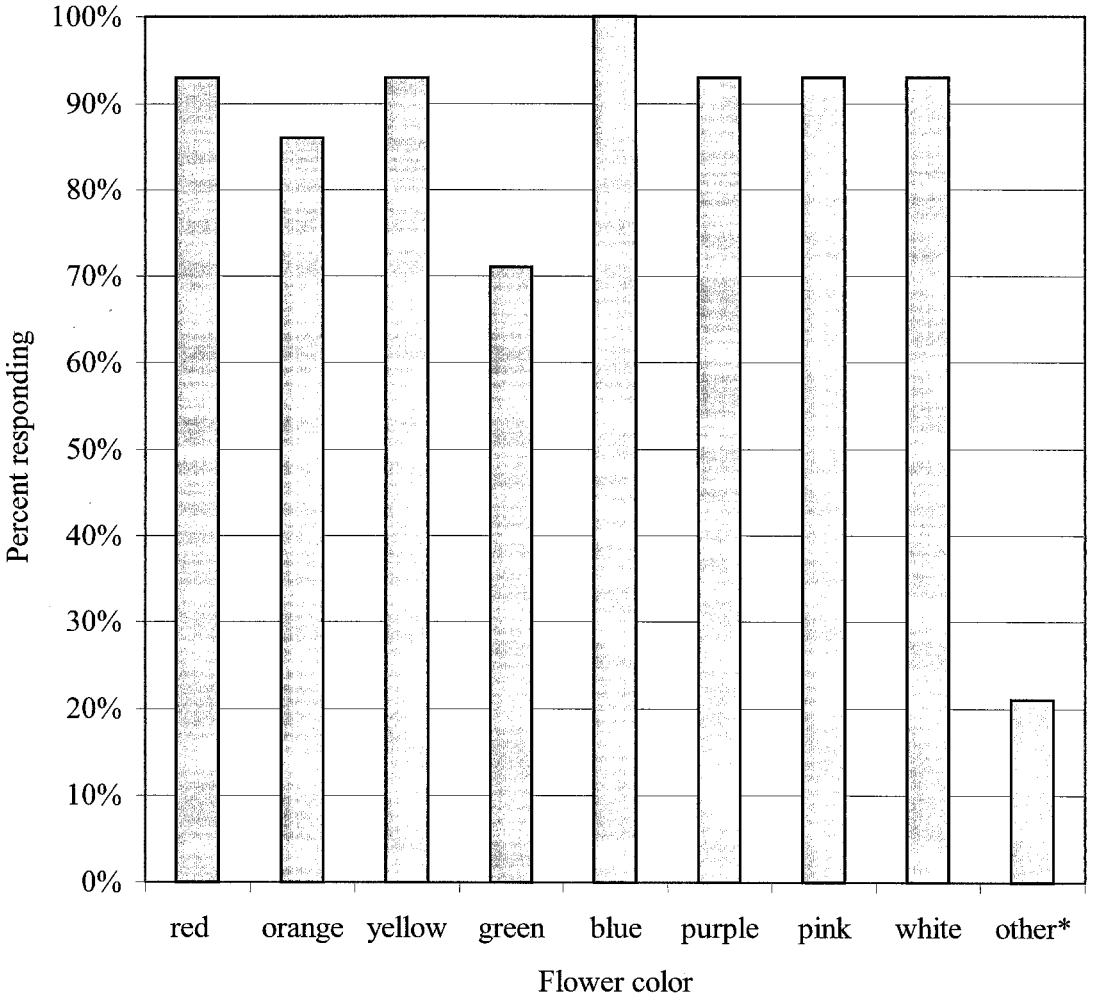


Figure 5.04. Results to question 4. *Which of the following plant flower colors do you utilize for Longwood's displays? (check all that apply)*

Responses ranged for question 4 from 21 to 100 percent (Figure 5.04). The most responded color was blue. The least responded criterion was other. Characteristics listed in other*: s*almon, fuchsia (there are so many), all*

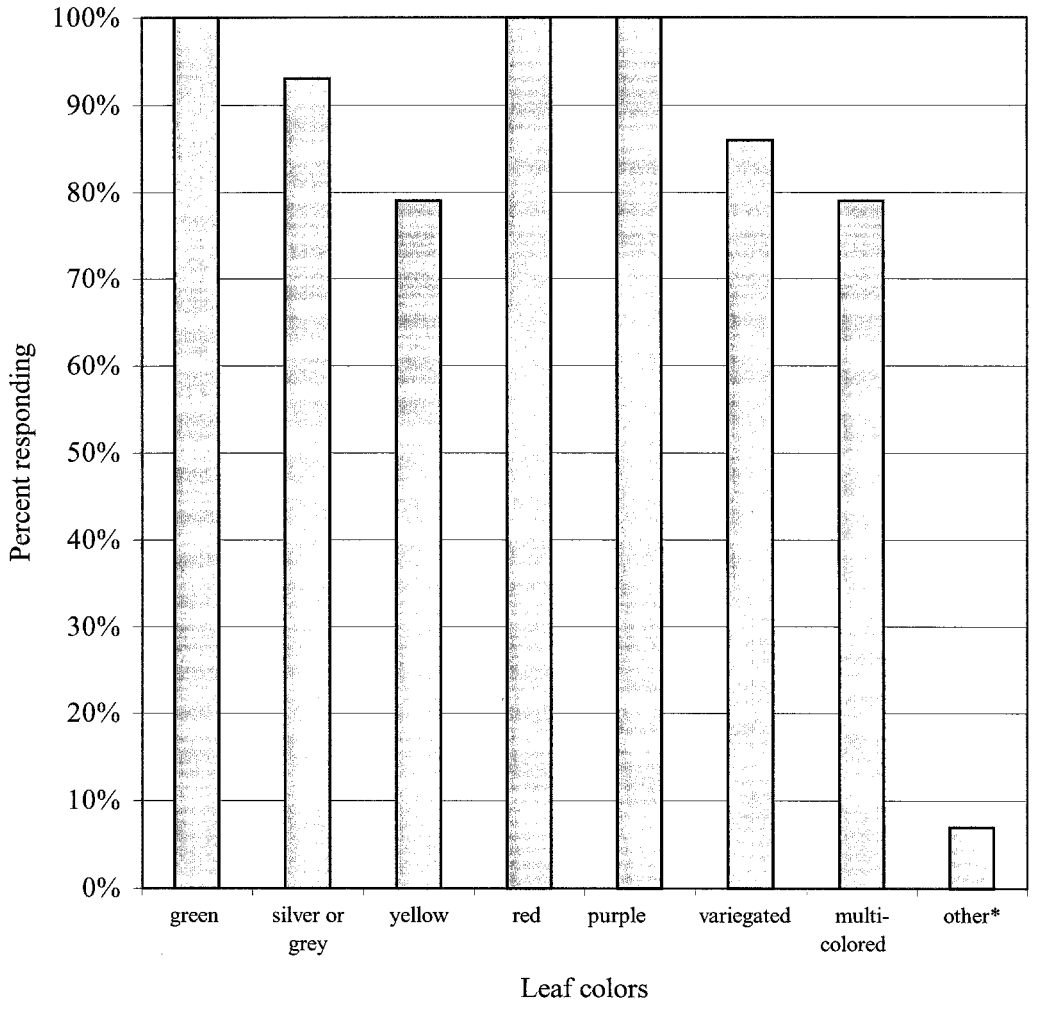


Figure 5.05. Results to question 5. *Which of the following leaf colors do you utilize for Longwood's displays? (check all that apply)*

Responses ranged for question 5 from 7 to 100 percent (Figure 5.05). The most responded colors were green, red, and purple. The least responded criterion was other. Characteristics listed in other*: *all.*

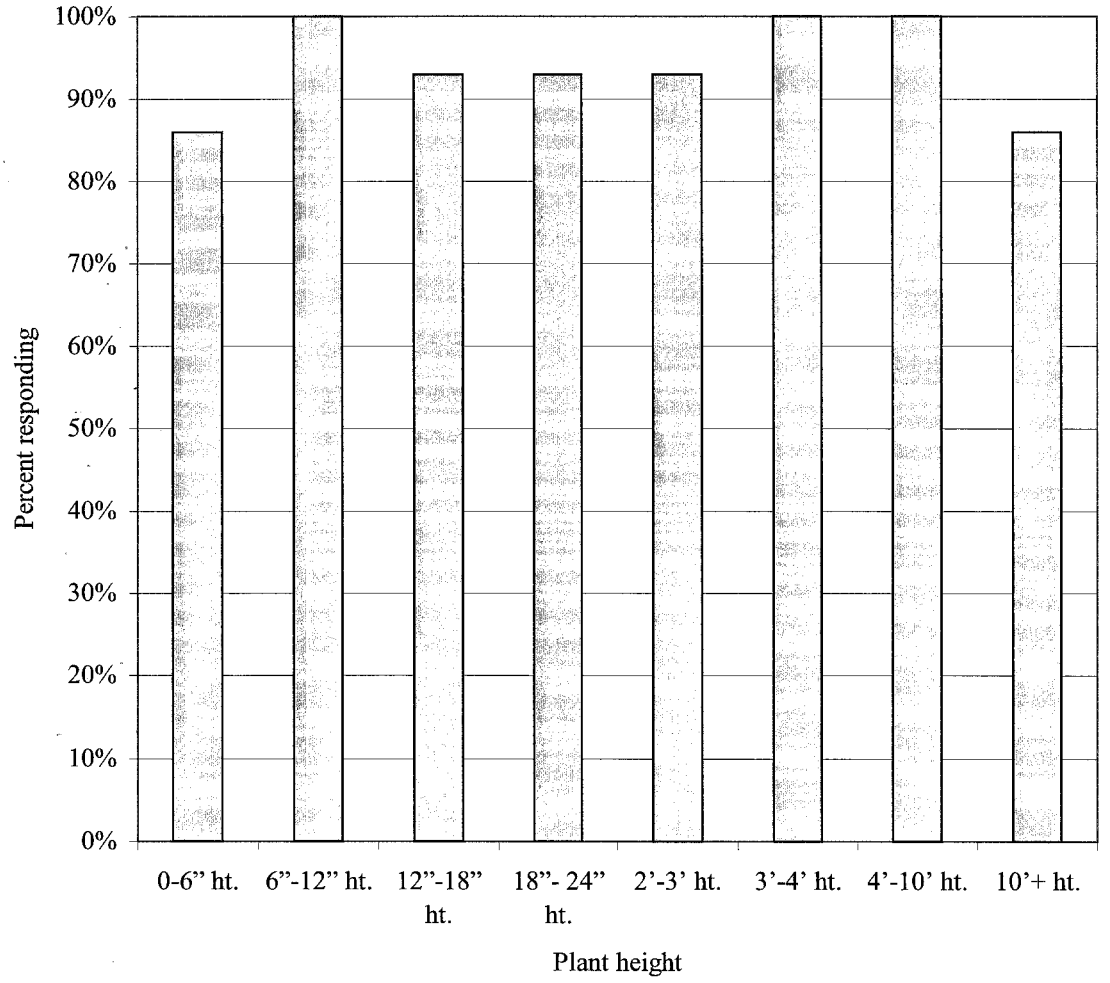


Figure 5.06. Results to question 6. *What size (height in inches (") or feet (')) of plant do you use in Longwood displays? (check all that apply)*

Responses for question 6 ranged from 86 to 100 percent (Figure 5.06). The most responded heights were 6-12", 3-4', and 4-10'. The least responded heights were 0-6" and 10'+.

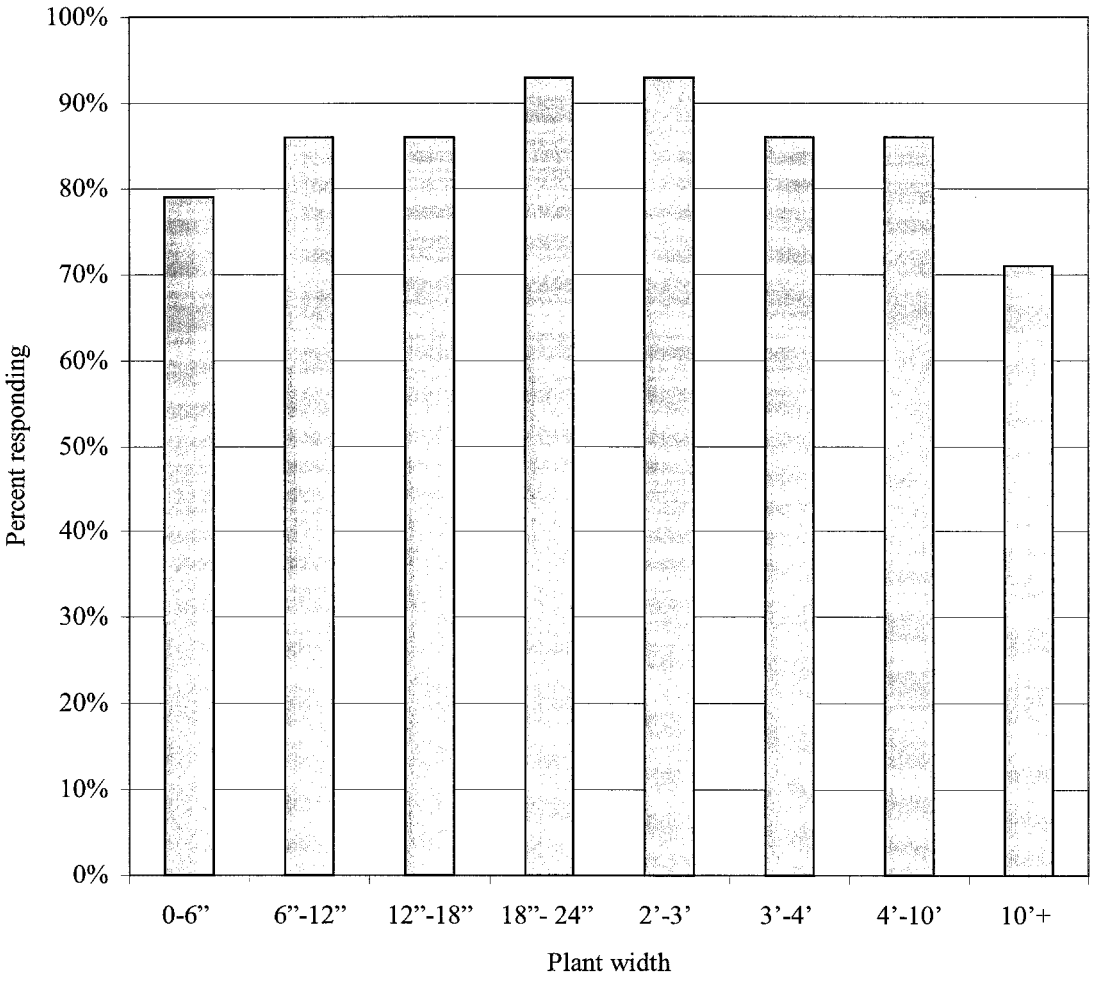


Figure 5.07. Results to question 7. *What size (width in inches (") or feet (')) of plant do you use in Longwood displays? (check all that apply)*

The responses for question 7 ranged from 71 to 93 percent (Figure 5.07). The most responded widths were 18-24" and 2-3'. The least responded width was 10'+.

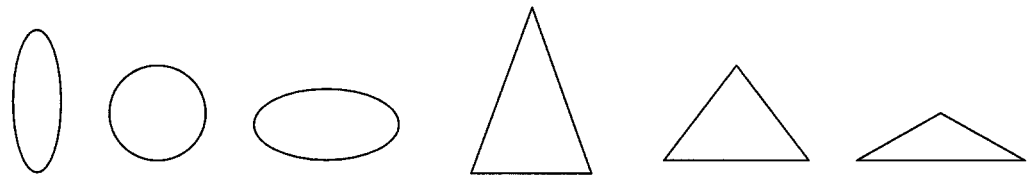


Figure 5.08. Results to question 8. *Of the following, which shapes illustrate the plant forms that you use in displays for Longwood? (circle all that apply)* The most responded shape was tall, triangular. The least responded shape was short, triangular.

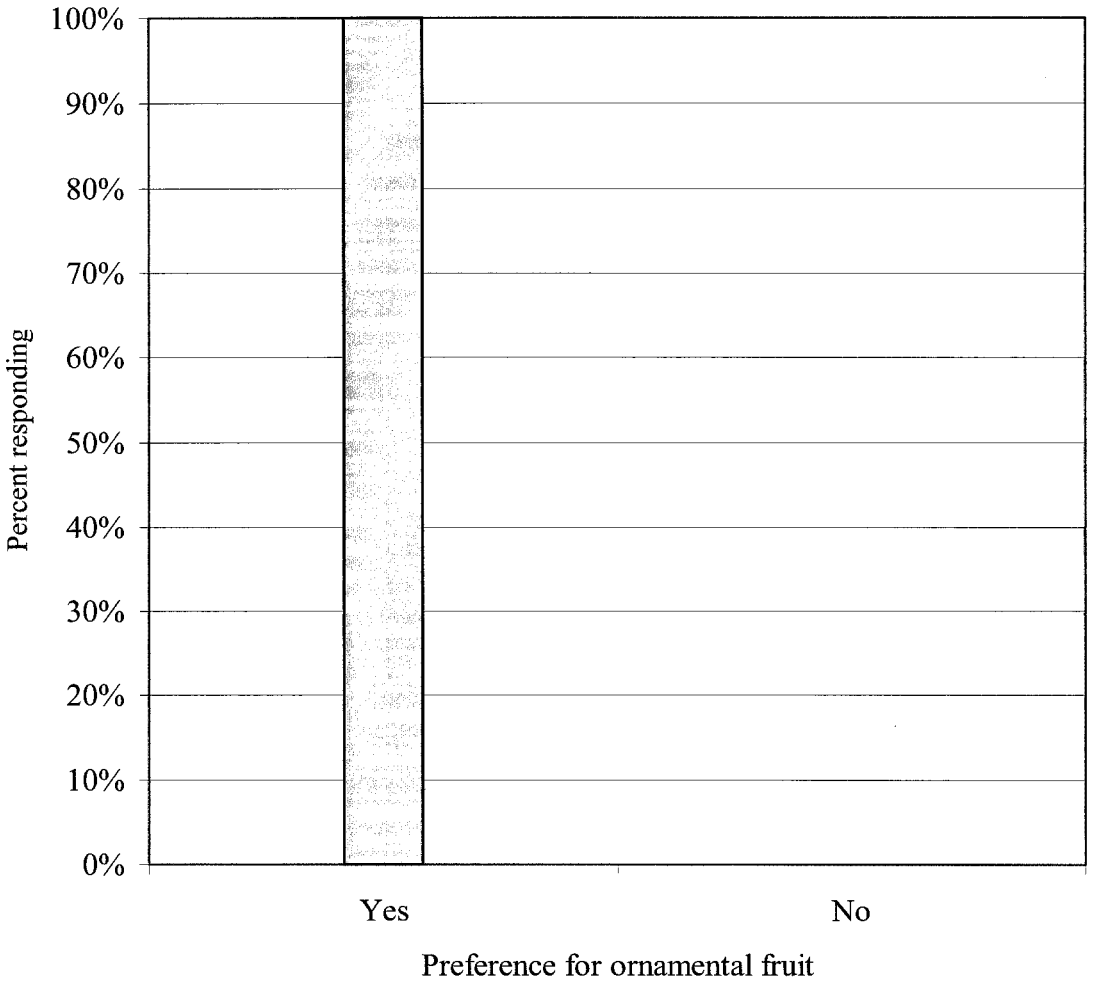


Figure 5.09. Results to question 9. *If a plant has ornamental fruit, would you consider using the plant in a Longwood display for this characteristic?*

All responses from question 9 indicated "Yes" (Figure 5.09).

Question 10: *What qualities do you look for in ornamental fruit? Please elaborate. (e.g. color = red & orange; size = 1" diameter; arrangement = cluster, etc.)*

The responses to question 10 were: color, size, density, glossiness, persistence, fragrance, whether it attracts wildlife, non-edible fruits because they last longer, stands out from foliage, bright color, showy display, less than 3" diameter, shape, red, orange, yellow, blue, black, white, size depends on plant, overall show, any bright color, size related to quantity.

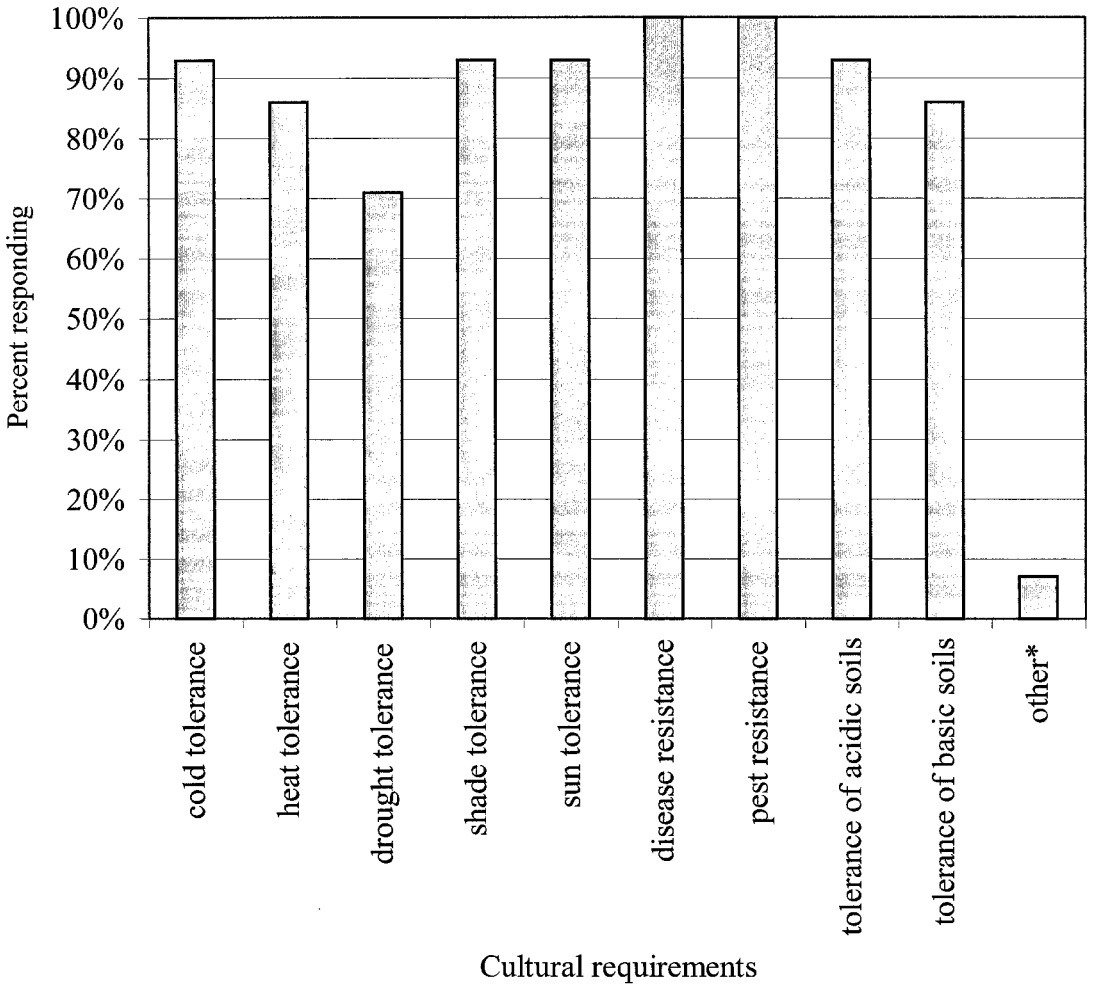


Figure 5.10. Results to question 11. *Of the following, please select the cultural requirements that you feel are an important characteristic of a display plant at Longwood: (check all that apply)*

Responses to question 11 ranged from 7 to 100 percent (Figure 5.10). The most responded requirements were disease and pest resistance. The least responded criterion was other. Response for other*: *air drainage.*

Table 5.01. Results to question 12. *For the following seasonal displays, please list all plant colors you use at Longwood Gardens.*

Display Season	**Colors**
Winter	blue, red, green, white, yellow, all colors, pink, maroon, gray
Early spring	blue, pink, yellow (softer pastels), lavender, all colors, green, white
Late spring	all colors
Early summer	all colors
Late summer	orange, yellow, red, brown, bright colors, bold colors, all colors
Early fall / Chrysanthemum festival	orange, red, yellow, blue, bright colors, bold colors, all colors
Late fall	all colors
Christmas	red, green, white, yellow, maroon, all colors

The responses to question 12 indicated all colors in all seasons.

Response to question 13. *Are there any other seasonal displays at Longwood Gardens not covered by Question 12? If so, please list the season(s) and the colors used for the season(s):*

One respondent to question 13 indicated: Gardenfest (Sept.) - reds, oranges, yellows, browns.

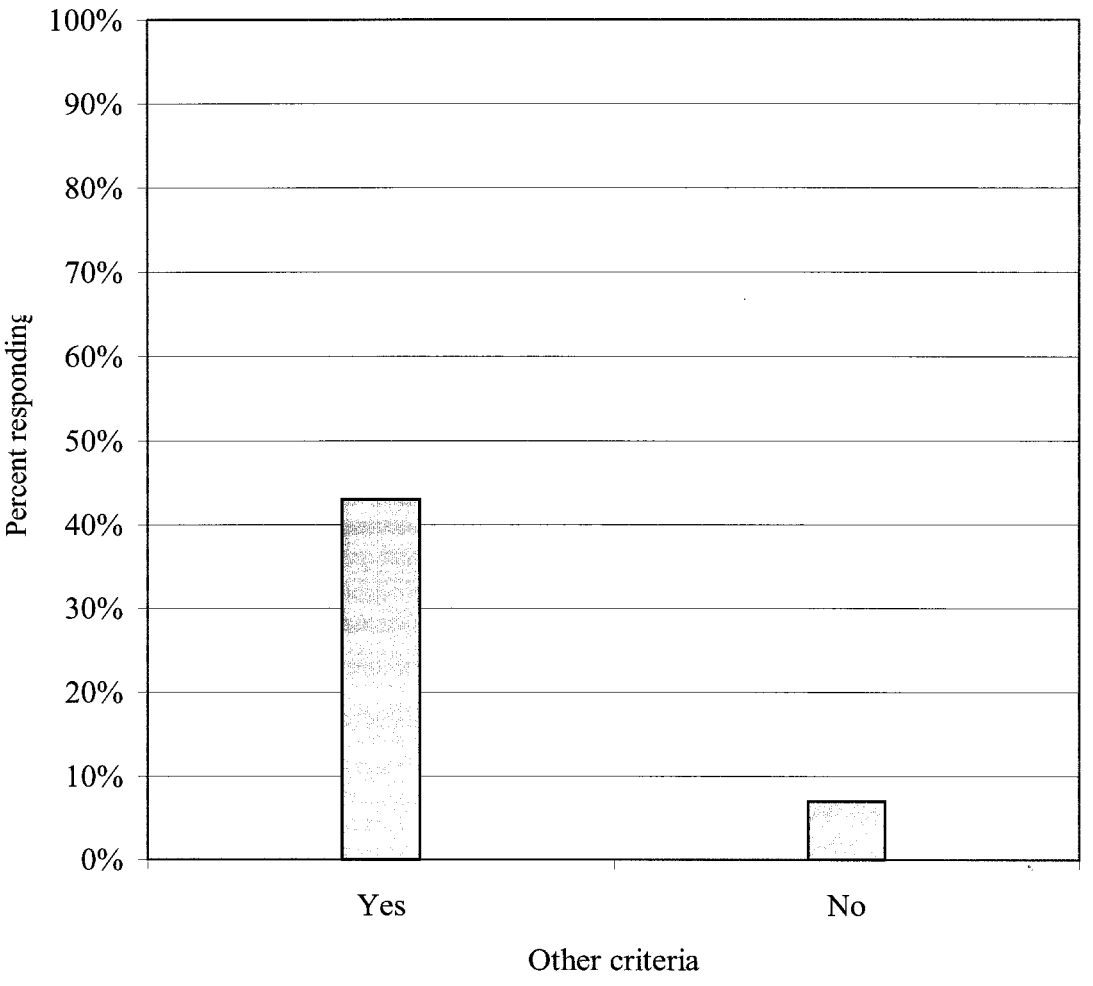


Figure 5.11. Results to question 14. *Other than color, are there any other criteria (size, texture, etc) that you look for when selecting plants for a certain season?*

Forty-three percent of the respondents to question 14 indicated other criteria. Seven percent did not indicate other criteria. The other criteria were:

- habit of flowers on Meconopsis punicea
- texture is important in winter
- Christmas needs strong evergreen foliage and fruit temperature tolerance

- light requirement, water requirements, size, form
- formal for fall and winter, informal for summer and spring

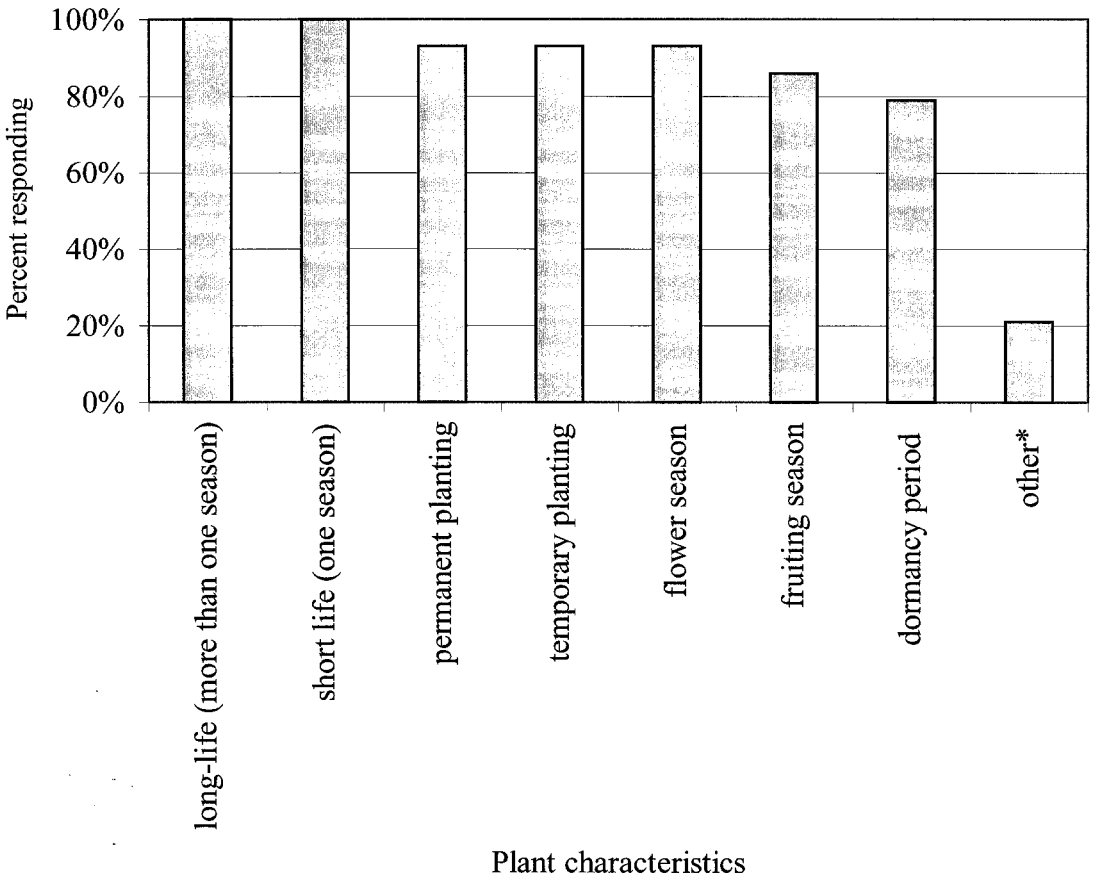


Figure 5.12. Results to question 15. *Of the following plant characteristics, which do you use as a factor when selecting plants for display? (check all that apply)*

Responses to question 15 ranged from 21 to 100 percent (Figure 5.12). The most responded characteristics were long-life and short-life. The least responded criterion was other. Responses to other*: *labor and effort to grow/maintain, greenhouse space required, attractiveness while on display, holds bottom leaves*

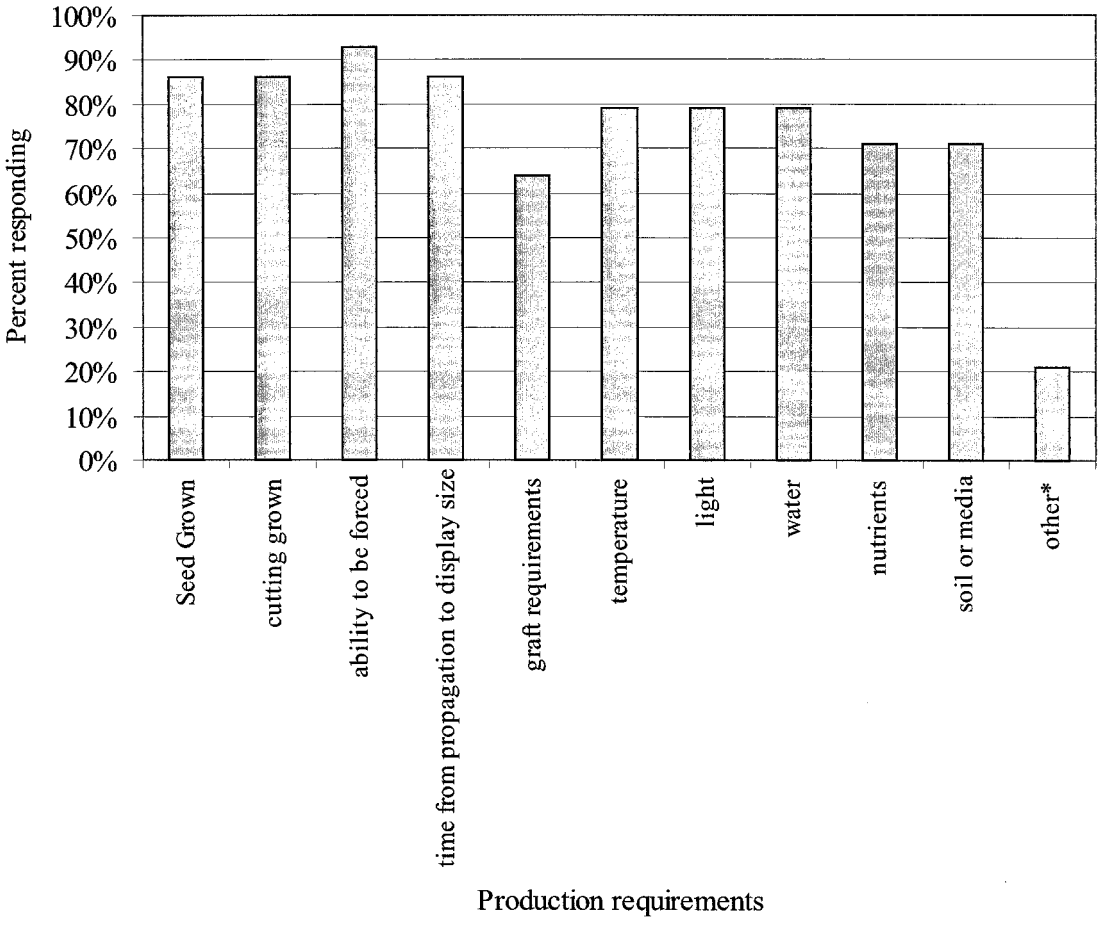


Figure 5.13. Results to question 16. *Of the following plant production requirements, which do you consider when selecting a plant for display? (check all that apply)*

Responses to question 16 ranged from 21 to 93 percent (Figure 5.13). The most responded requirement was ability to be forced. The least responded criterion was other. Responses to other*: *availability, pests (eg. Virus, diseases), number of pinches, deadheading, foliage removal, response to root zone heat*

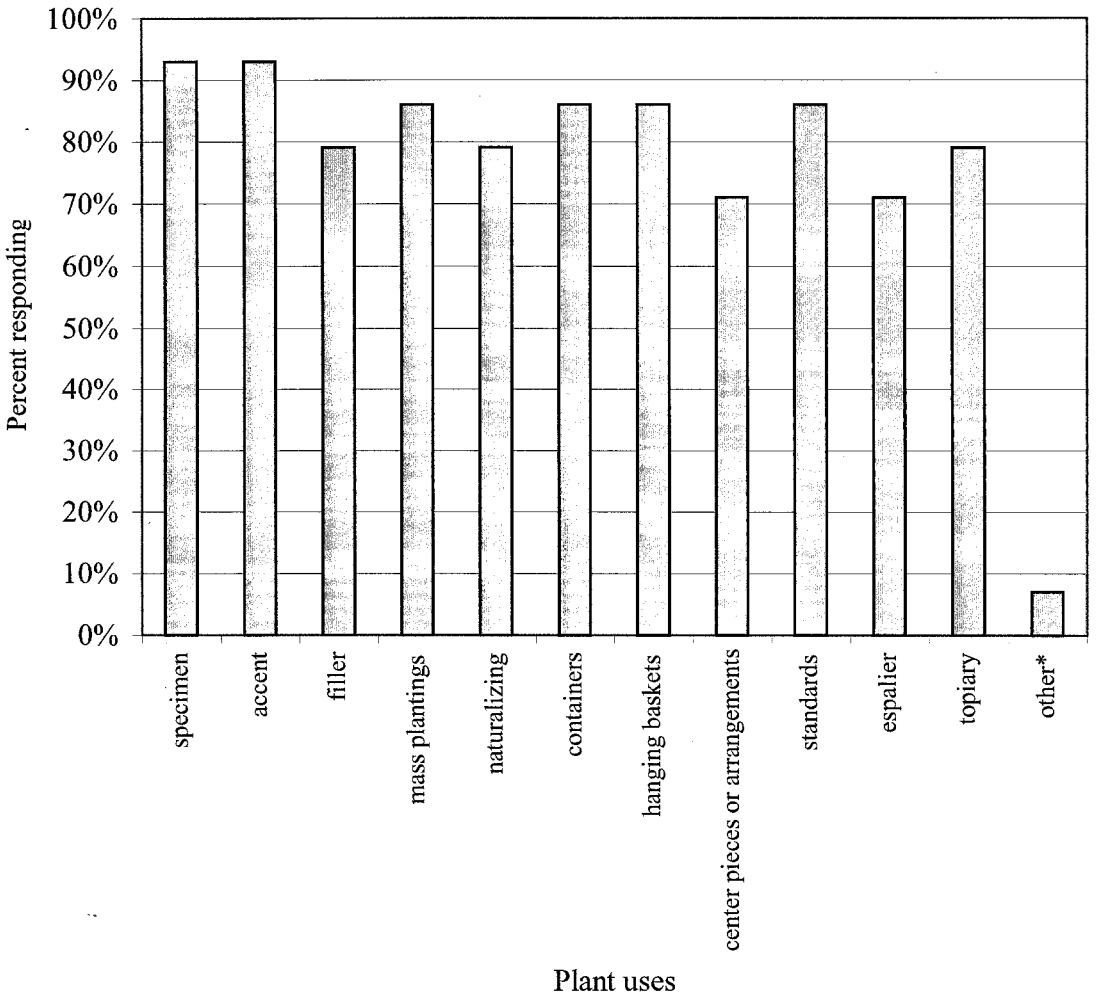


Figure 5.14. Results to question 17. *Of the following plant uses, which do you use at Longwood for display? (check all that apply)*

Responses to question 17 ranged from 7 to 93 percent (Figure 5.14). The most responded uses were specimen and accent. The least responded criterion was other.

Responses to other*: *hedges*

Responses to question 18: *Are there any characteristics of display plants at Longwood that you feel were not covered by this survey? If so, please list and explain:*

Two responses were made for question 18. These responses were:

- normal plants used in unusual/spectacular ways
- Unusual plants in normal ways

The survey results indicate selection criteria and preferences of the Longwood Plant Evaluation Committee. The intention of the survey results are to narrow the target list of Chilean plants. The results of the survey, combined with the researcher's observation of Plant Selection Committee meetings, did not narrow the target list of Chilean plants. The narrowing of the target list comes from observation of the plants by the researcher.

Target plants recommended for display

Ninety-two plants are on the final list of plants targeted for observation. Fifty-six of the 92 target list plants are listed as observed in Chile. These observed plants represent 61% of the target list. Thirty-six of the target list plants were not observed. These 36 plants represent 39% of the target list. The plants not observed are listed in the DISCUSSION chapter. The researcher lists 26 of the 56 observed plants that should be trialed at Longwood for display purposes. The 26 recommended plants represent 28% of the original target list and 46% of observed target list plants. Determination of the 26 target plants recommended for display is based upon field observations. The determination is based upon large inflorescence size as related to plant size, clear inflorescence colors, and clear leaf colors. A physical description and location of each of the 26 target plants recommended for display is presented.

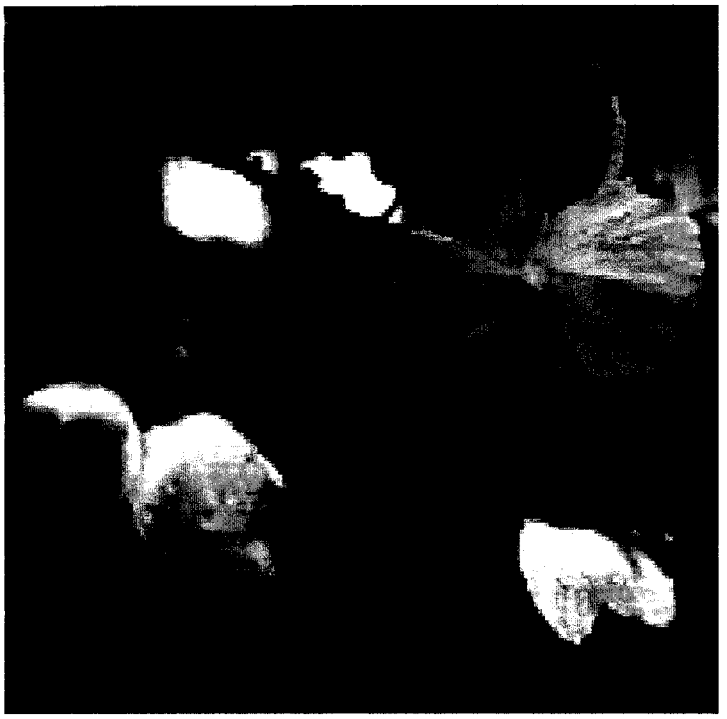


Figure 5.15. *Abutilon vitifolium.* In flower at Pumahuida Nursery near Santiago, Chile

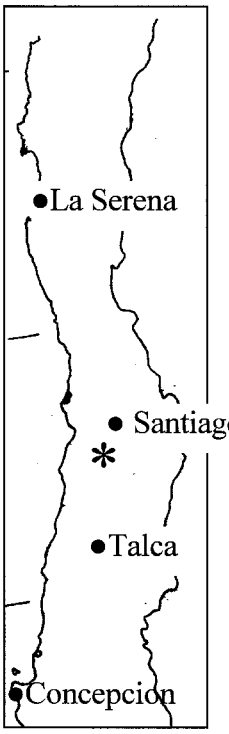


Figure 5.16. *Abutilon vitifolium* observed location *

***Abutilon vitifolium* (Cav.) Kearney, Malvaceae**

Habit: Phanerophyte (Griffiths, 1998)

Size: 2-3 m height by 2 m width (Hoffmann, 1995)

Foliage: Lobed, 9-10 cm length, green

Flower: Solitary or corymbose, 8 cm diameter, white, borne in spring

Location: Reported growing among shrub vegetation along the coast in the province of Valparaíso. Plants were observed at Pumahuida Nursery in Santiago.

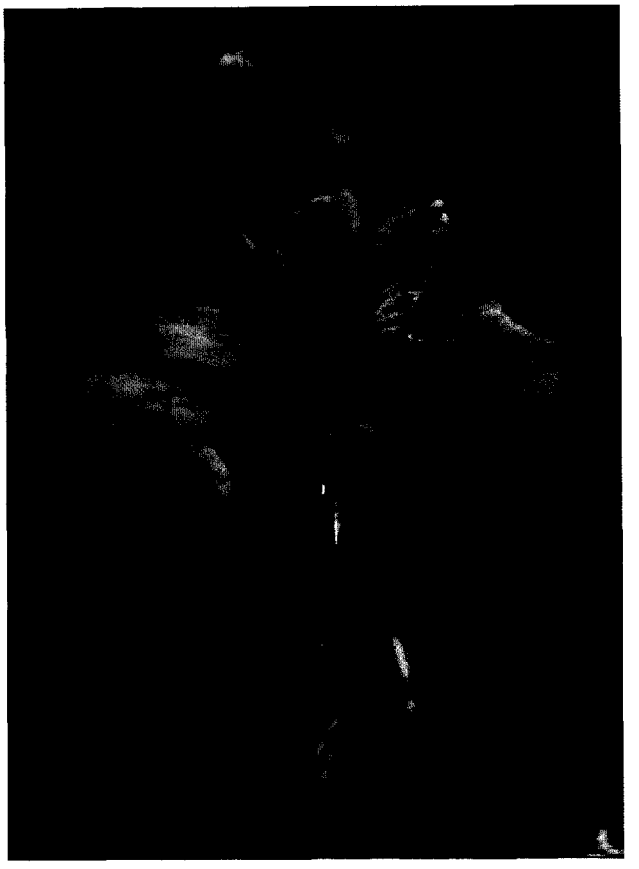


Figure 5.17. *Alstoemeria magnifica* ssp. *maxima.* Flower detail.

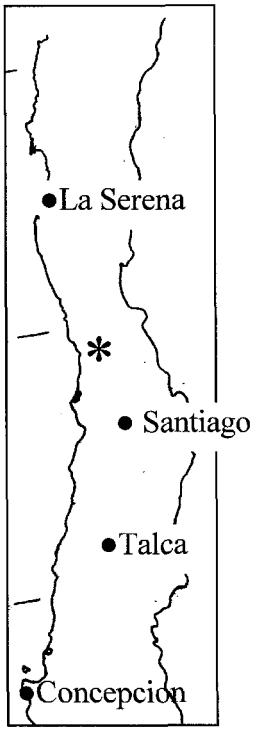


Figure 5.18. *Alstroemeria magnifica* ssp. *maxima* observed location *

***Alstroemeria magnifica* ssp. *maxima* (Phil.) E.Bayer, Alstroemeriaceae**

Habit: Geophyte

Size: 1 m height by 1 m width (Griffiths, 1995)

Foliage: Ensiform, pale-green

Flower: Zygomorphic, in a terminal umbel, pink with red, yellow, and brown on upper tepals, borne in spring

Location: Observed south of El Tofo mine along Route 5, grew in sandy-loam, sunny exposure

Figure 5.19. *Aristolochia chilensis.* Flower and foliage in La Campana National Park

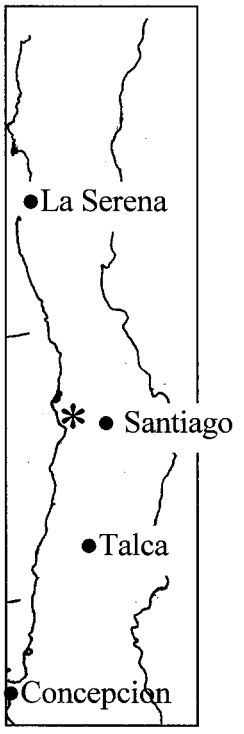


Figure 5.20. *Aritolochia chilensis* observed location *

***Aristolochia chilensis* Bridges ex Lindl., Aristolochiaceae**

Habit: Chamaephyte

Size: 0.4-1 m length (Hoffman, 1995)

Foliage: Entire, cordate, green with white venation (Griffiths, 1995)

Flower: Zygomorphic, funnel-shaped, brown exterior, yellow interior, malodorous, borne in spring

Location: Plant observed growing in Parque Nacional La Campana, west of Santiago, on a sandy-loam embankment, sunny exposure

Figure 5.21. *Calandrinia* sp. foliage

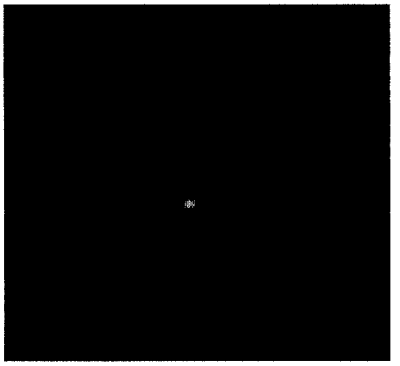


Figure 5.22. *Calandrinia* sp. flower

***Calandrinia* sp. Portulacaceae**

Habit: Chamaephyte

Size: 30 cm height by 10 cm width

Foliage: Spatulate, tomentose, dark-green with purple, basal rosette

Flower: Solitary, bright pink, borne on stalk above foliage in spring

Location: Plant observed growing in Parque Nacional Llanos de Challe north of La Serena, in sand, approximately 300 m from Pacific Ocean, sunny exposure

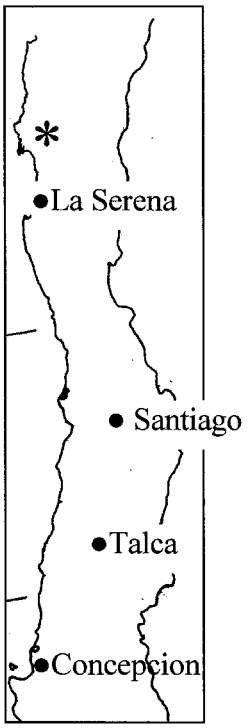


Figure 5.23. *Calandrinia* sp. observed location *

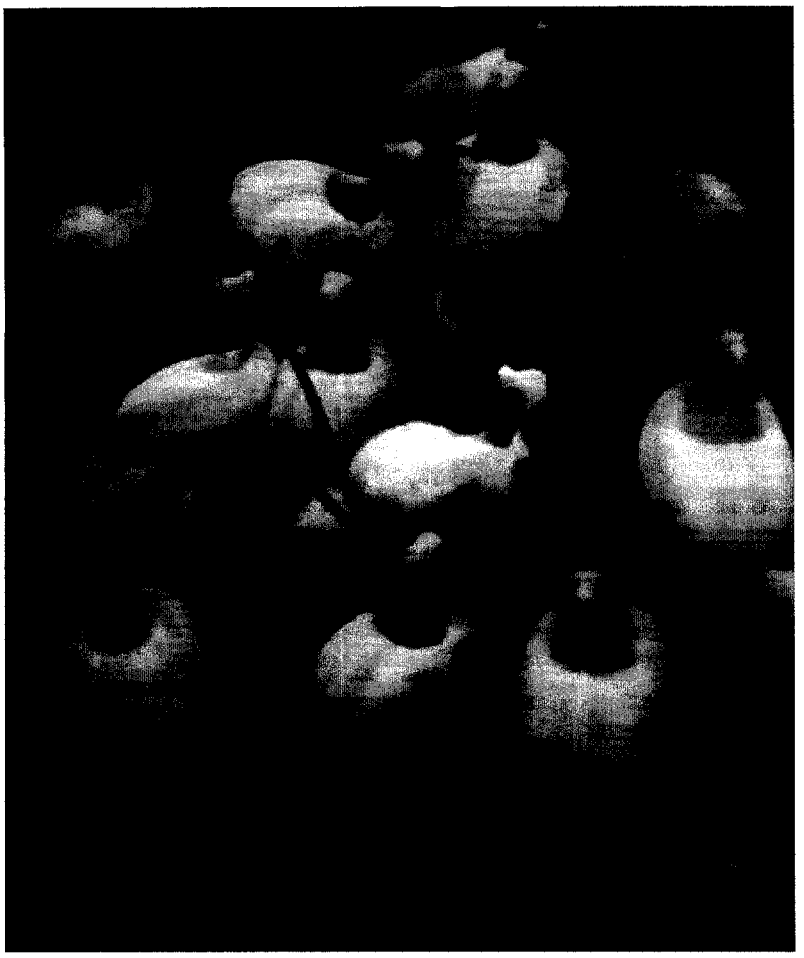


Figure 5.24. *Calceolaria* sp. flower detail

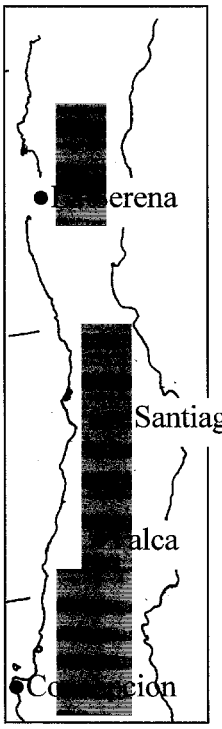


Figure 5.25. *Calceolaria* sp. Observed in multiple locations between La Serena and Concepcion (indicated by shading)

***Calceolaria* sp. Schrophulariaceae**

Habit: Chamaephyte

Size: Variable

Foliage: Hairy, rugose, borne in basal rosette

Flower: Cymose, slipper-like, 2 cm diameter, yellow, borne in umbel in spring

Location: Common in many locations throughout central Chile

Figure 5.26. *Cestrum parqui* near Colliguay

***Cestrum parqui* L'Herit., Solanaceae**

Habit: Phanerophyte

Size: 3 m height by 3 m width (Griffiths, 1995)

Foliage: Linear-lanceolate to elliptic, 14 cm length

Flower: 2.5 cm diameter, yellow-green to yellow,

borne in cymose inflorescence, 13 cm diameter,

spring

Location: Common in central Chile, grew in sandy-loam

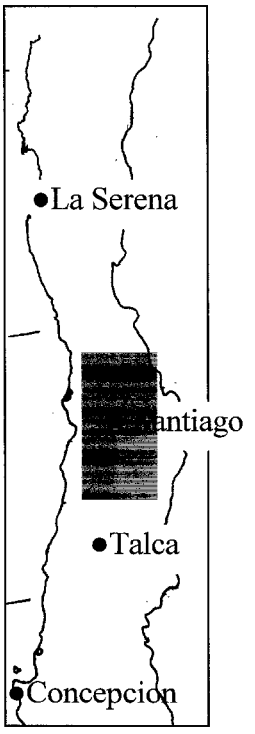


Figure 5.27. *Cestrum parqui* Observed in multiple locations around Santiago (indicated by shading)

Figure 5.28. *Chlorea chrysantha* flower detail

***Chlorea chrysantha* Poepp., Orchidaceae**

Habit: Chamaephyte

Size: 60-80 cm height (Hoffman, 1995)

Foliage: Oblong, 10-15 cm length, formed basal rosette

Flower: 3-4 cm diameter, yellow, borne in lax spike

Location: Plants common in many locations.

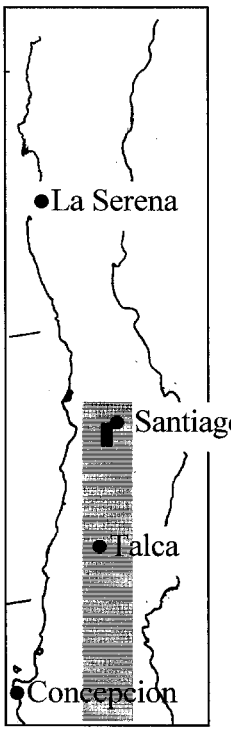


Figure 5.29. *Chlorea chrysantha*
Observed areas indicated by shading

***Cissarobyron elegans* Kunze ex Poepp., Gesneriaceae**

Habit: Phanerophyte (Hoffman, 1995)

Size: 20-30 cm height with equal spread

Foliage: Ovate, tomentose, 14 mm long by 10 mm wide

Flower: 1-2 cm diameter, pink

Location: Documented on rocky hillside along road to Farallones, east of Santiago, full exposure

Figure 5.30. *Cissarobyron elegans* observed location *

Figure 5.31. *Drimys winteri* flower and foliage

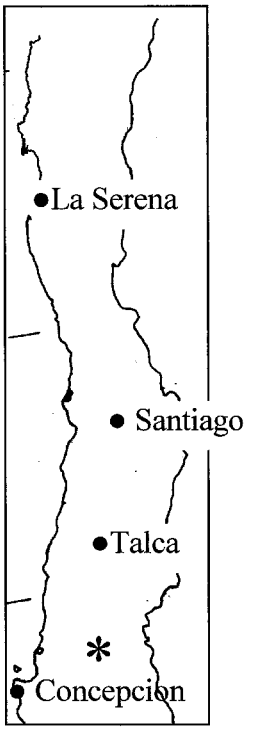


Figure 5.32. *Drimys winteri* observed location *

***Drimys winteri* Forst. & Forst., Winteraceae**

Habit: Phanerophyte

Size: 5-7 m height (Hoffman, 1995)

Foliage: Elliptic to oblong-lanceolate, coriaceous, 2.5-20 cm length by 1-8 cm width (Griffiths, 1995)

Flower: 1-2 cm diameter, white with yellow stamens, borne in pseudoumbels, 15-40 flowers per inflorescence

Location: Specimen was observed between Parque Nacional Nahuelbuta and Los Angeles

***Escallonia rubra* (Ruiz & Pav.) Pers., Grossulariaceae**

Habit: Phanerophyte (Griffiths, 1995)

Size: 4 m height

Foliage: Obovate to lanceolate, 2.5-5 cm length

Flower: 1.5 cm long, pink to red, borne in racemes or terminal panicles

Location: Observed at Jardin Botanico Mapulema in Santiago.

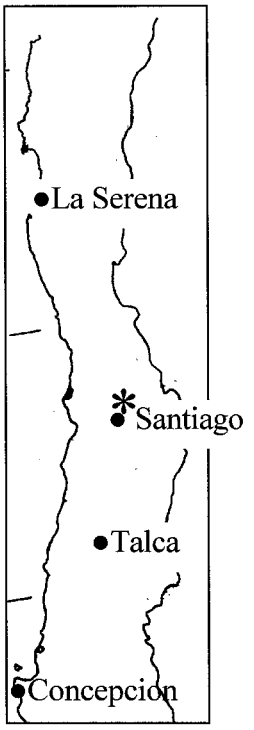


Figure 5.33. *Escallonia rubra* observed location *

Figure 5.34. *Eupatorium salvia* flower detail

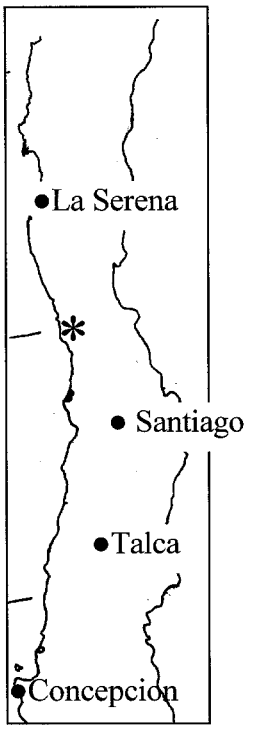


Figure 5.35. *Eupatorium salvia* observed location *

***Eupatorium salvia* Colla., Asteraceae**

Habit: Phanerophyte (Hoffman, 1995)

Size: 1-2 m height

Foliage: Lanceolate, dentate, 4-8 cm in length

Flower: White, 15-20 flowers in each terminal inflorescence

Location: Specimen was observed on top of hill in Parque Nacional Fray Jorge, grew in sandy-loam soil

Figure 5.36. *Fabiana imbricata* near Colliguay

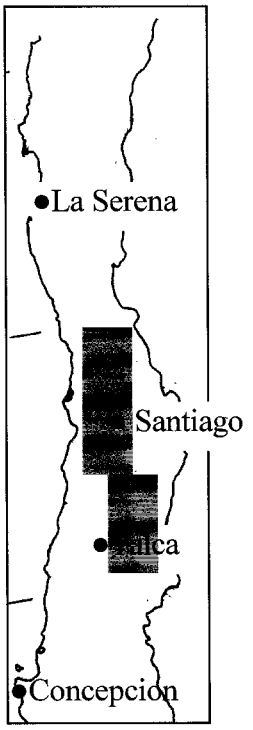


Figure 5.37. *Fabiana imbricata.* Observed locations indicated by shaded areas

***Fabiana imbricata* Ruiz & Pav., Solanaceae**

Habit: Phanerophyte (Griffiths, 1995)

Size: 2.5 m height, 2.5 m width

Foliage: Acicular, 1-2 cm length, 0.5 cm diameter

Flower: 1.3 cm diameter, white to pale pink, summer

Location: Plants observed in many locations throughout in central Chile, grew in full sun exposure

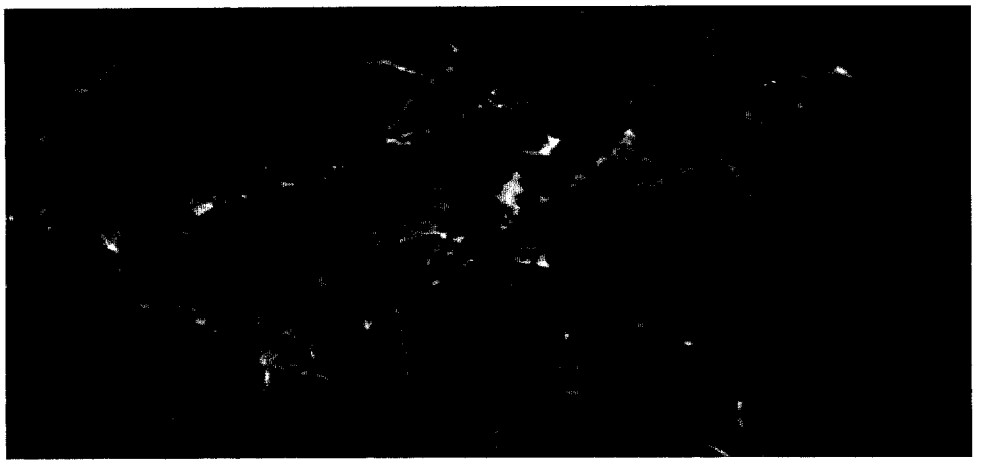


Figure 5.38. *Lepechinia salviae* in flower

***Lepechinia salviae* (Lindl.) Epling., Lamiaceae**

Habit: Phanerophyte (Hoffman, 1995)

Size: 2 m height, 2 m width (Griffiths, 1995)

Foliage: Ovate to deltoid, 5-8 cm length

Flower: Campanulate, weakly 2-lipped, 2-3 cm, reddish-pink with purple calyx

Location: Observed on hill west of Santiago called Cuesta del Melon, sandy-loam soil, full sun exposure

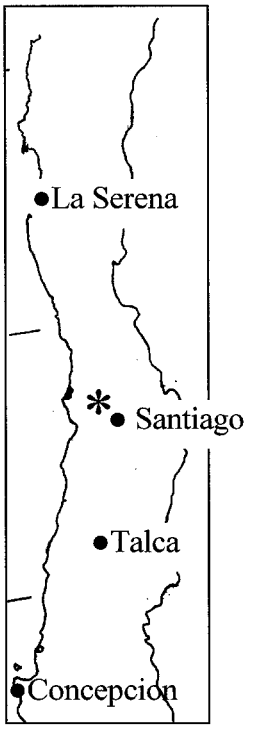


Figure 5.39. *Lepechinia salviae* observed location *

***Leucocoryne coquimbensis* F. Phil., Liliaceae**

Habit: Geophyte (Hoffman, 1995)

Size: 25-30 cm height

Foliage: Grass-like, to 30 cm length (Griffiths, 1995)

Flower: 5-6 cm diameter, white with violet edges, inflorescence umbel of 3-7 flowers, spring

Location: Best specimens were observed at research station of Universidad de Valparaiso, specimens also observed growing in sand at northern limits of La Serena

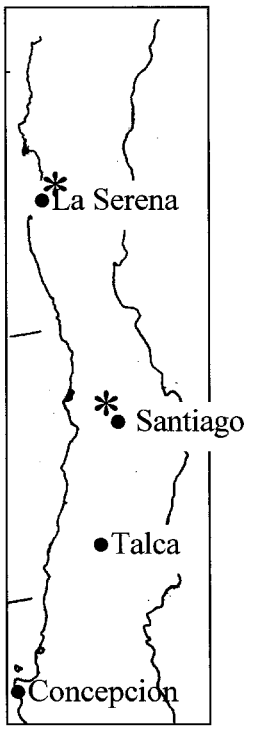


Figure 5.40. *Leucocoryne coquimbensis* observed locations *

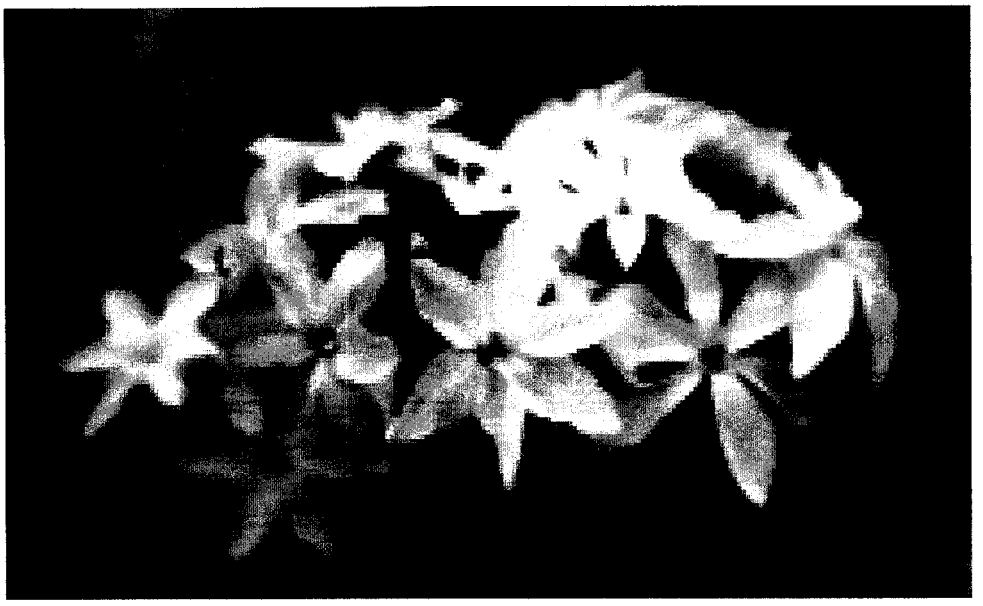


Figure 5.41 *Leucocoryne ixioides* flower detail

***Leucocoryne ixioides* (Hook.) Lindl., Liliaceae**

Habit: Geophyte (Hoffman, 1995)

Size: 45 cm height (Griffiths, 1995)

Foliage: Grass-like, to 45 cm length

Flower: 3-4 cm diameter, white with violet edges, inflorescent umbel, spring (Hoffman, 1995)

Location: Observed best specimens at research station of Universidad de Valparaiso

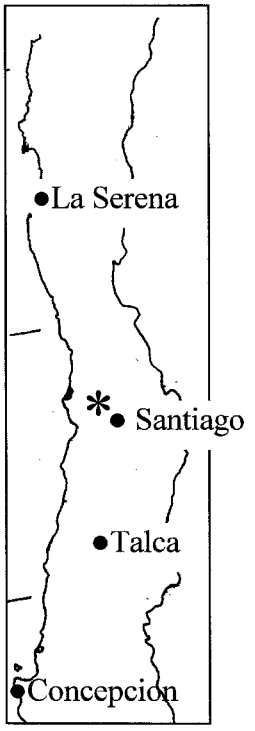


Figure 5.42. *Leucocoryne ixioides* observed location *

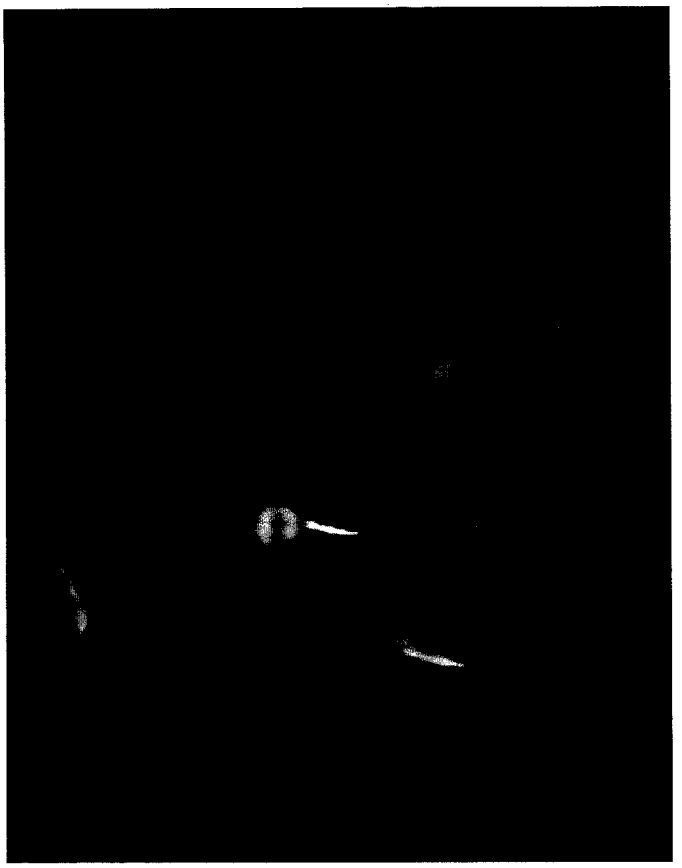


Figure 5.43. *Lobelia polyphylla* in flower. Near Los Vilos, Chile

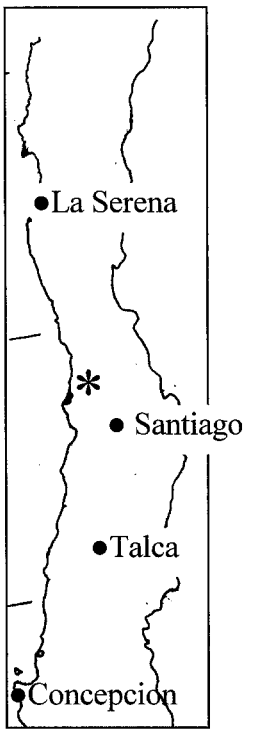


Figure 5.44. *Lobelia polyphylla* observed location *

Lobelia polyphylla **Hook. & Arn., Campanulaceae**

Habit: Phanerophyte (Hoffman, 1995)

Size: 1-2 m height

Foliage: Ovate to lanceolate, dentate margins, 8-10 cm in length

Flower: 2-3 cm length, purplish-red, terminal racemes, spring

Location: Specimen was observed north of Los Vilos

Figure 5.45. *Lobelia tupa* in flower in Pellhue, Chile

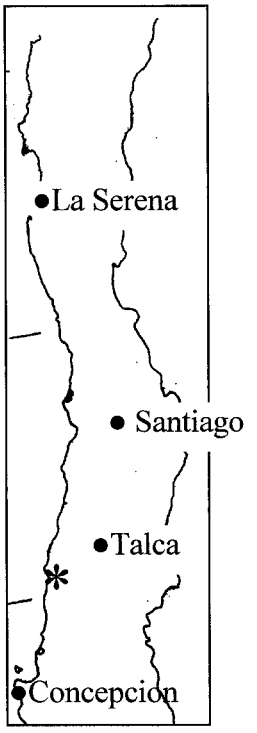


Figure 5.46. *Lobelia tupa* observed location *

***Lobelia tupa* L., Campanulaceae**

Habit: Phanerophyte (Griffiths, 1995)

Size: 2 m height

Foliage: Lanceolate, to 15 cm in length (Hoffman, 1995)

Flower: 4-5 cm length, orange-red, terminal racemes

Location: Observed in Pellhue, sandy soil, full exposure to sun and salt spray

Figure 5.47. *Nolana paradoxa* in flower

***Nolana paradoxa* Lindl., Solanaceae**

Habit: Therophyte (Griffiths, 1995)

Size: 25 cm in length, decumbent

Foliage: Ovate to elliptic, 5.5 cm length by 2 cm width

Flower: Campanulate, 3.5 cm diameter, bright blue, white throat, borne in spring

Location: Observed in many locations, sand Dunes and rocky terrain

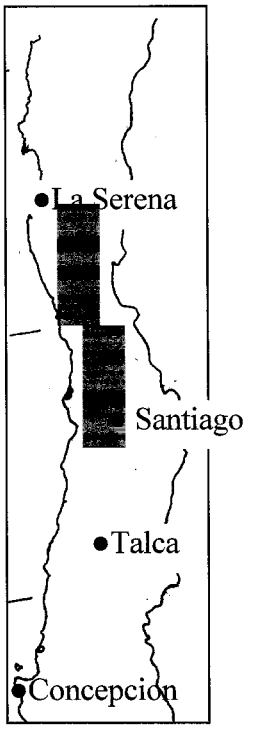


Figure 5.48. *Nolana paradoxa.* Observed locations indicated by shaded area

Figure 5.49. *Oenothera acaulis* flower detail. Old flower in lower right. Observed near Los Angeles.

***Oenothera acaulis* Cav., Onagraceae**

Habit: Chamaephyte (Griffiths, 1995)

Size: 15 cm in length, decumbent

Foliage: Oblanceolate, tomentose, 12-20 cm length

Flower: Petals emarginate, 5-8 cm diameter, white aging to pink, spring

Location: Observed north of Los Angeles, sandy loam soil, full exposure

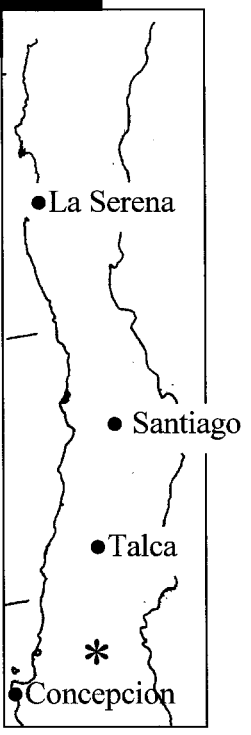


Figure 5.50. *Oenothera acaulis* observed location *

Figure 5.51. *Pasithea caerulea* flower spike

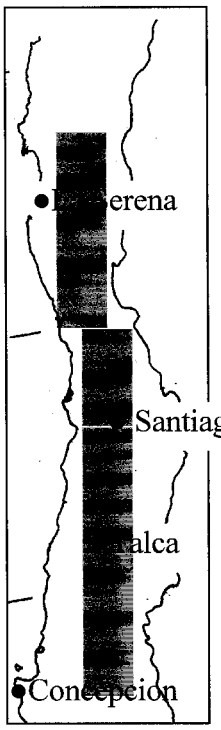


Figure 5.52. *Pasithea caerulea.* Observed locations in shaded area

***Pasithea caerulea* D. Don., Liliaceae (Asphodelaceae)**

Habit: Geophyte (Griffiths, 1995)

Size: 50 cm height (Hoffman, 1995)

Foliage: Linear, to 25 cm length (Griffiths, 1995)

Flower: 1.5 cm diameter, blue to purple, borne in racemes, spring (Hoffman, 1995)

Location: Common throughout central Chile, multiple types of soil, sand to heavy clay, full sun exposure

***Passiflora pinnatistipula* Cav., Passifloraceae**

Habit: Liane (Hoffman, 1995)

Size: 7-10 m

Foliage: Tri-lobed, 10 cm length by 13 cm width, lustrous (Griffiths, 1995)

Flower: Solitary, to 13 cm diameter, pink, summer (Hoffman, 1995)

Location: Cultivated specimen observed twining up tree at Monica Musalem's nursery, Pumahuida

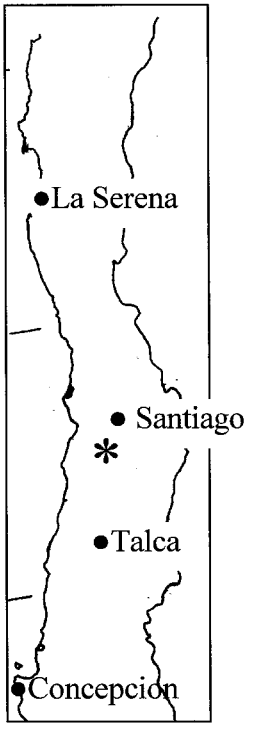


Figure 5.53. *Passiflora pinnatistipula* observed location *

Figure 5.54. *Phycella bicolor* in Pellhue, Chile

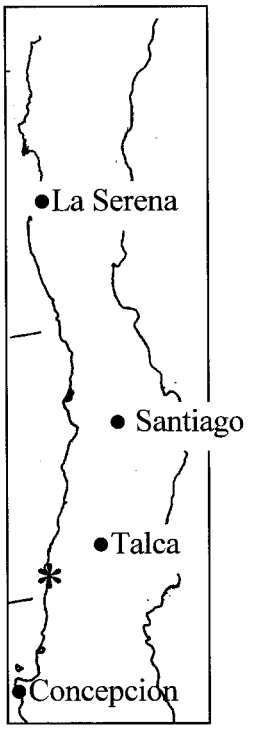


Figure 5.55. *Phycella bicolor* Observed location *

***Phycella bicolor* (Ruiz & Pav.) Herb., Amaryllidaceae**

Habit: Geophyte (Hoffman, 1995)

Size: 20-50 cm height

Foliage: Four, linear leaves, 1-1.5 cm width

Flower: Salverform, 3-5 cm length, red, borne in umbels of 4-5, spring

Location: Observed in town of Pellhue near Pacific Ocean

Figure 5.56. *Puya berteroniana* flower detail. Near Farallones

***Puya berteroniana* Mez., Bromeliaceae**

Habit: Chamaephyte

Size: To 4.5 m height in flower (Griffiths, 1995)

Foliage: Linear, toothed margins, 1 m length

Flower: 5-7 cm length, blue-green, borne on tomentose scape, spring to summer

Location: Observed on rocky hillside along road to Farallones, east of Santiago

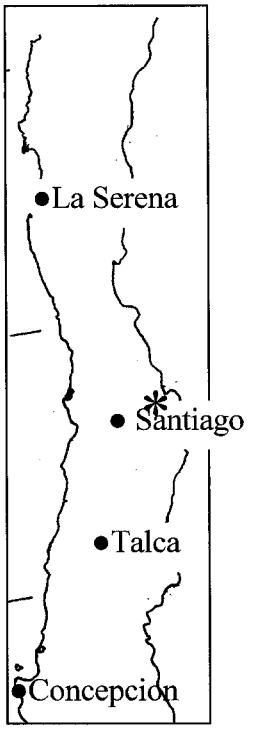


Figure 5.57. *Puya berteroniana* observed location *

Figure 5.58. *Puya chilensis* flower detail.
Jardin Mapulema, Santiago, Chile

***Puya chilensis* Molina, Bromeliaceae**

Habit: Chamaephyte

Size: To 4.5 m height in flower (Griffiths, 1995)

Foliage: Linear, toothed margins, 1 m length

Flower: 5-7 cm length, yellow-green, borne on tomentose scape, spring to summer

Location: Observed in Jardin Botanico Mapulema, Santiago

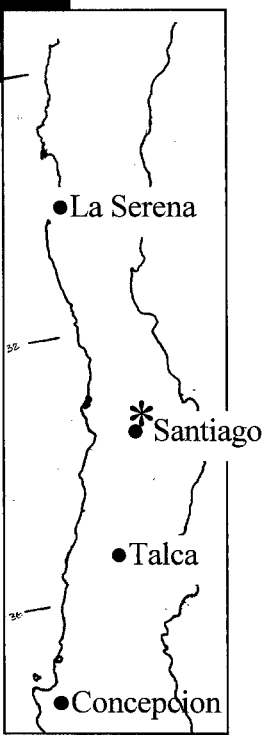


Figure 5.59. *Puya chilensis* observed location *

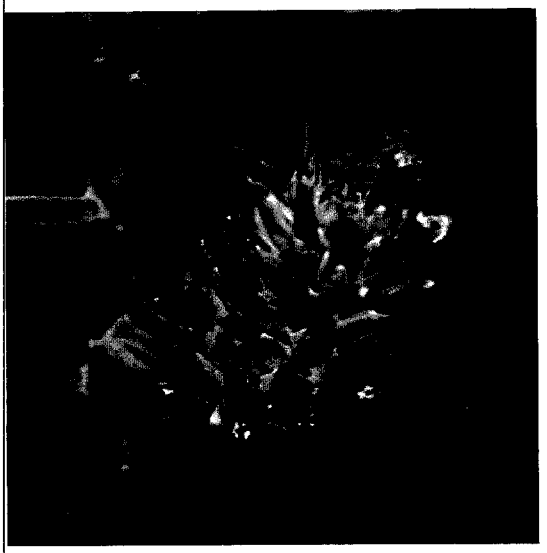


Figure 5.60. *Puya coerulea* flower detail. North of Santiago, Chile

Figure 5.61. *Puya coerulea*

***Puya coerulea* Lindl., Bromeliaceae**

Habit: Chamaephyte

Size: 2 m height in flower

Foliage: Linear, toothed margins, glabrous,

60 cm length (Hoffman, 1995)

Flower: Purple petals, inflorescence axis red, borne on

red, tomentose scape, spring to summer

(Griffiths, 1995)

Location: Observed along Route 5 northwest of Santiago

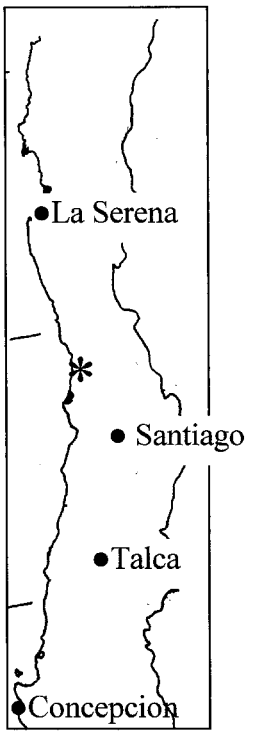


Figure 5.62. *Puya coerulea* observed location *

Figure 5.63. *Rhodphiala advena* mass in flower. Southeast of Concepcion

***Rhodophiala advena* (Ker-Gawl.) Traub., Amaryllidaceae**

Habit: Geophyte

Size: 20-30 cm height in flower

Foliage: Linear, grass-like (Hoffman, 1995)

Flower: Campanulate, 3-4 cm length, red with yellow throat, inflorescence umbel with 2-6 flowers, spring

Location: Plants observed between Santa Juana and Naciomiento

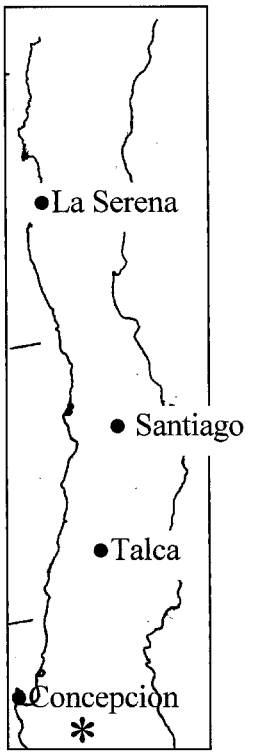


Figure 5.64. *Rhodophiala advena* observed location *

Additional information about specific observations or recommendations for utilizing the 26 recommended plants is depicted in the DISCUSSION chapter.

Table 5.02. Target plants recommended for display (*indicates desirable characteristic). Table represents a condensed listing of the descriptions of the 26 recommended plants.

Species	*Life form*	*Size*	*Flower Color*	*Ornamental*
Abutilon vitifolium	Phanerophyte	2-3 m by 2-3 m	White*	
Alstroemeria magnifica ssp. *maxima*	Geophyte	1 m by 1 m	Multi-colored*	
Aristolochia chilensis	Chamaephyte	1m	Yellow throat with brown outerside*	Dark green with white veins*
Calandrinia sp.	Chamaephyte	10 cm ht.	Hot pink*	Succulent, green*
Calceolaria sp.	Chamaephyte	Varies	Yellow*	One species had hirsuite, green foliage
Cestrum parqui	Phanerophyte	3 m ht.	Yellow*	
Chlorea chrysantha	Chamaephyte	60 - 80 cm ht.	Yellow*	
Cissarobyron elegans	Phanerophyte	30 cm ht.	Pink*	
Drimys winteri	Phanerophyte	5 - 7 m ht.	White*	Emerald green, laurel-like*
Escalloina rubra	Phanerophyte	4 m ht.	Pink to red*	
Eupatorium salvia	Phanerophyte	1 - 2 m ht.	White*	
Fabiana imbricata	Phanerophyte	2.5 m x 2.5 m	White to pink*	Small, rosemary-like*
Lepechinia salviae	Phanerophyte	1.2 m ht.	Dark purple*	
Leucocoryne ixioides	Geophyte	45 cm ht.	White with purple*	
Leucocoryne coquimbensis	Geophyte	15 - 45 cm ht.	White, pink, purple, multi-colored*	

Table 5.02. Target plants recommended for display (continued)

Species	*Life form*	*Size*	*Flower Color*	*Foliage*
Lobelia polyphylla	Phanerophyte	1.5 m x 1.5 m	Purple-red*	
Lobelia tupa	Phanerophyte	4 m	Orange-red*	
Nolana paradoxa	Therophyte	10 cm	Purple*	
Oenothera acaulis	Chamerphyte	10 cm ht., 50 cm w.	White to pink*	
Pasithea caerulea	Geophyte	50 cm ht.	Dark blue*	
Passiflora pinnatistipula	Liane	7 m length	Pink*	
Phycella bicolor	Geophyte	40 cm ht.	Red*	
Puya berteroniana	Phanerophyte	4.5 m ht.	Light blue*	Glaucous, serrated, strap-like foliage*
Puya chilensis	Phanerophyte	4.5 m ht.	Pale yellow to yellow-green*	Glaucous, serrated, strap-like foliage*
Puya coerulea	Phanerophyte	4.5 m ht.	Red bracts with purple flowers*	Glaucous, serrated, strap-like foliage*
Rhodophiala advena	Geophyte	30 - 45 cm ht.	Red with yellow throat*	

Chapter 6

DISCUSSION

This discussion covers additional notes made during the Chilean expedition or information obtained during research. Also included are recommendations for how Longwood can display the following plants.

Abutilon vitifolium (Cav.) Kearney. This plant was viewed at Monica Musalem's nursery, Pumahuida. Musalem said that it was scarce in the wild. She also added that there was a similar species with blue flowers. The author did not record the name of the blue-flowered species. Longwood could use this plant as a large, filler plant for edging of pathways in the Orangery. Longwood's Plant Records database shows this plant as being accessioned four times. All of the accessions were discarded because of white fly infestation.

Alstroemeria magnifica* ssp. *maxima (Phil.) E.Bayer This plant differed from other *Alstroemeria* spp. the researcher had seen because of its large size. The 1 m height and width would allow this plant to be used *en masse* in the conservatories. Longwood's plant records indicate an accession of *Alstroemeria magnifica* but none of *A. magnifica* ssp. *maxima.*

Aristolochia chilensis Bridges ex Lindl. This vine could be grown at Longwood on structural supports. The display qualities are its unique green with white veined foliage and Dutchman's pipe flowers. There are no accessions of this plant at Longwood.

***Calandrinia* sp.** Many different *Calandrinia* spp. were observed during the expedition in central Chile. This species, unknown to the author, was interesting because of its purple foliage. Longwood could use this plant in designs needing small plants that hold flowers above the foliage.

***Calceolaria* sp.** This unknown species would add yellow, unusual shaped flowers to displays. Any of the *Calceolaria* spp. observed in Chile could be grown *en masse* within the conservatories. A drift of these flowers would complement displays.

Cestrum parqui L'Herit. The arching branches of this plant would make it useful for informal displays in the conservatories. The white to yellow flowers would add to the display qualities. *Cestrum parqui* grows in many areas of Chile and Argentina. There are no accessions of this plant at Longwood.

Chlorea chrysantha Poepp. This plant is a terrestrial orchid found growing in many locations of central Chile. The plant often grows in semi-sheltered locations. A difficulty in acquiring this orchid would be because of Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) regulations that forbid the importation of orchids unless permits are obtained. *Chlorea chrysantha* could be used *en masse* in the conservatories or as a specimen in the Orchid House. There are no accessions of this plant at Longwood

Cissarobyron elegans Kunze ex Poepp. This plant grew on an exposed hillside with *Puya chilensis*, *Alstroemeria* sp., grasses, and bulbs. The tidy, compact form, along with its small pink flowers, would make this plant useful for the Mediterranean House or Silver Garden. There are no accessions of this plant at Longwood.

Drimys winteri Forst. & Forst. The large size of this evergreen tree, along with its white flowers that cover the entire plant, would make this a possibility for specimen planting in the East Conservatory. There is one accession of this plant at Longwood from the October 2001 research expedition.

Escallonia rubra (Ruiz & Pav.) Pers. Longwood Gardens' staff indicated this species as a desired plant when they reviewed the target list. The plant grows in Jardin Botanico Mapulema in Santiago. *E. rubra* is used as a landscape plant in Chile. Literature stated that it is used in Great Britain as a conservatory plant (Zizka and Grau, 1992).

Eupatorium salvia Colla. This plant was viewed growing in a windy, hilltop cloud forest and in dry pastureland. The form and white flowers could contribute to outdoor displays at Longwood as an alternate for *Eupatorium fistulosum* Barratt. There are no accessions of this plant at Longwood.

Fabiana imbricata Ruiz & Pav. This plant grows in many different environments. It was observed in dry lowlands and moister highlands. *F. imbricata* could be used in the East Conservatories as an informal mass. There are no accessions of this plant at Longwood.

Lepechinia salviae (Lindl.) Epling. The 2 m height of the plant allows it to be used in any displays requiring large forms with blue-purple flowers. Accessions of stem cuttings of this plant from the October 2001 research expedition failed to root in sand.

Leucocoryne coquimbensis F. Phil., ***Leucocoryne ixioides*** (Hook.) Lindl. Dr. Levi Manseur at Univerisdad de Valparaiso is researching this genus extensively to develop different flower colors and sizes. *Leucocoryne* spp. have potential use as a forced plant in the Orangery. Plant and seed accessions of *Leucocoryne* spp. are at Longwood from the October 2001 thesis research expedition.

Lobelia polyphylla H. & A., ***Lobelia tupa*** L. These plants grow in proximity to the Chilean coastline. They grow in sand and on rocky cliffs. The red and orange flower colors borne at heights from 1-2 m could add to displays at Longwood. Three seedling accessions of *Lobelia tupa* in Longwood from 1992 and 1993 did not germinate.

Nolana paradoxa Lindl. This blue-flowered groundcover could accent the edges of beds both in the conservatories and in the gardens as a seasonal display crop. No accessions of this species are at Longwood.

Oenothera acaulis Cav. The flower size on this species is large and should be compared with *Oenothera* spp. grown in Longwood to see if which flowers are better for displays. No accessions of this species are at Longwood.

Pasithea caerulea D. Don. This plant grows in all areas of mediterranean Chile. The plant could be incorporated to most displays of Longwood because of its blue-

purple flower color. Longwood has accessions of this species from the October 2001 expedition.

Passiflora pinnatistipula Cav. This plant was only seen at Pumahuida nursery. The Garden Walk in the conservatory utilizes *Passiflora* sp. This species deserves comparison because of its pink flowers and glossy foliage. Longwood has no accessions of this species.

Phycella bicolor (Ruiz & Pav.) Herb. This plant can be used in containers and in formal plantings in the conservatory at Christmas. *P. bicolor* can also be used in outdoor displays. The plant has tubular flowers. Longwood has seed accessions of this species from the October 2001 research expedition.

Puya berteroniana Mez., ***Puya chilensis*** Molina., ***Puya coerulea*** Lindl. These plants have tall flower scapes. The height of the scape, along with the silver foliage, could be effective for use on the northern side of the Silver Garden, where the roof is at its tallest. These species could also be used in large, movable containers for accent plantings in Conservatory and summer outdoor displays. An earlier accession of *P. berteroniana* in Longwood died in 1990 from reasons not recorded in the plant records. *P. coerulea* is an active seed accession from the October 2001 thesis research expedition.

Rhodophiala advena (Ker-Gawl.) Traub. This plant has strong potential for use in Christmas displays as mentioned for *Phycella bicolor* (R. et P.) Herb. The plant differs from *P. bicolor* by having a larger and more open flower.

Additional plants recommended for display

Fourteen additional plants are selected for trials that are not on the original target list. These plants, observed in Chile, warrant inclusion in recommended plants because of their display potential. The plants were not selected during the compilation of the original target list because their literature description was unappealing or they were not cited in any of the reviewed literature. Their physical characteristics are listed in this section. These plants are included in the **DISCUSSION** section as additional plants recommended for display.

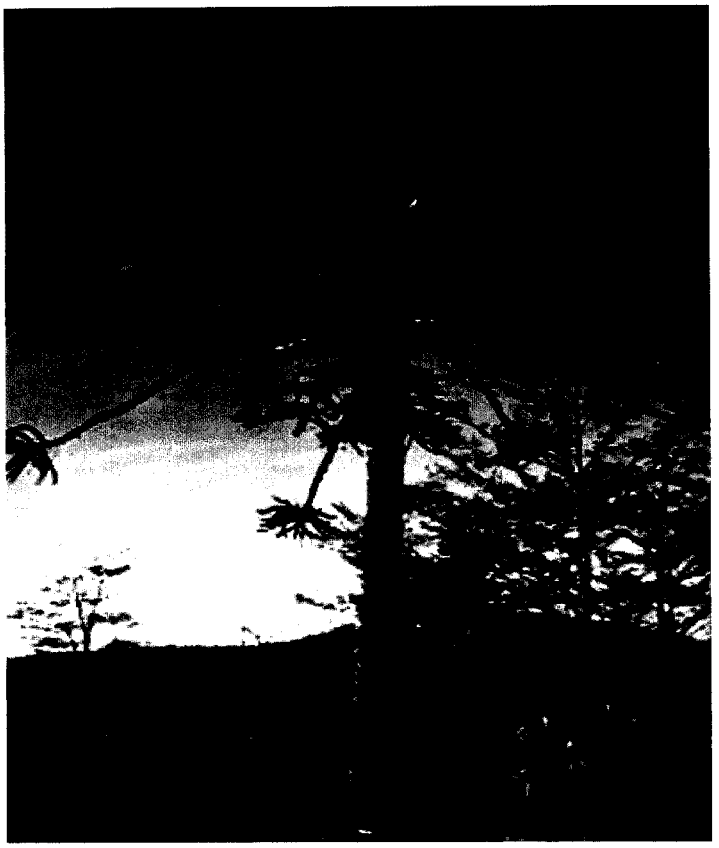


Figure 6.01. *Araucaria araucana* in Parque Nacional Nahuelbuta

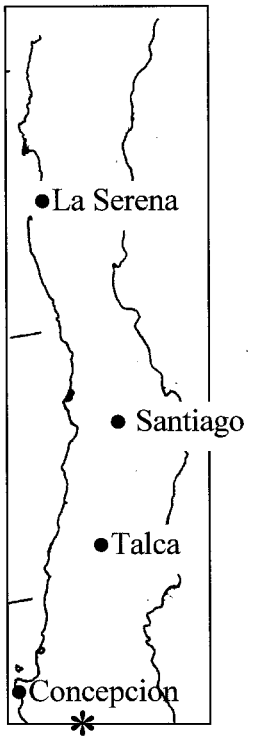


Figure 6.02. *Araucaria araucana* observed location *

***Araucaria araucana* (Molina) K. Koch., Araucariaceae**

Habit: Phanerophyte

Size: 30 m height (Griffiths, 1995)

Foliage: Stiff, triangular-ovate, 3 cm length, 2 cm width (Hoffman, 1995)

Flower: not applicable

Location: Observed in Parque Nacional Nahuelbuta

Figure 6.03. *Argylia radiata.* Near Pacific Ocean in Parque Nacional Llanos de Challe

***Argylia radiata* (L.) D.Don, Bignoniaceae**

Habit: Chamaephyte

Size: 20 cm height in flower (Griffiths, 1995)

Foliage: Finely dissected, 5 cm diameter (Hoffman, 1995)

Flower: Campanulate, 2.5-5 cm length, yellow, spring

Location: Observed in Parque Nacional Llanos de Challe along Pacific Ocean. Plant grew in sand and was exposed to saltwater spray.

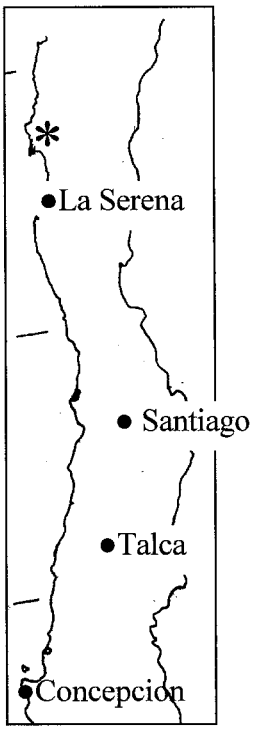


Figure 6.04. *Argylia radiata* observed location *

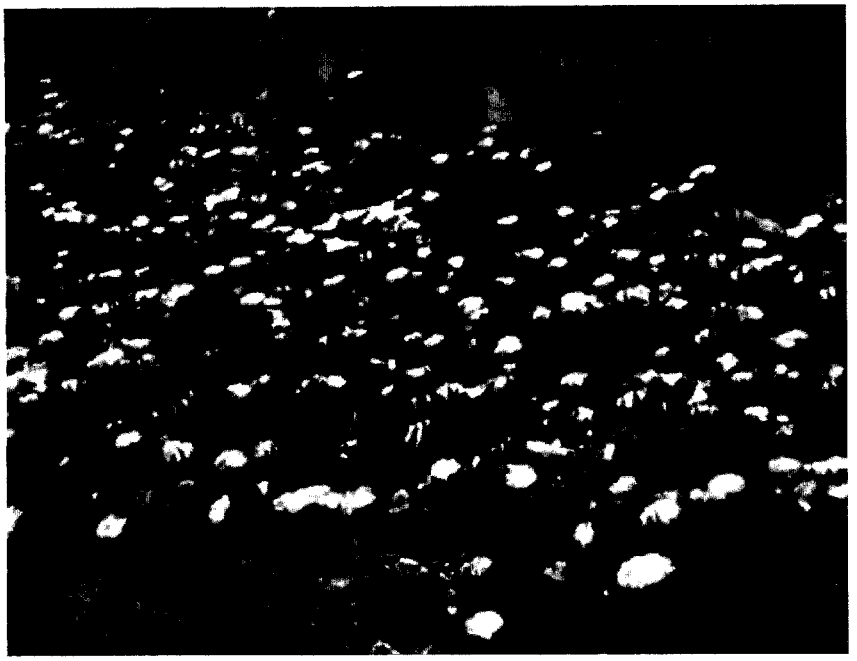


Figure 6.05. *Carpobrotus chilensis* in Jardin Botanico Mapulema

***Carpobrotus chilensis* (Molina) N. E. Br., Aizoaceae**

Habit: Chamaephyte (Griffiths, 1995)

Size: 8 cm height, indeterminate width

Foliage: Triquetrous, amplexicaul, fleshy

Flower: 10 cm diameter, violet, spring

Location: Observed in Jardin Mapulema in Santiago.

Plant(s) grew in full sun exposure

and sandy-loam soil.

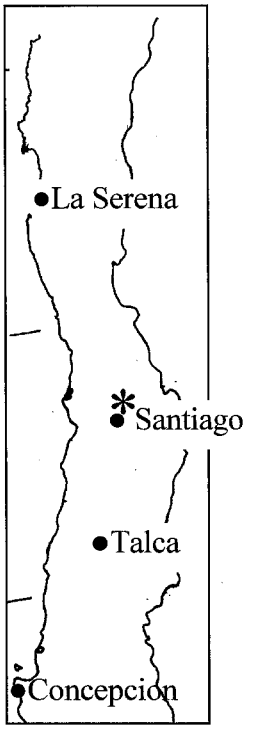


Figure 6.06. *Carpobrotus chilensis* observed location *

***Cordia decandra* Hook. & Arn., Boragninaceae.**

Habit: Phanerophyte

Size: 4 m height

Foliage: 3-5 x 0.4-0.7 cm, simple, coriaceous, glaucous beneath, grreen

Flower: 2-2.5 cm diameter, funnelform, white, in panicles to 20 cm diameter

Location: Observed in Cuesta de Bagonalles

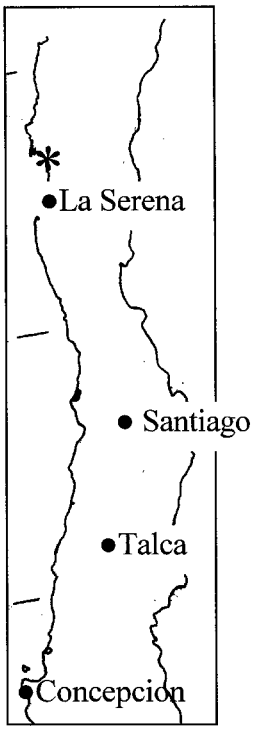


Figure 6.07. *Cordia decandra* observed location *

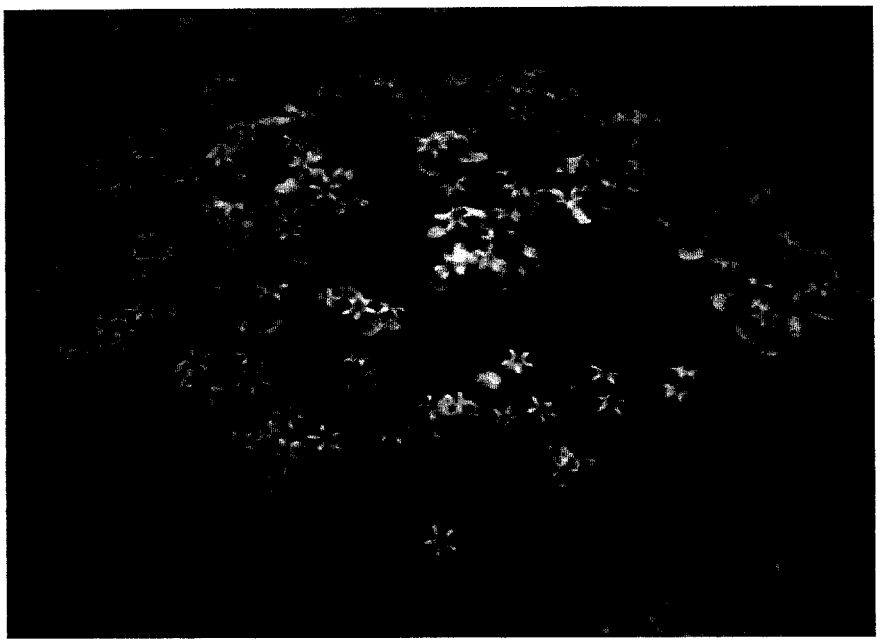


Figure 6.08. *Cruckshanksia verticilata.* Near Pacific Ocean in Parque Nacional Llanos de Challe

***Cruckshanksia verticilata* Phillippi., Rubiaceae**

Habit: Chamaephyte

Size: 8 cm height, equal width

Foliage: Fleshy

Flower: 2 cm diameter, yellow, spring

Location: Observed in Parque Nacional Llanos de Challe along Pacific Ocean. Plant grew in full sun exposure and sand. The location was a dry streambed.

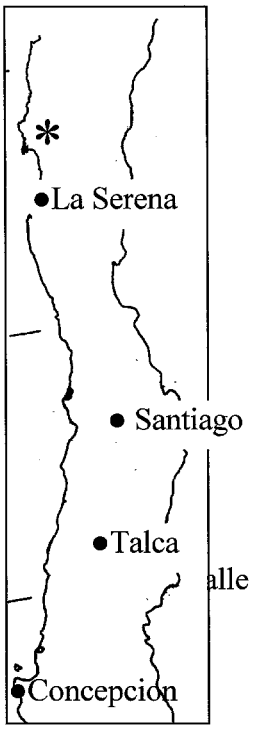


Figure 6.09. *Cruckshanksia verticilata* observed location *

Figure 6.10. *Embothrium coccineum* in flower

***Embothrium coccineum* Forst. & Forst., Proteaceae**

Habit: Phanerophyte

Size: 10 m height (Griffiths, 1995)

Foliage: Oblong, 12 cm length

Flower: 4.5 cm diameter, red, borne in racemes, 10 cm length, spring

Location: Frequently observed as a cultivated garden plant

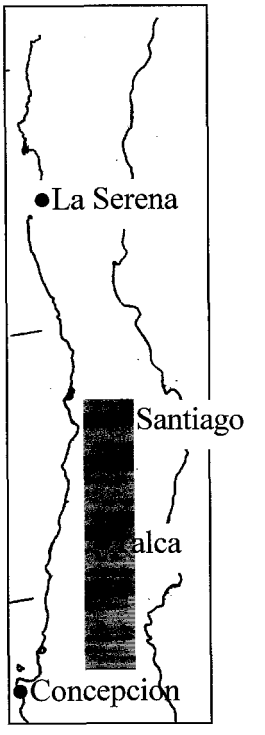
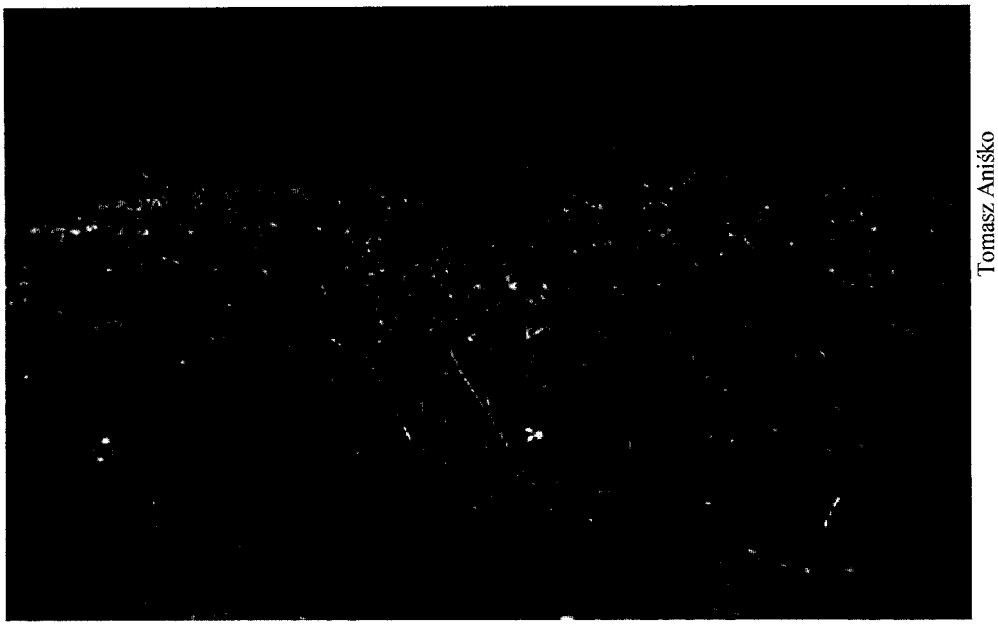


Figure 6.11. *Embothrium coccineum* observed locations (shaded area)



Tomasz Aniśko

Figure 6.12. *Geum chiloensis* in Jardin Botanico Mapulema

***Geum chiloensis* Balb. ex Ser., Rosaceae**

Habit: Chamaephyte (Griffiths, 1995)

Size: 50-60 cm height

Foliage: Lobed, cordate

Flower: Large, borne in erect cymes, red, spring

Location: Observed as bedding plant in Jardin Mapulema in Santiago. Plant(s) grew in full sun and sandy loam.

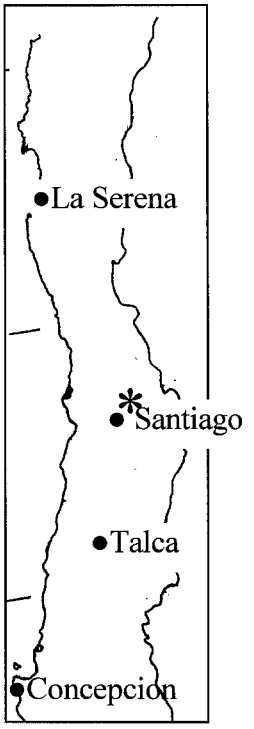


Figure 6.13. *Geum chiloensis* observed location *

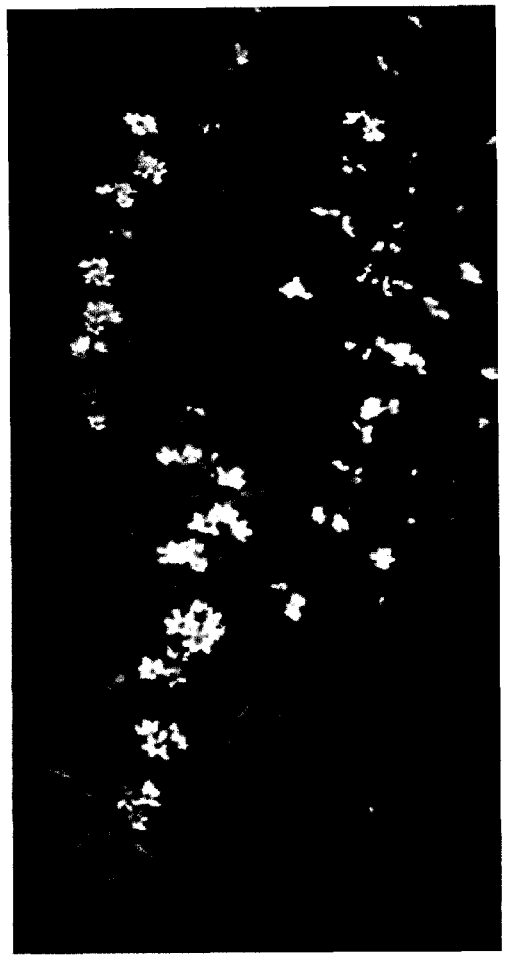


Figure 6.14. *Libertia formosa* in flower

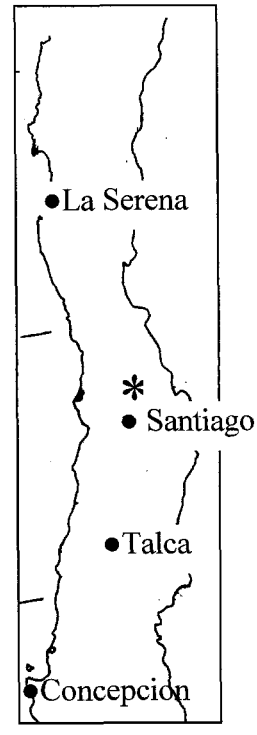


Figure 6.15. *Libertia formosa* observed location *

***Libertia formosa* Graham., Iridaceae**

Habit: Chamaephyte (Griffiths, 1995)

Size: 90 cm height

Foliage: Linear-ensiform, 12-40 cm length

Flower: 1.2-1.8 cm diameter, yellow-white, borne in crowded umbels, spring

Location: Observed plant in Jardin Mapulema in Santiago.

Figure 6.16. *Lupinus microcarpus* flower and foliage

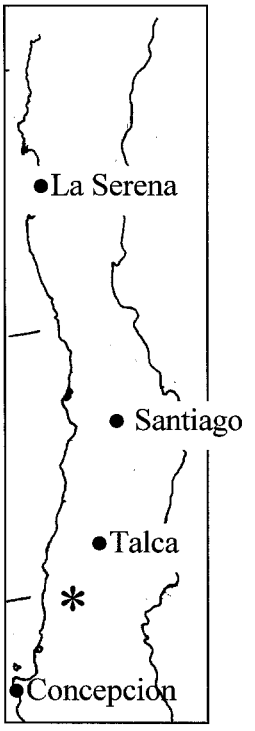


Figure 6.17. *Lupinus microcarpus* observed location *

***Lupinus microcarpus* Sims., Papilionaceae (Fabaceae)**

Habit: Thermophyte (Hoffmann, 1995)

Size: 10-30 cm height

Foliage: Arranged in a rosette, digitate, 5-15 cm length, glaucous

Flower: White, purple bracts, inflorescence 15-20 cm length

Location: Observed in compacted sandy loam along side of road between towns of Quirhue and Cauquenes. Plants grew in full sun exposure.

Figure 6.18. *Oxalis gigantea* north of La Serena

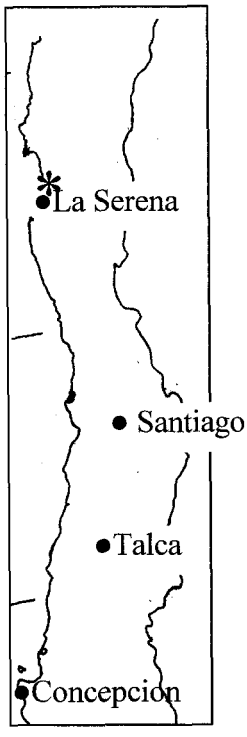


Figure 6.19. *Oxalis gigantea* observed location *

***Oxalis gigantea* Barnéoud., Oxalidaceae**

Habit: Phanerophyte (Griffiths, 1995)

Size: 1-2.5 m height

Foliage: Compound with three leaflets, fleshy

Flower: Yellow, 1-2 cm diameter, solitary or in 3-6 flowered umbellate cymes

Location: Observed growing in a sandy bank on northern limits of La Serena

Figure 6.20. *Rhodophiala bagnoldii* flower scape

***Rhodophiala bagnoldii* (Herb.) Traub., Amaryllidaceae**

Habit: Geophyte (Griffiths, 1995)

Size: 30 cm height

Foliage: Narrow-linear

Flower: 3-5.5 cm length, yellow, 4-6 flowers per scape

Location: Observed in field south of La Serena along Route 5. Soil was sandy-loam.

Figure 6.21. *Rhodophiala bagnoldii* observed location *

Figure 6.22. *Senecio yegua* in flower east of Talca

***Senecio yegua* (Colla) Cabr., Asteraceae**

Habit: Phanerophyte (Hoffmann, 1995)

Size: 3 m height

Foliage: Elliptic, 12-21 cm length, 3.5-8 cm width

Flower: Yellow, borne in terminal corymbs

Location: Observed in sandy-loam on hillside

of road to Reserva Nacional Altos de Lircay

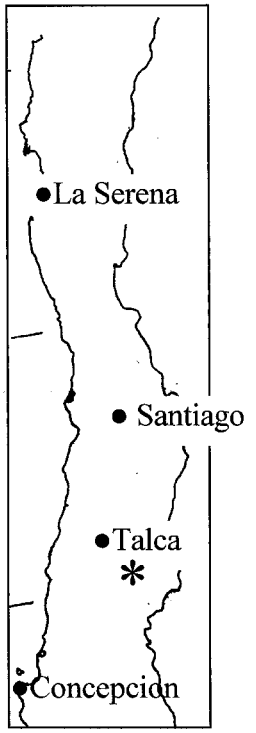


Figure 6.23. *Senecio yegua* observed location *

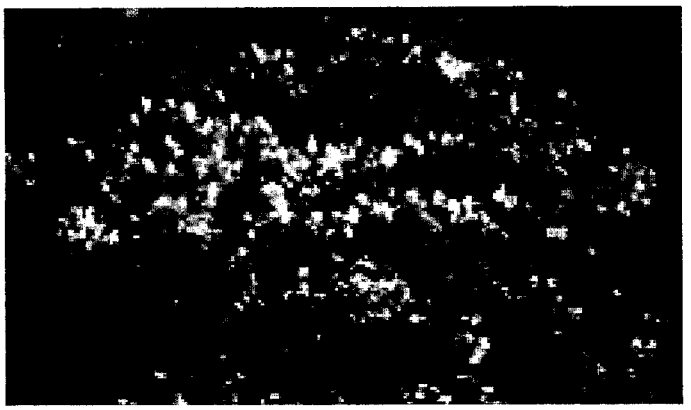


Figure 6.24. *Senna cumingii* in flower. Parque Nacional Fray Jorge

***Senna cumingii* (Hook. & Arn.) Irwin & Barneby., Fabaceae**

Habit: Phanerophyte (Griffiths, 1995)

Size: 30 cm – 3 m height

Foliage: Compound leaflets, 3.5 -12 cm

Flower: Golden-yellow, 9-26 mm, borne in corymbose panicles of 5-30 flowers

Location: Observed in sandy-loam in Parque Nacional Fray Jorge.

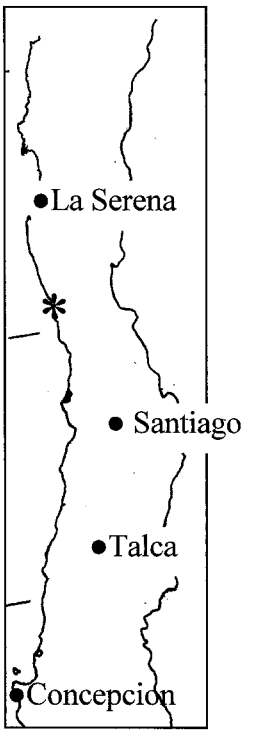


Figure 6.25. *Senna cumingii* observed location *

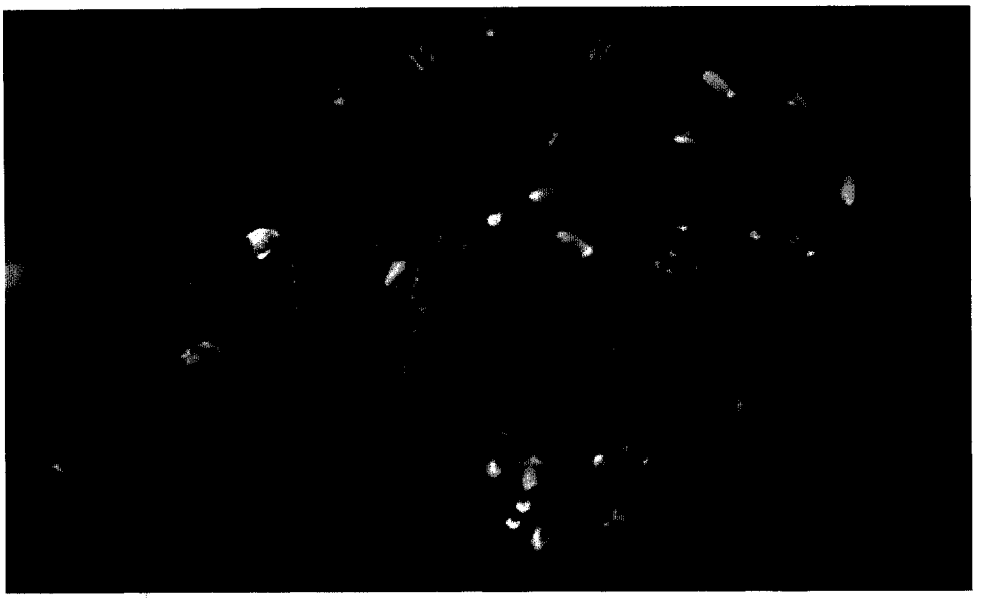


Figure 6.26. *Solanum ligustrinum* flower detail

***Solanum ligustrinum* Lodd., Solanaceae**

Habit: Phanerophyte (Hoffmann, 1995)

Size: 1-2 m height

Foliage: Ovate-lanceolate

Flower: 1 cm diameter, violet with yellow pistils,

borne in racemes

Location: Observed in sandy-loam along compacted roadsides

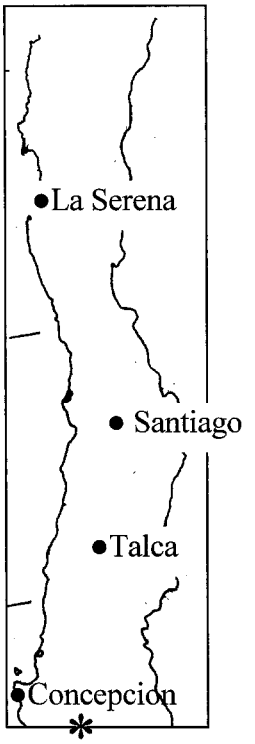


Figure 6.27. *Solanum ligustrinum* observed location *

The 14 additional plants recommended for display are in addition to the 92 plants on the final target list. The 14 plants were observed during the two-week expedition to Chile. Future expeditions to Chile of extended duration should discover additional plants with display potential.

Table 6.01. Additional plants recommended for display (* indicates desirable characterisitic)

Species	*Form*	*Size*	*Flower Color*	*Foliage*
Araucaria araucana	Phanerophyte	30 m ht.		Triangular needles*
Argylia radiata	Chamaephyte	20 cm ht.	Yellow*	
Carpobrotus chilensis	Chamaephyte	8 cm ht.	Violet*	Succulent, green
Cordia decandra	Phanerophyte	4 m ht.	White*	
Cruckshanksia verticilata	Chamaephyte	8 cm ht.	Yellow*	
Embothrium coccineum	Phanerophyte	10 m ht.	Red*	
Geum chiloensis	Chamephyte	50-60 cm ht.	Red*	
Libertia formosa	Chamaephyte	80 cm ht.	Yellow-white*	
Lupinus microcarpus	Thermophyte	10-30 cm ht.	White with purple bracts*	Digitate
Oxalis gigantea	Phanerophyte	1-2.5 m ht.	Yellow*	Compound with three leaflets*
Rhodophiala bagnoldii	Geophyte	30 cm ht.	Yellow*	
Senecio yegua	Phanerophyte	3 m ht.	Yellow*	
Senna cumingii	Phanerophyte	30 cm – 3 m ht.	Yellow*	
Solanum ligustrinum	Phanerophyte	1 – 2 m. ht.	Purple with yellow pistils*	

Target plants not recommended for display

The following 66 target list plants are not recommended for display. The plants either: are documented as observed but not of display quality at Longwood, require more observation, or were not observed during the expedition. The rationale for why the author does not recommend a plant is included with the plant name. Future plant expeditions to Chile should make an objective of documenting plants that were not observed or plants whose observation did not provide enough information about its display potential

Acacia caven (Mol.) Mol. Longwood already had *Acacia* spp. that are superior in display to this species.

Adesmia arborea Bert. This plant was not observed.

Alstroemeria haemantha Ruiz & Pav. This species is not as showy as *A. magnifica* spp. *maxima*.

***Alstroemeria* sp.** This plant, an unknown species according to Hoffmann (1995), was not observed.

Alstroemeria spathulata Presl. This species was not observed.

Aristotelia chilensis (Mol.) Stuntz. This plant has no spectacular characteristics.

Austrocedrus chilensis (D.Don) Pichi-Serm. & Bizzarri. The dense growth form of this conifer could be useful in displays. One small specimen was observed.

Azara celastrina D. Don. This species was not observed.

Azara petiolaris (D. Don) Johnston. This species was not observed.

Azara serrata Ruiz & Pav. This species was not observed.

Bomarea salsilla (L.) Herb. This plant was observed at Pumahuida Nursery in Santiago. The plant was nursery stock and too small to determine whether or not it had display potential.

Brodiaea porrifolia (Poepp.) Meigen. This lily relative is too small for any displays at Longwood.

Buddleja globosa Hope. Longwood has a trial program for evaluating *Buddleja* spp. and hybrids. This species has interesting globose flowers, but may not be superior to plants currently being evaluated.

Caesalpinia spinosa (Molina) Kuntze. Two observations are recorded of this plant. The first one, at Jardin Mapulema, is not spectacular. The second, at Parque Nacional Fray Jorge, would be a good display plant because of its shrubby habit and heavy flowering. This polymorphism could have been due to differences in environment or plant genetics. More specimens need to be observed and collections made for display potential.

Calandrinia affinis Gill. & Arn. This white flowering species was not observed.

Calceolaria purpurea Grah. This plant was not observed.

Calydorea xiphioides Esp. This species is too small for displays.

Carpobrotus aequilaterus (Haw.) N.E. Br. This species was not observed. *C. chilensis* is listed in Additional plants recommended for display.

Cassia arnottiana Gill. *ex* H. & A. This species was not observed.

Cassia closiana Phil. Compared to *Cassia* spp. currently growing in Longwood, this species is inferior.

Cassia stipulacea Ait. This species is inferior to species growing in Longwood.

***Chlorea* sp.** Several *Chlorea* spp. were observed in Chile but this unknown species illustrated in Hoffmann was not observed.

Chusquea cumingii Nees. This bamboo is frequently encountered in central Chile. The growth form is too informal for display at Longwood.

Citronella mucronata (Ruiz & Pav.) D. Don. Originally selected for its ornamental fruit, this species was not observed.

Clarkia gayana (Cav.) Lewis & Lewis. Observed in Colliguay, this plant was too small for display.

Conanthera trimaculata (D. Don) Meigen. The blue flowers on this plant are attractive but too small for display.

Eccremocarpus scaber Ruiz & Pav. Longwood already has plants of this species. The plants are not display quality.

Ephedra andina Poepp. *ex* C.A. Mey. This species was not observed.

Escallonia pulverulenta (Ruiz & Pav.) Pers. This species was not observed.

Euphorbia portulacoides L. This species was not observed.

Fascicularia bicolor (Ruiz & Pav.) Mez. This species was not observed.

Fluorensia thurifera (Mol.) DC. This species was not observed.

Francoa appendiculata Cav. This species was not observed.

Fuchsia lycioides Andr. This species was not observed.

Fuchsia magellanica Lam. The shrubby habit of this fuchsia might be good for display in the Orangery. It should be evaluated against *Fuchsia* spp. currently grown in Longwood. The flowers on this species are small and the plant does not produce a heavy floral display.

Herbertia lahue (Mol.) Goldbl. This species was not observed.

Jubaea chilensis (Molina) Baill. This palm would make a good addition to the Palm House because of its interesting, swollen trunk. However, our guide, Ms. Fernanda Larrain, while in Parque Nacional La Campana, stated that they were slow growing. One accession of this palm is in Longwood from the expedition.

Lapageria rosea Ruiz & Pav. This species was observed twice. Both observations had few flowers. *L. rosea* would need to be observed at different times to see if it produces more flowers in greater abundance at one time.

Lathyrus subandinus Phil. This species was observed in Reserva Nacional Radal Siete Tazas. The plant was attractive but the author has concerns about introducing an additional *Lathyrus* sp. to the United States because of their invasiveness.

Lepechinia chamaedryoides (Balb.) Epling. This species was not observed.

Leucocoryne violacescens Phil. This species was not observed.

Lobelia excelsa Bonpl. This species was not observed.

Lomatia hirsuta (Lam.) Diels. The large, serrated leaves of this protea family member make this plant look like open form of *Elaegnus pungens* Thunb. Based upon observations of current displays at Longwood, this plant would not be used. Flowers are small and insignificant.

Luma chequen (Mol.) A. Gray. This species was not observed.

Lupinus arboreus L. This California native has escaped from cultivation in Chile. The plant could be used in Longwood displays but an expedition to Chile should not use resources on a plant available from California.

Malesherbia linearifolia (Cav.) Persoon. This species was not observed.

Maytenus boaria Mol. This species was not observed.

Mutisia decurrens Cav. The author's observation of this vine is recorded as growing inside of a dense shrub. The flower is interesting but might not be large enough for Longwood's displays.

Ochagavia carnea (Beer) L.B. Sm. & Looser. This species was not observed.

Oxalis articulata Savigny. This species was not observed.

Persea lingue Nees. This avocado relative has no spectacular ornamental characteristics.

Phycella ignea Lindl. This species was not observed.

Placea arzae Phil. This species was not observed.

Puya venusta Phil. This species was not observed.

Rhodophiala rhodolirion (Baker) Traub. This species was not observed.

Salix chilensis Mol. This tree was observed in flower near Huasco. The flowers were attractive but the plant would need to be further evaluated to see if it could add more to displays than trees currently being used.

Salpiglossus sinuata Ruiz & Pav. This plant is interesting due to the venation of the leaves. More observation is needed to find larger flowers.

Satureja gilliesii (Grah.) Briq. This plant was observed at Pumahuida Nursery and had no outstanding display qualities.

***Schizanthus* spp.** Ruiz & Pav. There are beautiful specimens of this genus in central Chile. The author has concern about the flowers being too small for Longwood's displays.

Sisyrinchium junceum E. Meyer. The flowers on this species are too small for display at Longwood.

Solidago chilensis Meyen. This species was not observed.

Sophora macrocarpa Sm. Several specimens are included in the observations of this species. The range of observed species is poor to good in display potential. Selections could be made from wild populations.

Teucrium bicolor J. E. Sm. This species was not observed.

Tropaeolum azureum Miers *ex* Colla. This species was not observed.

Tropaeolum tricolorum Sw. This plant is an interesting small vine. The flowers may be too small for Longwood's displays.

Viviania marifolia Cav. This species was not observed.

The next chapter will draw conclusions and make recommendations based upon data presented in the thesis.

Chapter 7

CONCLUSIONS & RECOMMENDATIONS

This chapter begins by restating the goal of the thesis: determine which plants from central Chile have potential as display plants at Longwood Gardens. The researcher concludes from the research that:

- Longwood Gardens' staff should utilize plants from mediterranean regions in their displays.
- Plants from the mediterranean region of Chile currently serve as a small fraction of the total accessions of Longwood Gardens.
- Few plants from central Chile are used in Longwood displays.
- The survey responses from the Longwood Gardens Plant Evaluation Committee did not enable the researcher to select plants from the final target list.

The researcher recommends that:

- Longwood Gardens' staff should trial and evaluate 40 of the observed plants from Chile in their displays.
- Longwood Gardens' staff should participate in future plant explorations to Chile to collect germplasm of the 40 recommended plants. The explorations should also observe target plants that require more information.

The following are recommended for such trips:

- Obtain necessary permits.
- Determine locations of plants.
- Work with an in-country collaborator.
- Bring the necessary equipment for collecting plant material.
- Determine the season of travel.

Further information about each recommendation is contained in Appendix B (Page 98).

Appendix A

FINAL TARGET LIST

The following 92 plants represent the final target list. This list was taken to Chile and served as a focus for the research expedition.

Abutilon vitifolium
Acacia caven
Adesmia arborea
Alstroemeria haemantha
Alstroemeria pulchra
Alstroemeria sp.
Alstroemeria spathulata
Aristolochia chilensis
Aristotelia chilensis
Austrocedrus chilensis
Azara celastrina
Azara petiolaris
Azara serrata
Bomarea salsilla
Brodiaea porrifolia
Buddleja globosa
Caesalpinia spinosa
Calandrinia affinis
Calceolaria purpurea
Calceolaria sp.
Calydorea xiphioides
Carpobrotus equilaterus
Cassia arnottiana
Cassia closiana
Cassia stipulaceae
Cestrum parqui
Chloraea chrysantha
Chloraea sp.
Chusquea cumingii
Cissarobyron elegans
Citronella mucronata
Clarkia gayana
Conanthera trimaculata
Drimys winteri
Eccremocarpus scaber
Ephedra andina
Escallonia pulverulenta
Escallonia rubra
Eupatorium salvia
Euphorbia portulacoides
Fabiana imbricate
Fascicularia bicolor
Flourensia thurifera
Francoa appendiculata
Fuchsia lycioides
Fuchsia magellanica
Herbertia lahue
Jubaea chilensis
Lapageria rosea
Lathyrus subandinus
Lepechinia chamaedryoides
Lepechinia salviae
Leucocoryne coquimbensis
Leucocoryne ixiodes
Leucocoryne violacescens
Lobelia excelsa
Lobelia polyphylla
Lobelia tupa
Lomatia hirsuta
Luma chequen
Lupinus arboreus
Malsherbia linearifolia
Maytenus boaria
Mutisia decurrens
Mutisia subulata
Nolana paradoxa

Ochagavia carnea
Oenothera acaulis
Oxalis articulata
Pasithea caerulea
Passiflora pinnatistipula
Persea lingue
Phycella bicolor
Phycella ignea
Placea arzae
Puya berteroniana
Puya chilensis
Puya coerulea
Puya venusta
Rhodophiala advena
Rhodophiala rhodolirion
Salix chilensis
Salpiglossus sinuata
Satureja gilliesii
Schizanthus sp.
Sisyrinchium junceum
Solidago chilensis
Sophora macrocarpa
Teucrium bicolor
Tropaeolum azureum
Tropaeolum tricolor
Viviania marifolia

Appendix B

EXPEDITION PLANNING

Obtain necessary permits. Permit from CONAF allows collection of plant material from national parks. Send a facsimile request for permit to 011-562-390-0125. The request should state the intentions of the trip. The request should mention the uses of the plant material in a public display garden. The permit will request that the permitted abide by the Convention on Biological Diversity. Longwood Gardens has an import permit from the United States Department of Agriculture. The permit is required to reenter the United States with plant material.

Determine locations of plants. Dr. Clodomiro Marticorena, professor at Universidad de Concepcion, maintains a database of global positioning coordinates of many native plants. Dr. Marticorena provided a list of global positioning coordinates for plants on the final target list. These coordinates are on file in the Longwood Gardens' library. The email address of Dr. Marticorena is cmartico@udec.cl. Flavia Schiappacasse, professor at the Universidad de Talca, has outstanding knowledge of many Chilean plants. Her email is fschiap@pehuenche.utalca.cl.

Work with an in-country collaborator. Dr. Marcelo Kogan is head of the Department of Vegetable Science at Pontificia Universidad Catolica de Chile in Santiago wants to collaborate with Longwood on future expeditions. Dr. Kogan's email address is mkogan@puc.cl.

Bring equipment necessary for collecting germplasm. Dr. Mark Bridgen of Cornell University takes sterile Petri dishes containing a medium to place undeveloped seeds (Bridgen, 2002). Dr. Bridgen's email address is mpb27@cornell.edu. Many seeds stored in that manner mature by the end of a trip. Other equipment should include: a digging pick, paper bags for storing plants, re-sealable plastic bags, envelopes for storing seeds, and labels for shipping germplasm back to the Longwood Gardens.

Determine the season of travel. Chile is in the southern hemisphere. Spring season in central Chile is from September in La Serena until December in Concepcion. A major factor in collecting plants in central Chile is the difference of seasons from north to south. In mid-October, plants in the northern areas are setting seed while ones in the southern areas are still a month or more from flowering. Expeditions have to occur on three occasions when plants are in full flower in the different areas of the region. An expedition to collect from all regions of central Chile on one trip is unfeasible. A researcher has to travel southward from one region to another, observing plants in flower. The researcher has to gauge their progress according to the weather. Plants flower earlier in a warm spring. Plants flower later in a cold spring. A plant expedition across all regions of central Chile requires several months.

Precipitation would also determine timing of an expedition. Northern areas of central Chile have limited rainfall amounts. Many desirable plants flower after spring rains. Spring rains have to be considered when planning collection trips. Trips to northern areas would be most successful after spring rains.

Appendix C

TRAVEL LOG FROM RESEARCH EXPEDITION TO CENTRAL CHILE; 15-28 OCTOBER 2001

October 15, 2001 - Monday

We arrived at Santiago airport before Mark Bridgen. After proceeding through customs, we met Mark outside of the customs. The security at Santiago's airport was more secure than anything we have experienced in the United States. They have never allowed guests to go the gate with passengers. I guess that is what many years of war will do for security in a country. We later learn that street mailboxes are forbidden because of concern for mail bombs. If anyone wanted to mail a letter or package, they must have gone to the post office and mailed it from there.

Eduardo Olate, our guide, met us shortly after we arrived to drive us to our hotel for the evening in Santiago. Along the way, we see the hillsides planted with "little rays of sun" *Carpobrotus chilensis*. It was incredible to see roadsides full of *Elscholtzia californica*, a plant escaped from cultivation. The species was introduced from California. We arrived at our hotel, Alcala del Rio, and had lunch. After lunch, we ventured up the Cerro San Cristobal. Here, we saw the city's botanic garden, Jardin Botanico Mapulema. It was more of a park, but we saw many plants native to Chile. Later in the trip, we visited the Jardin Botanico Nacional, or National Botanic Garden, and there were more native plants at the small display garden in Santiago. The day was Columbus day, a Chilean national holiday, and it seemed that many of the city's residents have descended upon this

hill. After we visited the botanic garden, we headed further up the *cerro* to the monument of Santiago's patron saint. We headed back to our hotel and got ready for our early flight on Tuesday to Concepcion.

October 16, 2001 – Tuesday

A 6 AM shuttle arrived at our hotel to transport us to the airport. Eduardo met us at the airport for our 8 am flight to Concepcion. The flight was delayed because of fog over the city of Santiago, but at 9 am we took off with a planeload of Chilean businessmen and women. Around 10 in the morning we arrived in Concepcion, about 400 kilometers south of Santiago. We rented a vehicle, a green Toyota FourRunner, and headed even further south towards Parque Nacional Nahuelbuta. Before we left the city, we stopped by the University in Concepcion, where we met Dr. Clodomiro Marticorena. I had read about him via the internet before our trip. He was working with researchers at the Missouri Botanic Garden on the Flora of Chile. They have published two volumes, which we bought for the Longwood Gardens' Library. We were surprised to find that Dr. Marticorena had a database of the locations of many native Chilean plants. He generously compiled a list of the locations of all of the plants on my target list. I was pleasantly surprised at this show of generosity. This list could definitely help future explorations. We bought books at the University's bookstore for the Longwood Library and continued onto Nahuelbuta.

Along a road between Santa Juana and Naciomiento, we saw an incredible *Rhodophiala* sp. along the side of the road. We heard several names for the plant later in our trip, which showed that with the exception of the yellow rhodophiala, *Rhodophiala bagnoldi*, the nomenclature on this genus was confused. We heard some people cite

Phycella as *Rhodophiala*. The plant was approximately 13" in height and at first glance, we thought it was a bright daylily. The plant was growing in a grayish sandy-loam on a steep cut bank.

The color of the flower was a bright reddish-orange with yellow throat. Later, we stopped to observe a deep purple flower. The shrubby mass was *Solanum gayanum*. After we turned on a dirt road to Nahuelbuta, we saw several different types of *Chloraea sp.* growing on an embankment. These small orchids were yellow to orange in color and visually striking. The soil was orange and appeared to be clay. All plants appeared to possess display qualities. At the end of the day, we arrived in Nahuelbuta. The national park was a place that people should visit to experience the native stands of *Araucaria auricariodes*. The monkey puzzle trees grew up to heights of seventy-five feet or more provided for an awesome experience. Tomasz Aniśko took affinity to the park because of the large, misshapen trees. The park ranger was nice enough to tell us that we should return to the park in November in order to see more of the flora in flower. The Chilean national flower, *Lapageria rosea*, was supposed to be growing in the park. We did not see it but we did not have enough time to look for it extensively. At the top of one of the peaks amongst monkey puzzle trees, we saw *Rhodophiala* sp. and *Alstroemeria* sp. After leaving the park, we drove to Los Angeles. Along the way, we viewed a beautiful specimen of *Drimys winteri*. We checked into a hotel in Los Angeles and had dinner at a nearby Argentinean restaurant.

October 17, 2001 – Los Angeles to Talca

After we woke up early, we drove north along Route 5 towards Talca. Along the side of the road we stopped to see *Pasithaea coerulea, Leucocoryne* sp., *Tristagma biflora, Oenothera acaulis*, and *Fortunaria bicolor*. From clay to sand and fertile to brick-hard, *Pasithaea* was growing in all of these soils. *Pasithaea* was a nice blue flowering plant that would be a good "see-through" plant for Longwood's displays. Later, we observed a nice population of *Conanthera* sp. and *Calceolaria* sp. Along the road between Quirhue and Cauquenes, we observed a large population of *Rhodophiala* aff. *advena*. The plants were scattered all about a waterway. It seemed when the waters were high and the plants were in seed, the seeds were carried to other places via the water. The soil at this stop was a clay-loam. Also, later down the road we spotted a beautiful groundcover, *Lupinus microcarpus*. The groundcover grew on the side of the road near Cauquenes. The plants made a dense mat of white and blue-purple flowers. The plants would make add to a display at the front of a border in the Main Conservatory at Longwood. We later saw *Phycella bicolor*, *Lobelia tupa*, and *Alstroemeria* growing in the town of Pelhue. The site was along the Pacific Ocean and the plants were growing on sand amongst rocky cliffs and hills. At sunset, we walked down to the black sand beach, where I saw my first sunset over the Pacific Ocean.

October 18, 2001 – Talca

On this day, we met with Professor Flavia Schiappacasse from the University of Talca. Flavia was a graduate student of Mark Bridgen's at the University of Connecticut. Some things noted from our meeting with Flavia: the mountains east of Talca were most

spectacular for flowering in early January... most of the *Embothrium coccineum* was cultivated in people's gardens... *Fasicularia bicolor* was a small plant and most often grew south from Talca along the coast. We visited the nursery at the University where we observed many different forms of *Leucocoryne* spp. A nice plant in her nursery was *Conanthera bifolia*. It possessed small, purple flowers with reflexed petals and yellow pistil. *Conanthera* took six years to flower from seed. In order for the seeds to germinate, Flavia says they need to be soaked in water for three days. The water water should be changed every day and a temperature of sixty (60°) degrees Fahrenheit should be maintained. We were all excited about *Rhodophiala* after seeing it growing along the sides of the roads, and even more so when Flavia said that she was trying to get a tetraploid form to grow as a cut flower. After meeting with Flavia, Tomasz, Eduardo and I headed off to Altos de Lircay while Mark stayed at the University of Talca. Mark performed a sabbatic leave at Talca in 1996 and knew many of the staff and students in the University.

Along the road to the Altos de Lircay, we saw an incredible plant with gray leaves and stems and yellow, *Helianthus* like flowers about two inches in diameter. The plant was approximately ten feet in height. We keyed it out as *Senecio yegua*. Tomasz and I collected seeds. Once we reached Altos de Lircay in the Andean foothills, we realized that we were too early to see much in flower. At one lookout, we saw *Calceolaria* sp., *Solanum ligustinum,* and *Buddleja globosa,* and an unknown bromeliad with red center. Eduardo said that the leaves of *Buddleja* are used by some Chileans to make a tea.

The guard at the park, an amicable man, told us that December is the best time to visit the area. "A virtual garden," was his description.

October 19, 2001

We started the morning at our hotel. The proprietors are friends of Mark's because he lived in the hotel while he was on sabbatical leave in Talca. They were friendly people and the husband, Osvaldo, met his wife while working in the mines of Brazil. We headed out with Flavia and another of Mark's former students, Doris. They accompanied and guided us to Reserva Nacional Radal Siete Tazas. This translated to the National Reserve of Seven Cups, named for a series of seven waterfalls that occurred in the park. Halfway to the park on a country road, we stopped to see a spectacular view of one waterfall. Growing beside the lookout was an incredible *Hydrangea serratifolia*. The vine had large leaves but was not in flower. This would definitely be a specimen to look for with flowers. I doubt it would be hardy for outdoor use at Longwood, but could be tried for the conservatories. Once we were in the Reserve, we had a picnic lunch that we bought at a supermarket on our way to the area. After a quick lunch and some group photographs, we began hiking up the trail recommended by a guide stationed at the Reserve's entrance. On the trail, an interesting blue flower caught our attention. It was *Lathyrus subandinus*. Although it was a nice vine, I would be a bid concerned about bringing any kind of sweet pea back to the Delaware Valley because of potential invasiveness. Later, I spotted a variegated *Alstroemeria*. Mark, in his wisdom, dismissed it as a plant with virus and encouraged us to leave it where it grew. We hiked more along the trail, but we were too early in this part of the country to observe much floral display. We hiked back to the vehicles after a few hours, bid farewell to Flavia and Doris, and then headed on our return to Santiago. We

made it back into the city around nine-thirty at night, found a hotel, had dinner, and then went to bed.

October 20, 2001

After we met Eduardo and had breakfast, we journeyed north along Route 5 towards the city of La Serena. After leaving Santiago, we stopped for a bathroom break and discovered *Alstroemeria gayana* growing along the side of the road. Although the area was extremely dry, there was enough moisture from ocean breezes to permit the plants to grow and flower. Also growing along with the *Alstroemeria* were *Lupinus arboreus*. A few hours later, we stopped to see *Leucocoryne striata* flowering as it grew in the sand dunes of the coast.

As we continued driving, the coastal ranges became higher in elevation. The height forced moisture and breezes from the Pacific Ocean upwards until they became cool and condensed. As they cooled and condensed, they formed clouds that rolled over the tops of the coastal hills. The effect was awesome and looked like someone has placed massive amounts of dry ice on the tops of the hills in order to produce the effect. It was definitely something out of a storybook. After some driving, we eventually reached Parque Nacional Fray Jorge. The national park was a series of mountaintops along the Pacific. Even though we were in the southern beginnings of the Antofagasta desert, the peaks of the coastal range were high enough to cause the moisture to cool, condense and fall over the peaks. The vegetation on the mountaintops was strikingly different from that of the surrounding countryside. Dense shrub and megaherbs dominated the peaks. On this day, the cloud cover was so dense that our visibility was limited to fifty feet. Mark and Eduardo were here before when the sky was clear and they could see the brilliant waters of the Pacific on

one side and the snow covered peaks of the Andes to the east. The wind was ferocious. We were getting our gear together inside of the 4-Runner and the wind was rocking the vehicle back and forth. Once we got out and started hiking, we saw an incredible diversity of plants. Among the plants we saw were: *Eupatorium salvia, Alonsoa* sp., *Happlopappus* sp., *Calceolaria* sp., *Ageratum* sp., *Puya chilensis,* an unusual *Fuschia* with tiny leaves, and a nice *Senecio* sp. with bright, yellow flowers. We saw a grove of *Leucocoryne ixiodes* in flower. Later in the day, I will regret Mark and Eduardo's decision to collect bulbs of this plant as the flowers smelled like rotting onions. Unfortunately, the plants were stored in the back of the 4-Runner near my olfactory senses. Eventually, I became immune to the smell, but only after contemplating how to throw the bulbs out of the vehicle. Nearby, we also saw an *Alstroemeria* with pink and yellow flowers that Mark and Eduardo also collected. After leaving Fray Jorge, we happened upon a field full of yellow amaryllis-like flowers. We discovered that we were looking at the yellow rhodophiala, *Rhodophiala bagnoldii.* The field was sand so the plants were easy to dig. We collected a few plants to bring back for trial and evaluation. Later, we saw a pure white *Leucocoryne coquimbensis*. Again, the plants are growing in full sand. We headed on to La Serena and as we went, the *Nolana* made a wonderful groundcover along the shoulders of Route 5. We found a hotel along the beach for the night, celebrated Eduardo's birthday over dinner, and then retired for the evening.

October 21, 2001

We skipped breakfast in order to get a jump on the day. As we left La Serena, we stopped at a hill along railroad tracks to observe an enormous population *Leucocoryne coquimbensis*. Also growing on the hill was *Oxalis gigantea*. The *Oxalis* was different from other species in the genus with spikes rising approximately four feet in height. I tried digging at the base of the plant to see if there were any tubers like most other *Oxalis*. If there were, we could use the tubers to propagate the plant at Longwood for display. With yellow flowers, it would make a striking specimen for displays. Later, we took a break as we drove down the road and observed beautiful, blue *Nolana* sp. growing along the ground. We also saw an interesting yellow, flowering shrub called *Balbisia peduncularis*. Although I was not sure of its display potential at Longwood, it added a nice color to a landscape lacking of flower colors. North from La Serena, we stopped to see *Nicotiana glauca* along the sides of the road with glaucous foliage and tubular, creamy-yellow flowers. The plants were about six feet in height with some rising up to eight feet or more. Tomasz made a collection of seeds. An interesting note: CONAF, the Chilean government agency that controls the national parks of Chile, maintained the seasonal rainfall for different regions of Chile. I could look up the different rainfall amounts to see what how much water each region received and use this information to see how much water the plants would need to grow successfully.

We drove up to the desert in search of *Leontichir ovallei*. This plant, related to *Alstroemeria*, grew in one area of Chile in a national park. Mark and Eduardo saw the plant on a trip during the previous year. The plants lay dormant amongst the rocks on a

barren, desert hillside until they receive enough moisture to grow, flower and seed. Tomasz found a seed head so we were able to collect about twenty seeds of this unusual and rare plant. We headed deeper into Parque Nacional Llanos de Challe until we reached the Pacific Ocean and then we headed southwards towards La Serena. The road was unpaved and about a half of a mile off of the Ocean. We braked to a sudden stop when we saw a lot of colors coming from a dry streambed. The plants we saw included the yellow flowered *Rhodophiala bagnoldii, Cruckshanksia* sp., *Calceolaria* sp., *Alstroemeria* sp. with fine foliage, and *Oxalis gigantea*. The area was scattered with rocks. The soil was sandy. Although the area was devoid of significant rainfall, we were close enough to the ocean to receive enough moisture for the plants to grow and thrive. Near the town of Huasco, we saw another unusual *Nicotiana* with more rounded foliage (there are approximately twenty species in Chile) and *Salix chilensis*. The Chilean willow was in full flower and made a nice show along the waterways of north Huasco. Near Huasco, we rode alongside horse-mounted cowboys (Spanish – huaso) who were heading to a rodeo in their full Chilean cowboy attire. The dress consisted of silk shirt with a poncho and black pants. We checked into a small hotel in Huasco, had dinner and then called it a night.

October 22, 2001

After starting early towards La Serena, we made a stop to observe *Cordia decandra*, a white flowering woody shrub with recurved, green foliage in Cuesta de Bagonalles. I made a note to definitely add this plant to the target list for its display potential. Later, we saw *Alstroemeria magnifica* ssp. *maxima*. These beautiful pink and yellow flowers were growing along the side of a hill were in the mine of El Tofo. As we

continued along the dirt roads of the mine, we saw more giant lobelias. The dirt road of the mine was long and all of us fell asleep (except for the driver, Mark). Mark woke us up to see the fields full of *Nolana* and other small, yellow flowers. Later, we stopped to see *Alstroemeria magnifica* ssp. *maxima*, *Rhodophiala phycelloides*, *Lobelia polyphylla*, and *Leucocoryne* sp. We drove into a small beach town called Los Vilos where we found a hotel and stayed for the night.

October 23, 2001

We start off southward for the beaches west of Santiago. We saw *Puya coerulea* growing along the side of Route 5. Of all of the puya that we have seen, this one was the best specimen. If this plant were on display at Longwood, many visitors would stand at the plant and be in awe of the grayish-blue foliage and the purplish-blue with red bracted flowers. The color combination was awesome. At Los Molles, we saw *Alstroemeria pelegrina*. The flowers had a soft pink outer coloring to the petals with darker pink stripes down the center of the petals. Later, at Cuesta del Melon, a hillside west of Santiago, we saw *Cestrum parqui, Fuschia* sp., and *Sphacele salviae*. We took cuttings of *Sphacele*. From Cuesta del Melon, we drove to the coastal town of Zapallar, where we had hoped to find the Chilean passionflower, *Passiflora pinnatistipula*. We did not find the passionflower. From here, we drove to Vina del Mar, dropped Eduardo off at the bus station so that he could get back to Santiago. The rest of the day in Vina was designated as a free afternoon to get caught up on personal items.

October 24, 2001

Early, one of Eduardo's students, Fernanda Larrain, met us to guide us around the area. We set out for the Jardin Botanico Nacional near Vina to see their collections. Most of what we saw in the botanic garden consisted of plants from other countries around the world. We were surprised to see so many plants, including sweetgum, bald cypress, and magnolia, native to the United States. We headed to Colliguay after visiting the garden. Colliguay was an area west of Santiago where the flora was studied and documented by a team led by Gloria Montenegro, a professor from Eduardo's university. Along the road to Colliguay we saw *Alstroemeria ligtu, Clarkia tenella, Eupatorium salviae,* and *Mutisia* sp. We never found the exact area that Montenego's team had studied. We walked up a path near where the trail should have been but did not see many plants of interest. We headed back to our hotel for the night in Vina del Mar.

October 25, 2001

The group of Fernanda, Mark, Tomasz and I headed off from Vina del Mar towards Parque Nacional La Campana. We hiked around the park and some plants that we saw of note included: *Jubaea chilensis, Eupatorium salvia, Aristolochia chilensis, Drimys winteri,* and *Sophora* sp. We left the park and went to meet Levi Manseur from the University of Valparaiso. Mark and Levi were friends and Levi was working on a breeding project for *Leucorcoryne* spp. We walked around the area and talked with him and his research staff. After the meeting, we headed back to Santiago and found a hotel for the night.

October 26, 2001

On the last Friday of our trip, we met with the administration from the plant and soil sciences department of Eduardo's university. They were willing to work with Longwood for future plant exploration endeavors. Tomasz and I conducted research for the remainder of the morning with the books that Gloria Montenegro had in her office. For the afternoon, we became tourists and shopped at Los Dominicos. Fernanda and her boyfriend, Chris, gave us a tour of downtown Santiago and then we went out for a splendid dinner.

October 27, 2001

Fernanda met us again at our hotel and we went to Monica Musalem's nursery, Pumahuida, on the outskirts of Santiago near the airport. At the nursery, we saw many of the native plants that we had seen on our journey. Also, we saw many plants that had not been seen but might have potential for Longwood's displays. Flavia drove up from Talca with her family and we all met for a splendid lunch hosted by Monica. We could have stayed all night, but Mark had a flight to catch so we took him back to the airport. We returned the rental vehicle, met Eduardo as he was returning on a flight from La Serena, and then returned back to the hotel.

October 28, 2001

Eduardo gave Tomasz and me a tour of Santiago. We did most of it by foot, walking to all of the things that a tourist should see in Santiago. We bid our farewell to Eduardo at the end of the day, and then, glad to be returning home, we took a taxi to the airport to return to the United States.

Literature Cited

Arroyo, M.T.K., P.H. Zedler, and M.D. Fox (eds.). 1995. Ecology and biogeography of mediterranean ecosystems in Chile, California, and Australia. Springer-Verlag, New York.

Baxter, P., P. Brownless, S. Fraver, M. Gardner, S. Maxwell, D. Rae, and R. Rozzi. 1998. A quest For Chilean plants. RBG Edinburgh, Edinburgh, Scotland.

Bridgen, M.P. 2002. A nondestructive harvesting technique for collecting Chilean geophytes. Herbertia. Accepted.

Dallman, P.R. 1998. Plant life in the world's mediterranean climates. Univ. of Calif. Press, Berkeley.

Darrow, G.M. The strawberry: history, breeding, and physiology [Online], Available: http://www.nal.usda.gov/pgdic/Strawberry/book/bokfour.htm [2002, Mar. 24].

Graham, M., C.Sainsbury and R.Danbury. 1998. Rough guide: Chile. Rough Guides, London.

Griffiths, M. 1995. Index of garden plants. Macmillan, Bath, England.

Hinkley, D. 2001. Heronswood Nursery, Ltd. 2001 catalogue. Kingston, Wash.

Hoffman J., A. 1995. Flora silvestre de Chile: zona central. Fundacion Claudio Gay, Santiago, Chile.

Montenegro, G. 2000. Chile nuestra flora util. Univ. Catolica de Chile, Santiago, Chile.

Pearson, J. 2002.a. Averages and records - Concepcion, Chile [Online], Available: http://www.weather.com/weather/climatology/CIXX0007 [2002, Mar. 3].

Pearson, J. 2002.b. Averages and records - La Serena, Chile [Online], Available: http://www.weather.com/weather/climatology/CIXX0010 [2002, Mar. 3].

Rand McNally. 1970. Instant world atlas. Career institute, Mundelein, Ill.

Schultes, R.E. and M.J.N. von Thenen de J. 1998. The journals of Hipólito Ruiz: Spanish botanist in Peru and Chile 1777-1788. Timber Press, Portland, Ore.

Strahler, A.N. and A.H. Strahler. 1989. Elements of physical geography. Wiley, New York.

Williams, S. The amaryllis [Online], Available: http://pine.usask.ca/cofa/departments/hort/hortinfo/plants/amaryll.html [2002, Mar.23].

Zegers, C.D. 1997. Arboles nativos de Chile. CONAF, Santiago, Chile.

Zegers, C.D. and C.R. Garcia. 1997. Arbustos nativos de Chile. CONAF, Santiago, Chile.

Zizka, G. and J. Grau (eds.) 1992. Palmengarten: flora silvestre de Chile. Stadt. Frankfurt, Germany.