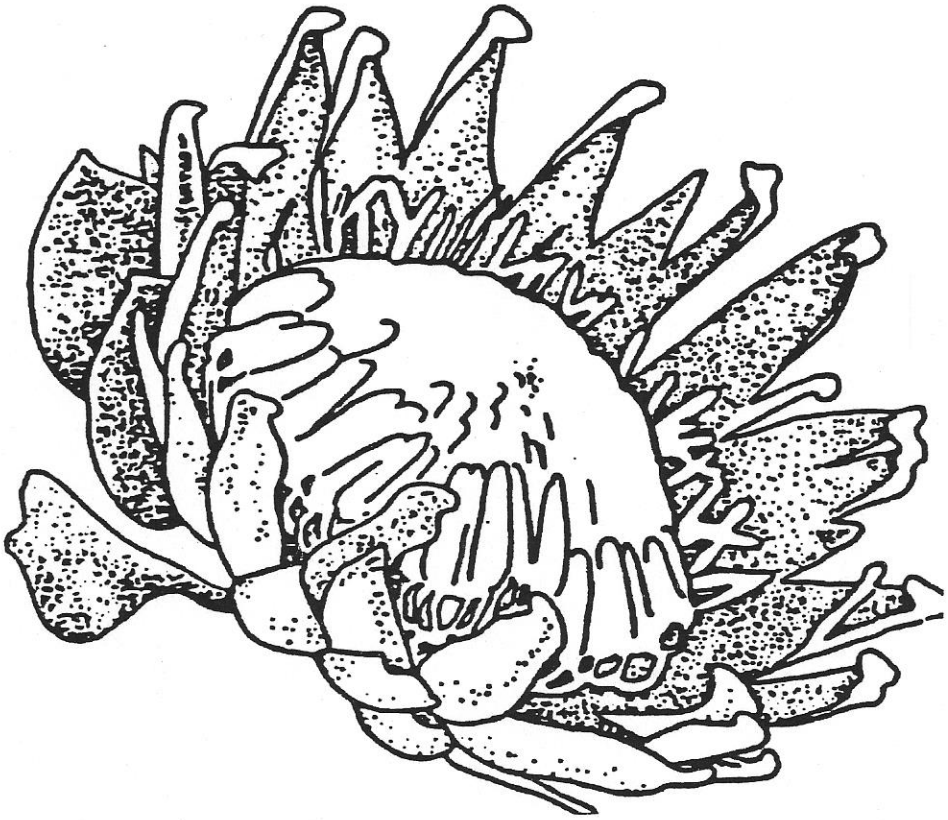
CALIFORNIA PROTEA ASSOCIATION

SO YOU WANT TO GROW PROTEAS!

A BEGINNERS GUIDE



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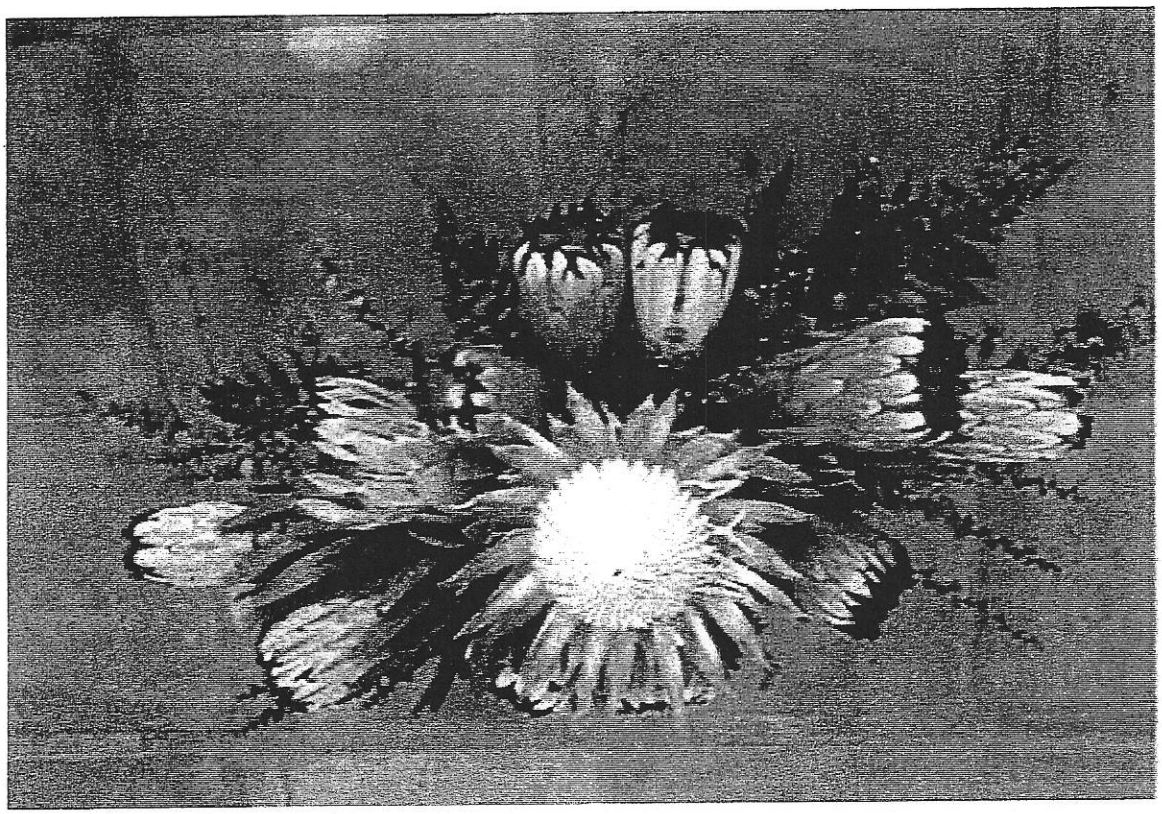
California Proteas



A King protea (*P. Cynaroides)* surrounded by Pink Minks *(P. Neriifolia)*

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CALIFORNIA PROTEA ASSOCIATION

So You Want To Grow Proteas!

A Beginners Handbook

SECOND EDITION

Foreword

Nearly seven years have passed since the original publication of the first edition of "So You Want To Grow Proteas." Times have changed and costs continue their upward spiral, but the knowledge gained in plant husbandry has offset financial impacts to some degree. Thus, the time has arrived to update to current data and produce a second edition of this publication.

Again, this handbook is dedicated to the California Protea Association and its members who were so helpful in generating a good deal of the data found herein.

A special vote of thanks go to members Peter Arth, Dick Bonner, Ben Gill, Dick Nagel and Dennis Perry, who took the time to review and comment on the contents and a very special thanks to George Shippey who not only supplied valuable input but also volunteered for the laborious chore of typing this manuscript.

May your Proteas prosper!

Alan M. Ferguson
Fallbrook, California
September 1998

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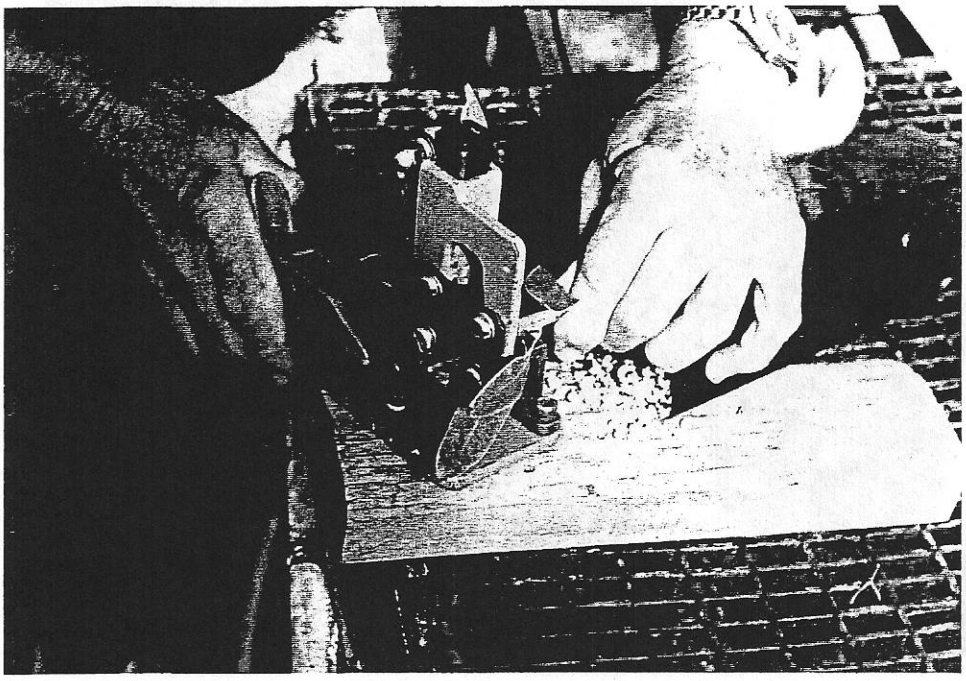
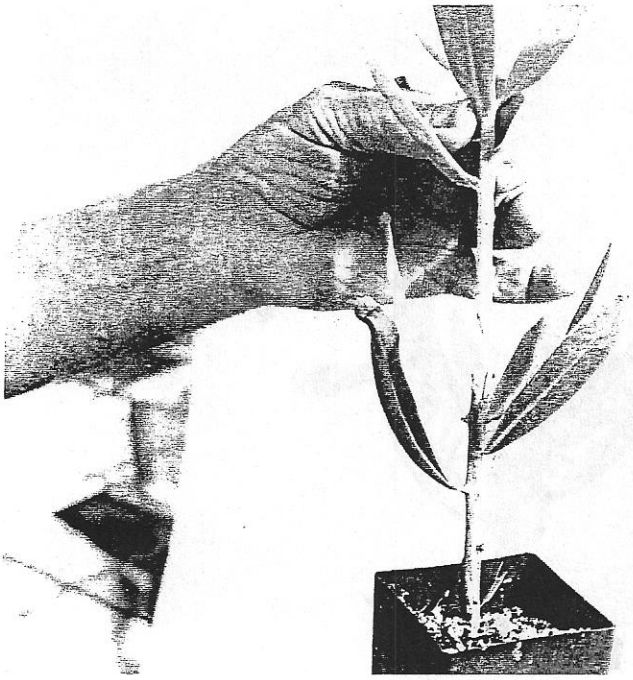
So You Want To Grow Proteas

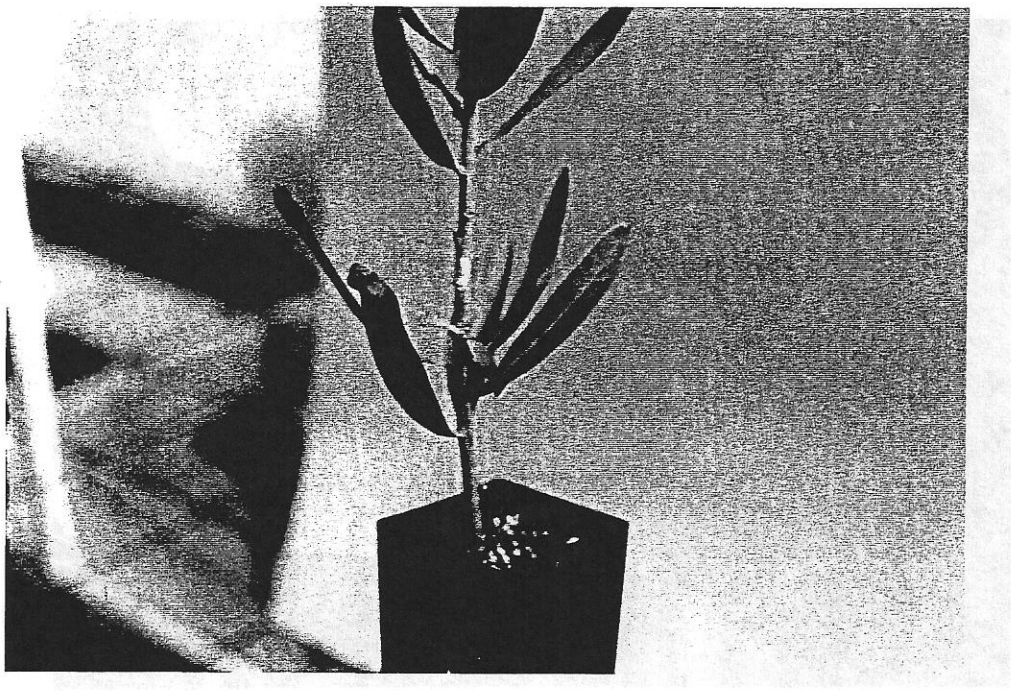


Using the cutting tool to notch the scion

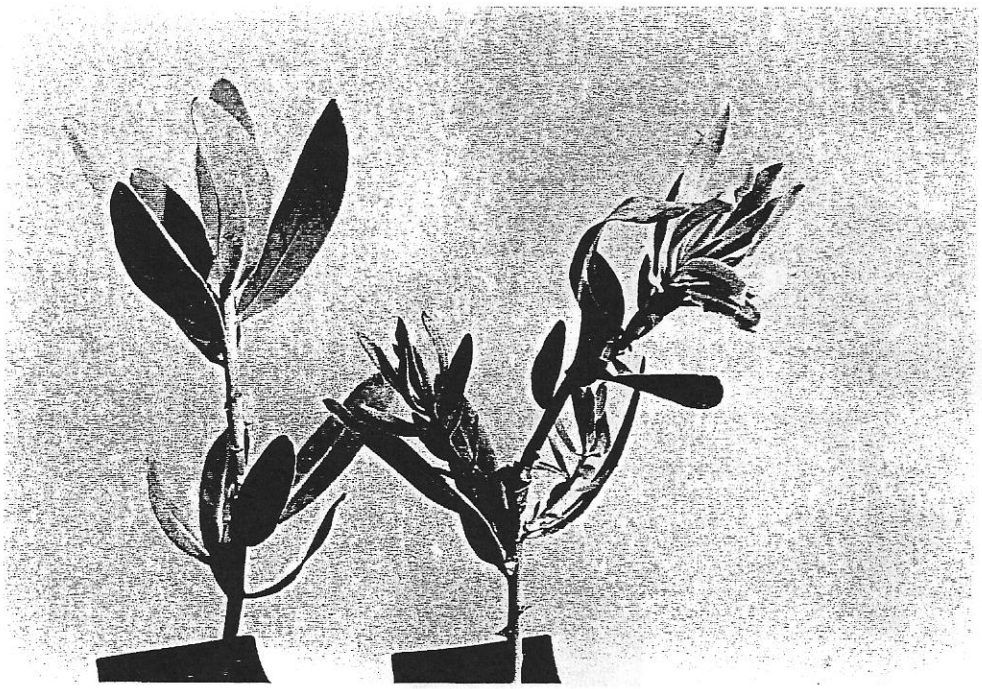


"V" noched scion ready for insertion in the corresponding rootstock.
Note that the diamters are the same so the cambiam layers match.

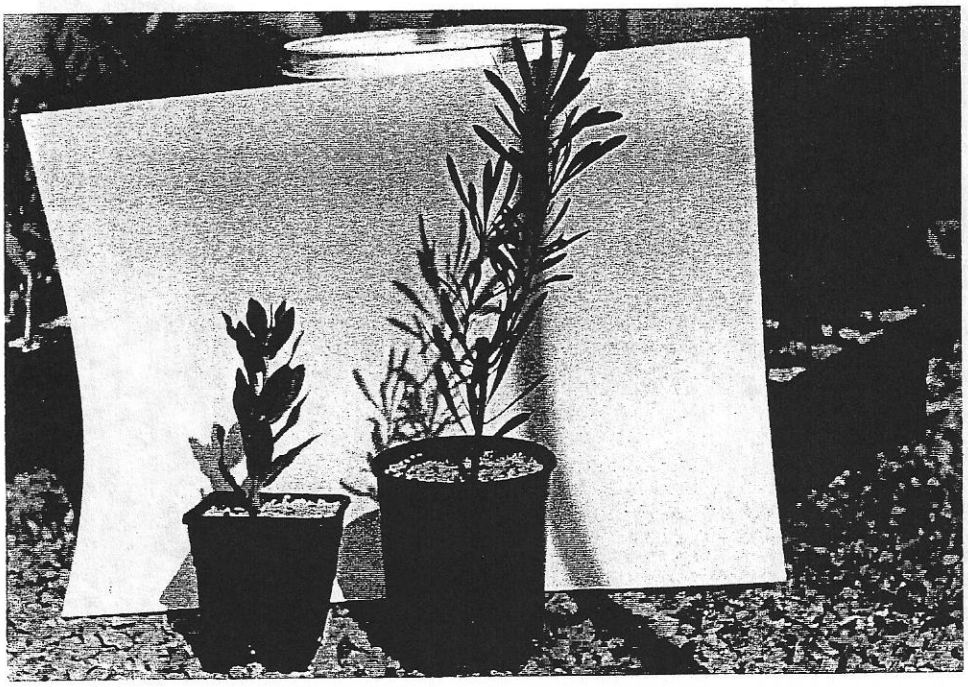
So You Want To Grow Proteas



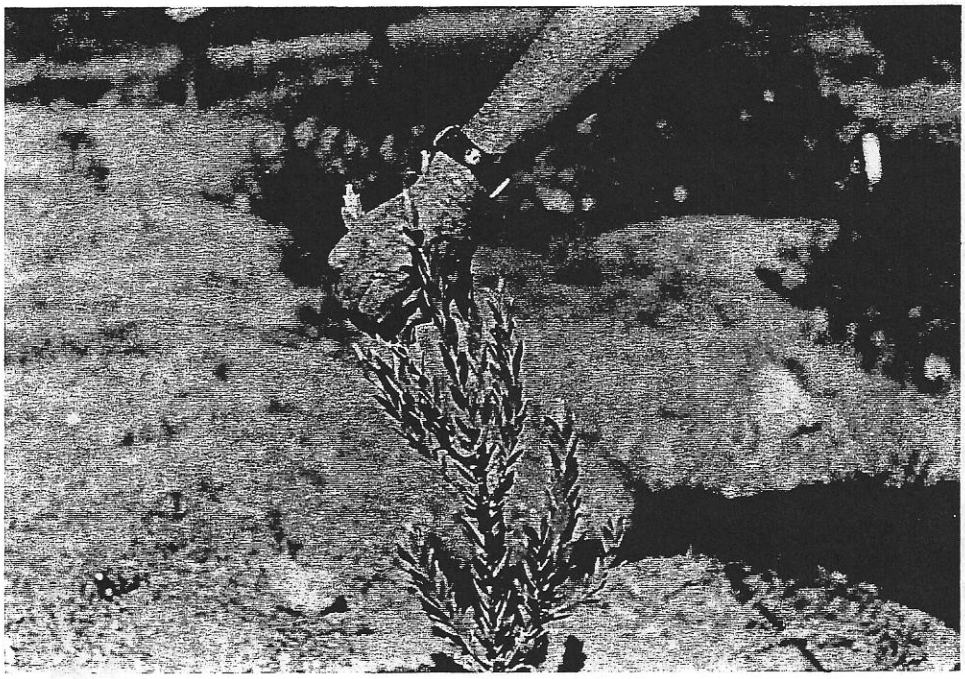
The scion and rootsock are joined and wrapped with elastic tap



A flourishing graft showing new growth development

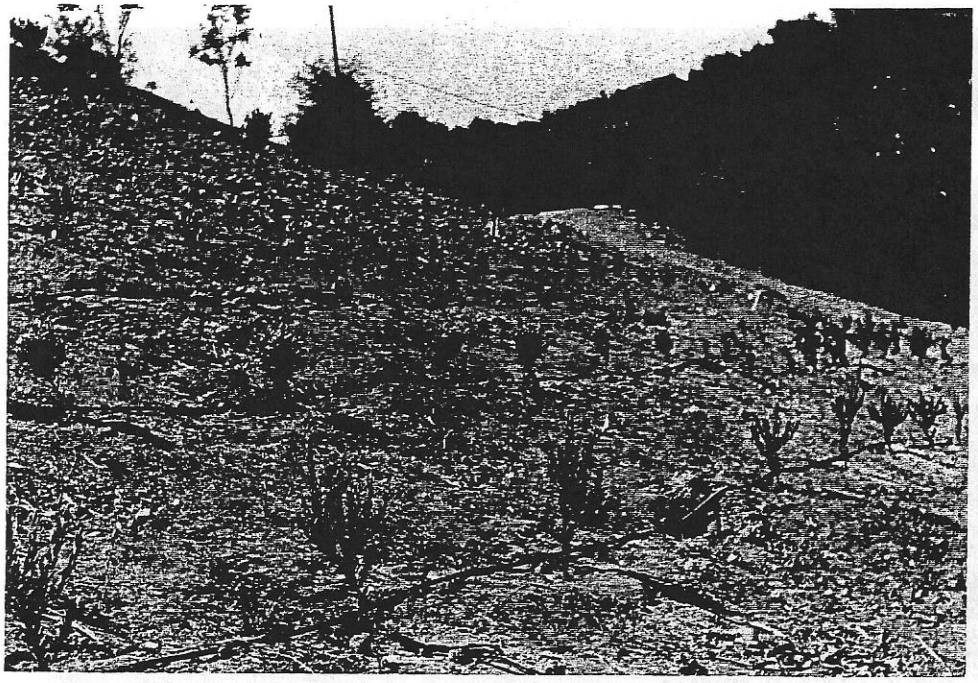


One gallon pot on the right. The top 6" of plant should be removed before planting

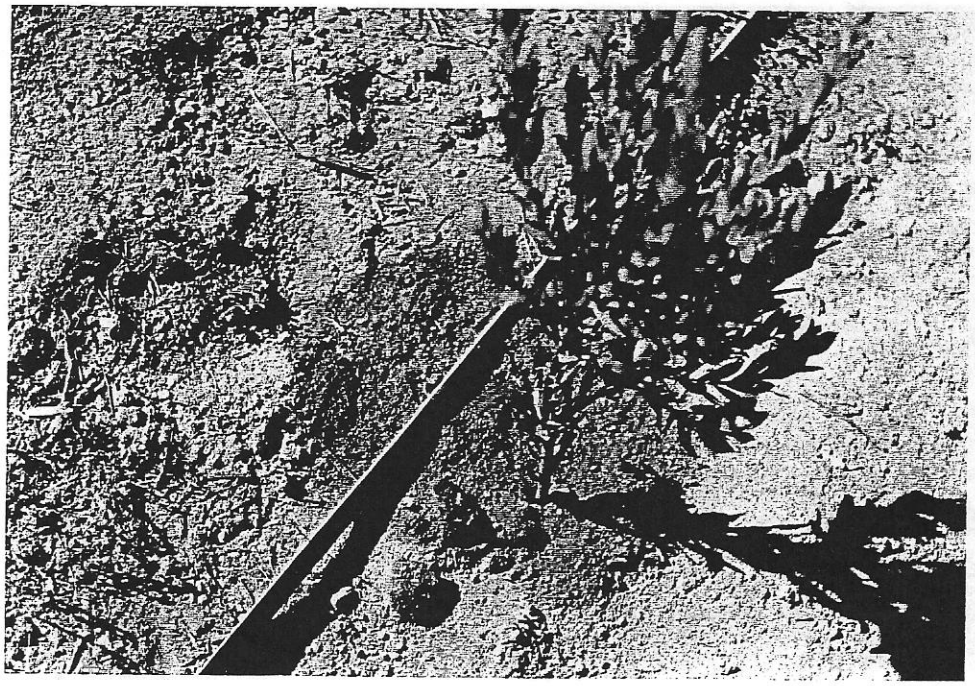


Topping a protea plant in the field

So You Want To Grow Proteas



Typical protea planting showing drip irrigation lines



Dripper watering a protea plant

CALIFORNIA PROTEA ASSOCIATION

So You Want To Grow Proteas!
A Beginners Handbook

The need for this handbook results from the growing interest in the cultivation of the Proteaceae family of the plant kingdom. The orientation is toward commercial production. However, the information is equally valid for the home gardener. The sources of data are derived from a consensus of successful California growers and nurserymen as well as international experience and scientific research.

Within California there are approximately 500 acres in commercial production, plus numerous ornamental plantings. Most are in San Diego County. There are some unique cultural conditions within the state as compared to those of the native Protea habitat. The majority of these problems have been surmounted, although there remain some unknowns that only experience and research can resolve. Nevertheless, by following a few basic guidelines, you should be successful in growing Proteas.

Historial Background:

"Proteaceae are an ancient family, probably one of the oldest flowering plants." (Dr. Marie Vogts). Before the land mass known as Gondwanaland spearated to form the continents of Africa and Australia some 300 million years ago, the ancestors of today's Proteaceae were present. The division of the continents resulted in the development of distinct genera, so that the Proteaceae of Africa, although related, are quite different in appearance from those of Australia.

Botanical Nomenclature:

The first introduction to Protea culture can lead to an array of confusing common and scientific names. Hence, a review of the nomenclature may provide a degree of clarification. In common usage the word Protea is often used to denote the family Proteaceae rather than just the genus Protea. In this handbook, the word Protea will have this broad meaning unless otherwise specified.

Term	Description
Family	The suffix "aceae" indicates the plant family as in Proteaceae or Orchidacea.
Genera (singular)	A group of structurally or phylogenetically related species such as Protea, Leucadendron, Banksia, etc. The first subdivision after family.

Species	The division of plant genera into plant groups having genetic similarities and, thus, being capable of interbreeding. The scientific names of species are always preceded by a capital letter or letters which denote the genus, as in P. Neriifolia or Lsp. Cordifolium. P. is used for the genus Protea, Lsp. is used for the genus Leucospermum, while Lcd. represents the genus Leucadendron.
Varieties	A subdivision of species which has distinct morphological characteristics and which will reproduce true from seed. The abbreviation (Var.) is often used after the name of the plant to indicate that it is a varietal selection. The five P. Cynaroides variants are an example.
Hybrid	The result of natural or artificial sexual crossing of two species. The propagation of hybrids can be accomplished only by means of cuttings. The letter "x" between the source species indicates a hybrid as in Lsp. Cordifolium x Lcd. Tottum, common name, "Hawaii Gold."

This system of classification is attributed to Carolus Linnaeus and was published as Genera Plantarum (1737). Modern taxonomy is based upon his work and applies to all members of the plant kingdom.

Common Names:

As the Protea floral industry developed, botanical names became too cumbersome for use in the marketplace, so common names were introduced to be either more descriptive or to enhance floral prestige. However, the assignment of names occurred as an uncoordinated event in several countries, and, thus, added to the confusion. The International Protea Association is attempting to standardize common name usage, as well as establish a registry for newly named hybrids. But there is a long road to travel before consensus is reached. When in doubt, stay with botanical names, unless dealing with hybrids.

This handbook will use botanical names with common names in parenthesis when appropriate.

Which Protea to Grow:

From the commercial aspect, we will be dealing with three genera of South African Proteaceae; Protea, Leucadendron and Leucospermum and the Australian genus Banksia. There are other genera and species of interest. However, they are outside the mainstream of the floral trade, and it will require further experimentation to satisfactorily introduce them to the California habitat.

A recent census of California growers provided the following distribution of plantings by genera and species. (Table 1.)

The distribution of the genera Leucadendron, Leucospermum and Banksia is somewhat suspect since many of the respondents to the census did not make the effort to itemize by species grown. Nevertheless, the census does provide a reasonable cross section of current cultivation by species. In all probability it reflects: (1) market acceptability, and (2) successful adaptation to the local habitat.

This census should not be interpreted as a finite planting guide. New varietal selections and hybrids are becoming available which appear to have good market potential. A good example is "Pink Ice." (The genus Leucadendron is primarily grown for foliage sales rather than flowers, and there is a steady demand for this product from florists.) (Addendum 1.) Finally, any planting should consider a few species outside of the mainstream not only for their individual beauty, but also to expand the horizon of cultural knowledge.

Where to Plant:

Proteas like full sun, ample wind movement, and an acidic, free-draining soil. As a general rule of thumb, any area where avocados have been successfully grown on a consistent basis will be acceptable for Protea. The one exception to this statement is that although mature Proteas are mildly frost tolerant, it is best to stay out of areas where temperatures are known to remain below 28 degrees for any extended period of time.

TABLE 1
CENSUS OF CALIFORNIA PROTEA PLANTINGS

Genus	Percent of Total Plantings
Banksia (B)	5.9
Leucadendron (Lcd)	12.0
Leucospermum (Lsp)	11.6
Protea (P)	70.5
	100.0
Species	
P. Compacta (Prince)	4.5
P. Cynaroides (King)	14.3
P. Eximia (Duchess or Rose Spoon)	22.4
P. Grandiceps (Princess)	1.4
P. Magnifica (Queen)	6.6
P. Neriifolia (Pink Mink & other Mink varieties)	26.4
P. Obtusifolia (Jester)	11.9
P. Repens (Sugarbush)	8.8
Miscellaneous	3.7
Lcd. Argenteum (Silvertree)	6.8
Lcd. Discolor	11.3
Lcd. Elimense	5.8
Lcd. Laureolum	9.4
Lcd. Salignum	10.6
Miscellaneous	56.1
Lsp. Catherinae	7.6
Lsp. Cordifolium (includes hybrids)	87.3
Miscellaneous	5.1
B. Ashbyi	14.3
B. Baxteri	2.0
B. Coccinea	2.5
B. Integrifolia	6.5
B. Menzesii	8.5
B. Occidentalis	1.8
B. Speciosa	13.5
Miscellaneous	50.9

TABLE 2
FROST SENSITIVITY

Most Sensitive	1. Leucospermum
	2. P. Neriifolia
	3. "Jack Clark" (Hybrid)
	4. P. Compacta
	5. P. Obtusifolia
	6. P. Repens
	7. P. Cynaroides
	8. P. Magnifica
Least Sensitive	9. P. Eximia

Tests conducted in New Zealand with a selection of 18-month-old plants indicated no frost damage at 30 degrees F., but severe damage at 26 degrees F. A missing feature of the test results was the length of time of exposure to cold temperatures. A brief exposure may result only in burning of the leaf tips or floral damage, while several hours of cold may ultimately destroy the plants. Proteas with lignotuber type of roots (P. Cynaroides is an example) can survive in temperatures down to 20 degrees F. All foliage is lost, but if this is removed after a six-week waiting period, the plant will normally regenerate.

The climate zones as defined in the Sunset Garden Book provide an initial insight as to favorable locations. Zones 24, 23 and 22 are generally acceptable, except for cold spots in the low ground. For Zones 19, 20 and 21, plant on high ground only. Zone 17 and microclimates in Zone 16 have some successful plants, but have been devastated from an occasional freeze known as the "Arctic Express." Fortunately for growers in these latter two zones, the Proteas, having a proteoid root system, were able to survive. Climate zones have one additional effect which should be noted. Flowers mature earlier in warmer interior zones, while those in a cooler coastal environment flower during a later period. This characteristic can have an impact on marketing strategy.

The majority of Proteas will do well in the climate zones already mentioned, although there is limited experience in Zones 16 and 17. As always, there are a few exceptions. Two Proteaceae that are noted for their exquisite flowers, with a ready demand in the floral trade, are the South African species Serruria Florida (The Blushing Bride) and from Australia, the Telopea Speciosissima (Waratah). However, in their respective countries they grow in a cool, humid environment with partial shade and fairly high rainfall, especially during the winter months. Therefore, plantings in Southern California have not been very successful, except as potted plants grown under conditions similar to Cymbidiums. Zones 24 and 17 are probably the best places to try them. They cannot stand a "Santa Ana" condition unless the plant and leaves are kept moist.

A third species, B. Coccinea, will grow well in Southern California if planted on north slopes. However, the color intensity of the flowers leaves something to be desired. In Australia, where the flowers are widely used by florists and have a rich color, they do best in a climate similar to Monterey Bay, which would suggest that Zone 17 is probably the indicated habitat for best floral quality.

A word of caution. If you are contemplating the conversion of a former avocado or citrus grove to Proteas, you should be aware of possible problems. Many avocado groves have become infested with Phytophthera Cinnamoni, also called root rot or PC, a soil fungus for which there is no remedy and which is highly contagious for Proteas. Secondly, residual fertilizer from previous cultivation may be detrimental. Phosphorus is the culprit. Research has indicated that phosphorus levels in excess of 20 ppm. can be detrimental, if not fatal for Protea. So be judicious before making the commitment to plant. Local land agricultural laboratories can test for both P. Cinnamoni and phosphorus.

In old citrus groves there may also be the problem of excessive residual fertilizer. Root rot is not a concern, but there is a possibility of nematodes which are miserable critters to control.

When possible, plant in virgin soil. You should be looking for acidic, free-draining soil. In San Diego County native soils derived from a granitic origin have a pH of 5.5 to 6.5, which is an ideal range for Proteas. Soil types ranging from very coarse decomposed granite to fine loams are suitable, provided they are not too thin or are not located immediately above an impervious material. Heavier soils can be used, provided they are on adequate slopes. However, extra care must be observed to prevent water-logging by over irrigation. Heavy clay conditions should be avoided.

Your local Soil Conservation Service representative can be of assistance in determining soil clarification, drainage characteristics, and the pH of property on which you wish to plant.

When to Plant:

In their native habitats, South African and Australian Proteaceae receive most of their rainfall during the winter months. Summers are relatively dry. As a consequence, major root development takes place during the wet months, and vegetative growth maximizes during the spring and early summer. The same characteristic is common to the California native chaparral.

Therefore, to capitalize on the natural order of growth, the best planting season is from November through February. If you are in a frost prone area, a delay until late February is a wise precaution. In Zones 17 and 24 a later date may be appropriate.

Some successful plantings have been made during all seasons of the year, but the mortality rate will increase as you approach the full summer.

What Size Plants to Buy:

Your plants can be purchased in 4" pots or 10" sleeves or in the one gallon size. The larger the pot, the better the root development and, therefore, all other things being equal, the better the rate of survival. For a commercial planting, the price differential between a 4" pot size and a one gallon container represents an increase in investment by a magnitude of at least two. One alternative is to buy 4" pot material, re-pot to one gallon size and hold until the plant has developed a larger root system. There are, however, added costs for taking this step, and, when one is dealing with more than a handful of plants, it can become a rather significant undertaking. Currently, most nurseries sell only gallon sizes costing between $3.50 and $5.00 depending on the variety.

An early spring planting of 4" pot sizes or sleeves is an acceptable way to plant, but it will require close attention to plant care during the first few months while the root system is developing.

All replacement plants in an existing plantation should be a one gallon size because they have sufficient root development to survive during the normal irrigation schedule.

Plants can be purchased in 5, 10 and 15 gallon sizes as pot specimens or for an "instant" garden, but it goes without saying that the unit cost will be considerably higher.

Cuttings vs. Seedlings:

Some nurseries will propagate plants from both seeds and cuttings, and it is important to know from which source your plants are derived. Most nurserymen will take cuttings only from plants having known and acceptable floral qualities, but this is not always the case, so don't be afraid to verify the source of the plant material. Seeds produce a much greater range of variability, and it may take two or three years before you know what your flower quality will be. Although seedlings may be a bit cheaper, the quality risk is higher. Hybrids are always taken from cuttings.

Propagation:

It is possible to propagate your plant material from either seeds or cuttings. It is not a complicated process, but it does entail an investment in the necessary equipment. It also requires diligence in assuring proper growing conditions and the prevention of disease.

Seeds must be purchased from overseas sources. The time from initial contact to the receipt of the seed may be serveral months. Secondly, even after proper seed treatment, the percentage of germination can be highly variable. Thirdly, some diseases such

as Batchelormyces are seed borne and require a special treatment before planting. This is especially true for P. Cynaroides (King). A detailed discussion of seed treatment is available in the Handbook of Diseases of Cut-Flower Proteas by Dr. Sharon Von Broembsen. This text can be obtained from the California Protea Association.

If you choose to use cuttings, you then have the responsibility of contacting growers who are amiable to selling the necessary plant material. There are also some promising new cultivars and hybrid materials from overseas.

For newcomers desiring to involve themselves in plant propagation, a good book obtainable from the bookstore on a campus of California Polytechnic University is, Hartman, Hudson T. and Kester, Dale E. 1983, Plant Propagation, Principles and Practices, Prentiss-Hall. Your local library may also have pertinent publications.

In summary, your decision to purchase plants versus propagation should be made on the basis of economics, time, and your personal interests.

Grafting:

On a worldwide basis, grafting has met with limited success. The best results have been obtained by the Protea Research Unit in South Africa which has been working on this technique for the past thirty years.

Locally (San Diego County), several nurserymen have had increasing success with both "wedge" and "bud" grafting using the hybrid "Pink Ice" as a root stock. This is a fairly recent event so it will take some time to determine the ultimate level of success, however, the current results look promising. Nevertheless, the search for compatible genera and species and improved methodology continues since the reward will be a significant advance in Protea culture. The goal is to develop sought-after Protea on rootstocks resistant to disease and well adapted to local cultural conditions. Both wedge and bud graft methods have been used and Australian growers have reported good results with Banksias by "approach" grafting.

Plant Selection:

Every grower should be cognizant of the need for plant selection to improve Protea quality. In each plantation there may be a plant or plants which have a unique characteristic such as disease resistance, unusual floral color or size, vigorous production or other features worth propagating for future benefit. These qualities can be determined by observation and the marking of the specific plant for future selection.

Vegetative propagation from cuttings taken from an identified plant provide genetic duplication and perpetuation. This is known as cloning and the offspring plants are called clones.

Flowering Periods:

Fortunately, the flowering period for Proteas occurs during the time of greatest floral demand, i.e., September through May. The overall season may shift two or three weeks one way or the other due to weather conditions, and, as previously noted, flower production in the cooler coastal climate will lag behind that of inland areas. Not all species bloom at the same time, so there will be a procession of distinctive blooms as the season progresses.

TABLE 3
BLOOMING PERIODS FOR ZONES 21 and 23

Genus	Blooming Time
Proteas, various	October to February
P. Compacta (Prince)	November to June
P. Cynaroides (King)	Nearly year around
P. Eximia (Duchess or Rose Spoon)	November to May
P. Grandiceps (Princess)	October to February
P. Magnifica (Queen)	September to January
P. Neriifolia (Pink Mink) (and other "Mink" cultivars)	November to April
P. Obtusifolia (Jester)	November to January
P. Repens, winter white	August to November
P. Repens, summer	February to May
Leucadendrons	February to May
Leucospermum	December to June
B. Ashbyi	May to August
B. Baxteri	August to April
B. Menziesii	May to October
B. Prionotes	March to September
B. Speciosa	

Among the Leucospermums, some species such as Lsp. Reflexum and Lsp. Tottum have a blooming period of only three weeks. The same applies to Lcd. Discolor. Foliage harvest is a year around activity.

Farm Layout:

The first step is the development of a farm plot plan showing the location, proposed roads, present or future buildings, water source, soil types, and topographic contours. Do give some careful thought to these items because once they have become reality, changes can be costly. The importance of locating all irrigation valves on your map as well as clearly marking them in the field cannot be overemphasized. The day may come when you are not around

to irrigate, and a neophyte may have to struggle with your system.

Give careful thought to access roads, from the standpoints of both susceptibility to erosion and ease of future maintenance and harvest. Paving would be ideal but few can afford this luxury. A provision for good drainage structures and channels is a must since soils suitable for Proteas are also highly erodible.

To avoid planting in unsuitable locations, it is important to identify soil types on your property. For example, the granitic zone of San Diego County has draws and gullies infilled with clays from historic erosion patterns and shallow soil uncerlain with the hardpan. These conditions are best avoided for Proteas. Undoubtedly, the same conditions occur elsewhere.

The design of your irrigation system is best left to an engineer or the supplier of your irrigation equipment; most provide this service. However, in order to provide adequate flow and control of water to each block, the designer must have the land plot with the aforementioned data, and also the layout of the planting blocks. If your property has both north and south facing slopes, be certain that the irrigation system is divided so that both slopes can be controlled separately, because a south slope will require from a third to a half more water per plant than a north slope. Finally, install pressure gauges or regulators at the beginning of each sublateral. Drip emitters function best under controlled uniform pressure.

Drip emitters have very small outlets that are easily clogged with grains of sand so the incorporation of a filter is a must, even though the water may be delivered from what is considered a domestic source. A fertilizer injector is a useful addition since this device can be used to introduce fungicides or other chemicals into the irrigation water. Over time, algae and/or carbonates may build up to block the emitters. Treatment is the periodic addition of a very mild sulfuric acid solution. It is also helpful to loop the drip laterals to avoid dead ends where debris can accumulate.

Be careful in how you mix genera within planting blocks as different plant genera may have different water requirements. You may mix the genera Leucospermum and Leucadendron in the same block as they have similar irrigation needs. The genus Banksia requires less water. Proteas have fairly uniform water requirements except for P. Cynaroides, which requires more water and probably should be irrigated separately.

Land Preparation:

Ideally, the native vegetation is cut by hand and left in situ to prevent soil erosion and minimize disturbing of the topsoil.

Once the brush is dry, and if the slopes are not too steep, a tractor can be used to go over the area to break the residual material into smaller segments. Burning of the clearned material is not recommended because of the sacrifice of soil fertility under the burning site.

If a hardpan layer has been identified it may be worthwhile to use a tractor to rip this area to improve future drainage.

Good top soil is a precious commodity -- preserve it!

Plant Spacing:

Proteas grow to be large shrubs, and, in the case of the Banksia genus, become small trees. Lcd. Argentium (Silvertree) will also become a tree. A plant spacing of 6' x 8' has been recommended in the past and used successfully by some growers since it gives a yet yield of 884 plants per acre. However, recent experience indicates that an increase in plant spacing not only improves flower production but also provides better access for routine care and harvest. Spacing requirements vary with genus and species. A suggested spacing is as follows:

TABLE 4
PLANT SPACING

Genus	Spacing	Plants/Acre
Protea and Leucospermum	6' x 6'	1090
Leucadendron, broad leaf	5' x 6'	1325
Leucadendron, narrow leaf, tall	5' x 5'	1600
Leucadendron, narrow leaf, short	4' x 4'	2500
Banksia, Speciosa	10' x 10'	200
Banksia, Occidentales	5' x 5'	1600
Banksia, Menziesii	6' x 6'	1090

The plant spacing is based upon a triangular, i.e., every other row is staggered so the effect is a series of visual triangles between plants.

Regardless of the spacing, each row should be on a uniform contour in order to maximize irrigation efficiency. Land is measured in a horizontal plane and, therefore, planting on a slope (the hypothenuse of a triangle) will result in more plants per acre.

How to Plant:

Method of planting is somewhat dependent on soil type. In coarse decomposed granitic soils the incorporation of a redwood/peatmoss mix in the amount of 1/3 mix to 2/3 soil is beneficial for moisture retention. Planting mix is helpful in all soil; however, in loamy soil direct planting without amendments has been successful.

Do not use any soil amendment derived from sewage sludge because of phosphorus content.

When planting, be sure to eliminate trapped air from the planting hole. You should also provide a slight basin to assure that the new plant is well watered, and to provide for the settlement of loose soil. The protruding stem of the plant should be slightly higher than the basin in order to avoid holding water around the stem. Once the plant is established, smooth out the basin to avoid trapping water. Proteas are very susceptible to stem and crown rot.

Cultivation:

No tillage is required. In fact, it can be detrimental in that many Proteas have surface roots (called proteoid roots) which can be easily damaged by hand or mechanical implements. Careful hand weeding in the immediate vicinity of the plant is the only safe solution. Away from the plants, in the open row, the use of rotary or "whip" type mowers is perfectly acceptable, but remember that the "whip" type mower will also remove the irrigation emitters if care is not exercised.

An option for weed control is mulching around the plant. This provides the additional benefit of water conservation. Do keep the mulch material away from the stem of the plant to avoid the possibility of encourating crown or stem rot. The clearing of chaparral from a virgin planting site can produce a good source of mulch once it has been run through a brush shredder. One grower has obtained mulch from the local power company--shredded tree trimmings. The use of straw mulch is not recommended because of the possible introduction of pathogens.

Chemical weed control is possible but it must be used very judiciously. There is some argument that glyphosate based herbicides may have a long-term deleterious effect. This argument has not been confirmed or denied by scientific research.

Fertilization:

The evolutionary development of Proteaceae occurred in what is considered sterile soil, deficient in nutritional minerals. The only source for the plants' needs came from the debris generated by the plant itself, making this family unique in the plant kingdom. Therefore, fertilizer requirements are minimal, and, as stated previously, the addition of any phosphorus can be fatal.

There is adequate potassium in California soils and, if nitrogen is needed, it should be applied in small amounts. The recommended application of nitrogen is 45 pounds of ammonium sulfate per acre or 0.8 oz. per plant on an annual basis. Half should be applied in the spring and the balance in the early fall.

In Southern California, the water supply has a fairly high pH, which, after a few years of irrigation, may evidence itself by tip burning of the leaves and/or change in leaf coloring due to the lack of micronutrients. The application of a water soluble chelate through the irrigation system is beneficial for the restoration of micronutrient availability. Magnesium sulfate (Epsom Salts) is not only an acidifier, but also provides one of the micronutrients. A tablespoon per mature plant during the winter and another during the summer is sufficient. The addition of agricultural grade sulfuric acid to the irrigation water will reduce pH; however, the equipment required to meter the proper amount is quite expensive.

Before committing yourself to any of the foregoing measures, be sure to have soil tests made. Your local Soil Conservation Service will run pH tests for you, but a test for micronutrients will require the services of a private laboratory.

The Western Fertilizer Handbook, horticultural edition, is available in the library system. This is a quasi-technical publication, but is easily understandable and covers the foregoing information in greater detail.

Pruning:

The purpose of early pruning is to develop a straight stem or trunk capable of supporting the future weight of the plant. This will also encourage formation of lateral growth for flower production. Delaying this process too long may allow the plant to reach a size that makes remedial efforts futile.

There is some debate as to how to prune, but there is full agreement that pruning is essential. The process should begin with the first year of planting when the terminals of the new growth are pinched out. This should be repeated in the second year. Thereafter, flower harvesting will provide the necessary pruning provided that only about 4" of the stem remains with at least two leaves.

Occasionally, you will find plants of the species P. Neriifolia that have a very twisted branch conformation that does not respond to prolonged pruning efforts. This tendency toward excessive twisting appears to be a genetic response and the only solution is plant replacement.

Normally, the staking of plants is not required if a regular pruning program is maintained since the development of a strong

stem will parallel that of the vegetative growth. However, plants in very windy locations may develop lesions at the soil line due to abrasion from constant movement. This condition provides an ideal vehicle for the introduction of fungal diseases. If wind damage of this type is observed, by all means stake the plants.

Irrigation:

Soil texture, topographic orientation, climate zone, age of the plant, species, and current weather conditions are all part of the formula for the determination of water needs. In their native habitat, the majority of Proteaceae survive in an environment of reasonably wet winters and dry summers. Dry season irrigation has improved the quality and production of this family but a point can be reached wherein the application of additional water will cause more damage than benefit. One cardinal rule -- DO NOT OVER IRRIGATE. Proteas must have a drying out period between irrigations to minimize conditions that promote root and stem rot. Overhead irrigation is not recommended because the application of water to leaves and stems only encourages fungal infections.

The following data regarding water application were developed from the inputs of 15 growers in Zone 21 and the eastern side of Zone 23 in San Diego County.

Schedule	Winter	Spring	Summer	Fall
Twice a week		x	x	
Once a week		x		x
As required	x			

The same group provided information on the quantity of water used, but in almost every case, the water requirement for Banksias was reduced by one half.

TABLE 5
QUANTITY OF WATER PER IRRIGATION

Age of Plant:	1 Yr.	2 Yr.	3 Yr.	4 Yr.	5 Yr.	6 Yr.
Quantity per Plant:						
1 gallon	x					
2 gallons		x				
3 gallons		x				
4 gallons			x			
5 gallons			x			
More than 5 gallons				x	x	x

These figures are only a guideline because they represent a number of different properties, species, and soil conditions.

One of the most useful tools for determining water needs is a Tensiometer. This instrument, when properly maintained, will give a continuous reading of the moisture level and thus will provide an indication of when the root zone is drying out. These instruments are available from most irrigation supply firms.

It is generally recognized that the most thorough and water/cost efficient irrigation method available today is the drip system. It is customary to start with one emitter (dripper) per plant, but as the plant grows in size, its water demand increases. By the third year it will become necessary to move the first emitter and to add a second so that the increased delivery is applied approximately 12" to 18" to each side of the trunk of the plant.

While overhead sprinklers are not recommended, a number of growers are adding micro-sprinklers for increased water needs. These can be inserted in the laterals in much the same manner as the emitters. There is not an extensive history on the use of micros, but it would appear that their use should be limited to species that develop foliage well above ground level, such as P. Neriifolia, P. Obtusifolia, P. Longifolia and a number of the Leucadendrons.

Mollusk and Insect Damage:

Insects and snails do not cause significant plant damage to any noticeable degree, but they do occasion marketing problems. Many of the Proteaceae generate abundant nectar which is very attractive to ants. P. Repens (Sugarbush) was, until quite recently, used as a source of sugar by people living in the more remote areas of the Cape region of South Africa.

For a serious infestation of ants in the field, the application of a spray containing Diazinon, such as Spectracide, should provide adequate protection.

Any infested flowers being prepared for shipment should first be placed in a box in a well ventilated area and sprayed with a low toxicity household insecticide such as Raid or Black Flag. Cover the box for a short time to allow dispersion of the insecticide and then uncover the box to allow thorough ventilation before removal of the flowers for final packing.

Snails do not damage Proteas but they do like to hide themselves in the foliage. Some southern states, notably Texas and Florida, do not have brown snails, and therefore conduct a rigid inspection of any imported plant materials. Floral products found to contain snails will be confiscated, and the threat is present that any future shipments from snail infested areas will be embargoed. This southern market is too important to be jeopardized by careless post harvest inspection.

Snails can be controlled by the application of small baits containing metaldehyde. The granular form is the best since it is

not attractive to birds or animals and should be distributed around the base of individual plants. These baits lose their effectiveness following rainfall, so repeat applications will be necessary.

Earwigs like to seek shelter in the bracts of P. Cynaroides (King) and while they do not cause damage, when they make their appearance they are quite disconcerting to florists and/or their customers. Treat the same as for ants but prior to packing, shake the blossoms to dislodge the remains.

Diseases:

The combination of California's Proposition 65 and increased restrictions imposed by the EPA on the use of pesticides have not only reduced the number of chemical tools available for disease control, but has placed greater responsibility upon the users for safe application. However, a number of products do remain that are satisfactory for the control of diseases on Protea. The one exception is that soil fumigants such as methyl bromide and Vapam are no longer available nor are there immediate substitutes.

Fortunately the disease level for Protea in California is far less than that found abroad due to lower humidity and less introduced contamination, but we are not immune. Both airborne and soilborne can affect Protea as well as seedborne diseases if the seeds are not properly treated. The major airborne infections are Boytritis, drechslera, and Elsinoe scab disease and several fungi that cause stem cankers. Greasy Leaf Spot which is quite common on P. Nerifolia, P. Magnifica, is not a disease, but a result of some external damage of source unknown. In many instances, it will disappear of its own accord. Generally speaking, the names of the fungi are far more impressive than the level of infection noted in California. Only Boytritis (grey mold) is fairly common.

Boytritis usually appears during the cool, damp months of spring when it appears on the leaves and flowers. The treatment is the application of one or more of the following trade name products: Chipco, Roval, Captan or Clearv 3336WP. Always follow the instructions and do rotate the use of these chemicals to avoid organism immunity.

The "Sudden Death" syndrome. The rapid collapse of a vigorous, healthy plant can usually be attributed to Phytopthera Cinnamoni although there are other soilborne damaging fungi. Phytopthera Cinnamoni, or PC, is most aggressive when soil temperatures reach 70 degrees F. in the spring and on into the summer months. There is no cure so the strategy becomes one of prevention. Chemically, the introduction of trade named products such as Ridomil, Subdue or Alliette into the irrigation water offer a degree of suppression while physical control, emphasizing sanitation, can reduce the chance of introduction of PC into the plantation.

Physical control begins with the choice of a good free-draining soil location and followed by the introduction of plants from a disease-free source. The judicious use of irrigation water is important to avoid a water logged condition and to allow a drying out period between irrigations since PC is transmitted in the soil by water. PC can also be transmitted by imported tools, infected plants, mechanical equipment and/or pedestrians, any of which have come from infected areas.

There are some 1,500 commercial and ornamental trees and plants which are hosts to PC and many itemized in bulletins published by the University of California, Cooperative Extension Service. Some knowledge of host plants is important because infection can be introduced to a Protea plantation by trees and shrubs used for landscaping. The possibility of infection is even more critical if the landscaping is at a higher elevation than that of the Proteas because PC spores are mobile in the presence of water and drainage from winter rains or irrigation can carry the infection downward. Crown or collar rot is also caused by one of the soilborne pathogens similar to PC. The development of crown or collar rot is initiated by injury to the cambium layer of the stem which provides an entry into the cells. This damage can be caused by careless use of tools or the abrasion of the soil against the stem due to wind motion. Staking of the plant has been suggested, but this contrary to industry practice. The better method is the careful pruning of the plant during development to form a lower profile while the stem is enlarging.

Verticillum Wilt: A report from Santa Barbara County suggests that this fungi was the cause of "Sudden Death" syndrome, however, this has not been verified and if it is a reality, it appears to be an isolated case. SEE Addendum 2.

Armillaria Mella (Oak Root Fungus): Has not been a problem for California Protea, although it is present in some soils.

The best disease prevention is maintaining a clean plantation. Dead branches or plants should be removed from the growing site and destroyed by burning. The rapid response to mold infections by the application of appropriate sprays will prevent its spread.

No attempt has been made to describe the physical symptons of the various diseases because they are so well elaborated in Dr. Von Broembsen's book entitled, Protea Diseases. This publication is a must for serious growers.

Plant Yield:

Table 6 is a sample of the average number of marketable stems or bunches that can be expected from a selected number of species. For Lcd. Discolor and Lcd. Safari Sunset, the normal bunch is

10 stems. For Lcd. Laureolum and B. Integrifolia, when cut for foliage, the average bunch is 7 to 10 stems.

TABLE 6
PLANT FLOWER YIELDS BY YEAR

Species	Yr.2	Yr.3	Yr.4	Yr.5	Yr.6	Yr.7	Yr.8
P. Cynaroides	0	1	3	6	8	8	8
P. Magnifica	0	2	4	8	10	10	10
P. Compacta	0	2	6	12	20	20	20
P. Obtusifolia	0	3	8	8	30	30	30
P. Eximia	0	2	6	15	20	20	20
P. Neriifolia	0	5	13	15	20	20	20
Lsp. Cordifolium	0	2	10	25	40	60	60
Lsp. Conocarpodendron	0	2	4	8	14	14	14
Lcd. Discolor (bunch)	0	1	2.5	4	6	6	6
Lcd. Laureolum (bunch)	0	2	8	10	12	12	12
Lcd. Safari Sunset(bu.)	0	1	2.5	4	6	6	6
B. Ashbyi & Speciosa	0	2	6	12	22	30	30

Recently, new hybrids have been introduced that have the potential for higher production and quality, however these hybrids need to stand the test of time under local conditions before they can be recommended. One grower has reported production as high as 300 blossoms per plant on a hybrid Leucospermum.

In order to provide data for cost and revenue projections, a model planting of 10 acres has been developed. This is not necessarily a recommended distribution, but it does provide enough variety to present a rational sample. Remember, this is a net planting of 1024 plants per acre and does not allow for land occupied by roads, etc.

TABLE 7
A PLANTING MODEL FOR 10 ACRES

Species	Number of Plants	Acres	Spacing
P. Compacta	545	0.5	6' x 6'
P. Cynaroides	1090	1.0	6' x 6'

P. Eximia	1090	1.0	6' x 6'
P. Magnifica	545	0.5	6' x 6'
P. Neriifolia	1635	1.5	6' x 6'
P. Obtusifolia	1090	1.0	6' x 6'
Lcd. Laureolum	1325	1.0	5' x 6'
Lcd. Safari Sunset	1600	1.0	5' x 5'
Lsp. Cordifolium	545	0.5	6' x 6'
B. Ashbyi and Speciosa	200	1.0	10' x 10'
B. Integrifolia	576	1.0	8' x 8'

A word of caution! The following pages show cost and revenue models based upon data in Tables 6 and 7. A model is a mathematical projection -- no more, no less. The assumption is made that the entire acreage is of uniform soil quality, fully planted and production has not been subjected to the vagaries of weather, markets or the ineptitude of man. In the real world of horticulture, the perfect condition does not exist so the reader must be prepared to discount the numbers shown to some degree.

TABLE 8
COST FOR A TEN-ACRE PROTEA PLANTING

Capital Items	
Land at $12,000/acre	$120,000
Irrigation system	15,000
Pickup	12,000
Sprayer, mower and tools	3,000
TOTAL	$150,000

TABLE 9
DEPRECIATION SCHEDULE

Item	Value	Expected Life	Annual Depreciation
Irrigation System	$ 15,000	10 Yrs.	$ 1,500
Pickup (no salvage)	12,000	5 Yrs.	2,400
Sprayer, weed eater and small tools	3,000	5 Yrs.	800
Plants	134,010	5 Yrs.	26,802
		TOTAL	$31,502

NOTE: Plants are capitalized for the first three years. The IRS has not established depreciation guidelines for Protea, but five years appears to be an acceptable life.

TABLE 10

COST TO DEVELOP AND OPERATE A 10-ACRE PROTEA PLANTING

	Yr.1	Yr.2	Yr.3	Yr.4	Yr.5	Yr.6	Yr.7	Yr.8
Cost:								
Land clearing	$ 3,000							
Irrigation system	15,000							
Plants	30,000							
Planting	2,500							
Amendments	500							
Fertilizer and chemicals	200	200	300	400	500	500	600	600
Water	1,050	1,260	2,520	3,150	5,040	5,460	5,880	5,880
Labor	16,640	16,640	16,640	16,640	16,640	16,640	16,640	16,640
Plant replacement	0	2,500	5,000	5,000	5,000	5,000	5,000	5,000
Equipment operation and maintenance	500	500	500	600	700	800	900	900
Miscellaneous	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
SUBTOTAL	$71,390	$23,100	$26,960	$27,790	$ 29,880	$30,400	$31,020	$31,020
Insurance	500	500	500	500	500	500	500	500
Supervision	2,000	800	800	800	800	800	800	800
Taxes	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500
SUBTOTAL	$76,390	$26,900	$30,760	$31,590	$ 33,680	$ 34,200	$ 34,820	$ 34,820
Depreciation	4,700	4,700	4,700	31,502	31,502	28,302	28,302	28,302
Total cost	$81,090	$31,600	$35,460	$63,092	$ 65,182	$ 62,502	$ 63,122	$ 63,122
less:								
Revenue per Table 11	0	0	$22,584	$67,656	$104,773	$146,861	$151,244	$151,244
GROSS INCOME	0	0	($12,876)	$ 4,564	$ 39,591	$ 84,359	$ 88,122	$ 88,122

TABLE 11

PROJECTED GROSS REVENUE FOR A 10-ACRE PROTEA PLANTING

Genus	Price/ Stem	Number of Plants	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
1) P. Cynaroides	$2.00	1090	$ 2,180	$ 6,450	$ 13,080	$ 17,440	$ 17,440	$ 17,440
2) P. Magnifica	1.75	545	1,907	3,815	7,630	9,537	9,537	9,537
3) P. Compacta	0.60	545	654	1,962	3,924	6,540	6,540	6,540
4) P. Obtusifolia	0.60	1090	1,962	5,232	9,810	19,620	19,620	19,620
5) P. Nerifolia	0.75	1635	6,131	15,941	18,393	24,525	24,525	24,525
6) P. Eximia	0.60	1090	1,308	3,924	9,810	13,080	13,080	13,080
7) Lsp. Cordifolium	0.30	545	327	1,635	4,087	6,540	9,810	9,810
8) Lcd. Laureolum	1.60	1325	4,240	16,960	21,200	25,400	25,400	25,400
9) Lcd. Safari Sunset (bu)	2.50	1600	4,000	10,000	16,000	24,000	24,000	24,000
10) B. Integrifolia	1.75	576	1,984	8,064	10,080	12,096	12,096	12,096
11) B. Ashbyi and Speciosa	1.00	200	400	1,200	2,400	4,400	6,000	6,000
Subtotal		10241	$25,093	$75,183	$116,414	$163,178	$168,048	$168,048
Less: Plant losses			2,509	7,527	11,641	16,317	16,804	16,804
Gross Income			$22,584	$67,656	$104,773	$146,861	$151,244	$151,244

TABLE 12

CASH FLOW PROJECTION

FOR A 10-ACRE PROTEA PLANTING

	Yr. 1	Yr. 2	Yr. 3	Yr. 4	Yr. 5	Yr. 6	Yr. 7	Yr. 8
Cash available:	$275,000	$48,610	$21,710	$13,535	$ 49,601	$120,694	$233,355	$349,779
Flower sales	-0-	-0-	22,584	67,656	104,773	146,861	151,244	151,244
Balance	275,000	48,610	44,294	81,191	154,374	267,555	384,599	501,023
Cash use:								
1) Development costs	51,000							
2) Operating cost	20,390	23,100	26,960	27,790	29,880	30,400	31,020	31,020
3) General expense Ins., taxes, sup.	5,000	3,800	3,800	3,800	3,800	3,800	3,800	3,800
4) Capital items:								
Land	120,000							
Irrigation system	15,000							
Pickup	12,000							
Sprayer, etc.	3,000							
Total	$226,390	$26,900	$30,760	$31,590	$ 33,680	$ 34,200	$ 34,820	$ 34,820
Ending Cash	$ 48,610	$21,710	$13,534	$49,601	$120,694	$233,355	$349,779	$466,203

Some comments on Table 10

1. Land is not capitalized because it is not depreciable. However, it must be included in the investment costs. As noted previously, the 10-acre planting is net acres. In reality some land is occupied by roads, rock outcrops, poor soil and/or buildings and, in all probability, a home site. Therefore, it would be wise to add the cost of an additional acre or two to provide for these probabilities.

Taking the sum of the capital items in Table 8 and adding the cost of the plants at the end of the third year, as shown on Table 9, the unit cost of investment per plant is slightly over $26. By increasing this sum to $30 or $32 per plant, and assuming land cost is as noted, a figure is available for the appraisal of potential property.

2. An inflation factor has not been consdered because it has been assumed that the rise in production cost will roughly parallel the increase in revenue from flower sales. Unfortunately, the latter has not been the case since the wholesale price of flowers has remained fairly static. To improve the revenue side, the growers have increased the number of plants per acre and, in some cases, have introduced higher yielding selections and/or hybrids that have greater market appeal.

3. Irrigation requirements are based on a water price of $650 per acre foot.

4. Direct labor is one full-time employee at $8.00 including benefits.

5. Plant replacement covers the annual loss of plants due to disease, gophers or the removal for poor quality. On average, the production of a given Protea will begin to decline by the ninth year, and the annual replacement will extend the life of the plantation. Gallon size plants have been priced at $3.50 to $5.00, depending on species.

Where Do I Sell My Flowers?

Basically, there are three avenues open to you, or a combination thereof, depending on the quantity of flowers available, the time, energy and money you wish to devote to selling.

A few growers have developed a direct relationship with retail florists or urban farmers markets -- the advantage being a higher price return per stem. In some instances a mail order business is an ancillary activity. The former requires the establishment of a regular delivery service with the attendant costs, and, in both cases, there are extra bookkeeping/collection problems.

Broker/wholesalers are intermediaries. Some sell only to other wholesalers, while others also have large retail accounts. The important point, if you choose this route, is to ascertain the degree of interest the broker/wholesaler has in promoting Protea. Is it an important part of his business or is it merely a sideline in order to have a broad inventory for prospective customers?

A second critical item is financial responsibility. The floral industry has been plagued with flower purveyors who are long on good intentions but short on financial resources. A common enticement is the offer of higher prices by taking the flowers on consignment, but promises do not pay the water bill, as many growers have sadly learned.

There are broker-wholesalers who have been in business for a number of years and have an excellent reputation for prompt payment. Even though you may have to accept a slightly lower price, the peace of mind in knowing you will be paid is worth the cost. Do take care in selecting the firm that will handle your flowers.

Lastly, there are large growers with sufficient product to support their own cold storage and packing facilities who have created outlets in the retail and wholesale trade. If the volume is large enough to support the necessary infrastructure, this is an option, but entails a large overhead and expense.

Marketing:

Proteas are a relative newcomer to the California floral scene, having only been grown on a commercial basis since the late sixties. The market share for these flowers has not expanded at the same rate as the level of new plantings nor have any major efforts been made to launch a marketing program. The result has been a rather static price level. Prices will not increase until demand exceeds supply.

The California Protea Association recognizes the need for a marketing program and in conjunction with the California Cut Flower Commission has prepared a number of colorful advertisements featuring individual flowers or floral designs for inclusion in floral trade journals along with articles featuring facets of Protea use. Even though funds are limited, it is a beginning and this activity should be supported by every Protea grower.

Imports, other than those from Hawaii, have not made significant inroads in the current market because of cost and shipping distance. The southern hemisphere is the source of competing flowers but is on an opposite blooming cycle. This generates floral production during the late spring, summer and early fall when domestic demand is lower. Imports do offer the opportunity to provide the trade with year-around availability of Protea. In most cases, quality of product on arrival in the United States has left something to be desired. However, foreign growers are not going to

ignore the market potential of this country and will strive to improve delivery and quality. Over the long run, imports will probably create temporary dislocations in local markets but will not have a major impact on the Protea trade in general.

Domestically there are some 30,000 retail florists, many of whom have seen Protea only in pictures or on trips to Hawaii. There is a uniform reluctance on the part of many to stock an unknown product without proof of public acceptance. Another factor is the relatively high unit price without knowledge of the offsetting benefit of long vase life and drying quality. Nevertheless, with a national population approaching 250 million and a growing level of disposable income, matched to less than a thousand acres of Protea production, the potential market is vast.

Because of the proximity of the Los Angeles metropolitan region to Protea plantations, there has been a tendency on the part of some growers and broker/wholesalers to oversupply this market, thus depressing the price. In turn, the Federal Crop Reporting Service uses this price information in its daily nationwide report to the floral trade. The result is diminished bargaining power. The goal of every Protea grower should be to "get Protea out of California."

Floral Quality:

Maintaining floral quality is part and parcel of successful marketing. All growers like to sell every flower produced. However, if quality levels are not maintained, this position can lead only to diminished prices and loss of market.

Stems should be cut in the cool of the day, placed in water as soon as possible and then stored in a shady place prior to delivery or packing, whichever the case may be. Refrigerated storage is ideal but few growers have such facilities.

Dr. Michael Reid, University of California, Davis, has developed a technique for prevention of leaf blackening for certain species during storage and shipment. Details of his methodology will be found in Addendum 3. In addition to "sugar pulsing," his recommendations regarding sanitation, re-cut of stems and storage temperatures are all part of the package for quality assurance and apply to each step of the marketing chain from grower to consumer.

There have been many failures in the quality area at all trade levels, and further education is required to improve the current situation. Nevertheless, quality control has to begin with the grower or subsequent steps are futile.

Cooperative Extension Services:

The University of California's Division of Agriculture and Natural Resources has two subdivisions: the Agricultural Experiment Station and the Cooperative Extension. The latter is the educational arm of the Division with offices in each county within the state staffed by specialists who bring technical advice to the farmer based upon research done in the Experiment Stations. The interplay between the farmer and the specialist becomes a two-way street in that problems which are discovered on the farm are often transmitted back to the Experiment Station for study.

The services of the Farm Advisor are available from any local county office. There may not be a Protea specialist, but the advisory personnel, with their broad background and training, can be very helpful in identifying specific problems. Take advantage of these services.

California Protea Association (CPA):

This is a non-profit organization composed of growers and/or neophytes with an interest in Protea. Membership is open to all, and the Association is dedicated to improvement of cultural practice and the promotion of Protea to the floral trade. By-monthly meetings are held in various locations in San Diego County, featuring both field trips and speakers of current interest in the cultural or marketing arena. Participation in the Association provides an excellent opportunity to meet and exchange ideas with fellow growers, as well as to be updated on new information as it comes along. The Association has also maintained a policy of "There are no secrets"--whatever information is available is available to all.

International Protea Association (IPA):

The goals and ideals are the same as CPA but of an international scope. Rather than interim mettings, IPA features a bi-annual conference held in rotation in member countries. In 1989, it was held in San Diego for the period of a week, with seminars on all facets of Protea production and marketing, as well as tours of surrounding plantations. A journal is published with current information on activity in each country plus updates on scientific developments. Membership is open to anyone.

Technical Publications:

Dr. Marie Vogts' South African Proteaceae is a beautifully illustrated publication with a great deal of valuable information. For a number of years it was considered to be the "Protea Bible." However, it is now out of print and can be found only in specialized libraries or in the hands of individuals. Dr. Von Broembsen's book on disease has already been mentioned and is available through the California Protea Association.

The ongoing research program for Proteas in the United States is conducted by the University of Hawaii Agricultural Extension Service. A number of technical papers have been issued directed to the industry in Hawaii, but, in many cases, the findings are also valid elsehwere.

The University has an experimental station devoted to Protea research. It is located in Kula, Maui, and is open to visitors. If you happen to be in the Islands, a visit will be well worth your while. There is a large test plot planting with ongoing work in hybridizing and plant selection.

The Bio-Ag Library, University of California, Riverside, maintains a large collection of foreign journals with articles pertaining to Protea. For a price, computer search facilities are available to aid in locating pertinent data.

The Arboretum, University of California, Santa Cruz, has a large Protea collection and personnel are available to answer questions, if you call ahead.

A collection of literature pertaining to Protea culture has been given to Mira Costa College, Oceanside, California, by members of the California Protea Association. This material will be found either in the main library or in the Horticultural Department.

Summary:

Each subject addressed in this Handbook could be expanded to a considerable degree. However, it is felt that the reader is provided with an adequate overview of the industry along with its successes and sorrows. Any agricultural enterprise is a lottery to some degree, so "investigate before you invest." The California Protea Association provides the opportunity to meet and consult with active growers before you make a commitment.

ADDENDUM 1

Proteaceae Recommended for the Foliage Market

All Genus Leucadendron	Female flower, Seed & Cone Characteristics	Male flower & Cone Characteristics	Foliage & Bract Characteristics	Product availability by month. Foliage availability year-round
L. Argentium Silver Tree	Large silver seedpods. Yellow flowers.	Golfball-sized silver cones. Yellow flowers.	Large silver leaves.	Feb.-May flowers, pods, cones
L. Daphnoides Winter Sunshine	Cones silver-gray. Foliage below cone turns red.	Yellow, ivory & white flowers	Bracts turn white, cream, yellow & red.	Dec.-March flowers March-May cones
L. Discolor Flame Tips	Bracts & flowers pale yellow-green. Tulip-like	Bright yellow bracts with large red male head. Single to multiple heads.	Bracts creamy green to bright red. Foliage green with red edges.	Feb.-March flowers
L. Eucalyptifolium Yellow Star	Small red cones	Butter yellow, scented flowers.	Star-shaped bright yellow bracts. 6 ft. bamboo-like foliage.	Jan.-March flowers
L. Galpinii	1" silver cones.	Tiny yellowish pompom clusters.	Grayish-green linear twisted (whorls) foliage.	Dec.-April cones & flowers
L. Laureolum Yellow Tulip	Green to pink cones surrounded by bright yellow bracts.	Bright yellow male head surrounded by bright yellow bracts.	Soft green foliage. Bright yellow bracts. Very showy.	Dec.-April Showy bracts
L. Linifolium	Seagreen grayish cones	Small, light yellow flowers.	Thin, delicate green leaves.	Dec.-May flowers & cones
L. Meridianum Winter Gold	Shiny, seagreen cones with silver hair.	Very bright yellow bracts, cupping small yellow flowers. Very showy.	Gray-green leaves. Very showy bright yellow bracts.	Nov.-May flowers
L. Rubrum Arrow Tips	Cone-like flower head (purple, red, brown). Opens to fluffy, white plume.	Prolific small plume-like golden flowers line the stem.	Dark-gray with brown tips.	Feb.-May flowers & cones
L. Salignum x Laureolum Safari Sunset	No significant difference between male and female. Both have large, colorful bracts. Light, clear red in summer, wine in winter, then golden yellow.		Foliage dark green with wine flush. Outstanding colored bracts.	Year-round w/foliage darkening into winter
L. Salicifolium	Green cones with burgundy shades.	Yellow male heads surrounded by light-colored bracts.	Light green foliage turning to yellow bracts.	Dec.-May flowers
L. Salignum	Small red cone with colored bracts around.	Round red flower head.	Small, pointed leaves. Yellow, red, pink bracts.	Feb.-May flowers
L. Tinctum Rose Cockade	Deep crimson 1" cone surrounded by ivory bracts. Very flashy.	Yellow pompoms	Pale green leaves. Outstanding red, yellow, pink bracts.	Dec.-May flowers
L. Uliginosum	Small, silver cones, yellow bracts.	Small yellow flowers	Ivory to yellow bracts. Silver-haired small leaves clothe serpentine stems.	Dec.-May flowers

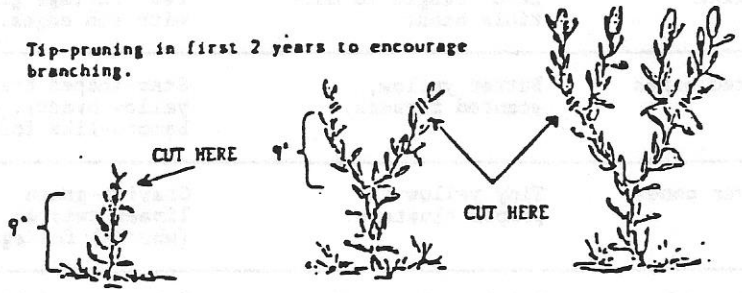
ADDENDUM 2

California Protea Association

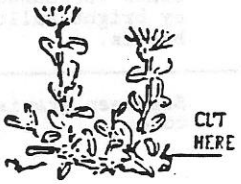
PRUNING

1. Proteas, Banksias and Telopeas For all varieties except those with a root stock:-

Tip-prune for the first 2 years whenever stems grow 9"-12" without branching then allow the plants to flower on the third year. Cut the flowers with a long stem, but always cut into stem with healthy green leaves.



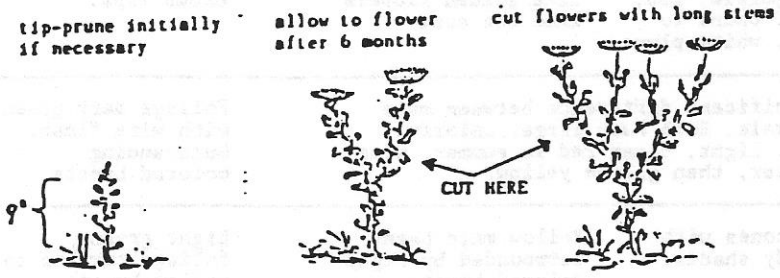
for varieties with a root stock (Protea cynaroides, Protea speciosa) the only pruning should be cutting the flower stems to within 4" of the ground after flowering.



2. Leucadendrons and Leucospermums

Tip-prune for the first growing season if no branching occurs then allow to flower. Subsequent pruning is achieved by picking the flowers.

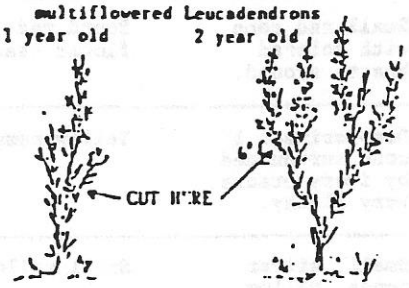
Cutting flowers of Leucospermums and single flower Leucadendrons (eg. 'Silvan Red', Lcd. tinctum, Lcd. salignum).



multi-flowered Leucadendrons

e.g. eucalyptifolium, macowanii, salicifolium.

cut large pieces when they flower, or after flowering if the flowers are left on the bush.



ADDENDUM 3

Verticillium Wilt of *Protea*

The rapid loss, which seems almost overnight in *Leucospermums*, of individual plants within many genera of *Proteaceae* has had many explanations. *Phytophthroa* has been the primary suspect, but the following abstract may shed some new light on this disease symptom. D.P.

Verticillium Wilt of *Protea* (*Leucospermum cordifolium*) Caused by *V. dahliae*. S.T. Koike, University of California Cooperative Extension, Salinas 93901, J.H. Nelson, T.B. Bishop Co., Goleta 93117, and D.K. Perry, Perry's Panorama, Somis, 93066.

In commercial floriculture, "protea" refers to the cut flowers produced by many genera of the *Proteaceae*. In California there are approximately 500 acres planted commercially; the estimated value of the harvest commodity is over 5 million dollars. In 1989 in Santa Barbara County, plants of pincushion protea (*Leucospermum cordifolium* Salisb. ex knight [Fourc.]) in commercial field plantings began to collapse and die. Symptoms on these plants, which had been in the field for 16 months, consisted of terminal shoot wilting, fading of foliage to light green, and eventual collapse and browning of the entire plant. Brown flecking and streaking also appeared in the stem xylem tissue. Isolations onto acidified potato dextrose agar consistently produced *Verticillium dahliae* Kleb. with the characteristic verticillate conidiophores and black microsclerotia. Pathogenicity was tested on rooted cuttings of *L. cordifolium* cv. Firewheel that were grown in a greenhouse for 10 months. The roots of ten of these plants were sliced with a razor, dipped in a spore suspension of one of the *V. dahliae* isolates (concentration of 1×10^6 conidia/ml), and repotted. Roots of control plants were cut and dipped into distilled water. All plants were maintained in a greenhouse at 20-25 C. After 8 months, the foliage of inoculated plants desiccated and faded, and vascular tissue had brown flecks. *V. dahliae* was reisolated from these plants. Control plants did not exhibit any wilt symptoms. This is the first report of Verticillium wilt on any protea species. Other commercially grown protea species were inoculated with *V. dahliae* using the same method as described. These plants were the following: *Banksia victoria*, *Leucodendron salignum*, *Protea compacta*, *P. cynaroides*, *P. eximia*, *P. magnifica*, *P. neriifolia*. Of these, only *B. victoria* (woolly orange banksia) developed wilting symptoms and was found to be infected with the pathogen.

ADDENDUM 4

SUGAR PULSING - THE NEW TRICK TO PREVENT LEAF BLACKENING

However beautiful our Protea blooms are, we're all aware of the dreaded leaf blackening, which causes unsightly splotches on the leaves of the most attractive Protea species within only a couple of days of cutting. Researchers at the University of California showed a couple of years ago that the blackening was caused by the protea bloom starving the leaves of the sugar that they need to remain green. They tried feeding sugar in the bucket water, but discovered that more than about 1% sugar caused the development of another type of black spotting!

Recently an Australian researcher showed that leaf blackening in some proteas can be overcome by "pulsing" the cut stems in very high concentrations of sugar. The U.C. researchers have repeated these results for California proteas and obtained equally striking results. Pulsing is a method of treating cut flowers for a short time with beneficial chemicals. The studies used different concentrations of sugar (10% - 40%) and the stems were placed in the sugar solution overnight at room temperature. The graph shows the effect of the treatments on blackening on the leaves of P. eximia and P. nerifolia, two of our most sensitive species. Clearly, the sugar treatment has a remarkable capacity to delay the onset of leaf blackening.

The following recommendations are provided as a guide so that you can try the sugar pulsing yourselves. Remember that cleanliness is always important--wash buckets with detergent and rinse with dilute Clorox. Sugar solutions should always contain a biocide. Clorox at a rate of 1 teaspoon in 8 gallons of water is a great biocide, but is not registered for use on cut flowers. Most of the commercial vase preservations contain a biocide, and they can be used as the base for the sugar pulse.

Cut flowers as normally, perhaps a little tighter than you usually would (they will open some during the pulse treatment, and the sugar helps them to open, anyway).

Prepare a solution of 20% table sugar (1 lb. 10 oz. per gallon) in water containing a biocide (commercial flower preservative or Clorox). Recut the Protea stems and put them in the bucket. Since sugar is expensive the solution should be fairly shallow (say 1.5 inches deep). Leave the flowers overnight in a cool shaded area.

Next morning rinse the flower bases (20% sugar is sticky) and pack them. Save the sugar solution -- it can be used again. Cool the flowers to 33 degrees Fahrenheit, and maintain them at that temperature during the transportation and marketing period.

The researchers suggest that you test this procedure yourselves before implementing it on a large scale. Since the sugar solution is relatively expensive, you may want to use the sucrose pulsing only on the most blackening-susceptible species, such as P. eximia, P. nerifolia, and P. obtusifolia.

Courtesy of Dr. Michael Reid, University of California, Davis.

So You Want to Grow Proteas!

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