Breeding *Leucospermum* for improved horticultural characteristics, disease tolerance and cultivation in tropical climates

XIV Protea Research Symposium and the XIX International Protea Association Conference

La Palma and Tenerife, Canary Islands, Spain

March 2022

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Diapositiva 1

4 Kenneth Leonhardt; 16/02/2020

Breeding Criteria for *Leucospermum*

- Horticultural characteristics
  - Long, slender, lightweight stems
  - Slender leaves without pubescence
  - Earlier and later flowering season
- Disease tolerance
  - *Phytophthora* root rot
  - *Sphaceloma* stem and leaf scab
  - *Dreschlera* leaf blight
  - *Botrytis* flower blight
- Tolerance to Tropical Climates

Breeding for improved foliar and stem characteristics

L. glabrum hybrid with large leaves and heavy stems.

L. conocarpodendron hybrid with hairy leaves.

L. lineare 'Starlight'
Flowers are small with poor color.
Excellent parent for long, straight, narrow, light weight stems with hairless, narrow leaves

Hybrids with *L. lineare* ‘Starlight’ as one parent

- Air flow through plant canopy is good
- Plants dry quickly, reducing foliar disease incidence
- Some warm temperature tolerance


L. Frosty, #89
High yielding, 8-month flowering season


L. Carmen, #102

L. reflexum

- Long, straight stems
- Small, narrow leaves
- Warm temperature tolerance
- *P. cinnamomi* tolerance
- Poor floral substance
- Reflexing styles

Hybrids with *L. reflexum* as one parent

L. Brandi Dela Cruz, #74

L. June, #232

Both are warm temperature tolerant, vigorous, have long stems and are tolerant of wet soils.

For box packing, harvest before styles reflex.

Hybrids with *L. reflexum* as one parent

L. Nadine's Choice, #244

L. Norman, #145 *Pc* resistant

L. reflexum hybrids are usually easy to propagate.
Older flowers flatten out.

Extend the flowering season, earlier and later

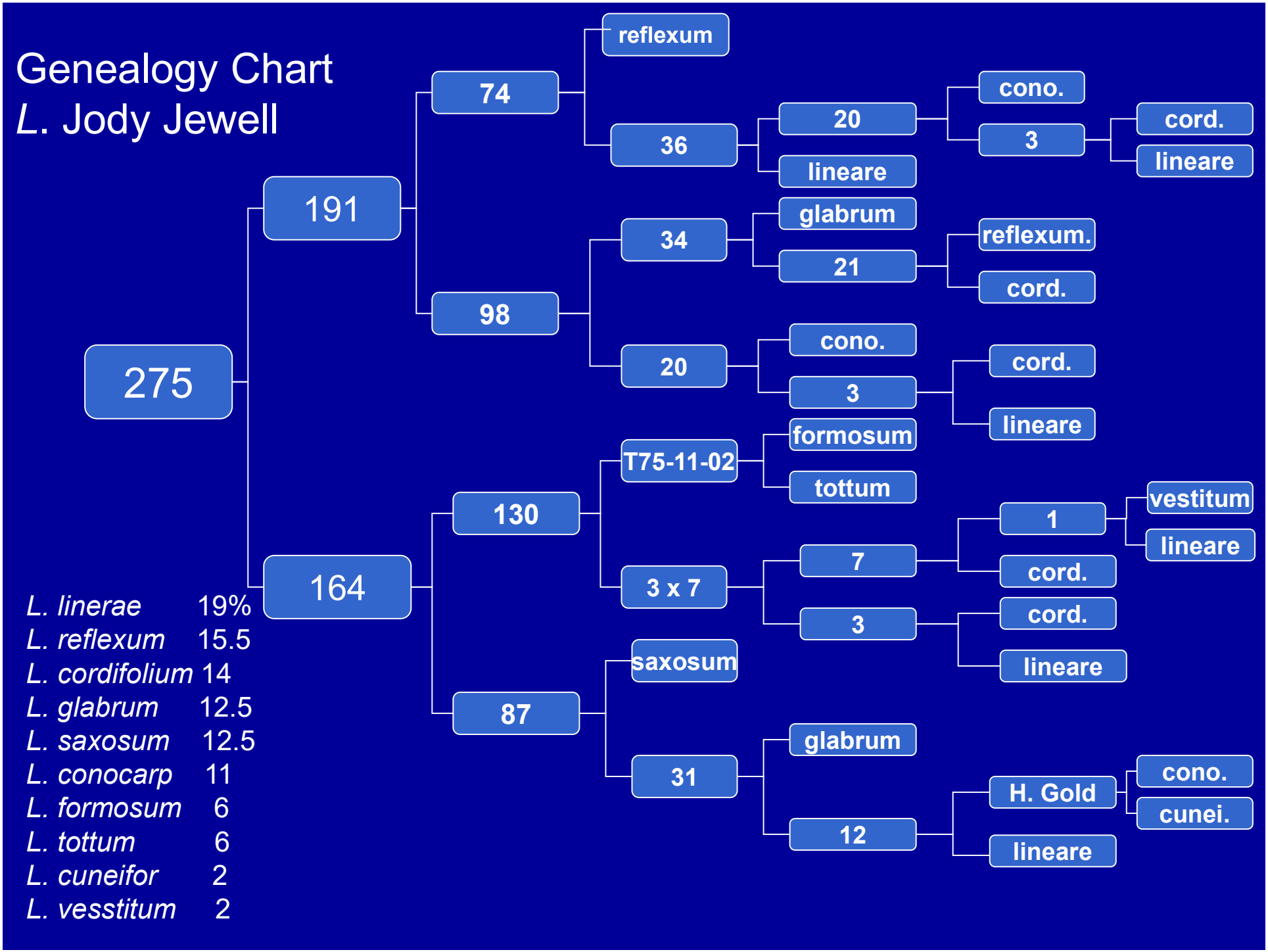
Beginning flowering date was recorded for 127 hybrids at Kula, Maui (960m) for the year 2007.

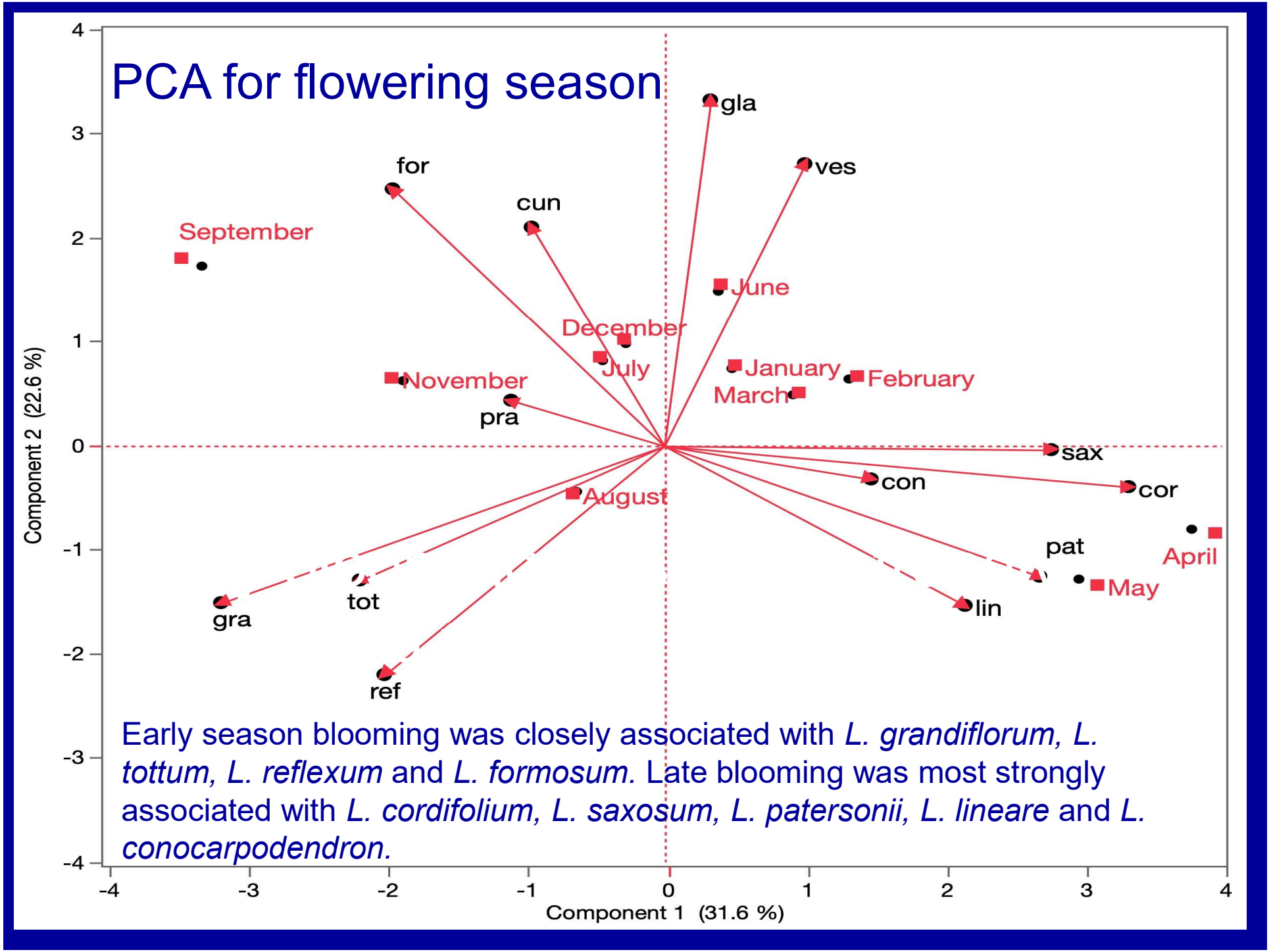
Early Season	Mid Season	Late Season
Aug-Nov	Dec-Mar	Apr-Jul
26 (20.5%)	65 (51.2%)	36 (28.3%)

Which species influence the seasonality of flowering?

Early
L. grandiflorium, L. tottum,
L. reflexum, L. formosum

Late
L. cordifolium, L. saxosum,
L. patersonii, L. lineare,
L. conocarpodendron


Genealogy Chart
L. Jody Jewell
275
191
74
reflexum
36
20
cono.
3
cord.
lineare
lineare
98
34
glabrum
21
reflexum.
cord.
20
cono.
3
cord.
lineare
164
130
T75-11-02
formosum
tottum
3 x 7
7
1
vestitum
lineare
cord.
3
cord.
lineare
87
saxosum
31
glabrum
12
H. Gold
cono.
cunei.
lineare
L. linerae 19%
L. reflexum 15.5
L. cordifolium 14
L. glabrum 12.5
L. saxosum 12.5
L. conocarp 11
L. formosum 6
L. tottum 6
L. cuneifor 2
L. vesstitum 2



Early season blooming was closely associated with *L. grandiflorum, L. tottum, L. reflexum* and *L. formosum.* Late blooming was most strongly associated with *L. cordifolium, L. saxosum, L. patersonii, L. lineare* and *L. conocarpodendron.*

X

L. saxosum

L. praecox

L. Candlelight, #192, flowers every day of the year

Breeding for *Phytophthora cinnamomi* (*Pc*) tolerance

The most important disease problem in Hawaii

L. cuneiforme

L. conocarpodendron

L. formosum

L. Hawaii Gold (*L. conocarpodendron* x *L. cuneiforme*) has moderate resistance to Pc and scab disease.

L. Spider (*L. formosum* x *L. tottum*) is used as a rootstock in South Africa for its tolerance to *Pc*.

L. saxosum, tolerance to *Pc* and scab

L. saxosum

L. reflexum

Hybrids with *L. formosum* as one parent

Unnamed #142

L. 'Spider'

- *L.* Spider is used as a root stock in South Africa because of its tolerance to *Pc* root rot

All of these hybrids are Pc resistant

Foliar diseases. A selection of *L. saxosum* was determined to be immuned to *Sphaceloma* (*Elsinoe*). Progeny of *L. saxosum*


L. saxosum


25% L. sax, glabrum, L. lineare +3
Nancy #248


L. sax x (*L. cono* x *L. cune*)
Tsuruo Murakami #146


Peppermint #262 25% *L. sax* +8


Gisela #87 *L. glabrum, L. lineare* + 3

L. Rachel (*L. lineare* x *L. vestitum*) x *L. glabrum*

Resistance to: *Sphaceloma* (*Elsinoe*) scab
Two isolates causing *Botrytis* blight
Two isolates causing *Drechslera* blight (moderate resistance)

L. Rachel is a parent of 11 UH cultivars and in the ancestry of many others


Queen Kathleen #75


Royal Pride #112


Tessie Amore #116


Koana #117, *Pc* resistant


Kula Sunrise #78


Kevin Halbrendt #123

Breeding for heat tolerance

Select pincushion cultivars that perform to commercial standards at low elevations in Hawaii

Expand the industry to less costly former plantation lands

- Current production of pincushions is restricted to areas where land is relatively expensive
- The demise of sugar & pineapple plantations has increased the availability of arable land

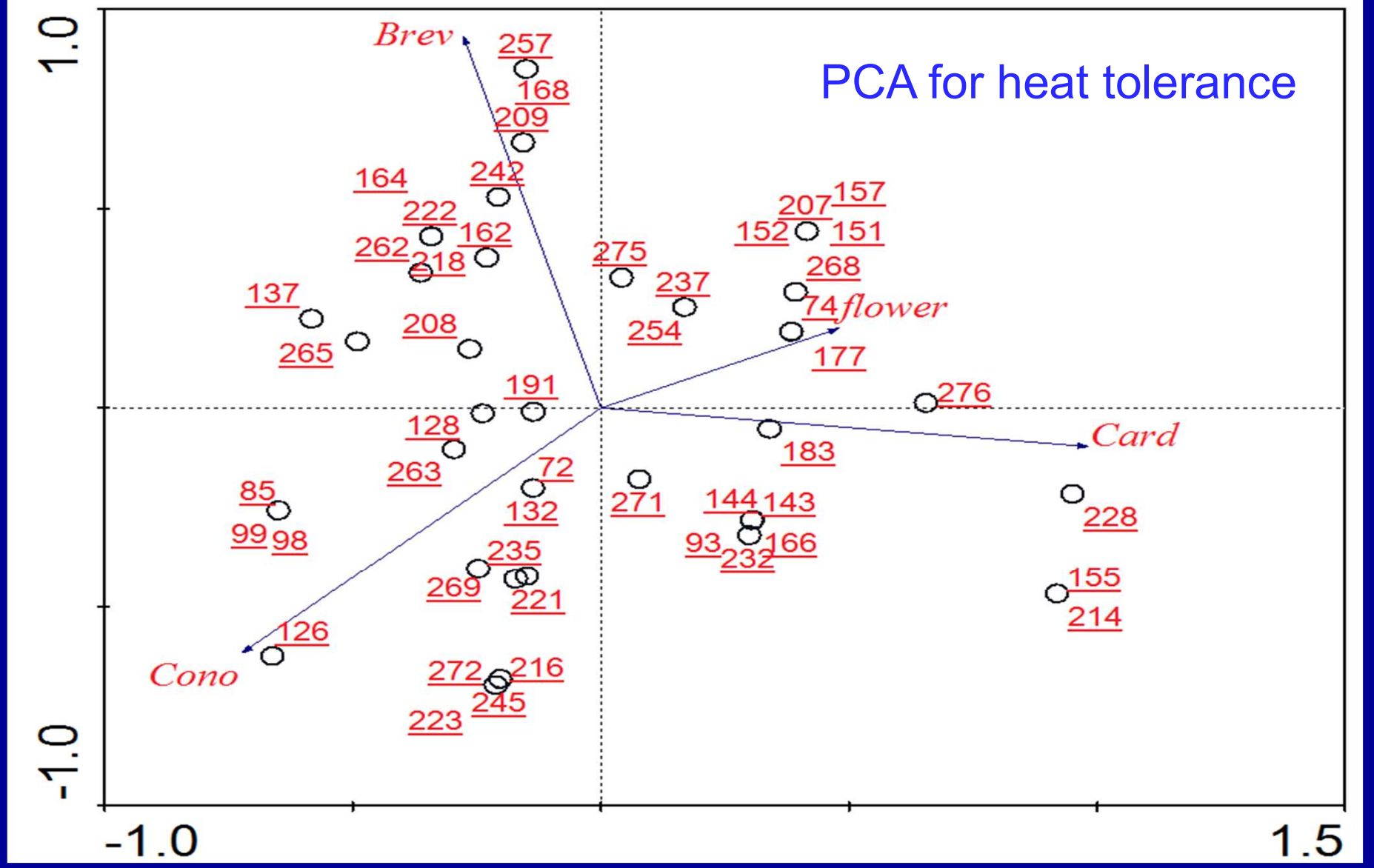
Temperature Influence on Plant Growth (*L*. Shannon, # 79)

Cool conditions at 930 meters

Warm conditions at 90 meters

Leucospermum taxonomic sections

Section	Species
Crassicaudex (4 sp.)	*L. cuneiforme, L. saxosum, L. gerrardii, L. innovans*
Conocarpodendron (3 sp.)	*L. conocarpodendron, L. pluridens, L. glabrum*
Tumiditubus (8 sp.)	*L. profugum, L. muirii, L. truncatum, L. spathulatum, L. praecox*
Brevifilamentum (6 sp.)	*L. cordifolium, L. lineare, L. cordatum, L. patersonii, L. tottum, L. vestitum*
Cardinistylus (6 sp.)	*L. formosum, L. reflexum, L. catherinae, L. gueinzii, L. grandiflorum, L. praemorsum*
Leucospermum (5 sp.)	*L. hypophyllocarpodendron, L. arenarium, L. parile, L. rodolentum, L. tomentosum*
Diastelloidea (10 sp.)	*L. pedunculatum, L. bolusii, L. calligerum, L. heterophyllum, L. prostratum, L. winteri, L. royenifolium, L. secundifolium, L. truncatulum, L. wittebergense*
Crinitae (4 sp.)	*L. gracile, L. mundii, L. oleifolium, L. saxatile*
Unnamed section (2 sp.)	*L. hamatum, L. harpagonatum*



The Principal Component Analysis data matrix shows a strongly positive correlation between axis 1, flowering at low elevation, and axis 2, Cardinistylus. Each three-digit number represents a hybrid.

Section Cardinistylus

L. grandiflorum –
heat tolerant, large flower
large foliage, large stems

L. formosum –
tolerance to *Pc*
and wet soils

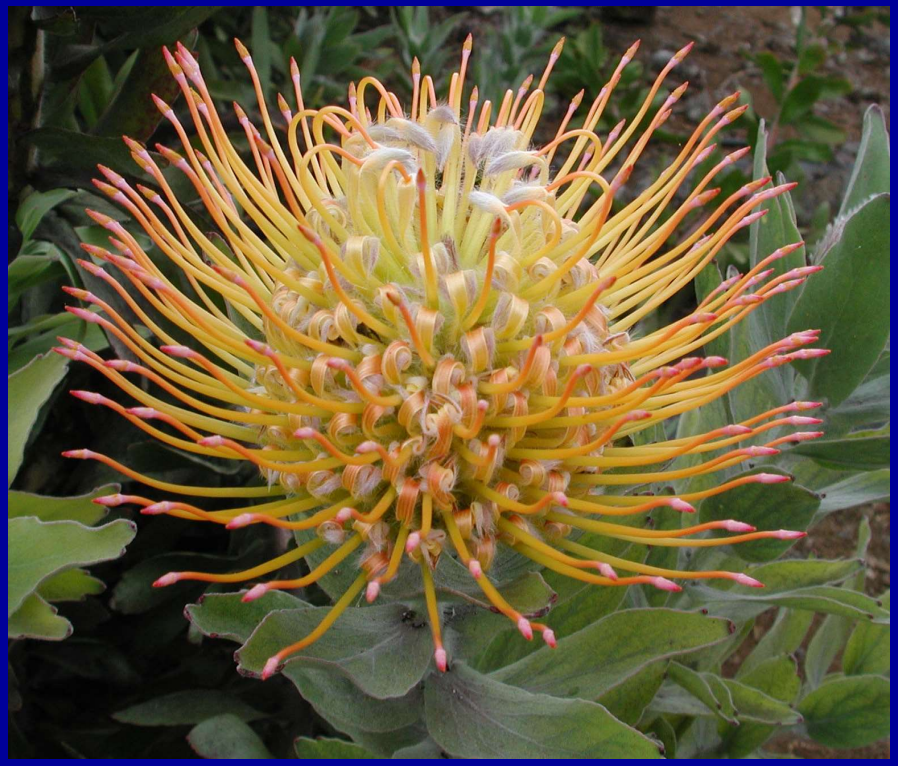
L. reflexum –
tolerance to *Pc,*
has erect growth

L. catherinae –
stream banks

L. gueinzii –
stream banks and
other moist areas

L. grandiflorum

Hybrids with *L. grandiflorum* as one parent both flowered at 75m



Unnamed, #159
Semi-erect growth habit

Unnamed, #229
Erect growth habit
25% *L. reflexum*

Section Cardinistylus species that have not been used in breeding

Natural hybrids include:

L. catherinae x *L. reflexum*

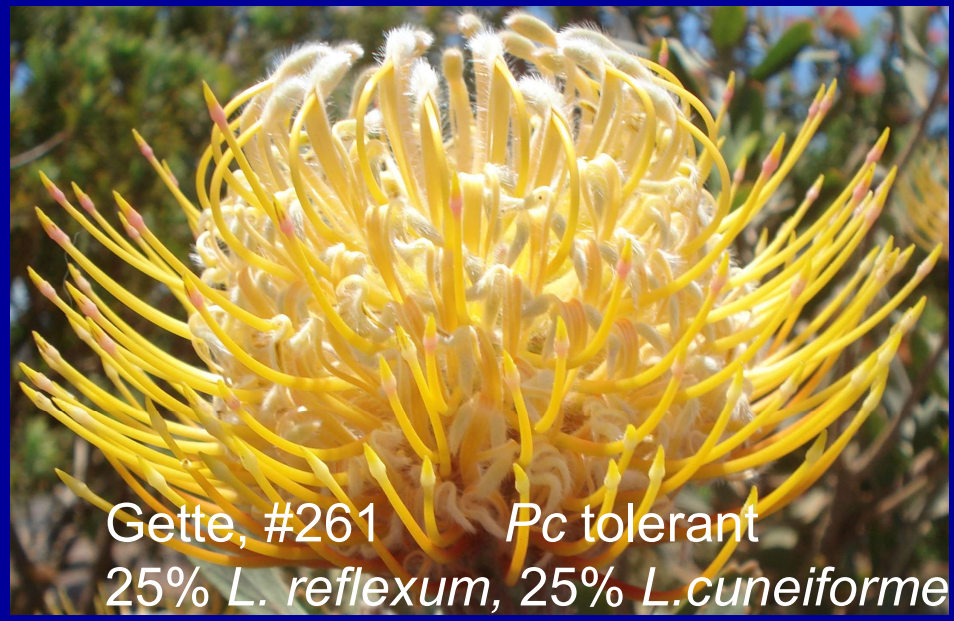
L. gueinzii x *L. lineare*

Warm Temperature Tolerant Hybrids with Erect Growth Habit

Debbie Hamrick, #151
25% *L. formosum*, 25% *L. reflexum*

Unnamed, #207
25% *L. formosum*, 25% *L. reflexum*

Brandi dela Cruz, #74
50% *L. reflexum*, 31% *L. lineare*



Gette, #261 *Pc* tolerant
25% *L. reflexum*, 25% *L.cuneiforme*

More Low-Elevation Selections

L. Bolero, #155
50% *L. grandiflorum*, 25% *L. reflexum*

L. Peppermint, #262
25% *L. saxosum* + 8 other species

L. Georgette, #162
34% *L. lineare*, 25% *L. reflexum*

Unnamed, #191
L. reflexum, L. lineare + 3

Leucospermum species used and not used to make registered hybrids.

Taxonomic Section	**Species used (16)**	**Species unused (32)**
Crassicaudex (4 sp.)	*L. cuneiforme, L. saxosum* (2)	*L. gerrardii, L. innovans*
Conocarpodendron (3 sp.)	*L. conocarpodendron*	*L. pluridens*
	L. glabrum	
Tumiditubus (8 sp.)	*L. erubescens* (2)	*L. fulgens, L. utriculosum*
	L. praecox (1)	*L. profugum, L. muirii*
	L. spathulatum (1)	*L. truncatum*
Brevifilamentum (6 sp.)	*L. cordifolium, L. lineare*	*L. cordatum*
	L. patersonii, L. tottum	
	L. vestitum	
Cardinistylus (6 sp.)	*L. formosum* (1), *L. reflexum*	*L. catherinae, L. gueinzii*
	L. grandiflorum (3)	*L. praemorsum*
Leucospermum (5 sp.)	*L. hypophyllocarpodendron* (1)	*L. arenarium, L. parile*
		L. rodolentum
		L. tomentosum
Diastelloidea (10 sp.)		*L. bolusii, L. calligerum*
		L. heterophyllum
		L. pedunculatum
		L. prostratum, L. winteri
		L. royenifolium
		L. secundifolium
		L. truncatulum
		L. wittebergense
Crinitae (4 sp.)		*L. gracile, L. mundii*
		L. oleifolium, L. saxatile
Unnamed section (2 sp.)		*L. hamatum*
		L. harpagonatum

Highlighted species have naturally hybridized.

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Conocarpodendron (3 sp.)	*L. conocarpodendron*	*L. pluridens*
	L. glabrum	
Tumiditubus (8 sp.)	*L. erubescens*	*L. fulgens, L. utriculosum*
	L. praecox	*L. profugum, L. muirii*
	L. spathulatum	*L. truncatum*
Brevifilamentum (6 sp.)	*L. cordifolium, L. lineare*	*L. cordatum*
	L. patersonii, L. tottum	
	L. vestitum	
Cardinistylus (6 sp.)	*L. formosum, L. reflexum*	*L. catherinae, L. gueinzii*
	L. grandiflorum	*L. praemorsum*
Leucospermum (5 sp.)	*L. hypophyllocarpodendron*	*L. arenarium, L. parile*
		L. rodolentum
		L. tomentosum
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		L. pedunculatum
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		L. royenifolium
		L. secundifolium
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Crinitae (4 sp.)		*L. gracile, L. mundii*
		L. oleifolium, L. saxatile
Unnamed section (2 sp.)		*L. hamatum*
		L. harpagonatum

Bolded species are fragrant.

Taxonomic Section	**Species used (16)**	**Species unused (32)**
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Conocarpodendron (3 sp.)	*L. conocarpodendron*	*L. pluridens*
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Tumiditubus (8 sp.)	*L. erubescens*	*L. fulgens, L. utriculosum*
	L. praecox	*L. profugum, L. muirii*
	L. spathulatum	*L. truncatum*
Brevifilamentum (6 sp.)	*L. cordifolium, L. lineare*	*L. cordatum*
	L. patersonii, L. tottum	
	L. vestitum	
Cardinistylus (6 sp.)	*L. formosum, L. reflexum*	*L. catherinae, L. gueinzii*
	L. grandiflorum	*L. praemorsum*
Leucospermum (5 sp.)	***L. hypophyllocarpodendron***	***L. arenarium, L. parile***
		L. rodolentum
		L. tomentosum
Diastelloidea (10 sp.)		***L. bolusii, L. calligerum***
		L. heterophyllum
		L. pedunculatum
		L. prostratum, L. winteri
		L. royenifolium
		L. secundifolium
		L. truncatulum
		L. wittebergense
Crinitae (4 sp.)		*L. gracile, L. mundii*
		L. oleifolium, L. saxatile
Unnamed section (2 sp.)		*L. hamatum*
		L. harpagonatum

Breeding for fragrance

L. hypophyllocarpodendron hypophyllocarpodendron

L. hypophyllocarpodendron canaliculatum

Flowerheads of both have a rose-like fragrance

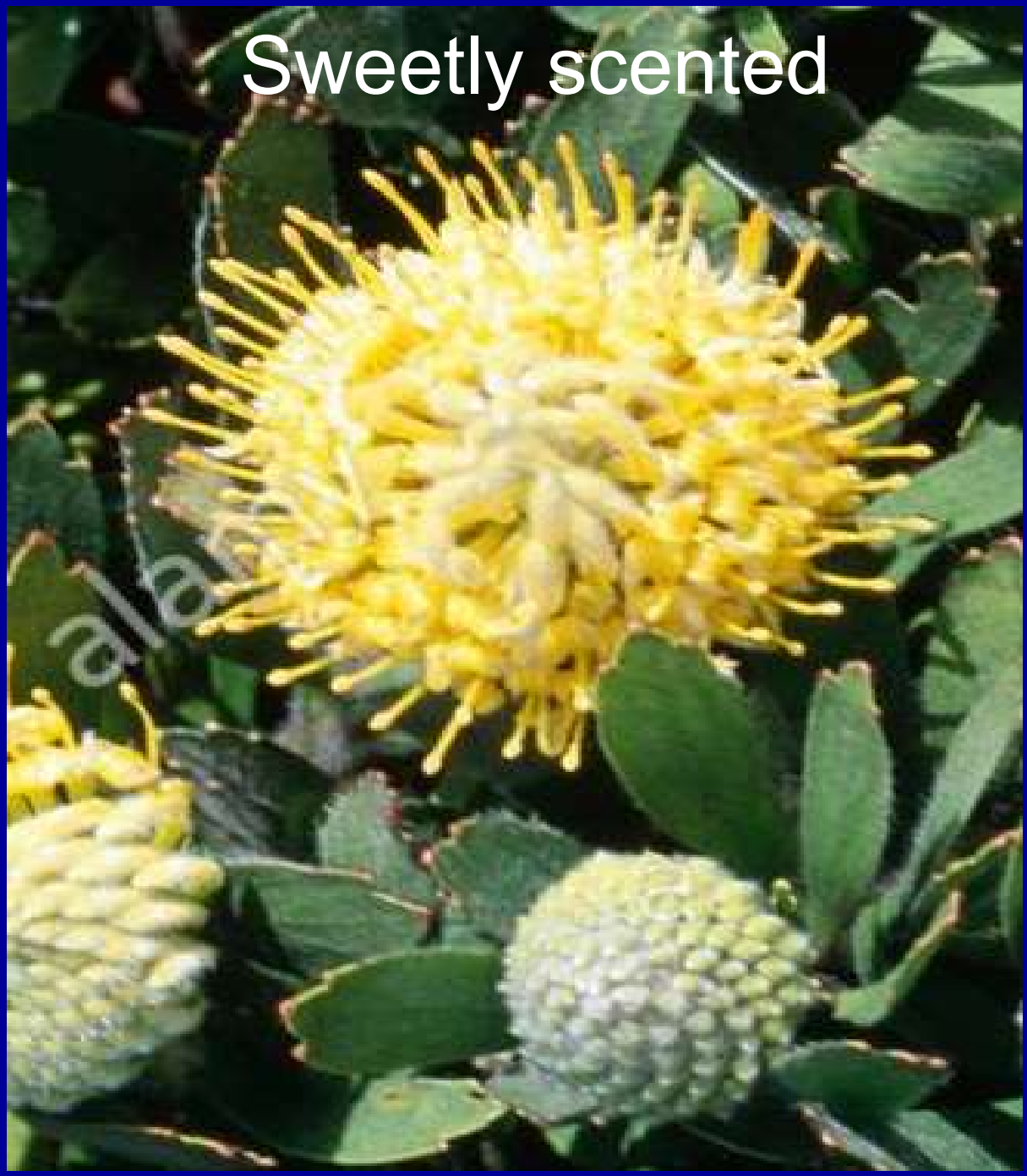
L. 'Thomson's Gift'

L. conocarpodendron
x
L. hypophyllocarpo-dendron

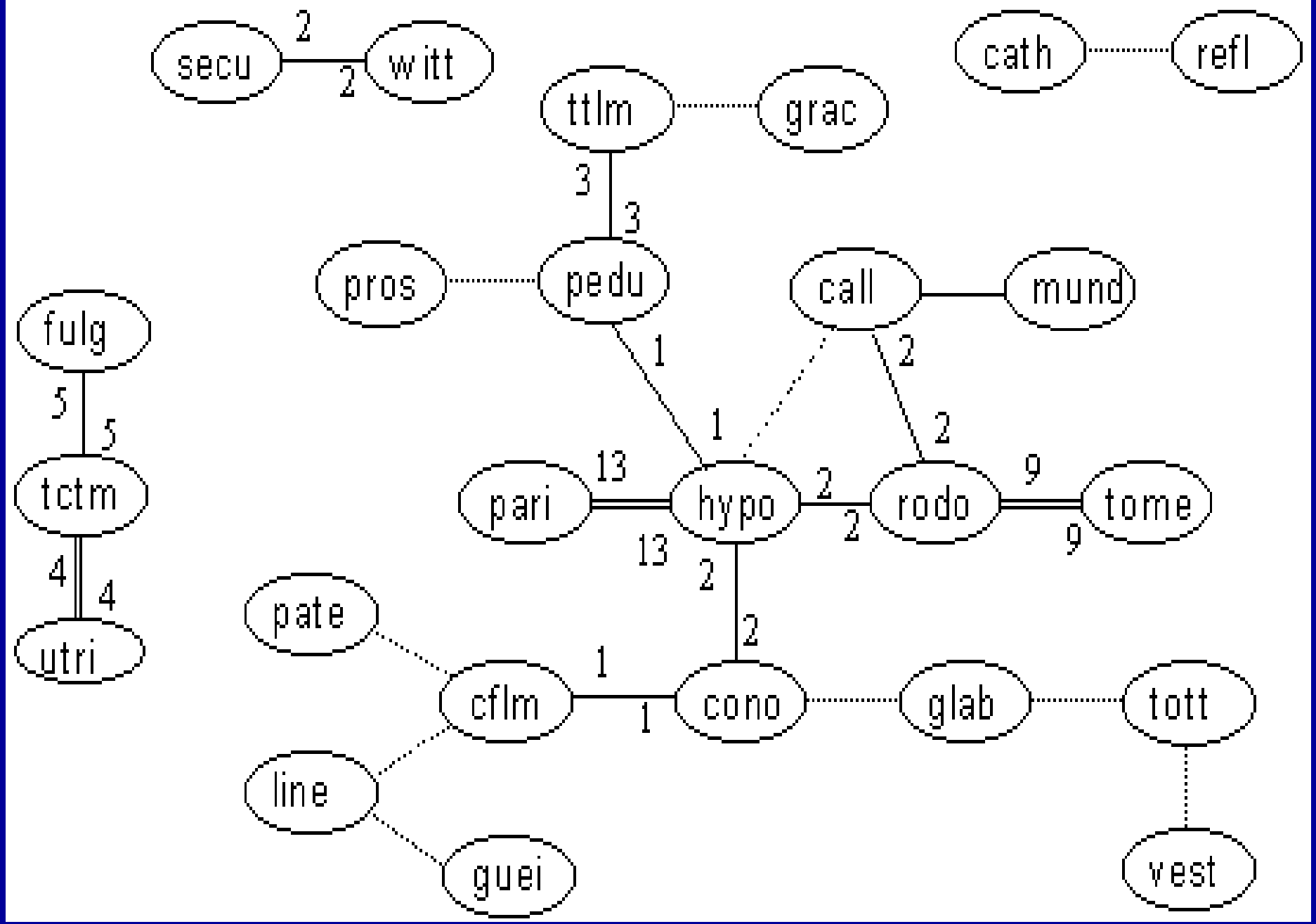
Originator: S. Thompson. Selected: 1987.

REG: 1995. PBR granted in ZA 1995, cancelled 2010.

PBR in NZ 2002, expires 2025.



Relationships wthin the genus *Leucospermum* Rebelo 2020



Section Leucospermum
All sweetly scented

L. parile

L. rodolentum

L. tomentosum

According to Rebelo (2020) there is rampant, natural hybridization occurring within the section Leucospermum

Section Diastelloidea, all sweetly scented

L. prostratum

L. calligerum

L. secundifolium

L. bolusii

Section Diastelloidea, All sweetly scented

L. truncatulum

L. pedunculatum

L. *heterophyllum*

Big improvements can come from small wild relatives

Solanum pimpinelifolium Source of nematode resistance for tomato

Diastella thymelaeoides x *Leucospermum oleifolium*

X

Diastella thymelaeoides

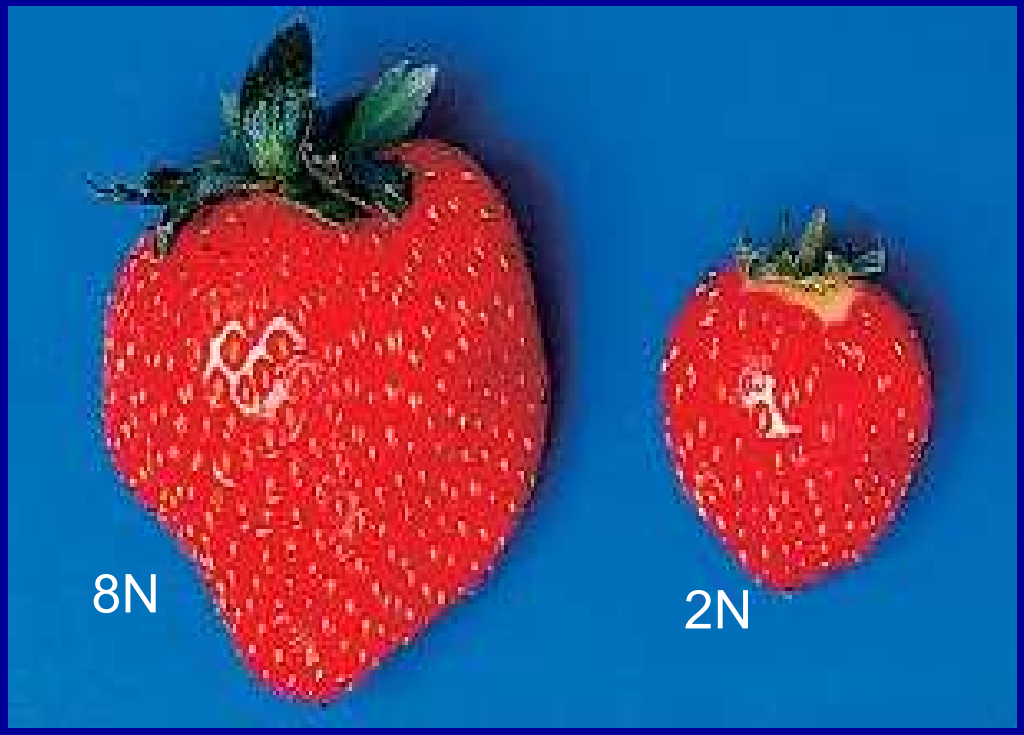
Leucospermum oleifolium

Diastella divaricata, above left
Diastella buekii, above
Diastella fraterna at left

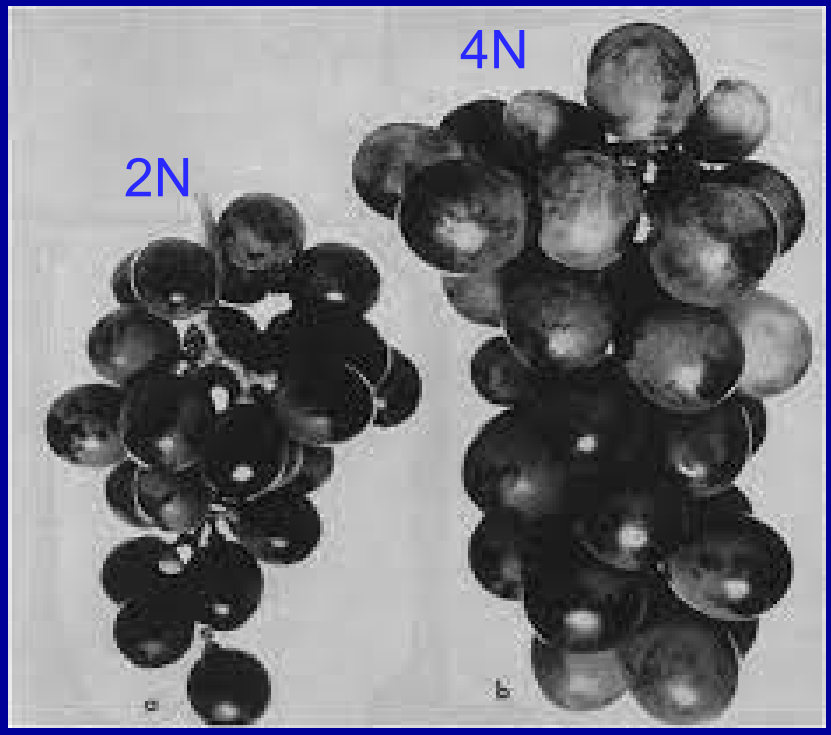
Diastella secies are year-round flowering and come in colors of pink, lavender and white.

Polyploidy = multiple chromosome sets

Important polyploid crops include wheat (4N & 6N), peanut (4N), oats (6N), banana (3N), white potato (4N), sweet potato (6N), strawberry (8N), coffee (4N), sugar cane (8N), cotton (4N), apple (2N & 3N)



Strawberry

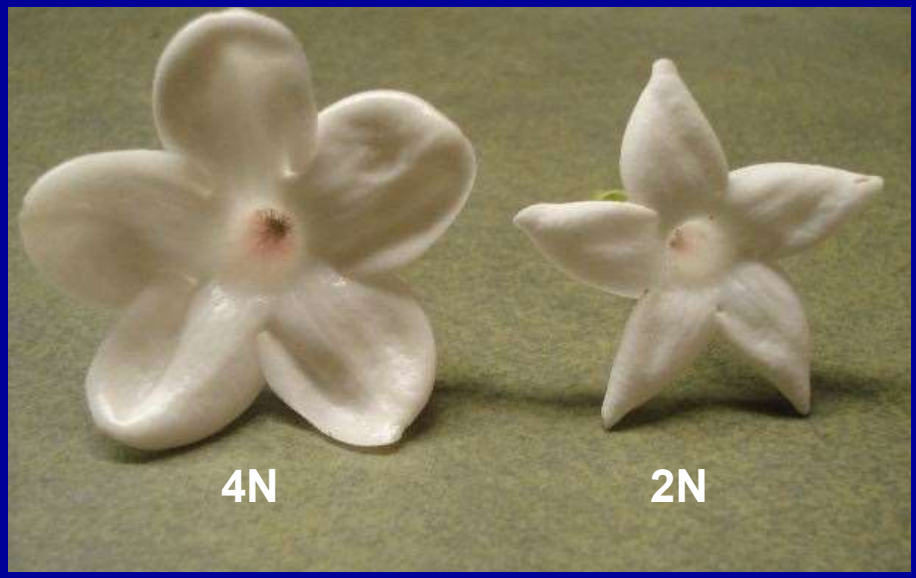


Grape

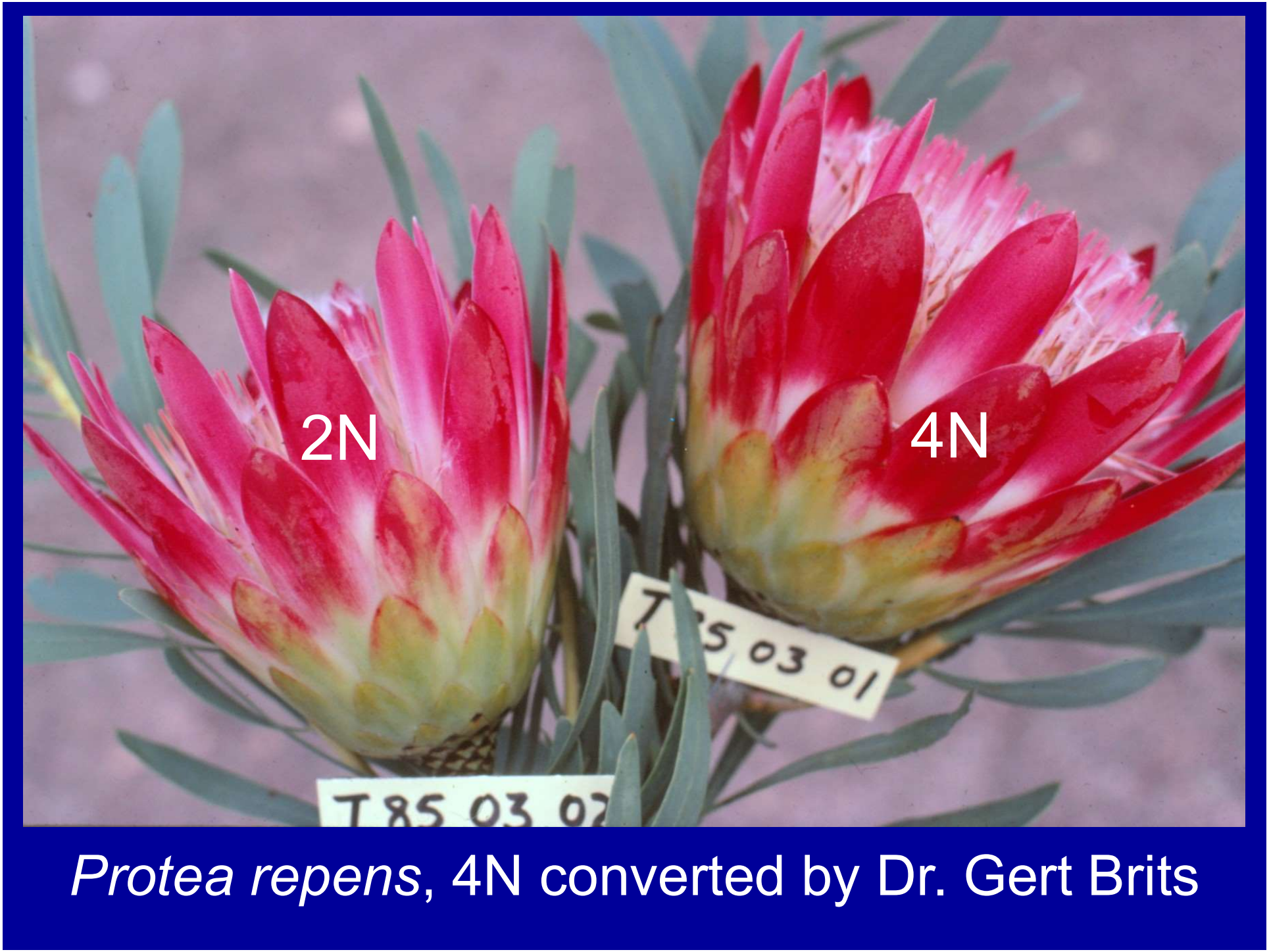
Delonix regia

C. One Tree Hill X *C.* Melinga

Blc. Orange Nugget



Marsdenia floribunda



Protea repens, 4N converted by Dr. Gert Brits

L. cordifolium x *L. tottum*

2N

4N

L. cordifolium

On tetraploid (4N) *Leucosermum* hybrids:

"Tetraploid flowers were quite spectacular and were generally successful in their aim to obtain novel, robust flower heads (typically expected of tetraploids) to overcome the thin styles sometimes found in diploid hybrids, say with *L. tottum*." Brits 2020.

L. cordifolium x *L. vestitum*

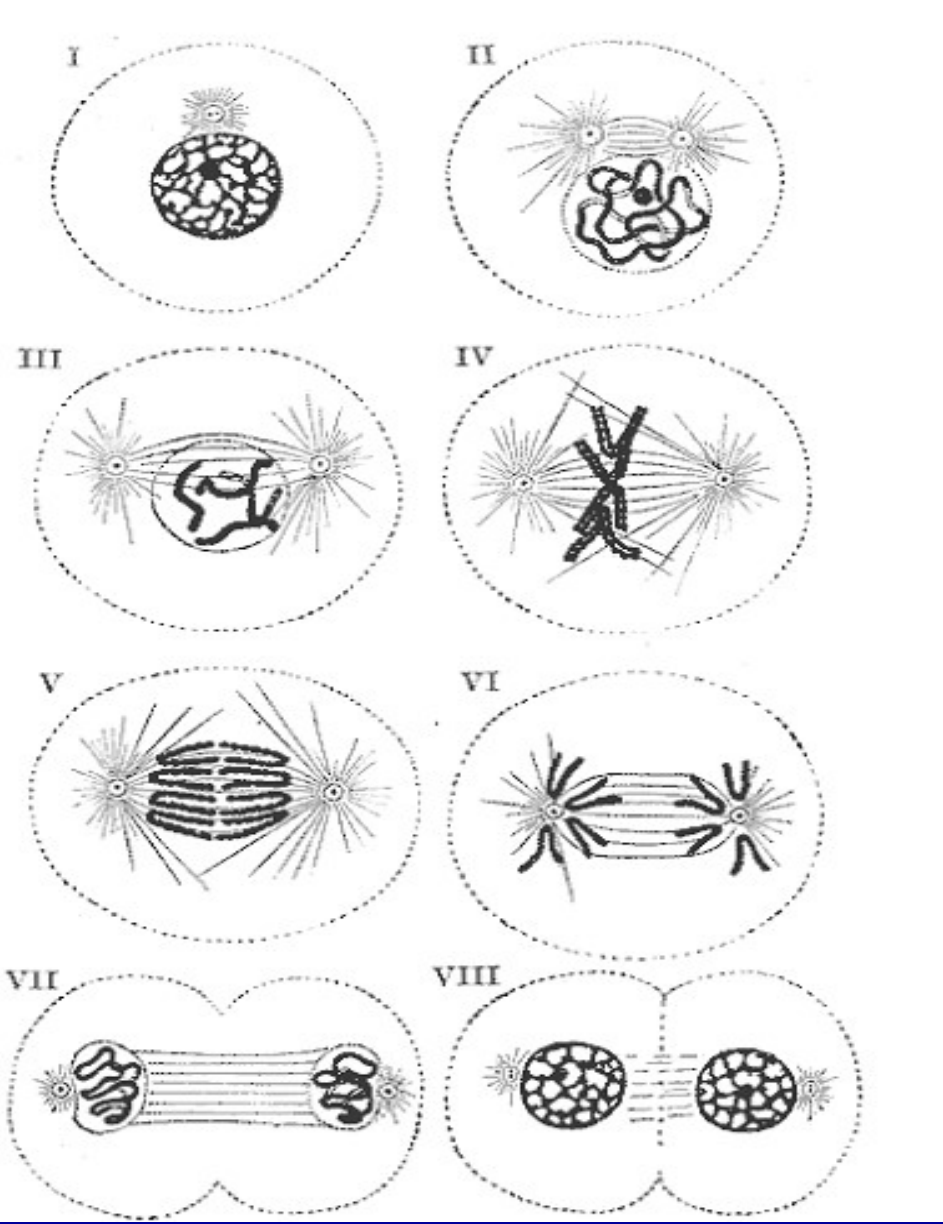
Tetraploid Induction: Treat highly active meristem of diploid plants with anti-mitotic agents such as colchicine or oryzalin

Adonsonia digitata

Clusia rosea

Callophyllum inophyllum

How Does Colchicine Work?



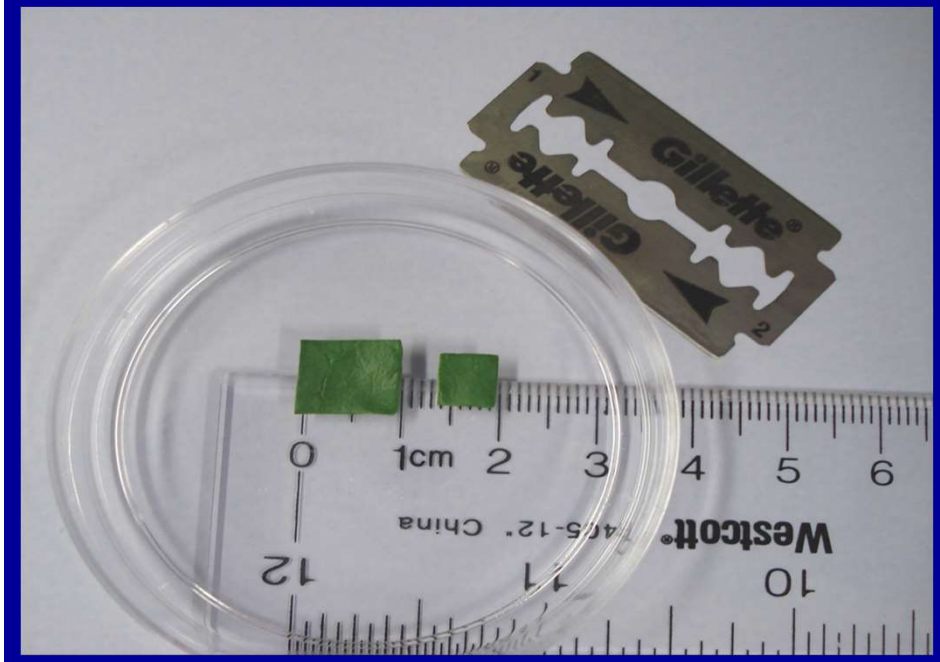
In Mitosis

The chromosomes of a cell are duplicated

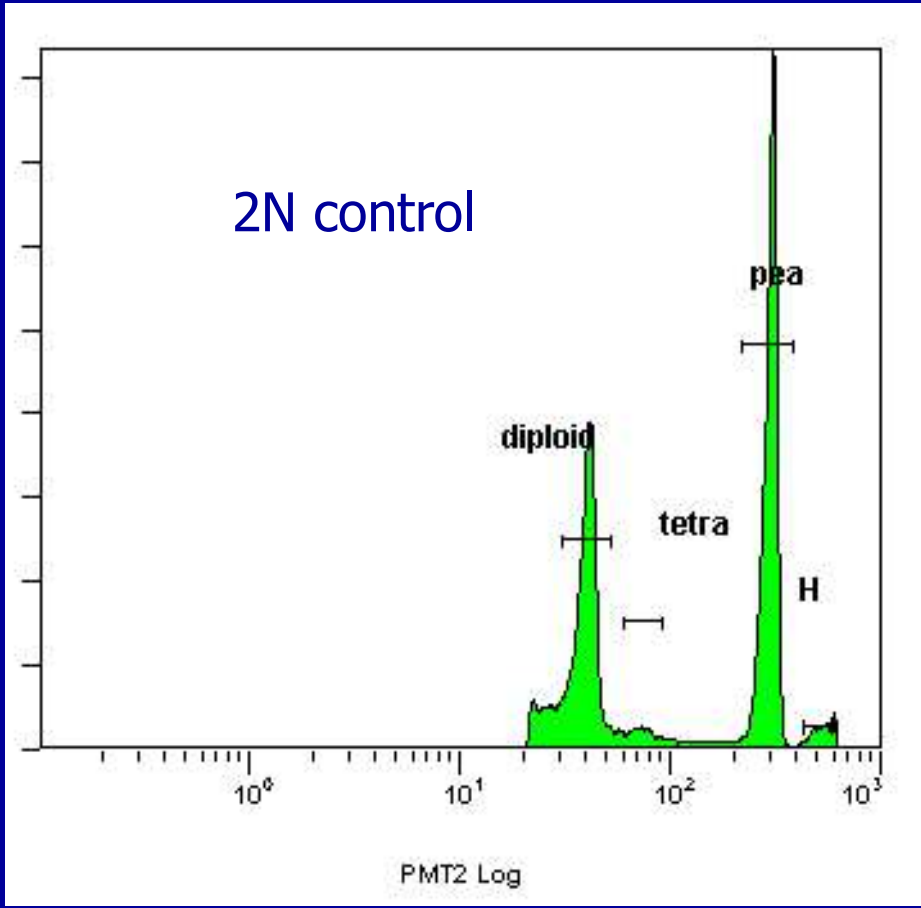
Spindle fibers then line up the chromosomes, and pull them into two new cells.

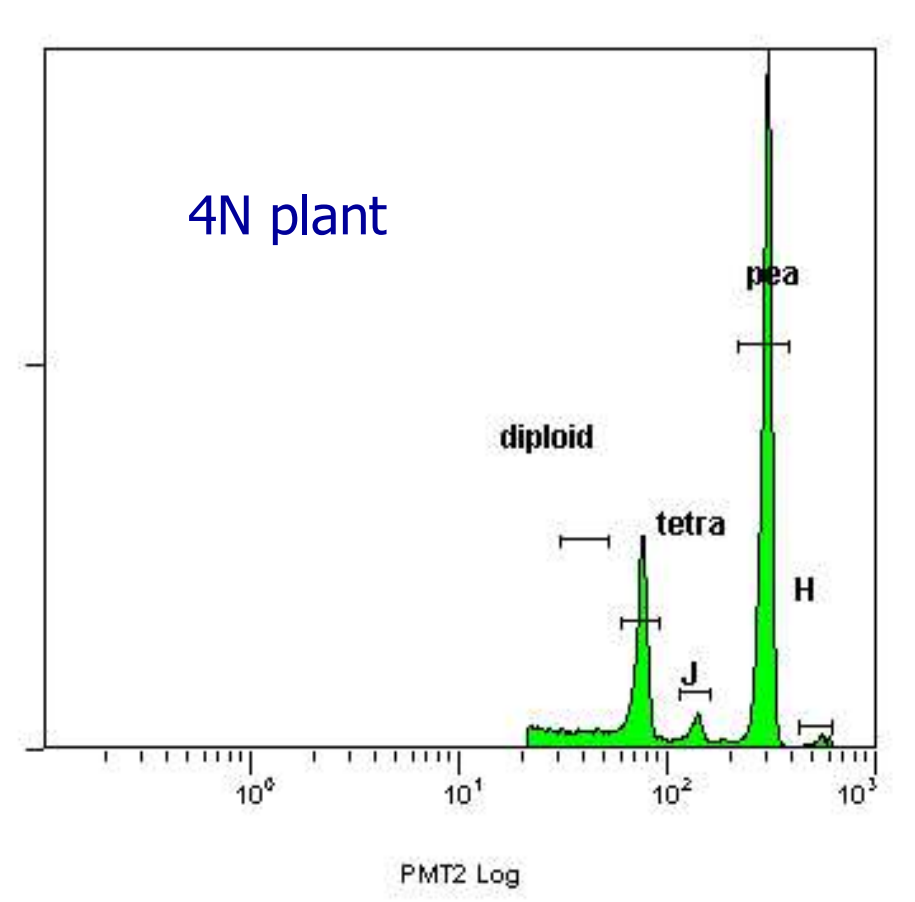
Colchicine disrupts the formation of the spindle fibers.

Flow cytometry quantifies nuclei stained with propidium iodide



Histograms for 2N and 4N African tulip trees





	# of nuclei	PI fluorescence
diploid	9,712	40.0
tetraploid	1,103	73.7

	# of nuclei	PI fluorescence
diploid	none	
tetraploid	9,948	74.6


L. Ali'i, #165
L. lineare, L. glabrum, L. cordifolium, L. conocarpodendron, L. reflexum & L. vestitum


L. Lilian's Peach, #226
L. lineare, L. glabrum, L. conocarpodendron, L. cuneiforme,
L. formosum, L. tottum, L. reflexum & L. vestitum

ACKNOWLEDGEMENTS

From the University of Hawaii

- Pamela Shingaki, Ag Research Technician
- Dr. Mark G. Wright, Entomologist
- Thomas Littleton, Graduate Student
- Norman Nagata, County Extension Agent

From South Africa

- Dr. Tony Rebelo, Protea Atlas Project
- Dr. Gert Brits, Emeritus Protea Breeder