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Patterns in the seed germination response to smoke in plants from the Cape Floristic Region, South Africa

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De Lange and Boucher (1990) discovered the germination enhancing effect of plant-derived smoke on seed of fynbos species. This finding has been applied to horticulturally important fynbos species and to date 301 species have been tested for a response to smoke. Germination in 150 (49.8%) of these was significantly improved by smoke treatment; the remaining 151 species showed no significant response. Families in which species showed a significant response included the horticulturally important Asteraceae (everlastings), Bruniaceae (brunias), Crassulaceae (crassulas), Ericaceae (ericas), Geraniaceae (pelargoniums), Mesembryanthemaceae (mesembs), Proteaceae (proteas) and Restionaceae (restios). No species responded in the families of geophytes such as Amaryllidaceae and Hyacinthaceae and in the Iridaceae the majority of species studied (also geophytes) did not respond. Further analysis of the germination results using ordinal logistic regression confirmed that the geophytic growth form was a robust predictor of response to smoke; geophytes exhibited a very low germination response to smoke. In addition, the analysis indicated that serotinous species had seeds that were less likely to respond to smoke than non-serotinous species, presumably as a consequence of their seeds not being in the soil when fire occurs. It also indicated that plants with some capacity to re-sprout were less likely to respond to smoke than obligate seeders.

Introduction

Fynbos is a unique type of vegetation that is dominant in the Cape Floristic Region (CFR) in the southwestern Cape, at the southern tip of Africa. The CFR covers an area of 90 000km^2 (35 000 miles^2), which is less than four percent of the area of South Africa, yet it contains 8 600 plant species and has, for its size, the richest temperate flora in the world. Over two-thirds of the Cape plant species and seven of the plant families are endemics to the region. Fynbos, which is a plant community of small shrubs, evergreen and herbaceous plants and bulbs, is exceptionally rich in species and contributes most of the species to the flora of the CFR. It is perhaps best known as the home of the South African proteas (sugarbushes, pincushions and conebushes), ericas (Cape heaths) and helichrysums (everlastings), and is also typified by the Restionaceae (Cape reeds or Cape grasses) (Goldblatt 1978, Brown *et al.* 1995).

Many of the wildflowers from these families are cultivated as ornamentals in parks and gardens around the world or are of importance as floricultural crops. Propagation of fynbos plants from seed is difficult, as seeds of many species are dormant when shed and require very specific environmental 'messages' or cues before they will germinate (Brown 1993a). Fynbos occurs in areas with a Mediterranean climate (winter rainfall) and the environment is characterised by a number of stress factors such as summer drought, low soil fertility and periodic fires. The fires have a frequency of four to 40 years and are a natural phenomenon in fynbos (Kruger 1983). Fire provides the major cues for germination in the wild and it is necessary to simulate these cues when attempting to germinate wildflower seed in the laboratory and nursery (Brits 1996, Brown and Van Staden 1997, Keeley and Bond 1997, Van Staden *et al*. 2000).

Within fynbos and other Mediterannean vegetation types, fire stimulated plant recruitment can be caused by fire stimulated flowering (Keeley and Keeley 1984), fire stimulated seed release (from serotinous plants; Lamont *et al*. 1991) or by fire stimulated germination (Le Maitre and Midgley 1992). Heat from fires can stimulate germination in some species, particularly those with hard, impermeable seed coats (e.g. many legumes; Jeffrey *et al*. 1988). However, for a wide range of fynbos species, smoke from fires can, independently of the heat associated with fires, stimulate seed germination (De Lange and Boucher 1990). A germination response to smoke is wide-spread in fynbos: out of 220 species screened for a response, 54% showed a significant improvement in germination following smoke application (Brown 1993a, Brown and Botha 2002). Similar studies on seeds of Western Australian and Californian species have found the smoke response to be widespread (Dixon and Roche 1995, Dixon *et al.* 1995, Keeley and Bond 1997, Tieu *et al*. 1999).

Plant and seed responses to fire and/or smoke can be interpreted as adaptations to ensure seed germination occurs following fire. *Post* fire, above-ground vegetation will be much reduced. Thus, for species that exhibit a germination response to smoke, seedlings are likely to emerge into comparatively high light environments that are suitable for subsequent seedling growth (Baskin and Baskin 1998). Consequently, species that (a) require high light patches for seedling establishment, (b) that are dependent on seeds for regeneration (i.e. cannot re-sprout) and (c) which do not form an aerial seed bank (i.e. are not serotinous) may be likely to respond to smoke as a germination cue. However, at least for Australian kwongan vegetation, Dixon and Roche (1995) found that growth form and post-fire regeneration strategy did not affect the likelihood of a species responding to smoke. Nonetheless, it is currently unknown, for fynbos, whether characteristics, such as growth form, affect the likelihood of a species exhibiting a germination response to smoke.

It is generally well accepted that there is a relationship between seed size and successional status: small-seeded species typically require open, high light environments for establishment (Salisbury 1942, Swaine and Whitmore 1988). This occurs because small-seeded species lack the initial seed reserves to enable seedling persistence in the low light conditions that are typically associated with germinating beneath pre-existing plant cover (Leishman and Westoby 1994, Westoby *et al*. 2002). This is reflected by the finding that small-seeded species are typically more likely to respond to light, as a germination cue, than larger seeded species (Milberg *et al*. 2000, Pearson *et al*. 2002). Consequently, a light requirement for germination may enable small-seeded species to avoid germinating in the shade. By analogy it could be hypothesised that, in fynbos, small-seeded species detect the presence of suitable microsites for germination (i.e. those free from above-ground vegetation) via the effect of smoke on germination, since smoke is likely to signal the presence of burnt sites. Thus, there may be a relationship between seed size and response to smoke with small-seeded species most likely to respond since they may be most dependent on detecting vegetation free (burnt) patches for germination.

In this paper we examine the germination response of 301 fynbos species to smoke in an attempt to test if there are predictable patterns of responses associated with plant life-history traits, such as seed size, growth form, fire-survival strategy, seed retention/shedding characteristics and seed dispersal agents.

Materials and Methods

Collation of germination data

Germination data analysed in this study (Appendix 1), consist of new and unpublished data recently generated in laboratory and nursery trials, together with data from previously published studies. Seeds used in the current study were collected from natural populations in the wild in various localities in the southwestern and southern Cape Province from a minimum of 100 (on average, 200–300) individual plants per species representative of the population. The new germination data were generated using the methods outlined previously in Brown (1993a). Data on seed mass was obtained by determining the mean air-dry seed mass of 10 samples of 100 seeds.

Data from the following published germination studies were included in the appendix: De Lange and Boucher (1990), Brown (1993a), Brown (1993b), Brown *et al*. (1993), Baxter *et al.* (1994), Brown *et al*. (1994), Brown *et al.* (1995), Pienaar (1995), Pierce *et al.* (1995), Keeley and Bond (1997), Brown and Botha (1998) and Brown and Botha (2002).

Information on the life-history characters of growth form, fire-survival strategy, seed retention/shedding characteristics and seed dispersal mode for species occurring in the Cape Floristic Region was obtained from published and unpublished sources. The following published sources were used: Williams (1972), Bond and Goldblatt (1984), Burman and Bean (1985), Linder (1985), Brits (1986), Vogts (1989), Linder (1991), Schumann *et al.* (1992), Van Wilgen and Forsyth (1992), McDonald and Cowling (1995), Brits (1996), Manning and Goldblatt (1996), Keeley and Bond (1997), Manning and Goldblatt (1997), Goldblatt and Manning (2000), Linder (2001) and Rebelo (2001).

The following gave of their time in personal communications to provide the mostly unpublished information requested: PA Botha, C Boucher, RM Cowling, H Jamieson, JC Manning, I Nänni, EGH Oliver, JP Rourke, DA Snijman, KE Steiner, TH Trinder-Smith and A-L Vlok.

Statistical analysis

Information from published and unpublished sources on growth form, fire survival strategy, seed retention/shedding characteristics and seed dispersal mode for species occurring in the Cape Floristic Region was obtainable for 301 species. In addition, information on seed mass was obtainable for 221 of these species.

To determine whether there were predictable patterns of smoke response between different plant groupings, ordinal logistic regression was used. Germination percentages were used to calculate an index, analogous to the Relative Light Germination Index of Milberg *et al*. (2000), expressing a smoke requirement for germination: Relative Smoke Germination (RSG):

$$RSG = Gs/(Gs + Gc)$$

where Gs is percentage germination in the presence of smoke and Gc is percentage control germination (absence of smoke). We considered relative values preferable to germination percentages since a significant statistical difference between the plus and minus smoke treatments may have little ecological significance, particularly in scenarios where control germination values are comparatively high. RSG values can take a range of values varying from 0 (germination only in the absence of smoke) to 1 (germination only with smoke). RSG was not calculated for species where germination both with and without smoke was less than 10%: consequently 76 species were excluded from the overall dataset. RSG values were subsequently divided into three categories: ≤0.6 was considered as little or no ecologically meaningful effect of smoke, >0.6 to ≤0.8 as a moderate positive effect of smoke on germination and >0.8 as a highly positive ecological effect of smoke on germination. No, moderate and high ecological effects of smoke were coded 0, 1 and 2, respectively for the logistic analysis.

Initially the logistic analysis was conducted on the 166 species for which seed mass data were available. For each plant species, the probability that it would exhibit either, no, moderate or high positive germination responses to smoke was examined with respect to: (1) seed mass (continuous scale in mg); (2) seed dispersal mode (two categories: wind/passive dispersal (0) or animal/bird dispersal (1)); (3) post-fire regeneration strategy (two categories: dependent on regeneration from seed (0) and some ability to re-sprout (1)); (4) seed retention/shedding characteristics (two categories: seeds held in canopy (0) and seeds shed to soil (1)); and (5) growth form (four categories: annual, geophyte, herbaceous perennial and woody) using the ordinal logistic regression analysis procedure of Minitab 13 (Minitab Inc. PA, USA). Because there is no defined order to the four variables for growth form, three dichotomous dummy variables were created (Tabachnick and Fidell 2001). Thus growth form (1) was coded 1 if the growth form was geophyte and 0 if otherwise, growth form (2) was coded 1 if herbaceous perennial and 0 otherwise and growth form (3) was coded 1 if woody perennial and 0 if otherwise. Note annuals are designated by zeros on all three dummy variables. Since the initial analysis including seed mass revealed that seed mass was not a significant predictor of a species response to smoke the full data set of 225 species was subsequently analysed without the seed mass data.

To evaluate the contribution of each main factor to the full logistic model containing all five terms, the logistic regression analysis was repeated for all possible four-term reduced models followed by likelihood ratio tests, where $G = 2[\log L_{\text{full}} - \log L_{\text{reduced}}]$, and G is distributed as χ^2 with 1 df, to determine the significance of the change in log-likelihood after removal of each term (Tabachnick and Fidell 2001).

Results and Discussion

Patterns in response to smoke shown by different plant families

Table 1 shows a list of the families to which test species belonged and whether the family contained species that showed significantly improved germination with smoke treatment. The families showing a positive response include the horticulturally important families Asteraceae (everlastings), Bruniaceae (brunias), Crassulaceae (crassulas), Ericaceae (ericas), Geraniaceae (pelargoniums), Mesembryanthemaceae (mesembs), Proteaceae (proteas) and Restionaceae (restios). Our results (Table 1) indicate that a statistically significant smoke response is found in a wide range of families which is in agreement with Keeley and Bond (1997) who reported that the smoke response has arisen independently in a range of distantly related families. Amongst those families in which species were not responsive were families of geophytes such as Amaryllidaceae (*Cyrtanthus*) and Hyacinthaceae (*Albuca*). Most of the species (12 out of 14, studied) in the Iridaceae (*Bobartia, Geissorhiza, Moraea, Romulea*) also did not respond. This latter finding highlighted the possibility of the smoke response being related to life-history traits.

This and other studies have found that the smoke response is phylogenetically widespread in fynbos (De Lange and Boucher 1993, Brown 1993a, Brown *et al.* 1993, Brown *et al.* 1995), in Californian chaparral (Keeley and Fotheringham 1998) and in Western Australian plant communities (Roche *et al.* 1997). However, although a positive germination response to smoke is found in a wide range of families within fynbos, not all the species within a family or genus exhibit the same smoke response. For example, despite having similar life-history strategies, 66% of the *Erica* species investigated (33 of 50) responded to smoke; the remaining 34% did not. This may reflect adaptation for regeneration in very specific micro-sites or that species use alternative cues to stimulate post fire regeneration. However, this remains to be tested.

Smoke-enhanced germination in fynbos has been recorded for a wide range of plant species showing a variety of life-history traits, i.e. in both regeneration strategies (annual seeders and long-lived re-sprouters), in both dispersal

Table 1: Plant families tested for a germination response to smoke. A positive smoke response was defined as a significant ($P < 0.05$) increase in germination (as assessed with a t-test) in a smoke treatment relative to a non-smoke treated control. Figures in brackets represent the number of species tested in each family
✔ = Germination improved significantly in some species tested
✖ = No improvement in germination for any of the species tested

✖ AGAPANTHACEAE (1)	✖ HYACINTHACEAE (2)
✖ AMARYLLIDACEAE (1)	✔ IRIDACEAE (14)
✖ ANACARDIACEAE (1)	✖ LANARIACEAE (1)
✖ ASPHODELACEAE (2)	✔ MESEMBRYANTHEMACEAE (20)
✔ ASTERACEAE (42)	✔ MOLLUGINACEAE (1)
✔ BRASSICACEAE (4)	✖ MONTINIACEAE (1)
✔ BRUNIACEAE (4)	✔ PENAEACEAE (2)
✔ CAMPANULACEAE (8)	✔ POACEAE (3)
✔ CARYOPHYLLACEAE (2)	✔ PROTEACEAE (32)
✔ CRASSULACEAE (2)	✔ RESTIONACEAE (64)
✖ CUPPRESSACEAE (1)	✖ RHAMNACEAE (1)
✖ CYPERACEAE (2)	✔ ROSACEAE (1)
✖ DIPSACACEAE (1)	✖ RUBIACEAE (1)
✖ EBENACEAE (1)	✖ RUTACEAE (1)
✔ ERICACEAE (50)	✔ SCROPHULARIACEAE (9)
✔ FABACEAE (8)	✖ STERCULIACEAE (5)
✖ GENTIANACEAE (1)	✔ STILBACEAE (1)
✔ GERANIACEAE (8)	✔ THYMELAEACEAE (1)
✔ HAEMODORACEAE (2)	

modes (wind/passive or animal) (Figure 1), in all growth forms from annuals to trees (Figure 2) and in large- and small-seeded species. However, the logistic regression analysis indicated that only the geophytic growth form affected the likelihood of a species responding to smoke: geophytes are less likely to respond to smoke than other species (Tables 2 and 3, Figure 2). Keeley and Bond (1997) also found that fire-related stimuli had no promotive effect on germination for a range of geophytes. Similarly, working on four Mediterranean *Muscari* spp., Doussi and Thanos (2002) found no effect of fire related treatments on germination. This suggests that vegetative reproduction and aestivating coupled with enhanced reproductive output *post* fire resulting from fire-stimulated flowering may result in little selection for a smoke response in geophytes.

As predicted, serotinous species and those with some *post* fire ability to re-sprout, were less likely to exhibit a germination response to smoke than non-serotinous species and those wholly dependent on seed for regeneration. This is perhaps unsurprising given that for serotinous species seeds are not in the soil when a fire occurs — dispersal, not germination, is triggered by fire. Further, for species that can re-sprout and do not have an obligate requirement for regeneration from seeds the selection pressure for a positive smoke response may be less strong than for species that only reproduce by seed. The effect of these two characteris-

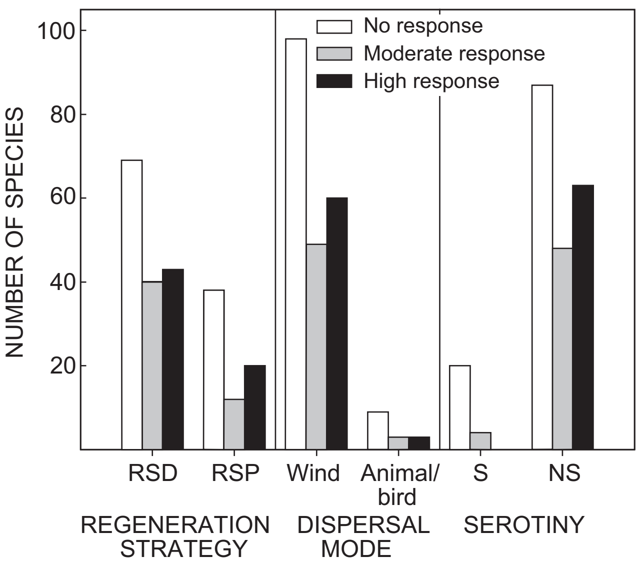

Figure 1: Number of fynbos species with different regeneration strategies, canopy and soil seed banks and different dispersal modes responding to smoke-mediated germination. RSP = re-sprouter; RSD = re-seeder; S = serotinous; NS = non-serotinous (i.e. soil stored seeds). Bars refer to no, moderate and high smoke response

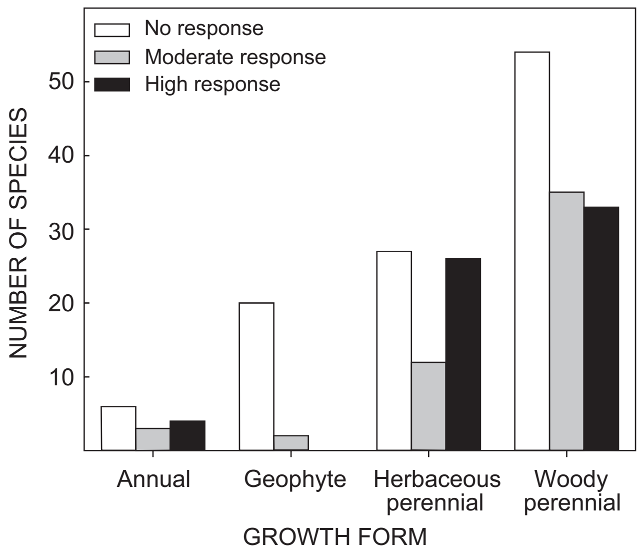

Figure 2: Number of fynbos species with different growth forms exhibiting smoke-mediated germination. Bars refer to no, moderate and high smoke response

Table 2: Log-likelihood ratio test for each six parameter reduced logistic model compared to the full seven parameter model using the 166 species for which seed mass data were available. Values for the log-likelihood test are presented for each reduced model, compared to the full model, in addition to the associated P-value for χ^2 with df = 1. Growth forms 1, 2 and 3 correspond to geophytes, herbaceous perennials and woody perennials, respectively. Annuals are represented by zeros on all three dummy variables. Odds-ratios are provided for terms that make a significant contribution to the model. The odds-ratio indicates the change in likelihood of a species responding to smoke when changing from the variable coded 0 to the variable coded 1. Thus, geophytes are 0.05 times as likely (i.e. are less likely) to respond to smoke than other growth forms

Term removed from full model	Log-likelihood	$2[\log L_{full} - \log L_{reduced}]$	P-value	Odds ratio
None	–150.058	–	–	–
Seed mass	–150.843	1.57	n.s.	n/a
Regeneration strategy	–153.352	6.59	<0.05	0.30
Serotiny	–154.863	9.61	<0.005	8.33
Dispersal mode	–150.236	0.356	n.s.	n/a
GF1	–154.305	8.49	<0.005	0.05
GF2	–150.061	0.01	n.s.	n/a
GF3	–150.070	0.02	n.s.	n/a

n.s. = not significant

Table 3: Log-likelihood ratio test for each five parameter reduced logistic model compared to the full size parameter model for all 225 species. Values for the log-likelihood test are presented for each reduced model, compared to the full model, in addition to the associated P-value for χ^2 with df = 1. Growth forms 1, 2 and 3 correspond to geophytes, herbaceous perennials and woody perennials, respectively. Annuals are denoted by zeros on all three dummy variables. Odds-ratios are provided for terms that make a significant contribution to the model. The odds-ratio indicates the change in likelihood of a species responding to smoke when changing from the variable coded 0 to the variable coded 1

Term removed from full model	Log-likelihood	$2[\log L_{full} - \log L_{reduced}]$	P-value	Odds ratio
NONE	–208.740	–	–	–
RS	–211.792	6.10	<0.05	0.67
DM	–210.351	3.22	n.s.	n/a
SS	–219.871	22.26	<0.001	9.09
GF1	–215.150	12.82	<0.001	0.04
GF2	–208.751	0.02	n.s.	n/a
GF3	–208.865	0.25	n.s.	n/a

n.s. = not significant

tics on the smoke response, presumably explains why, although woody plants appear to be unlikely to exhibit a high smoke response (Figure 2), the effect was not significant (Tables 2 and 3): many of the serotinous plants and those with a re-sprouting ability are woody. Furthermore, this may explain why Keeley and Bond (1997) found that a significant portion of woody plants in fynbos and Californian chaparral did not respond to smoke: many woody plants have the ability to re-sprout *post* fire or have serotinous seeds.

In agreement with the study of Dixon and Roche (1995) we found that seed mass was not a reliable predictor of response to smoke. While there is some association between growth form and seed mass (mean seed mass for annuals, geophytes, herbaceous perennials and woody perennials was 0.47mg, 9.85mg, 8.80mg and 29.18mg, respectively) even when the effect of seed mass, independent of the influence of growth form, was investigated using logistic regression it was found to not be a reliable predictor of response (Table 2). This suggests that in contrast to the effect of light, small seeds (see Milberg *et al.* 2000) are not any more or less likely to respond to smoke than large seeds. In fynbos, seeds may be able to detect above ground vegetation gaps through either the presence of smoke or light. Consequently, it may be of value to investigate whether small seeded species, in fynbos, are more likely to respond to light as a germination cue than larger seeded species and whether there are interactions between the effect of light and smoke on seed germination.

The current findings indicate that a positive smoke response is most common in the following species groups: non-serotinous annual and herbaceous species with no ability to re-sprout *post* fire. The other groups, that are less likely to respond to fire, may have alternative fire response mechanisms, such as fire induced flowering or seed release or can tolerate fire and re-sprout. Thus although a smoke germination response may be advantageous by stimulating post-fire regeneration it is only one of a suite of adaptations exhibited by fynbos species for survival in fire prone environments. Clearly, further work is required to understand the ways that smoke induced germination contributes to regeneration success in the field and to more fully understand the regeneration niche requirements of fynbos plants.

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Appendix 1: Species from the Cape Floristic Region tested for a germination response to smoke. Smoke response (SR) as assessed by a significant difference between the control and smoke treatment using a t-test ($P < 0.05$): Y = yes; N = no. Growth form (GF): A = annual; G = geophyte; HP = herbaceous perennial; WP = woody perennial. Regeneration strategy (RS): RSD = seeder; RSP = re-sprouter. Seed retention (SS): S = serotinous/canopy stored; NS = shed/stored in soil. Dispersal mode (DM): A = animal/bird; W/P = wind/passive (in Mesembryanthemaceae, H = water dispersal) (germination and life-history data obtained from a wide variety of souces [see references in materials and methods in text]). Species nomenclature is according to Goldblatt and Manning (2000). Germination data are generally given as percentages. However, for some groups, especially the Ericaceae, germination is given as number of seedlings per gram of seed. Where data were available, ± standard error was included with germination %. Abbreviation GPNG = germination percentages not given in reference

Species	Control germination (%)	Smoke germination (%)	Seed mass (mg)	SR	GF	RS	SS	DM
GYMNOSPERMS								
Cupressaceae								
Widdringtonia nodiflora	54±17	67±13	10.50	N	WP	RSP	S	W
ANGIOSPERMS – MONOCOTYLEDONS								
Agapanthaceae								
Agapanthus africanus	59	59	6.80	N	G	RSP	NS	W
Amaryllidaceae								
Cyrtanthus ventricosus	42±6	38±4	–	N	G	RSP	NS	W
Asphodelaceae								
Kniphofia uvaria	72	76	3.04	N	G	RSP	NS	P
Trachyandra sp.	80±4	78±5	–	N	G	RSP	NS	P
Cyperaceae								
Mariscus thunbergii	49	49	0.41	N	HP	RSP	NS	P
Isolepis incomptula	GPNG	GPNG	–	N	A	RSD	NS	P
Haemodoraceae								
Wachendorfia paniculata	41	37	5.26	N	G	RSP	NS	W
Wachendorfia paniculata	60±20	78±5	–	N	G	RSP	NS	W
Wachendorfia thyrsiflora	15	54	14.30	Y	G	RSP	NS	W
Hyacinthaceae								
Albuca flaccida	70±4	40±8	–	N	G	RSP	NS	W
Albuca sp.	GPNG	GPNG	4.80	N	G	RSP	NS	W
Iridaceae								
Aristea africana	23	46	1.19	Y	G	RSP	NS	W
Aristea major	73	67	4.44	N	G	RSP	NS	W
Aristea racemosa	68	90	4.42	Y	G	RSP	NS	W
Bobartia gladiata	62±16	56±10	7.63	N	G	RSP	NS	P
Bobartia gladiata subsp. *gladiata*	74	80	7.34	N	G	RSP	NS	P
Geissorhiza sp.	74	60	0.50	N	G	RSP	NS	P
Moraea ochroleuca	18	17	1.72	N	G	RSP	NS	P
Moraea ramosissima	83	86	5.52	N	G	RSP	NS	P
Pillansia templemannii	81	81	58.82	N	G	RSP	NS	P
Romulea sp.	2±1	6±2	2.86	N	G	RSP	NS	P
Tritioniopsis parviflora	74	74	13.00	N	G	RSP	NS	W
Tritioniopsis triticea	72	66	5.43	N	G	RSP	NS	W
Watsonia borbonica	61	47	16.67	N	G	RSP	NS	W
Watsonia tabularis	75	71	13.33	N	G	RSP	NS	W
Lanariaceae								
Lanaria lanata	52	50	20.00	N	G	RSP	NS	P
Poaceae								
Pentaschistis colorata	0	24±7	–	Y	HP	RSP	NS	W
Pseudopentameris macrantha	5	26	4.33	Y	HP	RSP	NS	W
Themeda triandra	6±2	36±3	–	Y	HP	RSD/RSP	NS	W
Restionaceae								
Askidiosperma andreaeanum	6±4	42±13	–	Y	HP	RSP	NS	P
Askidiosperma chartaceum	52	58	1.58	N	HP	RSD	NS	P
Askidiosperma esterhuyseniae	23	23	0.82	N	HP	RSD	NS	P
Askidiosperma paniculatum	53	67	2.68	Y	HP	RSD	NS	P
Calopsis impolita	1±1	4±3	–	N	HP	RSD	NS	P

Appendix 1 cont.

Species	Control germination (%)	Smoke germination (%)	Seed mass (mg)	SR	GF	RS	SS	DM
Calopsis paniculata	23.6 (590±93g^{-1})	23.9 (598±27g^{-1})	0.30	N	HP	RSD/RSP	NS	P
Cannomois parviflora	0	0	37.00	N	HP	RSP	NS	A
Cannomois virgata	2±5	18±3	248.00	Y	HP	RSP	NS	A
Chondropetalum ebracteatum	66	85	1.26	Y	HP	RSD	NS	P
Chondropetalum hookerianum	2	10	1.16	Y	HP	RSD	NS	P
Chondropetalum hookerianum	1±2	61±24	1.20	Y	HP	RSD	NS	P
Chondropetalum mucronatum	4±4	81±9	4.03	Y	HP	RSD	NS	P
Chondropetalum tectorum	0.1 (1±2g^{-1})	2.1 (21±17g^{-1})	0.12	Y	HP	RSD	NS	P
Chondropetalum tectorum	36	34	0.09	N	HP	RSD	NS	W/P
Dovea macrocarpa	2±4	77±8	–	Y	HP	RSD	NS	P
Elegia caespitosa	0	2	1.89	N	HP	RSD	NS	P
Elegia capensis	0.3 (5±4 g^{-1})	1.0 (20±17g^{-1})	0.50	N	HP	RSP	NS	P
Elegia cuspidata	2.4 (14±7g^{-1})	5.2 (30±10g^{-1})	1.42	Y	HP	RSD	NS	P
Elegia equisetacea	3	14	0.80	Y	HP	RSD	NS	P
Elegia fenestrata	11.3 (164±3g^{-1})	21.1 (306±25g^{-1})	–	Y	HP	RSD	NS	P
Elegia filacea	16	32	0.45	Y	HP	RSD	NS	P
Elegia grandis	24	43	15.62	Y	HP	RSD	NS	P
Elegia grandispicata	16	4	0.91	N	HP	RSD	NS	P
Elegia persistens	1	15	1.10	Y	HP	RSD	NS	W/P
Elegia spathacea	13	54	0.52	Y	HP	RSD	NS	W/P
Elegia stipularis	GPNG	GPNG	0.85	N	HP	RSD	NS	P
Elegia thyrsifera	2	2	2.20	N	HP	RSD/RSP	NS	P
Hydrophilus rattrayi	2	1	5.56	N	HP	RSP	NS	A
Hypodiscus neesii	0	0	47.78	N	HP	RSP	NS	A
Hypodiscus sp.	0	7	5.68	Y	HP	RSP	NS	A
Hypodiscus striatus	0	0	45.00	N	HP	RSP	NS	A
Ischyrolepis ocreata	10	47	2.17	Y	HP	RSD	NS	P
Ischyrolepis sieberi	1	69	2.61	Y	HP	RSP	NS	P
Ischyrolepis subverticillata	5±5	64±8	1.86	Y	HP	RSP	NS	P
Mastersiella digitata	1	2	5.54	N	HP	RSD	NS	A
Restio bifarius	30	45	2.75	Y	HP	RSD	NS	P
Restio brachiatus	53±23	76±23	0.50	N	HP	RSD	NS	P
Restio dispar	12	61	3.45	Y	HP	RSP	NS	P
Restio festuciformis	9.0 (281±25g^{-1})	13.2 (412±12g^{-1})	0.24	Y	HP	RSD/RSP	NS	P
Restio pachystachyus	76	78	2.94	N	HP	RSD	NS	P
Restio praeacutus	40±14	58±11	–	N	HP	RSD	NS	P
Restio similis	13±21	44±18	0.10	Y	HP	RSD	NS	P
Restio tetragonus	2±2	97±4	–	Y	HP	RSP	NS	P
Restio triticeus	37±15	94±8	0.88	Y	HP	RSP	NS	P
Rhodocoma arida	19	54	0.87	Y	HP	RSD	NS	P
Rhodocoma capensis	0.2 (10±22g^{-1})	50.6 (2 410±315g^{-1})	0.19	Y	HP	RSD/RSP	NS	P
Rhodocoma fruticosa	68	97	1.04	Y	HP	RSP	NS	P
Rhodocoma gigantea	23±6	79±11	1.38	Y	HP	RSD	NS	P
Staberoha aemula	1±2	62±8	1.66	Y	HP	RSD	NS	W
Staberoha banksia	4	42	4.17	Y	HP	RSD	NS	W/P
Staberoha cernua	1±2	43±8	1.10	Y	HP	RSP	NS	W
Staberoha distachyos	6±2	32±15	–	Y	HP	RSP	NS	W
Staberoha vaginata	1±2	8±4	1.76	Y	HP	RSD	NS	W
Thamnochortus bachmannii	0.1 (1±2g^{-1})	7.9 (61±12g^{-1})	0.11	Y	HP	RSD	NS	W
Thamnochortus cinereus	1.1 (6±5g^{-1})	20.3 (107±44g^{-1})	0.99	Y	HP	RSP	NS	W
Thamnochortus erectus	GPNG	GPNG	–	N	HP	RSP	NS	W
Thamnochortus insignis	10	28	1.26	Y	HP	RSD	NS	W
Thamnochortus lucens	GPNG	GPNG	0.54	N	HP	RSP	NS	W
Thamnochortus pellucidus	0.3 (1±2g^{-1})	7.9 (27±14g^{-1})	2.85	Y	HP	RSD	NS	W
Thamnochortus platypteris	1	4	2.45	N	HP	RSD	NS	W
Thamnochortus punctatus	0.05 (1±1g^{-1})	2.2 (38±13g^{-1})	–	Y	HP	RSD	NS	W
Thamnochortus rigidus	10	10	1.40	N	HP	RSD	NS	W
Thamnochortus spicigerus	0.4 (1±2g^{-1})	3.7 (12±3g^{-1})	2.60	Y	HP	RSD	NS	W
Thamnochortus sporadicus	1±1	4±2	–	Y	HP	RSP	NS	W
Willdenowia incurvata	18±7	14±4	125.0	N	HP	RSD/RSP	NS	A
ANGIOSPERMS – DICOTYLEDONS								
Anacardiaceae								
Rhus tomentosa	GPNG	GPNG	10.87	N	WP	RSP	NS	A
Asteraceae								
Arctotis acaulis	27	29	7.66	N	HP	RSP	NS	W
Arctotis stoechadifolia	4	23	6.78	Y	HP	RSP	NS	W

Appendix 1 cont.

Species	Control germination (%)	Smoke germination (%)	Seed mass (mg)	SR	GF	RS	SS	DM
Chrysocoma coma-aurea	10	10	0.32	N	WP	RSD	NS	W
Corymbium glabrum var. *glabrum*	3	5	6.35	Y	WP	RSP	NS	W
Corymbium laxum subsp. *bolusii*	14	22	6.45	Y	WP	RSP	NS	W
Cotula turbinata	57	55	–	N	A	RSD	NS	W
Dimorphotheca nudicaulis	96±6	78±10	–	N	HP	RSP	NS	W
Edmondia sesamoides	11±1	98±1	0.20	Y	WP	RSD	NS	W
Eriocephalus africanus	GPNG	GPNG	18.18	Y	WP	RSD	NS	W
Euryops linearis	31	73	1.17	Y	WP	RSD	NS	W
Euryops speciosissimus	24	64	7.20	Y	WP	RSD	NS	W
Euryops virgineus	6	31	1.08	Y	WP	RSD	NS	W
Euryops virgineus	13	15	–	N	WP	RSD	NS	W
Felicia aethiopica subsp. *aethiopica*	18	30	0.65	N	HP	RSD	NS	W
Felicia heterophylla	22	46	1.72	Y	A	RSD	NS	W
Helichrysum foetidum	12±1	64±1	0.03	Y	HP	RSD	NS	W
Helichrysum patulum	24±1	98±1	0.10	Y	WP	RSD	NS	W
Helichrysum tinctum	GPNG	GPNG	–	Y	HP	RSD	NS	W
Hirpicium alienatum	54	72	–	N	WP	RSD	NS	W
Hymenolepis parviflora	34	32	2.47	N	WP	RSD	NS	W
Metalasia densa	1±1	14±3	–	Y	WP	RSD	NS	W
Metalasia muricata	3	2	0.26	N	WP	RSD	NS	W
Oedera capensis	47	48	0.47	N	WP	RSP	NS	W
Oedera capensis	5	20	–	N	WP	RSP	NS	W
Oncosiphon grandiflorum	47	45	–	N	A	RSD		W
Oncosiphon suffruticosum	46	45	–	N	A	RSD	NS	W
Osteospermum fruiticosum (Syn. *Dimorphotheca fruiticosa*)	31	36	–	N	HP	RSP	NS	W
Othonna bulbosa	GPNG	GPNG	–	N	G	RSD	NS	W
Othonna parviflora	GPNG	GPNG	–	Y	WP	RSD	NS	W
Othonna quinquedentata	44±7	63±7	–	Y	WP	RSD	NS	W
Phaenocoma prolifera	59±3	97±1	1.96	Y	WP	RSD	NS	W
Plectostachys serphyllifolia	13	10	0.04	N	HP	RSD	NS	W
Senecio halimifolius	37	34	0.22	N	WP	RSD	NS	W
Senecio pinifolius	30	25	3.33	N	HP	RSP	NS	W
Senecio rigidus	80	90	–	Y	WP	RSD	NS	W
Senecio umbellatus	56±19	79±6	0.27	Y	HP	RSD	NS	W
Senecio umbellatus	99	99	–	N	HP	RSD	NS	W
Syncarpha eximia	96±2	92±2	–	N	WP	RSD	NS	W
Syncarpha speciosissima	17±3	30±1	8.20	Y	WP	RSD	NS	W
Syncarpha vestita	6±4	88±5	0.55	Y	HP	RSD	NS	W
Trypteris sinuata	64	56	–	N	WP	RSD	NS	W
Ursinia paleacea	GPNG	GPNG	0.56	Y	WP	RSD	NS	W
Ursinia sericea	15	16	1.30	N	HP	RSP	NS	W
Ursinia tenuifolia	67	64	0.54	N	HP	RSD	NS	W
Brassicaceae								
Heliophila coronopifolia	92	93	0.66	N	A	RSP	NS	W
Heliophila macowaniana	GPNG	GPNG	–	N	A	RSD	NS	P
Heliophila pinnata	68	62	–	N	A	RSD	NS	P
Heliophila sp.	GPNG	GPNG	–	Y	A	RSD	NS	P
Bruniaceae								
Audouinia capitata	4	14	–	Y	WP	RSD	NS	A
Berzelia lanuginosa	2±1	6±2	0.52	N	WP	RSP	S	W
Brunia albiflora	1	9	5.88	Y	WP	RSD	S	W
Brunia laevis	1	6	3.12	Y	WP	RSD	NS	W
Campanulaceae								
Cyphia incisa	GPNG	GPNG	–	N	HP	RSD	NS	P
Lobelia coronopifolia	1	5	0.38	Y	HP	RSP	NS	P
Lobelia linearis	2	8	–	Y	WP	RSP	NS	P
Lobelia sp.	0	9	0.11	Y	HP	RSP	NS	P
Monopsis lutea	10	35	0.10	Y	HP	RSD	NS	P
Roella ciliata	32	92	0.15	Y	WP	RSP	NS	P
Roella triflora	5	50	0.18	Y	WP	RSP	NS	P
Wahlenbergia cernua	0	45±6	–	Y	A	RSD	NS	P
Caryophyllaceae								
Dianthus sp.	GPNG	GPNG	–	N	HP	RSD/RSP	NS	P

Appendix 1 cont.

Species	Control germination (%)	Smoke germination (%)	Seed mass (mg)	SR	GF	RS	SS	DM
Silene cretica	2±1	15±2	1.00	Y	A	S	NS	P
Crassulaceae								
Crassula capensis	GPNG	GPNG	–	Y	HP	RSD	NS	W
Crassula coccinea	27	28	0.03	N	HP	RSD	NS	P
Dipsacaceae								
Scabiosa africana	14	10	–	N	HP	RSP	NS	W
Ebenaceae								
Diospyros glabra	60	60	–	N	WP	RSP	NS	P
Ericaceae								
Erica baccans	9	37	0.08	Y	WP	RSD	NS	W
Erica brachialis	1 072±296g^{-1}	1 226±236g^{-1}	0.10	N	WP	RSD	NS	W
Erica caffra	GPNG	GPNG	0.014	Y	WP	RSD	NS	W
Erica canaliculata	528±280g^{-1}	3 540±860g^{-1}	–	Y	WP	RSD	NS	W
Erica capensis	56±16g^{-1}	104±26g^{-1}	–	Y	WP	RSD	NS	W
Erica capitata	1 968±780g^{-1}	3 100±800g^{-1}	–	N	WP	RSD	NS	W
Erica cerinthoides	500±370g^{-1}	1 400±960g^{-1}	0.10	N	WP	RSP	NS	W
Erica clavisepala	4±9g^{-1}	324±110g^{-1}	–	Y	WP	RSD	NS	W
Erica cruenta	4 260±700g^{-1}	4 380±1 100g^{-1}	0.03	N	WP	RSD/RSP	NS	W
Erica curvirostris	470±132g^{-1}	990±313g^{-1}	0.03	Y	WP	RSD	NS	W
Erica deflexa	168±48g^{-1}	266±66g^{-1}	–	Y	WP	RSP	NS	W
Erica diaphana	GPNG	GPNG	0.15	Y	WP	RSD/RSP	NS	W
Erica discolor	2.2±0.7 (162±48g^{-1})	3.6±0.7 (266±49g^{-1})	0.14	Y	WP	RSP	NS	W
Erica ericoides	1 552±220g^{-1}	2 524±320g^{-1}	–	Y	WP	S	NS	W
Erica formosa	3.8±1.3 (1 928±671g^{-1})	8.6±0.7 (4 374±336g^{-1})	0.02	Y	WP	RSD	NS	W
Erica gallorum	8±8g^{-1}	18±11g^{-1}	–	N	WP	RSD	NS	W
Erica glauca var. *elegans*	9.7±5.8 (640±380g^{-1})	20.6±9.4 (1 360±620g^{-1})	0.15	N	WP	RSD	NS	W
Erica glauca var. *glauca*	0.16±0.1 (14±9g^{-1})	11.8±2.0 (1 060±180g^{-1})	0.11	Y	WP	RSD	NS	W
Erica glomiflora	0.15±0.1 (734±185g^{-1})	2.6±0.4 (1 765±200g^{-1})	0.06	Y	WP	RSD	NS	W
Erica grata	404±76g^{-1}	4 250±680g^{-1}	–	Y	WP	RSD	NS	W
Erica halicacaba	3 100±620g^{-1}	2 750±1170g^{-1}	–	N	WP	RSD	NS	W
Erica hebecalyx	1 370±75g^{-1}	2 410±461g^{-1}	0.09	Y	WP	RSD	NS	W
Erica hirtiflora	GPNG	GPNG	0.02	Y	WP	RSD	NS	W
Erica junonia var. *minor*	6±5g^{-1}	10±7g^{-1}	0.05	N	WP	RSD	NS	W
Erica lateralis	1.7±0.3 (698±111g^{-1})	10.8±3.4 (4 330±1 360g^{-1})	0.025	Y	WP	RSD	NS	W
Erica leptopus	GPNG	GPNG	–	N	WP	RSD	NS	W
Erica longifolia	350±105g^{-1}	2 580±400g^{-1}	0.10	N	WP	RSD	NS	W
Erica nudiflora	2±4g^{-1}	20±10g^{-1}	–	Y	WP	RSD	NS	W
Erica oatesii	408±256g^{-1}	1 604 928g^{-1}	–	Y	WP	RSD	NS	W
Erica oblongiflora	131±40g^{-1}	196±86g^{-1}	–	N	WP	RSD	NS	W
Erica patersonii	88±4g^{-1}	86±5g^{-1}	0.13	N	WP	RSD	NS	W
Erica perlata	(10 800±4 580g^{-1})	33 940±5 440g^{-1}	–	Y	WP	RSD	NS	W
Erica peziza	2 108±433g^{-1}	2 480±748g^{-1}	0.025	N	WP	RSD	NS	W
Erica phylicifolia	26±9g^{-1}	296±18g^{-1}	–	Y	WP	RSD	NS	W
Erica pillansii	22±15g^{-1}	16±6g^{-1}	0.04	N	WP	RSD	NS	W
Erica pinea	3.1±0.8 (184±47g^{-1})	6.5±1.7 (390±102g^{-1})	0.17	Y	WP	RSD	NS	W
Erica plukenettii	18±15g^{-1}	316±81g^{-1}	0.07	Y	WP	RSD/RSP	NS	W
Erica recta	124±120g^{-1}	250±60g^{-1}	–	N	WP	RSP	NS	W
Erica sessiliflora	39.0	72.0	0.19	Y	WP	RSD	S	W
Erica simulans	26±11g^{-1}	54±18g^{-1}	–	Y	WP	RSD	NS	W
Erica sitiens	0.9±0.6 (140±90g^{-1})	6.5±1.6 (1 040±260g^{-1})	0.06	Y	WP	RSD	NS	W
Erica spectabilis	1 120±80g^{-1}	2 060±304g^{-1}	0.06	Y	WP	RSD	NS	W
Erica sphaeroidea	0.9±0.3 (34±11g^{-1})	11.3±6.6 (428±250g^{-1})	–	Y	WP	RSP	NS	W
Erica taxifolia	110±46g^{-1}	180±38g^{-1}	0.06	Y	WP	RSD	NS	W
Erica thomae	298g^{-1}	1326g^{-1}	–	Y	WP	RSD	NS	W
Erica tumida	2g^{-1}	20g^{-1}	0.09	Y	WP	RSD	NS	W

Appendix 1 cont.

Species	Control germination (%)	Smoke germination (%)	Seed mass (mg)	SR	GF	RS	SS	DM
Erica turgida	20g^{-1}	28g^{-1}	–	N	WP	RSD	NS	W
Erica verecunda	9 580g^{-1}	5 900g^{-1}	0.01	N	WP	RSD	NS	W
Erica versicolor	1	3	0.09	Y	WP	RSD	NS	W
Erica vestita	300g^{-1}	800g^{-1}	0.08	Y	WP	RSD	NS	W
Fabaceae								
Cyclopia intermedia	GPNG	GPNG	–	Y	WP	RSP	NS	A
Indigofera filifolia	3	1	10.0	N	WP	RSP	NS	P
Otholobium fruticans	23	24	–	N	WP	RSP	NS	P
Otholobium fruticans	4	65	3.44	Y	WP	RSP	NS	P
Podalyria calyptrata	3	3	27.03	N	WP	RSD	NS	A
Podalyria sericea	5	12	25.00	N	WP	RSD	NS	A
Psoralea pinnata	10	12	8.13	N	WP	RSD	NS	P
Virgilia divaricata	3	5	62.5	N	WP	RSD	NS	P
Gentianaceae								
Chironia linoides subsp. *emarginata*	8	11	0.02	N	WP	RSD	NS	P
Geraniaceae								
Pelargonium auritum	80	84	–	N	G	RSP	NS	W
Pelargonium capitatum	8	8	4.27	N	WP	RSD	NS	W
Pelargonium crithmifolium	40	80		Y	HP	RSD	NS	W
Pelargonium cucullatum	4	4	4.44	N	WP	RSD/RSP	NS	W
Pelargonium peltatum	4	4	12.50	N	HP	RSD	NS	W
Pelargonium quercifolium	4	4	4.76	N	WP	RSD/RSP	NS	W
Pelargonium sp.	GPNG	GPNG	–	N	HP	RSD	NS	W
Pelargonium suburbanum	16	16	9.09	N	WP	RSD	NS	W
Mesembryanthemaceae								
Amphibolia hutchinsonii	2±3	27±7	–	Y	WP	RSD	NS	H
Carpanthea pomeridiana	13±13	10±7	1.22	N	A	RSD	NS	H
Caryotophora skiatophytoides	13±6	15±5	9.20	N	HP	RSD	NS	P
Conicosia pugioniformis	10±6	19±4	0.61	N	HP	RSD	NS	W
Drosanthemum bellum	27	30	0.11	N	WP	RSD	NS	H
Drosanthemum bicolor	29	30	0.07	N	WP	RSD	NS	H
Drosanthemum speciosum	2±3	48±16	0.08	Y	WP	RSD	NS	H
Drosanthemum stokoei	75±10	77±8	0.13	N	WP	RSD	NS	H
Drosanthemum thudichumii	10g^{-1}	1 000g^{-1}	–	Y	WP	RSD	NS	H
Erepsia anceps	1±2	10±4	–	Y	WP	RSD	NS	H
Erepsia aspera	4±2	11±7	0.61	N	WP	RSD	NS	H
Lampranthus aureus	2±3	19±7	0.29	Y	WP	RSD	NS	H
Lampranthus bicolor	2±3	4±2	–	N	WP	RSD	NS	H
Lampranthus haworthii	3±3	10±5	1.11	Y	WP	RSD	NS	H
Lampranthus multiradiatus	0	21±10	0.32	Y	WP	RSD	NS	H
Leipoldtia schultzei	91	92	–	N	WP	RSD	NS	H
Oscularia deltoides	10±8	17±9	0.14	N	WP	RSD	NS	H
Ruschia carolii	7±6	70±7	0.46	Y	WP	RSD	NS	H
Ruschia macowanii	43±17	49±12	0.26	N	WP	RSD	NS	H
Ruschia multiflora	5±7	23±9	0.76	Y	WP	RSD	NS	H
Molluginaceae								
Pharnaceum elongatum	0	47	–	Y	WP	RSP	NS	P
Montinaceae								
Montinia caryophyllacea	GPNG	GPNG	–	N	WP	RSD/ RSP	NS	P
Penaeaceae								
Endonema retzioides	36	86	–	Y	WP	RSP	NS	A
Penaea sp.	4±3	28±8	0.60	Y	WP	RSP	NS	P
Proteaceae								
Aulax cancellata	22±6	40±5	37.00	N	WP	RSD	S	W
Aulax umbellata	43	45	33.33	N	WP	RSD	S	W
Leucadendron coniferum	79	98	10.53	Y	WP	RSD	S	W
Leucadendron daphnoides	10	14	200.00	N	WP	RSD	NS	P
Leucadendron gandogeri	87	93	20.00	N	WP	RSD	S	W
Leucadendron laureolum	60	27	22.20	N	WP	RSD	S	W
Leucadendron linifolium	28	33	11.74	N	WP	RSD	S	W

Appendix 1 cont.

Species	Control germination (%)	Smoke germination (%)	Seed mass (mg)	SR	GF	RS	SS	DM
Leucadendron rubrum	20	61	24.84	Y	WP	RSD	S	W
Leucadendron salicifolium	96±2	94±2	20.00	N	WP	RSD	S	W
Leucadendron salignum	47	75	9.09	Y	WP	RSP	S	W
Leucadendron sessile	76	71	200.00	N	WP	RSD	NS	W/P
Leucadendron tinctum	21	83	250.00	Y	WP	RSD	NS	P
Leucadendron xanthoconus	81	86	11.93	N	WP	RSD	S	W
Leucospermum cordifolium	76	54	100.00	N	WP	RSD	NS	A
Leucospermum conocarpodendron	11	9	100.00	N	WP	RSD	NS	A
Leucospermum glabrum	21	22	111.10	N	WP	RSD	NS	A
Leucospermum praecox	5	2	76.92	N	WP	RSD	NS	A
Leucospermum prostratum	4	21	24.30	Y	WP	RSP	NS	A
Mimetes argenteus	6	6	28.57	N	WP	RSD	NS	W/P
Mimetes cucullatus	4	5	37.03	N	WP	RSD	NS	W/P
Protea acuminata	14	17	13.50	N	WP	RSD	S	W/P
Protea compacta	68±5	88±4	90.90	Y	WP	RSD	S	W
Protea cordata	68	74	26.30	Y	WP	RSD	S	W/P
Protea cynaroides	44	41	33.33	N	WP	RSD	S	W/P
Protea eximia	82	83	37.03	N	WP	RSD	S	W/P
Protea magnifica	64±2	76±8	229.1	N	WP	RSD	S	W
Protea longifolia	18	22	52.63	N	WP	RSD	S	W/P
Protea punctata	18	12	14.29	N	WP	RSD	S	W/P
Protea repens	36	26	90.90	N	WP	RSD	S	W/P
Serruria florida	17±6	20±1	–	N	WP	RSD	NS	A
Serruria phylicoides	3±1	23±3	12.00	Y	WP	RSD	NS	A
Serruria villosa	1	8	12.66	Y	WP	RSD	NS	A
Rhamnaceae								
Phylica ericoides	8±2	9±4	–	N	WP	RSD	NS	A
Phylica pubescens	28±12	24±11	19.23	N	WP	RSD	NS	A
Rosaceae								
Cliffortia ruscifolia	0	28±2	–	Y	WP	RSD	NS	P
Rubiaceae								
Anthospermum spathulatum	GPNG	GPNG	–	N	WP	RSD	NS	P
Rutaceae								
Agathosma tabularis	8	11	1.56	N	WP	RSD	NS	A
Scrophulariaceae								
Chenopodiopsis chenopodiodes	GPNG	GPNG	–	Y	A	RSD	NS	P
Chenopodiopsis hirta	GPNG	GPNG	–	Y	A	RSD	NS	P
Dischisma capitatum	8±4	20±2	–	Y	A	RSD	NS	P
Hebenstreitia paarlensis	GPNG	GPNG	–	Y	HP	RSD	NS	P
Manulea cheiranthus	2±1	32±4	–	Y	A	RSD	NS	P
Nemesia lucida	12±4	24±6	–	Y	A	RSD	NS	W
Nemesia versicolor	GPNG	GPNG	–	Y	A	RSD	NS	W
Selago sp.	GPNG	GPNG	0.10	Y	A	RSD	NS	P
Zaluzianskya villosa	1	23	0.05	Y	A	RSD	NS	P
Sterculiaceae								
Hermannia alnifolia	0	1	–	N	WP	RSP	NS	P
Hermannia hyssopifolia	2±1	0	–	N	WP	RSP	NS	P
Hermannia rudis	2±1	2±1	–	N	WP	RSP	NS	P
Hermannia scabra	GPNG	GPNG	–	N	WP	RSD	NS	P
Hermannia sp.	GPNG	GPNG	0.96	N	WP	RSD	NS	P
Stilbaceae								
Stilbe vestita	1	3	1.41	Y	WP	RSP	NS	P
Thymelaeaceae								
Passerina vulgaris	GPNG	GPNG	0.51	Y	WP	RSD	NS	P