CSIRO PUBLISHING

Australian Systematic Botany, 2019, **32**, 519–546
https://doi.org/10.1071/SB19028

The diversity and multiple uses of southern African legumes

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Abstract. Southern Africa has a rich legume flora comprising 133 indigenous genera and 1620 indigenous species, of which 1059 species (65%) are endemic to the flora of southern Africa region. An additional 128 non-indigenous species have become naturalised, of which 59 are invasive, resulting in 1748 species from 165 genera. There are 22 (17%) endemic genera, one endemic tribe (Hypocalyptieae) and one near-endemic tribe (Podalyrieae, with 122 of the 123 species endemic). The diversity of uses (given as total/indigenous spp.) include food and beverages (127/115 spp.), medicine (338/291 spp.), magic and charms (113/104 spp.), timber (59/55 spp.), firewood (43/31 spp.) and 10 more minor use categories. Regression analyses showed that the levels of endemism in subfamilies and tribes are directly related to the numbers of species but that the number of useful species is not related to species numbers, except for the non-papilionoid subfamilies (all uses) and non-genistoid papilionoids (medicinal uses only). The Phaseoleae and Millettieae showed high residual values in several analyses, indicating that they have been favoured in the selection of useful plants. Diversity in habit and chemistry seems to explain at least partly the use patterns.

Additional keywords: commercial legumes, endemism, Fabaceae, genistoid legumes, least-square regression analysis, Leguminosae, ornamental legumes, pasture legumes, flora of southern Africa.

Received 3 April 2019, accepted 13 August 2019, published online 1 October 2019

Introduction

The Leguminosae (Fabaceae) are well known as one of the most important plant families in terms of the numbers of species that are used, not only as sources of food and medicine for humans and animals, but also sources of other material such as timbers, fuels, tans, dyes, fibres, gums and insecticides (Lewis *et al*. 2005). The success of the family in dominating many inhospitable and disturbed habitats has been ascribed to the ability to fix atmospheric nitrogen, thus allowing the plants to grow in nutrient-poor soils (Sprent 2001; Sprent *et al*. 2017). In southern Africa, legumes feature prominently among the ~700 indigenous and naturalised plant species highlighted by Van Wyk and Gericke (2018) for their exceptional utility value in traditional and contemporary uses (including commercial uses) by all the diverse cultural groups of the region. Only indigenous and naturalised non-indigenous legume species (i.e. only those that form part of the flora of the region) are included in this paper.

In a recent inventory of the food plants of southern Africa, Welcome and Van Wyk (2019) found that the Apocynaceae had the highest number of edible species (137), closely followed by the Fabaceae, with 135 species. On the basis of the data in Peters *et al*. (1992), it was shown that the Fabaceae are the most diverse food-plant family in sub-Saharan Africa, with 175 edible species, followed by the Apocynaceae, with 108 species. At a global level, using the data in Van Wyk (2005) and Wiersema and León (2016), the Fabaceae were shown to have the highest species diversity of commercialised food plants, exceeding the Rosaceae and Poaceae.

The medicinal plants of southern Africa have been relatively well recorded, with a detailed inventory of ethnomedicinal taxa for the flora of southern Africa (FSA) region published by Arnold *et al*. (2002). This dataset was used for regression analyses by Douwes *et al*. (2008), in which the Fabaceae were found to be second only to the Asteraceae in terms of the numbers of ethnomedicinal taxa (369 of 2422 taxa *v*. 387 of 2681 taxa). The Apocynaceae turned out to be less important, with 127 medicinal taxa of 853 taxa. The conclusion was that Fabaceae and other families with high residuals were selected because of their high diversity of bioactive chemical compounds. In a regression analysis of medicinal taxa of southern Africa by Yessoufou *et al*. (2015), the Fabaceae had the highest residual value of +97.6 taxa (i.e. the 369 actual ethnomedicinal taxa exceeded the predicted number of 271.4 by 97.6 taxa).

The patterns of diversity, endemism and indigenous use of the legumes are explored in this paper. How many indigenous and naturalised species are used as sources of food, medicine, timber, firewood and various other practical human uses? Using least-square regression analysis, attempts were made to find possible relationships among the total numbers of indigenous species, levels of endemism and patterns of use. Is endemism directly related to diversity? Are some taxonomic groups (subfamilies, tribes and genera) preferred above others in terms of their use as

food or medicine? Does the selection of edible and medicinal species in the Cape Floristic Region with its very high levels of endemism, especially in genistoid legumes, differ from other legumes in the FSA region? Are trees preferentially selected or does their apparent popularity simply reflect the higher diversity of plant parts that can be used (roots, bark, bark exudates, wood, stems, leaves, flowers, fruits and seeds)? Can southern African legumes provide insights into the reasons why the family occupies such a prominent position as a source of traditional and commercial products?

Materials and methods

The newposa database of all indigenous and naturalised vascular plants (botanical database database of southern Africa (BODATSA), South African National Biodiversity Institute, see http://www.http://newposa.sanbi.org/, accessed 4 February 2019) was used as a starting point to compile an inventory of all southern African legumes and to record the levels of endemism. Naturalised species are non-indigenous (exotic, alien) plants that became established as reproductive populations and, thus, part of the flora. Data for southern Africa medicinal and magical or charm plants came from Arnold *et al*. (2002), which was updated to include newly recorded species. The recent inventory of food plants by Welcome and Van Wyk (2019) was used for edible plants and all food-related uses, except that cultivated species (those that are not naturalised, and, therefore, not part of the FSA flora) were excluded. All food uses and medicinal uses and various other uses were recorded at species level only (infraspecific taxa were reduced to species level), as shown in Appendix 1, and summarised in Table 1. To avoid duplication and to simplify the analyses and presentation of data, the species is used as the basic classification unit throughout. Various other uses (for timber, firewood, dyes, tans, soap substitutes, adhesives, cordages, beads, weaving and basketry, dental care, fish poisons, ornamentals and pasture or cover crops) were taken from Van Wyk and Gericke (2000, 2018) and some other literature sources as cited in the text below. Unlike food plants, medicinal plants and magical or charm plants, the numbers of 'other uses' (analysed collectively) potentially exceed the number of species because the same species is often recorded under several different 'other' uses.

The classification of genera follows the subfamilial system proposed by Legume Phylogeny Working Group (2017). Tribal delimitations and associated nomenclature have not yet reached stability, so that the tribal classification system used by Lewis *et al*. (2005) is followed, but with some modifications to more accurately reflect current taxonomic and phylogenetic concepts. Levels of endemism include newly describes species, which is particularly relevant because of ongoing taxonomic studies in the genera *Aspalathus* (Stirton and Muasya 2016), *Otholobium* (Stirton and Muasya 2017), *Psoralea* (Bello *et al*. 2017; Stirton *et al*. 2018) and *Rhynchosia* (Ajao *et al*. 2018).

Least-square regression analyses were performed in Microsoft Excel. For food plants, medicinal plants and magic or charm plants, the numbers of species were analysed, whereas for all other uses, the combined number of uses was analysed. The numbers of species per subfamily or tribe were used as the independent variables and the number of endemic species, or the number of species with recorded uses, as dependent variable. Five separate analyses were performed for each variable studied, namely of all groups of indigenous legumes, all non-papilionoid legumes (i.e. all basally divergent subfamilies), all papilionoid legumes, all genistoid legumes and all non-genistoid (papilionoid) legumes.

Results

A summary of the diversity and endemism of southern African legumes is presented in Table 1, together with an indication of the numbers of species that have been recorded as having value as food, medicine and charm plants, or as sources of material for crafts and other practical and ornamental uses. These data have been subjected to a series of regression analyses to explore relationships between the total numbers of species and the numbers of endemic and useful species. The regression analyses and association statistics that were performed are listed in Table 2. Examples of southern African legumes are depicted in Fig. 1–3, representing the three major groups of legumes that were subjected to regression analyses, namely the non-papilionoid group (Fig. 1), the genistoid group (Fig. 2) and the non-genistoid group (Fig. 3). The non-papilionoid group (Fig. 1) is represented by a selection of species from the basally divergent subfamilies, namely, the Cercidoideae, Detarioideae, Dialioideae and Caesalpinioideae. Examples of genistoid legumes (Fig. 2) include taxa from tribes Swartzieae, Sophoreae, Podalyrieae, Crotalarieae and Genisteae, whereas the non-genistoid group (Fig. 3) includes representatives from tribes Dalbergieae, Indigoferae, Hypocalypteae, Millettieae, Abrieae, Psoraleeae, Phaseoleae, Galegeae and Trifolieae. The main results are summarised in Fig. 4–6 and discussed below.

Discussion

Diversity and endemism

A summary of the diversity and endemism of southern African legumes is shown in Fig. 4. There are 165 genera of southern African legumes, of which 133 are indigenous and 32 non-indigenous and naturalised. The total number of indigenous and naturalised species add up to 1748, of which 1620 are indigenous and 128 naturalised exotics (i.e. non-indigenous species that have become part of the flora). There are 22 endemic genera and 1059 endemic species, representing 61% of all southern African legumes and 65% of the indigenous species. Endemism is mainly concentrated in the genistoid legumes, with 515 endemics of 573 indigenous species in Crotalarieae, 122 of 123 in Podalyrieae and 62 of 83 in Genisteae. Non-genistoid tribes with high levels of endemism include the traditional tribe Psoraleeae (84 of 97 species) and Galegeae (51 of 57 species). The Hypocalypteae is the only tribe confined to southern Africa, with all three species being endemic to the Cape flora (all three species are shown in Fig. 3). According to molecular-systematic studies, these plants have their closest relatives among the Australian tribes Mirbelieae and Bossiaeeae (Crisp *et al*. 2000) and the Baphioid clade of Sophoreae (Kajita *et al*. 2001). Wojciechowski *et al*. (2004) found only moderate support for a sister-group relationship between *Hypocalyptus* and the Mirbelieae–Bossiaeeae. Bark and wood anatomical characters, notably the presence of tanniniferous tubes in the

Table 1. List of all legume genera of the flora of southern Africa (FSA) region, showing the total numbers of indigenous, naturalised and endemic species and the numbers of utilised species for 15 categories of use

Naturalised exotics are indicated with an asterisk (*)

Taxon	Number of species	FSA species	FSA indigenous	FSA endemics	Naturalised	Food and drink	Medicine	Magic and charm	Timber	Firewood	Dyes, tans	Soap substitutes	Adhesives	Cordage	Beads	Weaving	Dental care	Fish poisons	Ornamentals	Pastures
Cercidoideae																				
Adenolobus	2	2	2	1																
Bauhinia	160	9	6	2	3	1	5		1							2			5	
Piliostigma	3	1	1	0		1	1	1	1	1	1	1		1						
Tylosema	5	2	2	1		2	1								2					
Detarioideae																				
Afzelia	11	1	1	0		1	1	1	1	1					1					
Baikiaea	6	1	1	0			1		1		1									
Brachystegia	26	1	1	0																
Colophospermum	1	1	1	0			1	1	1	1							1			
Guibourtia	14	2	2	0		1	1		1	1										
Julbernardia	11	1	1	0																
Schotia	4	4	4	2		3	3	2	1	2	1								1	
*Tamarindus**	1	1	0	0	1	1	1	1											1	
Dialioideae																				
Dialium	28	2	2	1		2	2		2						1					
Caesalpinioideae																				
Umtiza clade																				
*Acrocarpus**	1	1	0		1														1	
*Ceratonia**	2	1	0	0	1	1													1	
*Gleditsia**	16	1	0	0	1	1	1												1	
Umtiza	1	1	1	1			1	1	1											
Tribe Cassieae																				
Cassia	30	1	1	0			1	1												
Chamaecrista	330	12	12	0		2	6	3												
Senna	300	16	3	0	13	3	12	3											13	
Caesalpinia group																				
Biancaea	6	1	1	0		1	1	1			1	1	1						1	
Burkea	1	1	1	0		1	1		1	1	1									
*Caesalpinia**	9	1	0	0	1	1	1												1	
Erythrophleum	10	2	2	0		0	1	1	2	1										
Gelrebia	8	4	4	3																
Guilandina	19	1	1	0			1	1							1					
Haematoxylum	5	1	1	1																
Hererolandia	1	1	1	1																
Pomaria	16	3	3	3		1	2	1												
Pterolobium	10	1	1	0			1													
Peltophorum group																				
Parkinsonia	12	2	1	1	1	1	2	1	1										1	
Peltophorum	7	1	1	0		1	1	1	1	1				1					1	
Tribe Mimoseae																				
Adenopodia	7	1	1	1			1	1												
Amblygonocarpus	1	1	1	0					1											
*Desmanthus**	24	1	0	0	1															1
Dichrostachys	14	1	1	0		1	1	1	1	1				1						
Elephanthorrhiza	9	9	9	5		1	5	1		1	3				1					
Entada	28	3	3	0			2	1						1	2					
*Leucaena**	22	1	0	0	1		1	1		1									1	1
*Mimosa**	510	2	0	0	2		2	1											1	
Neptunia	12	1	1	0		1														
Newtonia	15	1	1	0			1	1												
*Prosopis**	44	4	0	0	4	1	1			4									1	4

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Table 1. (*continued*)

Taxon	Number of species	FSA species	FSA indigenous	FSA endemics	Naturalised	Food and drink	Medicine	Magic and charm	Timber	Firewood	Dyes, tans	Soap substitutes	Adhesives	Cordage	Beads	Weaving	Dental care	Fish poisons	Ornamentals	Pastures
Xerocladia	1	1	1	1																
Xylia	9	1	1	0																
Tribe Ingeae																				
Afrocalliandra	2	1	1	1																
Albizia	120	14	11	1	3	3	12	5	3	2		1		2					1	
Faidherbia	1	1	1	0		1	1	1	1	1							1		1	
*Paraserianthes**	1	1	0	0	1		1			1									1	
Senegalia	207	17	17	5		8	12	5	6	6	1		1	3		1	1		1	
Vachellia	161	34	32	6	2	12	14	7	7	7	4			8	2				3	
Tribe Acacieae																				
*Acacia**	987	17	0	0	17		4		2	5	3								17	
Papilionoideae																				
Tribe Swartzieae																				
Bobgunnia	2	1	1	0			1		1	1			1							
Cordyla	7	1	1	0		1	1	1												
Tribe Sophoreae																				
Baphia	47	2	2	1		1	2		1			1				1	1			
Bolusanthus	1	1	1	0			1		1										1	
Sophora	50	1	1	0																
*Styphnolobium**	1	1	0	0	1		1												1	
Xanthocercis	3	1	1	0		1	1		1											
Tribe Podalyrieae																				
Amphithalea	42	42	42	42																
Calpurnia	7	6	6	5			4												1	
Cyclopia	23	23	23	23		11	10													
Liparia	20	20	20	20																
Podalyria	17	17	17	17															2	
Stirtonanthus	3	3	3	3																
Virgilia	2	2	2	2		2			2										2	
Xiphotheca	10	10	10	10																
Tribe Crotalarieae																				
Aspalathus	292	292	292	292		6	4	2								1				
Bolusia	7	2	2	0																
Calobota	16	15	15	15			1	1		1										
Crotalaria	702	65	62	26	3	1	8	3											3	1
Euchlora	1	1	1	1						1										
Ezoloba	1	1	1	1																
Lebeckia	14	14	14	14																
Leobordea	51	44	44	27			6	3					1							
Listia	7	6	6	5																1
Lotononis	91	88	88	87			3	1												
Pearsonia	13	9	9	9																
Rafnia	20	20	20	20		4	2													
Rothia	2	1	1	0																
Wiborgia	10	10	10	10																
Wiborgiella	8	8	8	8																
Tribe Genisteae																				
Argyrolobium	80	54	54	33		5	7	4												
*Cytisus**	65	2	0	0	2		1												2	1
Dichilus	5	5	5	5			1	1												
*Genista**	90	1	0	0	1														1	
*Lupinus**	230	4	0	0	4															4
Melolobium	15	15	15	15			3	2												
Oberholzeria	1	1	1	1																
Polhillia	8	8	8	8																

(*continued next page*)

Table 1. (*continued*)

Taxon	Number of species	FSA species	FSA indigenous	FSA endemics	Naturalised	Food and drink	Medicine	Magic and charm	Timber	Firewood	Dyes, tans	Soap substitutes	Adhesives	Cordage	Beads	Weaving	Dental care	Fish poisons	Ornamentals	Pastures
*Spartium**	1	1	0	0	1														1	
*Ulex**	1	1	0	0	1														1	
Tribe Dalbergieae																				
Aeschynomene	180	10	10	0																
*Arachis**	69	1	0	0	1	1	1													
Dalbergia	250	6	5	2	1		5	3	4					1		1			1	
Kotschya	31	2	2	0																
Ormocarpum	18	2	2	0		1	2	2												
Pterocarpus	40	3	3	0			3	1	3		1									
Smithia	20	1	1	0																
Stylosanthes	25	1	1	0			1	1												
*Tipuana**	1	1	0	0	1														1	
Zornia	75	4	4	0			3	1												
Tribe Indigoferae																				
Cyamopsis	4	3	2	0	1	1							1							
Indigastrum	8	8	8	0			2	1												
Indigofera	700	206	204	85	2	2	30	7			3						1		1	
Microcharis	36	4	4	0																
Tribe Hypocalypteae																				
Hypocalyptus	3	3	3	3																
Tribe Millettieae																				
Craibia	10	1	1	0					1											
Derris	60	1	1	0			1													
Milletia	150	2	2	1			2	2	2										1	
Mundulea	1	1	1	0			1	1	1									1		
Philenoptera	12	4	4	1		2	4	1	2								1	1		
Ptycholobium	3	3	3	0																
Requienia	3	2	2	0																
Tephrosia	350	52	52	25	1	1	20	3									1	3	1	
Xeroderris	1	1	1	0		1	1		1		1									
Tribe Abrieae																				
Abrus	18	3	3	1			2	2							1					
Tribe Desmodiae																				
Alysicarpus	25	4	4	0			4													
Desmodium	275	14	11	0	1		8	1											1	
*Lespedeza**	35	1	0	0	1															1
Pseudarthria	4	1	1	0			1													
Tribe Psoraleeae																				
Cullen	34	4	4	1		1	1													
Otholobium	61	47	47	41			4	1												
Psoralea	71	46	46	42			4			1										
Tribe Phaseoleae																				
Alistilus	3	1	1	0																
Bolusafra	1	1	1	1																
*Cajanus**	34	1	0	0	1	1	1	1												
Canavalia	60	6	5	0		3	3													
*Clitoria**	62	1	0	0	1		1													1
Decorsea	6	3	3	2			1													
Dipogon	1	1	1	1		1													1	
Dolichos	60	9	9	7		1	1	2						1						
Dumasia	10	1	1	0			1													
Eriosema	150	48	48	21		5	7													
Erythrina	120	12	12	4			6	5	2					1	3				2	
Flemingia	30	1	1	0			1													
Galactia	60	1	1	0																

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Table 1. (*continued*)

Taxon	Number of species	FSA species	FSA indigenous	FSA endemics	Naturalised	Food and drink	Medicine	Magic and charm	Timber	Firewood	Dyes, tans	Soap substitutes	Adhesives	Cordage	Beads	Weaving	Dental care	Fish poisons	Ornamentals	Pastures
Lablab	1	1	1	0	1	1	1	1												1
*Macroptilium**	17	1	0	0	1															1
Macrotyloma	24	6	6	1			1													1
Mucuna	105	3	3	0			3	1												
Neonotonia	2	1	1	0			1													
Neorautanenia	3	2	2	0		1	1	1										1		
Nesphostylis	4	1	1	0																
Ophrestia	1	1	1	0																
Otoptera	2	1	1	0			1													
*Pueraria**	1	1	0	0	1														1	
Rhynchosia	230	69	69	28		3	13	3				1								
Sphenostylis	7	2	2	0		1	2													
Teramnus	9	1	1	0																
Vigna	104	15	15	1		6	3	4												1
Tribe Sesbanieae																				
Sesbania	60	17	14	1	3	3	3	1				1							3	
Tribe Loteae																				
Lotus	125	6	3	0	3		2												1	2
*Ornithopus**	5	3	0	0	3															3
Tribe Robinieae																				
*Robinia**	4	1	0	0	1		1		1	1									1	
Tribe Galegeae																				
Astragalus	2500	2	1	0	1		1													
*Glycyrrhiza**	20	1	0	0	1	1	1													
Lessertia	59	56	56	51		2	9	1											1	
Tribe Hedysareae																				
*Alhagi**	3	1	0	0	1															
Tribe Trifolieae																				
*Medicago**	83	7	0	0	7	1	2	1												6
*Melilotus**	20	3	0	0	3		2													3
Trifolium	250	18	2	2	16	2	4	2												16
Trigonella	55	3	1	0	2		1													2
Tribe Fabeae																				
*Vicia**	20	6	0	0	6															6
*Lathyrus**	160	1	0	0	1														1	
Total number of species		1748	1620	1059	128	127	338	113	59	43	21	6	5	20	14	6	7	6	85	57

bark and wood of *Hypocalyptus* species (Stepanova *et al*. 2013) and in some species of *Daviesia* and *Gastrolobium* of the Mirbelieae–Bossiaeeae (Stepanova *et al*. 2017), but in no other legumes, provide further evidence of a relationship.

At least 128 alien (non-indigenous) species of legumes have become naturalised in southern Africa, representing 7.3% of the total legume flora. The majority of these plants were introduced as ornamental shrubs and trees or as pasture legumes and fodder or cover crops (Glen 2002; Bromilow 2019). Non-indigenous legumes represent a large percentage (28%) of the 465 useful species listed in Appendix 1, not only for pastures or cover crops (91%, 52 of 57 species) and ornamentals (72%, 61 of 85 species), but also for food (nearly 10%, 12 of 127 species), medicine (14%, 47 of 338 species), magic or charms (8%, 9 of 113 species), timber (7%, 4 of 59 species), firewood (28%, 12 of 43 species) and dyes and tans (19%, 4 of 17 species).

Endemism was explored in five regression analyses (Table 2). The results for all subfamilies, tribes and groups showed a strong relationship between the number of species and the number of endemic species, with 92.6% of the variance explained by the species numbers (R^2 = 0.9263, s.e. = 28.4, P < 0.001). Four tribes had residuals exceeding the standard error, namely the Crotalarieae (residual +51, predicted 464, actual 515), Podalyrieae (residual +32, predicted 91, actual 122), Phaseoleae (residual –77, predicted 143, actual 66) and Indigoferae (residual –85, predicted 170, actual 85). This analysis highlighted the dominance of papilionoid legumes in the levels of endemism.

Table 2. Summary of the results of 30 regression analyses performed on five major groups of indigenous southern African legumes
The number of species per subfamily or tribe was the independent variable and the number of endemic species or species with recorded uses the dependent variable. Statistically highly significant results are shown in bold

Major group and use analysed	R^2-value	Standard error	*P*-value	Subfamilies, tribes or supra-generic groups with residuals exceeding the standard error of the regression (predicted, residual, actual)
All groups				
Endemic species	**0.9263**	28.4	<**0.001**	Crotalarieae (464, +51, 515); Podalyrieae (91, +32, 122); Phaseoleae (143, –77, 66); Indigoferae (170, −85, 85)
All uses	0.1474	30.4	<0.053	Ingeae (27, +116, 143); Phaseoleae (40, +60, 100); Crotalarieae (80, –31, 49)
Food uses	0.1867	5.6	<0.028	Ingeae (5, +19, 24); Phaseoleae (7, +15, 22); Podalyrieae (6, +7, 13)
Medicinal uses	0.2835	10.6	<0.005	Phaseoleae (18, +28, 46); Ingeae (11, +27, 38); Millettieae (12, +16, 28); Indigoferae (20, +12, 32); Crotalarieae (39, –17, 22)
Magic and charm uses	0.0234	4.5	<0.015	Ingeae (4, +14, 18); Phaseoleae (6, +11, 17); Dalbergieae (3, +5, 8); Podalyrieae (5, –2, 1)
Other uses	0.0043	12.8	<0.752	Ingeae (8, +55, 63);
Non-papilionoids				
Endemic species	0.7313	2.4	<0.003	Caesalpinia group (4, +4, 8); Cassieae (4, –4, 0)
All uses	**0.962**	8.9	<**0.001**	Detarioideae (22, +9, 31); Mimoseae (40, –10, 30); Cassieae (34, –15, 19)
Food uses	**0.9225**	2	<**0.001**	Mimoseae (7, –4, 3)
Medicinal uses	**0.9914**	1.1	<**0.001**	Caesalpinia group (9, –2, 7)
Magic and charm uses	**0.9717**	1	<**0.001**	Cercidoideae (2, –2, 1)
Other uses	**0.8977**	6.6	<**0.001**	Cassieae (14, –14, 0)
Papilionoids				
Endemic species	**0.9257**	34.8	<**0.001**	Crotalarieae (468, +47, 515); Phaseoleae (143, –77, 66); Indigoferae (170, –85, 85)
All uses	0.3208	22.4	<0.018	Phaseoleae (35, +65, 100); Millettieae (23, +33, 56); Crotalarieae (76, –27, 49)
Food uses	0.3151	5.1	<0.019	Phaseoleae (6, +16, 22); Podalyrieae (5, +8, 13)
Medicinal uses	0.3128	11	<0.020	Phaseoleae (17, +29, 46); Millettieae (11, +17, 28); Indigoferae (19, +13, 32); Crotalarieae (37, –15, 22)
Magic and charm uses	0.3382	4.1	<0.014	Phaseoleae (6, +11, 17); Dalbergieae (3, +5, 8); Podalyrieae (5, –5, 0)
Other uses	0.0817	5.3	<0.266	Millettieae (4, +13, 17); Phaseoleae (5, +10, 15); Dalbergieae (4, +6, 10)
Genistoids				
Endemic species	**0.9983**	10.2	<**0.001**	Podalyrieae (109, +14, 122); Genisteae (73, –11, 62)
All uses	0.8144	8.4	<0.036	Podalyrieae (23, +11, 34)
Food uses	0.4164	4.7	<0.240	Podalyrieae (6, +7, 13)
Medicinal uses	0.8177	4	<0.035	–
Magic and charm uses	0.6279	3.3	<0.110	Genisteae (2, +5, 3)
Other uses	0.0622	3.4	<0.686	Genisteae (4, –4, 0)
Non-genistoids				
Endemic species	**0.7854**	17	<**0.001**	Psoraleeae (43, +40, 83); Galegeae (26, +25, 51)
All uses	0.6129	19.6	<0.003	Phaseoleae (37, +35, 100); Millettieae (28, +28, 56); Psoraleeae (37, –25, 12); Indigoferae (76, –27, 49)
Food uses	0.3917	5	<0.030	Phaseoleae (10, +12, 22); Indigoferae (11, –8, 3)
Medicinal uses	**0.7447**	7.8	<**0.001**	Millettieae (15, +13, 28); Phaseoleae (35, +11, 46); Indigoferae (41, –9, 32); Psoraleeae (20, –11, 9)
Magic and charm uses	0.5287	3.7	<0.007	Phaseoleae (10, +7, 17); Dalbergieae (3, +5, 8); Indigoferae (12, –4, 8); Psoraleeae (6, –5, 1)
Other uses	0.2786	5.6	<0.078	Millettieae (5, +12, 17); Dalbergieae (3, +7, 10)

The new subfamily classification system for legumes (Legume Phylogeny Working Group 2017) recognised the former tribes Cercideae, Detarieae and Dialioideae as subfamilies, and included the former Mimosoideae as a group within a broadened Caesalpinioideae. This non-papilionoid group is represented in Fig. 1 by a selection of species from all four of the basally divergent subfamilies. A regression analysis at a tribal or group level, in which all papilionoid legumes were excluded, gave an R^2-value of 0.7313, a standard error of 2.4 and a *P*-value of <0.001. Only two groups had residuals marginally exceeding the standard error, namely, the *Caesalpinia* group, with residual +4, predicted 4 and actual 8, and the tribe Cassieae, with residual –4, predicted 4 and actual 0).

By far the most diverse group of southern African legumes is the subfamily Papilionoideae, with 17 indigenous tribes, 92 indigenous genera and 1479 indigenous species. Both the diversity and endemism are not evenly distributed among the tribes but, in general, the numbers of endemic species agree closely with the numbers of species in the tribes ($R^2 = 0.9257$, s.e. = 34.8, $P < 0.001$). Three tribes with residuals exceeding the standard error were the Crotalarieae (residual +47, predicted 468, actual 515), the Phaseoleae (residual –77, predicted 143, actual 66) and Indigoferae (residual –85, predicted 170, actual 85).

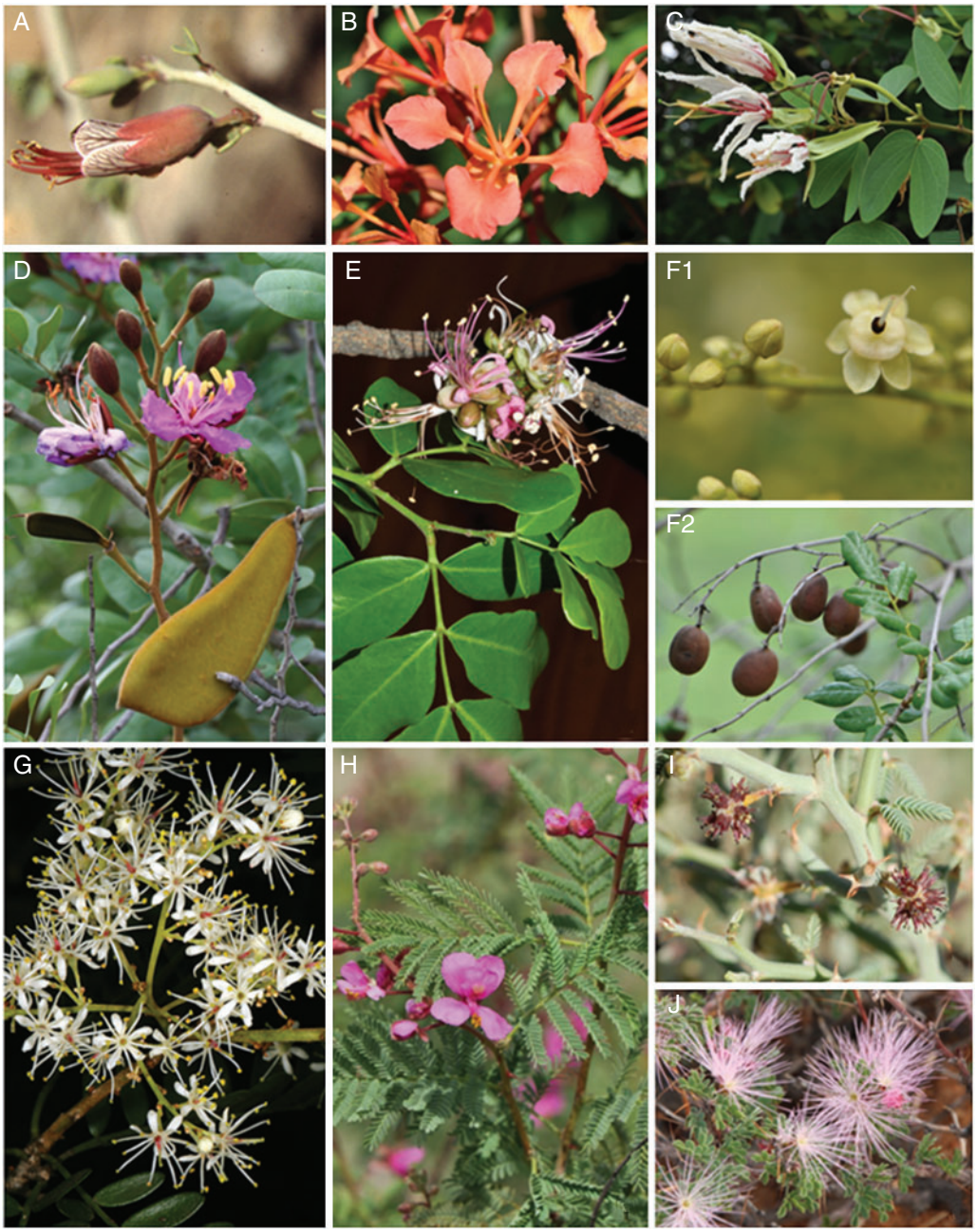

Fig. 1. A selection of southern African legumes. A–C. Cercidoideae. D, E. Detarioideae. F1, F2. Dialioideae. G–J. Caesalpinioideae. A. *Adenolobus garipensis* (E.Mey.) Torre. B. *Bauhinia galpinii* N.E.Br. C. *Bauhinia petersiana* Bolle subsp. *macrantha* (Oliv.) Brummitt & J.H.Ross. D. *Baikiaea plurijuga* Harms. E. *Schotia latifolia* Jacq. F. *Dialium schlechteri* Harms. G. *Umtiza listeriana* Sim. H. *Gelrebia rubra* (Engl.) Brenan. I. *Xerocladia viridiramis* (Burch.) Taub. J. *Afrocalliandra reducta* (J.H.Ross) E.R.Sousa & L.P.Queiroz. Photos by B.-E. van Wyk (A–F, H), A. E. van Wyk (G), C. Mannheimer (I) and M. Koekemoer (J).

The genistoid tribes have a high concentration of species in the temperate region of South Africa (Trytsman *et al*. 2016) and have the highest levels of endemism. Fig. 2 includes examples of genistoid legumes from the tribe Swartzieae, Sophoreae, Podalyrieae, Crotalarieae and Genisteae. A regression analysis of these five genistoid tribes confirmed the assumption that a very high proportion of the variance can be explained by the numbers of species (R^2 = 0.9983, s.e. = 10.2, and P < 0.001). The Podalyrieae has a somewhat higher level of endemism than the model predicted (residual +14, predicted 108, actual 122), whereas the Genisteae has a lower one (residual –11, predicted 73, actual 62).

Fig. 2. A selection of southern African legumes from the genistoid tribes. A. Swartzieae. B, C. Sophoreae. D–F. Podalyrieae. G–O. Crotalariae. P–R. Genisteae (P – R). A. *Cordyla africana* Lour. B. *Bolusanthus speciosus* (Bolus) Harms. C. *Sophora inhambanensis* Klotzsch. D. *Podalyria calyptrata* (Retz.) Willd. E. *Liparia splendens* (Burm.f.) Bos & De Wit. F. *Virgilia divaricata* Adamson. G. *Aspalathus capensis* (Walp.) R.Dahlgren. H. *Bolusia acuminata* (DC.) Polhill. I. *Calobota pungens* (Thunb.) Boatwr. & B.-E.van Wyk. J. *Crotalaria lebeckioides* Bond. K. *Lebeckia sepiaria* (L.) Thunb. L. *Leobordea pulchra* (Dümmer) B.-E.van Wyk & Boatwr. M. *Lotononis sericophylla* Benth. N. *Pearsonia grandifolia* (Bolus) Polhill. O. *Rafnia amplexicaulis* Thunb. P. *Argyrolobium harmsianum* Harms. Q. *Dichilus strictus* E.Mey. R. *Melolobium microphyllum* (L.f.) Eckl. & Zeyh. Photos by B.-E. van Wyk.

The group here referred to as the non-genistoid group comprises 58 indigenous genera and 694 indigenous species, which are distributed in nine indigenous tribes. Fig. 3 shows selected species from this group, representing the tribes Dalbergieae, Indigoferae, Hypocalypteae, Millettieae, Abrieae, Psoraleeae, Phaseoleae, Galegeae and Trifolieae. Tribal delimitations have not yet reached stability, so that the tribal classification system in Lewis *et al*. (2005) was used with the understanding that these groupings are subject to change and improvement. For example, the Psoraleeae are known to be part

Fig. 3. A selection of southern African legumes from the non-genistoid tribes. A, B. Dalbergieae. C. Indigoferae. D–F. Hypocalypteae. G, I. Millettieae. H. Abrieae. J. Psoraleeae. K–P. Phaseoleae. Q. Galegeae. R. Trifolieae. A. *Aeschynomene rehmannii* Schinz. B. *Dalbergia armata* E.Mey. C. *Indigofera auricoma* E.Mey. D. *Hypocalyptus coluteoides* (Lam.) R.Dahlgren. E. *Hypocalyptus oxalidifolius* (Sims) Baill.). F. *Hypocalyptus sophoroides* (P.J.Bergius) Baill. G. *Millettia stuhlmannii* Taub. H. *Abrus precatorius* L. I. *Desmodium repandum* (Vahl) DC. J. *Psoralea pinnata* L. K. *Bolusafra bituminosa* (L.) Kuntze. L. *Canavalia rosea* (Sw.) DC. M. *Dipogon lignosus* (L.) Verdc. N. *Dolichos falciformis* E.Mey. O. *Eriosema salignum* E.Mey. P. *Rhynchosia monophylla* Schltr. Q. *Lessertia carnosa* Eckl. & Zeyh. R. *Trifolium africanum* Ser. Photos by B.-E. van Wyk.

of a larger clade that includes the Phaseoleae (Hu *et al*. 2000; Kajita *et al*. 2001; Egan and Crandall 2008; Stefanovic *et al*. 2009; de Queiroz *et al*. 2015; Egan *et al*. 2016), but these insights from molecular studies are not yet reflected in the formal tribal-classification system. In comparison with other non-genistoid groups, the tribes Indigoferae, and especially Phaseoleae, stand out as fairly diverse, with relatively large numbers of endemic species. As shown later on, the Phaseoleae are of special interest in the context of edible and medicinal plants. However, a regression analysis of the non-genistoids (R^2 = 0.7854,

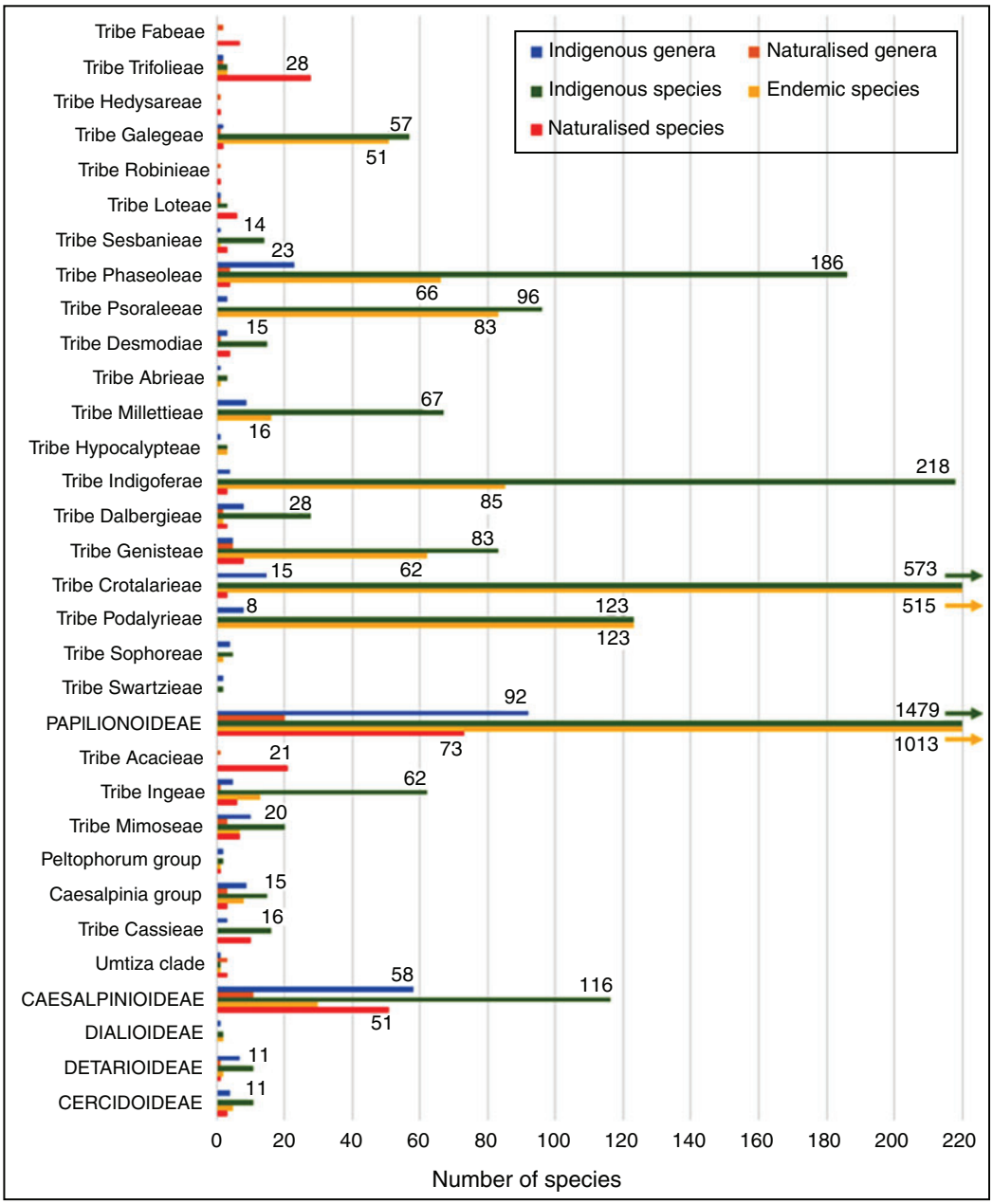

Fig. 4. Diversity and endemism of southern African legumes, showing the numbers of indigenous, endemic and naturalised species.

s.e. = 17.0, $P < 0.001$) showed that only the Psoraleeae and Galegeae had residuals exceeding the standard error (Psoraleeae: residual +40, predicted 43, actual 83; Galegeae: residual +25, predicted 26, actual 51).

In general, the results showed a high level of agreement between the diversity within the tribes and genera, and the corresponding levels of endemism. The agreement is almost perfect for genistoid legumes, but somewhat less so for the non-genistoids and especially for the non-papilionoids. There is a statistically significant relationship between overall species numbers and endemic species numbers, but this relationship is not evenly spread across the three major groups of indigenous legumes.

Diversity of uses

Southern Africa is known as a region of exceptional botanical and cultural diversity. Because different cultural groups have a different combination of available species (including endemic species) for use as food, medicine and craft materials, a large overall diversity of useful species can also be expected. The numbers of recorded species of southern Africa have not yet

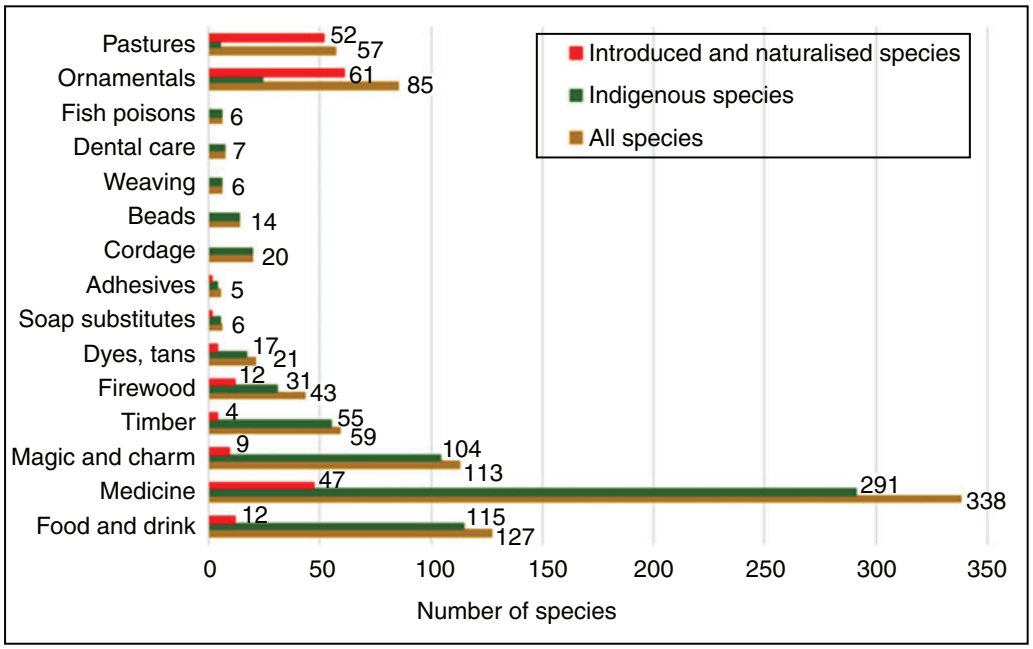

Fig. 5. The uses of southern African legumes and the numbers of species recorded for each category of use.

reached stability and new species are still being discovered and described. However, far more incomplete are the recorded numbers of useful species for some of the 21 main language and cultural groups of southern Africa (Van Wyk *et al*. 2011). However, this review covers all available plant-use data (including all traditional and modern uses) for all the cultural groups of southern Africa. Recent ethnobotanical surveys have consistently showed new records of medicinal, edible and craft plants. Historically, the main focus of ethnobotanical studies has been on the medicinal uses of plants, resulting in the large reference work of Watt and Breyer-Brandwijk (1962) and the database of southern African medicinal plants by Arnold *et al*. (2002). The traditional source of information on the food plants of southern Africa (Fox and Norwood Young 1982) was much expanded in a recent detailed review by Welcome and Van Wyk (2019), where numerous additional references can be found. This list showed that there are 1740 southern African plant species with food uses, of which 135 are legumes. The legumes are exceeded only by the Apocynaceae in terms of the numbers of edible species (137). Other everyday uses of legumes are often not recorded, because they are considered to be trivial and not of much scientific interest. However, several popular publications and field guides can be used to find information about those species well known to be sources of timber, firewood, dyes, tans, ropes and other products. Alien and naturalised species were usually imported because of their utility value, so that an almost perfect agreement can be expected between the number of naturalised legume species and the number of useful ones. Almost all of these exotics were originally imported for their ornamental value as garden plants or as cultivated fodder plants, and many of them have become naturalised and sometimes invasive. The only exceptions are *Arachis* and *Cajanus* (peanut and pigeon pea respectively, which were imported for their edible seeds) and *Glycyrrhiza* (licorice, which was imported for medicinal use).

A comprehensive list of uses of southern African legumes is presented in Appendix 1 and summarised in Table 1 and Fig. 5. Examples of the various uses of southern African legumes are shown in Fig. 6. There are 465 species with human uses as food, medicine and various other applications, of which 337 (72%) are indigenous and 128 (28%) are naturalised exotics.

Regression analyses of the total number of uses for all the groups of legumes, all non-papilionoids, all papilionoids, all genistoids and all non-genistoids (Table 1) showed a pattern almost the exact opposite of what was found for endemism. A summary of the results of all analyses is presented in Table 2. The analysis of all groups and all uses showed a surprising lack of agreement between species numbers and uses, with only 14.7% of the variance explained by the model ($R^2 = 0.1474$, s.e. = 30.4, $P = 0.053$). In contrast, the non-papilionoids showed an almost perfect agreement between species numbers and uses, with no less than 96% of the variance explained by the model (Table 2). Groups with residuals exceeding the standard error were the Detarioideae (predicted 22, residual +9, actual 31), Mimoseae (predicted 40, residual –10, actual 30) and the Cassieae (predicted 34, residual –15, actual19). Analyses for the other main groups showed relatively low R^2-values and P-values. All papilionoids gave an R^2-value of 0.3208, a standard error of 22.4 and a P-value of 0.0178, with three tribes having residuals exceeding the standard error. These were the Phaseoleae (predicted 35, residual +65, actual 100), Millettieae (predicted 23, residual +33, actual 56) and the Crotalarieae (predicted 76, residual –27, actual 49). The genistoids had a somewhat higher R^2-value of 0.8144, a standard error of 8.4 and a P-value of 0.0360, with only the

Fig. 6. A selection of indigenous southern African legume species representing different categories of use. A, B. *Vigna subterranea* (L.) Verdc. (pulse). C. *V. unguiculata* (L.) Walp. (pulse). D. *Aspalathus linearis* (Burm.f.) Dahlgren (rooibos tea). E. Rooibos tea (unfermented and fermented). F. *Cyclopia subternata* Vogel (honeybush tea). G. Honeybush tea (modern and traditional processing). H1, H2. *Argyrolobium tuberosum* Eckl. & Zeyh. (edible root). I. *Vachellia karroo* (Hayne) Banfi & Galasso (edible gum). J. *Lessertia* (*Sutherlandia*) *frutescens* (L.) Goldblatt & J.C.Manning (herbal medicine). K. *Albizia adianthifolia* (Schum.) W.Wight (medicinal bark). L. *Schotia brachypetala* Sond. (powdered medicinal bark). M. *Baikiaea plurijuga* Harms (timber). N. *Vachellia karroo* (firewood). O. *Elephantorrhiza burkei* Benth. (rhizome used for tanning). P. *Erythrina lysistemon* Hutch, (seeds used as beads). Q. *Listia bainesii* (Baker) B.-E.van Wyk & Boatwr. (cultivated pasture). *Lebeckia ambigua* E.Mey. (cultivated pasture). Photos by B.-E. van Wyk.

Podalyrieae having a residual value exceeding the standard error (predicted 76, residual +11, actual 34). The non-genistoids gave an R^2-value of 0.6129, a standard error of 19.6 and a *P*-value of 0.003. The following four tribes had residuals exceeding the standard error: once again, Phaseoleae (predicted 65, residual +35, actual 100), Millettieae (predicted 28, residual +28, actual 56), Psoraleeae (predicted 37, residual –25, actual 12) and Indigoferae (predicted 76, residual –27, actual 49).

The diverse secondary metabolites in plant families were shown to be an important factor in the selection for medicinal use (Douwes *et al*. 2008), but they are also important in other uses and applications such as food, beverages, dyes, tans, adhesives and soap substitutes. Detailed comparative studies at generic and species levels may yield interesting results.

Food uses

When non-indigenous, cultivated crop plants were excluded from the list of Welcome and Van Wyk (2019), then a total of 127 legume species was recorded as having food-related uses (Appendix 1, Table 1). Of these, 115 are indigenous and 12 are naturalised aliens (Fig. 5). Food uses include edible roots (27 spp.), edible bark (1 sp.), bark for curdling milk (9 spp.), bark to make ash for use as cooking lime (1 sp.), edible gum (23 spp.), leaves (usually with petioles and stems) as vegetables (28 spp.), teas (26 spp.), flavourants (13 spp.), edible flowers (3 spp.), nectar sources (2 spp.), edible pods (39 spp.), edible seeds (25 spp.), seed oil (3 spp.), coffee substitutes (14 spp.), alcoholic beverages (1 sp.), non-alcoholic beverages (5 spp.) and yeasts or ferments (1 sp.). Edible pods and seeds are the most important categories, and are represented in Fig. 6 by two indigenous species of commercial interest, namely *Vigna subterranea* (L.) Verdc. or jugo bean (Fig. 6A, B) and *V. unguiculata* (L.) Walp. or cowpea (Fig. 6C).

Cape genistoid legumes of the tribes Podalyrieae and Crotalarieae are unimportant as food sources, yet they provide several traditional teas (Van Wyk and Gorelik 2017), mainly in the genera *Aspalathus* (6 spp.) and *Cyclopia* (11 spp.). *Aspalathus linearis* (Burm.f.) R.Dahlgr. is the source of rooibos tea (Fig. 6D, E), a herbal beverage that has become popular in many parts of the world. On a smaller but rapidly increasing scale, *Cyclopia* species, and especially *C. genistoides* (L.) R.Br. (Fig. 6F), *C. intermedia* E.Mey. and *C. subternata* Vogel, are the source of commercial quantities of honeybush tea (Fig. 6G), both for local consumption and export.

Regression analyses (Table 2) showed that variation and diversity in food uses are better explained by species numbers in non-papilionoid legumes ($R^2 = 0.9235$, s.e. =2.0, $P < 0.001$) than in any other groups. The group predominantly comprises trees (especially the genera *Senegalia* and *Vachellia*), thus presenting a larger diversity of plant parts for use as food (such as roots, bark and gum exudates, in addition to pods and seeds). Among papilionoids, the Phaseoleae stood out as having a high residual of +16 (predicted 6, actual 22). Although genera such as *Argyrolobium* (Fig. 6H) have few species with edible (often sweet) fleshy roots, several genera of the Phaseoleae produce edible tubers, leaves, pods and seeds (e.g. *Eriosema*, *Canavalia* and *Vigna*), hence, explaining their prominence as food plants.

The importance and dominance of the legumes as a food-plant family can, thus, be ascribed to the diversity of plant parts that can be used as food items. Furthermore, their ability to fix atmospheric nitrogen not only allow these plants to grow as pioneer species in poor soils, but also to produce high levels of protein in their leaves, pods and seeds. Few (if any) other species-rich food-plant families have a similar diversity of edible roots, stems, bark exudates, leaves, flowers, fruits and seeds (Welcome and Van Wyk 2019).

Rigorous and quantitative comparative studies of primary metabolites such as sugars, polysaccharides, amino acids, lectins and proteins may also help explain the nutritional value and popularity of southern African food legumes. The high number of edible Phaseoleae species, when compared with Crotalarieae species, may be partly due to nutritional factors and seed size (generally large in the former and small in the latter) but also chemical protection; the lectins in the seeds of Phaseoleae are destroyed by heat and leaching, whereas the quinolizidine and pyrrolizidine alkaloids protecting the seeds of the Podalyrieae, Crotalarieae and Genisteae are heat-stable and not so easily dealt with (Wink and Van Wyk 2008; Erbaş 2010).

Medicinal uses

The most diverse uses of legumes are in traditional medicine, with at least 338 species being on record as sources of medicine for internal and topical applications in both humans and domestic animals (Fig. 5). Of these, 291 (86%) are indigenous and 47 (14%) are naturalised exotics. Available data from the database of Arnold *et al*. (2002) were the main source of information (where many additional references can be found), but data were added from other publications, including Dlamini (1981), Pooley (1993, 2005, 2013), Dold and Cocks (2000), Grace *et al*. (2002), Von Ahlefeldt *et al*. (2003), Leffers (2003), Moteetee and Van Wyk (2007), Van Wyk *et al*. (2008*a*, 2008*b*, 2009), Mannheimer and Curtis (2009), Boon (2010), Corrigan *et al*. (2011), Moffett (2010), Van Wyk and Gorelik (2017), Van Wyk and Gericke (2000, 2018), Magwede *et al*. (2019), Mhlongo and Van Wyk (2019), Mogale *et al*. (2019) and Moteetee *et al*. (2019). No detailed synthesis is yet available and ongoing ethnobotanical research is continuously showing new use-records and even new species records. The number of medicinal legumes (species and infraspecific taxa) included in Arnold *et al*. (2002) was 428, rivalled only by the Asteraceae with 404 medicinal taxa. The total number of medicinal plant taxa recorded by Arnold *et al*. (2002) is 3481, so that medicinal legumes represent 12.3% of all medicinal plants and 1.8% of the total flora of southern Africa. From a commercial perspective, southern African legumes are unimportant, despite their large numbers. *Lessertia frutescens* (L.) Goldblatt & J.C.Manning (= *Sutherlandia frutescens* (L.) R.Br.; Fig. 6J) is the only medicinal legume that has been commercialised to any extent (as an adaptogenic tonic). Rooibos tea (*Aspalathus linearis*) and honeybush tea (*Cyclopia* species) are partly sold for their perceived health benefits (Joubert *et al*. 2008; Joubert and De Beer 2011), in addition to their value as tasty herbal decoctions, enjoyed in much the same way as infusions of black tea.

Regression analyses showed that medicinal species are generally not randomly selected (i.e. that some taxa seem to be preferred) and that only two groups showed an agreement between available species numbers and medicinal uses. These were the non-papilionoid genera ($R^2 = 0.9914$, s.e. = 1.1, $P < 0.001$) and the non-genistoids ($R^2 = 0.7447$, s.e. = 7.8, $P < 0.001$; Table 2). The Millettieae (predicted 15, residual +13, actual 28) and Phaseoleae (predicted 35, residual +11, actual 46) seem to have been favoured in the selection process, whereas the opposite is true for the Indigoferae (predicted 41, residual –9, actual 32) and the Psoraleeae (predicted 20, residual –11, actual 9). The larger number of plant parts provided by the

predominantly arboreal non-papilionoids, and the popularity of bark in traditional medicine (Grace *et al*. 2002) again appear to be important considerations. Bark is commonly sold in traditional medicine markets in southern Africa, either as solid pieces (Fig. 6K; *Albizia adianthifolia* (Schumach.) W.Wright) or in chopped or powdered form (Fig. 6L; *Schotia brachypetala* Sond.).

Magic and charm uses

The use of plants for magic and charm purposes is commonly encountered in southern Africa and involves many unusual practices. Van Wyk and Wink (2018) cautioned against dismissing these traditions as unscientific or implausible without a proper consideration of traditional concepts of physical and mental health. Fruits from lemons and limes were once a 'magic' cure for scurvy, until a 'rational' explanation for their efficacy could be provided by the discovery of Vitamin C, more than 200 years later. Treatments for mental conditions such as bereavement and stress are easily classified as magic medicine, without a proper knowledge of the plants, their uses and nitrogen-containing metabolites. For example, several shrubby legumes (known as '*musapelo*) are used to treat stress in Lesotho (Moteetee and Van Wyk 2007). *Lessertia frutescens* is one of the most popular of the '*musapelo* plants and *in vivo* anti-stress activity has been experimentally demonstrated (Smith and Myburgh 2004). Bitter tonics and bitter substances are not only associated with appetite stimulation (the so-called '*amarum* effect') but also with stress relief (Olivier 2012; Olivier and Van Wyk 2013).

In total, 104 indigenous and nine exotic legume species have been recorded as having traditional uses as magic and charm plants (Appendix 1, Table 1, Fig. 5). Regression analyses showed a rather weak association between species numbers and magical uses, with the exception of the non-papilionoid group (R^2 = 0.9717, s.e. = 1.0, $P < 0.001$). In this analysis, the subfamilies and tribes had residuals very close to predicted values. The Cercidoideae had a residual of –2, a predicted value of 3 and an actual value of 1. Although an explanation for the apparent random selection of magical and charm plants from the non-papilionoid group is currently lacking, further studies of the chemical constituents and their bioactivities (especially alkaloids and other nitrogen-containing compounds with potential anti-stress, mind-altering and appetite-stimulating effects) across taxonomic groups may provide some new insights in the future.

Timber

Legumes dominate when it comes to sources of high-quality timber, with 59 recorded species, of which 55 are indigenous (Appendix 1, Table 1). Among the 140 most popular timbers of southern Africa (Dyer *et al*. 2016), 37 species (26%) are legumes. The remaining 103 species are from 27 other families. Celastraceae occupies a very distant second place, with only seven species (5%), followed by several families with two to five timber species each. The list of legume timbers includes 33 from the FSA region, two from just outside the FSA region and two naturalised (and cultivated) exotics. Some of the best-known examples of commercial timbers include *Afzelia quanzensis* Welw. (chamfuti), *Baikiaea plurijuga* Harms (Zambezi or Zimbabwe teak, Fig. 6M), *Dalbergia melanoxylon* Guill. & Perr. (African blackwood), *Guibourtia coleosperma* (Benth.) J.Léonard (African rosewood), *Millettia stuhlmannii* Taub. (panga panga) and *Pterocarpus angolensis* DC. (kiaat). Several species also have local uses as protective fences or as a source of poles for constructing traditional huts and cattle enclosures. The combined regression analysis for all other uses (Table 2) showed that the tree-dominated non-papilionoid group has the highest diversity of uses and that they have apparently been randomly selected.

Firewood

In common with timbers, the legumes dominate as sources of commercial and semi-commercial firewood. The four most popular commercial species in southern Africa are the following three indigenous members of the family: *Dichrostachys cinerea* (L.) Wight & Arn. or sickle bush, *Vachellia erioloba* (E.Mey.) P.J.H.Hurter or camel thorn and *V. karroo* (Hayne) Banfi & Gallaso or sweet thorn (Fig. 6N) and one exotic (*Acacia cyclops* A.Cunn. ex G.Don, rooikrans). *Colophospermum mopane* (J.Kirk ex Benth.) J.Kirk ex J.Léonard (mopane) and *Acacia saligna* (Labill.) H.L.Wendl. (Port Jackson) are also important in the subtropical and the Cape regions respectively. Van Wyk *et al*. (2008*b*) and Van Wyk and Gericke (2018) provided use-records for most of the well known firewood sources of southern Africa, but the list is undoubtedly incomplete. Important legume firewood is found among the Ingeae (9 spp.), Mimoseae (6 spp.), Detarioideae (5 spp.), *Caesalpinia* group (2 spp.) and Crotalarieae (2 spp.). The regression analyses showed that the predominantly wood early lineages have the highest diversity of use, with evidence for random selection, based on availability.

Other traditional uses

Various other uses of legumes are listed in Appendix 1 and Table 1, and illustrated in Fig. 5 and 6. Unlike medicinal plants, where naturalised exotics have become part of the local *materia medica*, other traditional uses are apparently less dynamic and are mostly based on indigenous legumes. *Acacia* species have been imported from Australia as ornamental trees and as commercial sources of tans (Table 1); however, these species are apparently not used for tanning in rural areas. The traditional materials used for tanning leather and colouring traditional baskets are mainly obtained from the Millettieae (4 spp.), Mimoseae (3 spp.), Indigoferae (3 spp.), Detarioideae (2 spp.) and the *Caesalpinia* group (2 spp.). The bright red root of *Elephantorrhiza burkei* Benth. (Fig. 6O) is one of the popular traditional materials to turn raw hides into leather. Tans and dyes are no longer much used, except in rural areas. Traditional, non-commercial soap substitutes have been recorded for the Cercidoideae, *Caesalpinia* group, Ingeae, Sophoreae and Phaseoleae. Ropes and cordage, made from the inner bark of trees or the twining stems of vines, come mainly from the Ingeae (5 spp.), Mimoseae (2 spp.), Phaseoleae (2 spp.), Cercidoideae (1 sp.), Peltophorum group (1 sp.) and Dalbergieae (1 sp.). Seeds of the following groups are traditionally used as decorative beads:

Cercidoideae (2 spp.), Mimoseae (2 spp.), Phaseoleae (2 spp.), Detarioideae (1 sp.), *Caesalpinia* group (1 sp.) and Abrieae (1 sp.). The bright orange or red seeds of *Abrus precatorius* L. (Fig. 3H) and *Erythrina lysistemon* Hutch. (Fig. 6P) are often seen in traditional markets. Fibrous and flexible stems used for weaving and basketry have been recorded from diverse and unrelated species of the Cercidoideae (2 spp.), Dialioideae (1 sp.), Ingeae (1 sp.), Sophoreae (1 sp.), Crotalarieae (1 sp.), Dalbergieae (1 sp.) and Detarioideae (1 sp.). Traditional dental care includes an example of bark fibres used as dental floss (from *Faidherbia albida* (Delile) A.Chev.) and six other species where fibrous roots or stems serve as toothbrushes. Fish poisons are typical of the Millettieae and easily explained by the presence of rotenoids, which are known insecticidal and piscicidal agents (Southon 1994). The uses of legumes are often related to their chemical constituents (e.g. saponins, gums, pigments and biologically active alkaloids and lectins), so that comparative quantitative data are needed for more detailed analyses. The family is exceptionally rich in flavonoids (anthocyanins, flavones, flavonols, chalcones, flavanones, proanthocyanidins, isoflavonoids) and nitrogen-containing constituents (cyanogenic glycosides and non-protein amino acids, as well as quinolizidine, pyrrolizidine, indole and isoquinoline alkaloids), terpenoids (diterpene acids, triterpenoid saponins and tetraterpenoids), quinones (benzoquinones and anthraquinones), acetylenic compounds, furanocoumarins and xanthones (Harborne *et al*. 1971; Kinghorn and Balandrin 1984; Southon 1994; Hegnauer and Hegnauer 1994, 1996, 2001; Veitch 2010; Wink 2013).

Ornamental plants

A large number of legume species has been recorded as cultivated ornamental plants in southern Africa (Glen 2002) but few of these are commonly encountered. In Appendix 1 and Table 1, only those 85 cultivated species that are either indigenous or naturalised (and have, thus, become part of the FSA flora) are listed. Of these, 61 species (72%) are naturalised and only 24 species (28%) are indigenous. Most of these species are trees or shrubs imported for their ornamental value, but their popularity has decreased as a result of their invasive potential and associated legal restrictions. Non-indigenous species often flourish and become invasive because the natural enemies of their home countries are no longer a limiting factor. Indigenous species have become more popular in recent years and the list of common indigenous garden trees from the legume family is likely to expand in the future (Van Wyk *et al*. 2008*b*). The fact that most of the species are woody, contributed to the high R^2-value of 0.8977 in the regression analysis (Table 2).

Pasture plants

Several indigenous legumes have the potential to be developed as pasture and cover crops (Trytsman *et al*. 2011, 2019; Trytsman 2013), but only a few species have thus far been commercialised to any extent. These include *Listia bainesii* (Bak.) B.-E.van Wyk & Boatwr. (Fig. 6Q), *Lablab purpureus* (L.) Sweet and *Vigna unguiculata*. (Fig. 6C). Other species that have been evaluated for their commercial potential as cultivated pastures include *Alysicarpus rugosus* (Willd.) DC., *Macrotyloma axillare* (E.Mey.) Verdc., *Mucuna pruriens* (L.) DC., *Neonotonia wightii* (R.Grah. ex Wight & Arn.) J.A.Lackey, *Rhynchosia minima* (L.) DC., *Stylosanthes fruticosa* (Retz.) Alston, *Vigna vexillata* (L.) A.Rich., *Cullen tomentosum* (Thunb.) J.W.Grimes and *Lessertia* species (Trytsman *et al*. 2019). *Lebeckia ambigua* E.Mey. is apparently the only species currently under development as a new pasture crop and the importance of suitable nitrogen-fixing symbionts in new crop development of legumes was clearly demonstrated (Howieson *et al*. 2013). Of the 57 species with historical or contemporary uses as pasture legumes and cover crops, 52 (91%) are introductions from other parts of the world. It is important to note that only naturalised and invasive species are listed in Appendix 1 and Table 1, and no other commonly cultivated alien species is included. The scope of the paper was limited to the flora of southern Africa and the non-inclusion of commonly cultivated alien species has only a small effect on the overall regression analyses.

Regression analyses of all other uses (i.e. excluding food, medicinal and magic or charm uses) showed that the early divergent subfamilies and lineages (the non-papilionoid group) not only have the highest diversity of uses but that they have apparently been randomly selected (R^2 = 0.8977, s.e. = 6.6, $P < 0.001$), as shown in Table 2. The genera *Senegalia* and *Vachellia* feature prominently, reinforcing the concept that it is the diversity of available plant parts that often determines the use value of a legume species.

Summary and conclusions

In total, 1748 species and 165 genera of indigenous and naturalised legumes have thus far been recorded for the FSA region. Of these, 133 genera and 1620 species are indigenous, and 22 genera (17%) and 1059 species (65%) are endemic. The 128 naturalised species are mostly ornamental plants and pasture or cover crops (or were originally imported for these purposes).

Food uses have been recorded for 127 species (115 indigenous), medicinal uses for 338 species (291 indigenous), and magic and charm uses for 113 species (104 indigenous). Smaller numbers of species are sources of timber (59 spp., 55 indigenous), firewood (43 spp., 31 indigenous), dyes and tans (21 spp., 17 indigenous), soap substitutes (6 spp., 5 indigenous), adhesives (5 spp., 4 indigenous), cordage (20 spp., all indigenous), beads (14 spp., all indigenous), weaving (6 spp., all indigenous), dental care (7 spp., all indigenous) and fish poisons (6 spp., all indigenous). There are 85 ornamental species, of which 61 are non-indigenous and naturalised, and 57 pasture or cover crops, of which 52 are non-indigenous and naturalised.

Among southern African legumes, levels of endemism are closely related to diversity, with statistically significant results being obtained in all regression analyses (four analyses with $P < 0.001$, one analysis with $P < 0.003$). The genistoid tribes Crotalarieae, Podalyrieae and Genisteae, as well as the Psoraleeae and Galegeae, show high levels of endemism and diversity. Endemism, therefore, appears to be directly related to diversity, at least in some groups of legumes and especially in those groups that are endemic to the species-rich Cape Floristic Region.

The general pattern demonstrated here is that the early divergent lineages of southern African legumes are used in direct proportion to their species diversity. This is true for all

categories of use that were analysed. In contrast, the selection of useful papilionoid legumes, and especially the genistoids and other mega-diverse clades of the Cape Floristic Region, falls far short of their pronounced species diversity. The Crotalarieae, and to some extent also the Indigoferae, showed negative residuals in many analyses (Table 2). An exception is the medicinal use of non-genistoid legumes, where 82% of the variance can be explained by species numbers ($P < 0.001$). The Phaseoleae and Millettieae showed high residual values, indicating that they have been favoured in the selection for medicinal uses. These two tribes feature prominently in all analyses of papilionoid legumes, with almost invariably showing highest residual values.

It seems that the success of the legumes is not only due to their ability to fix atmospheric nitrogen, but also to their diversity in habit and chemistry. The reason behind the selective use and popularity of certain lineages of legumes for human use is less obvious. Comparative studies at the generic and species levels may show hitherto neglected species with new uses and potential socio-economic value.

Conflicts of interest

The author declares that he has no conflicts of interest.

Declaration of funding

Financial support from the South African National Research Foundation (Grant number 8442 to the South African Research Chair in Indigenous Plant Use) and the University of Johannesburg is gratefully acknowledged.

Acknowledgements

The author thanks the organisers of the 7th International Legume Conference for logistic support, as well as the editors of this Special Edition and anonymous reviewers, for improvements to earlier versions of the manuscript.

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Handling editor: Ashley Egan

Appendix 1. Alphabetical list of all indigenous and naturalised legumes of southern Africa with recorded human uses for 15 categories of use

Naturalised exotics are indicated with an asterisk (*)

Indigenous and naturalised species with recorded uses in southern Africa	Food and drink	Medicine	Magic and charms	Timber	Firewood	Dyes, tans	Soap substitutes	Adhesives	Cordage	Beads	Weaving	Dental care	Fish poisons	Ornamentals	Pastures and cover crops	Total number of uses	Uses per genus	Number of useful spp.	Naturalised exotics
Abrus laevigatus E.Mey.		1	1													2		1	
Abrus precatorius L.		1	1							1						3	5	1	
Acacia adunca A.Cunn. ex G.Don*														1		1		1	1
Acacia baileyana F.Muell.*														1		1		1	1
Acacia crassiuscula H.L.Wendl.*														1		1		1	1
Acacia cyclops A.Cunn. ex G.Don*					1									1		2		1	1
Acacia dealbata Link*					1	1								1		3		1	1
Acacia decurrens (J.C.Wendl.) Willd.*		1			1	1								1		4		1	1
Acacia implexa Benth.*		1												1		2		1	1
Acacia longifolia (Andrews) Willd.*														1		1		1	1
Acacia mearnsii De Wild.*		1		1	1	1								1		5		1	1
Acacia melanoxylon R.Br.*				1										1		2		1	1
Acacia paradoxa A.Cunn. ex G.Don*														1		1		1	1
Acacia podalyriifolia A.Cunn. ex G.Don*														1		1		1	1
Acacia pycnantha Benth. *		1												1		2		1	1
Acacia retinodes Schltdl.*														1		1		1	1
Acacia saligna (Labill.) H.L.Wendl.*					1									1		2		1	1
Acacia stricta (Andrews) Willd.*														1		1		1	1
Acacia viscidula A.Cunn. ex Benth.*														1		1	31	1	1
Acrocarpus fraxinifolius Wight & Arn.*														1		1	1	1	1
Adenopodia spicata (E.Mey.) C.Presl		1	1													2	2	1	
Afzelia quanzensis Welw.	1	1	1	1	1					1						6	6	1	
Albizia adianthifolia (Schumach.) W.Wight	1	1	1	1	1											5		1	
Albizia amara (Roxb.) Boivin		1	1													2		1	
Albizia anthelmintica (A.Rich.) Brongn.	1	1		1												3		1	
Albizia antunesiana Harms		1														1		1	
Albizia brevifolia Schinz		1														1		1	
Albizia forbesii Benth.		1	1		1				1							4		1	
Albizia harveyi E.Fourn.	1	1														2		1	
Albizia julibrissin (Willd.) Durazz.*														1		1		1	1
Albizia lebbeck (L.) Benth. *		1														1		1	1
Albizia petersiana (Bolle) Oliv.		1														1		1	
Albizia suluensis Gerstner		1														1		1	
Albizia tanganyicensis Baker f.		1	1													2		1	
Albizia versicolor Welw. ex Oliv.		1	1	1			1		1							5	29	1	
Alysicarpus glumaceus (Vahl) DC.		1														1		1	
Alysicarpus rugosus (Willd.) DC.		1														1		1	
Alysicarpus vaginalis (L.) DC.		1														1		1	
Alysicarpus zeyheri Harv.		1														1	4	1	
Amblygonocarpus andongensis (Welw. ex Oliv.) Exell & Torre				1												1	1	1	
Arachis hypogaea L.*	1	1														2	2	1	1
Argyrolobium argenteum Eckl. & Zeyh.	1															1		1	
Argyrolobium baptisioides (E.Mey.) Walp.	1															1		1	
Argyrolobium collinum Eckl. & Zeyh.		1														1		1	
Argyrolobium harveyanum Oliv.	1															1		1	
Argyrolobium longifolium (Meisn.) Walp.			1													1		1	
Argyrolobium lotoides Harv.		1	1													2		1	
Argyrolobium marginatum Bolus	1	1														2		1	
Argyrolobium sandersonii Harv.			1													1		1	
Argyrolobium speciosum Eckl. & Zeyh.		1														1		1	

(*continued next page*)

Appendix 1. (*continued*)

Indigenous and naturalised species with recorded uses in southern Africa	Food and drink	Medicine	Magic and charms	Timber	Firewood	Dyes, tans	Soap substitutes	Adhesives	Cordage	Beads	Weaving	Dental care	Fish poisons	Ornamentals	Pastures and cover crops	Total number of uses	Uses per genus	Number of useful spp.	Naturalised exotics
Argyrolobium stipulaceum Eckl. & Zeyh.		1														1		1	
Argyrolobium tomentosum (Andrews) Druce			1													1		1	
Argyrolobium transvaalense Schinz		1														1		1	
Argyrolobium tuberosum Eckl. & Zeyh.	1	1														2	16	1	
Aspalathus alpestris (Benth.) R.Dahlgren	1															1		1	
Aspalathus angustifolia (Lam.) R.Dahlgren	1															1		1	
Aspalathus chortophila Eckl. & Zeyh.			1													1		1	
Aspalathus commutata (Vogel) R.Dahlgren		1														1		1	
Aspalathus cordata (L.) R.Dahlgren	1	1														2		1	
Aspalathus crenata (L.) R. Dahlgren	1	1														2		1	
Aspalathus laricifolia P.J.Bergius			1													1		1	
Aspalathus linearis (Burm.f.) R.Dahlgren	1	1														2		1	
Aspalathus pendula R.Dahlgren	1															1		1	
Aspalathus sanguinea Thunb.											1					1	13	1	
Astragalus atropilosulus (Hochst.) Bunge		1														1	1	1	
Baikiaea plurijuga Harms		1		1		1										3	3	1	
Baphia massaiensis Taub.	1	1					1				1	1				5		1	
Baphia racemosa (Hochst.) Baker		1		1												2	7	1	
Bauhinia bowkeri Harv.		1														1		1	
Bauhinia forficata Link*														1		1		1	1
Bauhinia galpinii N.E.Br.		1		1							1			1		4		1	
Bauhinia petersiana Bolle	1	1														2		1	
Bauhinia purpurea L.*														1		1		1	1
Bauhinia tomentosa L.		1									1			1		3		1	
Bauhinia variegata L.*		1												1		2	14	1	1
Biancaea decapetala (Roth) Alston*	1	1	1			1	1	1						1		7	7	1	1
Bobgunnia madagascariensis (Desv.) J.H.Kirkbr. & Wiersema		1		1	1			1								4	4	1	
Bolusanthus speciosus (Bolus) Harms		1		1										1		3	3	1	
Burkea africana Hook.	1	1		1	1	1										5	5	1	
Caesalpinia pulcherrima (L.) Sw.*	1	1												1		3	3	1	1
Cajanus cajan (L.) Millsp.*	1	1	1													3	3	1	1
Calobota sericea (Ait.) Boatwr. & B.-E.van Wyk		1	1		1											3	3	1	
Calpurnia aurea (Aiton) Benth.		1												1		2		1	
Calpurnia glabrata Brummitt		1														1		1	
Calpurnia intrusa (R.Br. in W.T.Aiton) E. Mey.		1														1		1	
Calpurnia sericea Harv.		1														1	5	1	
Canavalia ensiformis (L.) DC.	1	1														2		1	
Canavalia gladiata (Jacq.) DC.*	1	1														2		1	1
Canavalia rosea (Sw.) DC.		1														1		1	
Canavalia virosa (Roxb.) Wight & Arn.	1															1	6	1	
Cassia abbreviata Oliv.		1	1													2	2	1	
Ceratonia siliqua L.*	1													1		2	2	1	1
Chamaecrista absus (L.) Irwin & Barneby		1														1		1	
Chamaecrista biensis (Steyaert) Lock	1	1	1													3		1	
Chamaecrista falcinella (Oliv.) Lock		1														1		1	
Chamaecrista mimosoides (L.) Greene	1	1	1													3		1	
Chamaecrista plumosa E.Mey.		1	1													2		1	
Chamaecrista stricta E.Mey.		1														1	11	1	
Clitoria ternatea L.*		1													1	2	2	1	1
Colophospermum mopane (J.Kirk ex Benth.) J.Kirk ex J.Léonard		1	1	1	1							1				5	5	1	
Cordyla africana Lour.	1	1	1													3	3	1	
Craibia zimmermannii (Harms) Dunn				1												1	1	1	
Crotalaria agatiflora Schweinf.*														1		1		1	1

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Appendix 1. (*continued*)

Indigenous and naturalised species with recorded uses in southern Africa	Food and drink	Medicine	Magic and charms	Timber	Firewood	Dyes, tans	Soap substitutes	Adhesives	Cordage	Beads	Weaving	Dental care	Fish poisons	Ornamentals	Pastures and cover crops	Total number of uses	Uses per genus	Number of useful spp.	Naturalised exotics
Crotalaria brevidens Benth.*		1												1		2		1	1
Crotalaria burkeana Benth.	1	1														2		1	
Crotalaria capensis Jacq.		1												1		2		1	
Crotalaria distans Benth.			1													1		1	
Crotalaria globifera E.Mey.		1														1		1	
Crotalaria juncea L.*		1													1	2		1	1
Crotalaria laburnifolia L.		1														1		1	
Crotalaria lanceolata E.Mey.			1													1		1	
Crotalaria natalitia Meisn.		1														1		1	
Crotalaria pallida Aiton		1	1													2	16	1	
Cullen tomentosum (Thunb.) J.W.Grimes	1	1														2	2	1	
Cyamopsis tetragonolobus (L.) Taub.	1							1								2	2	1	
Cyclopia aurescens Kies		1														1		1	
Cyclopia bowieana Harv.	1	1														2		1	
Cyclopia burtonii Hofmeyr & E.Phillips	1	1														2		1	
Cyclopia buxifolia (Burm.f.) Kies	1	1														2		1	
Cyclopia falcata (Harv.) Kies	1															1		1	
Cyclopia genistoides (L.) R.Br.	1	1														2		1	
Cyclopia intermedia E.Mey.	1	1														2		1	
Cyclopia longifolia Vogel	1	1														2		1	
Cyclopia maculata (Andrews) Kies	1	1														2		1	
Cyclopia meyeriana Walp.	1															1		1	
Cyclopia sessiliflora Eckl. & Zeyh.	1	1														2		1	
Cyclopia subternata Vogel	1	1														2	21	1	
Cytisus proliferus L.f.*														1	1	2		1	1
Cytisus scoparius (L.) Link.*		1												1		2	4	1	1
Dalbergia armata E.Mey.		1	1	1												3		1	
Dalbergia melanoxylon Guill. & Perr.		1		1												2		1	
Dalbergia nitidula Baker		1	1	1												3		1	
Dalbergia obovata E.Mey.		1	1	1					1		1					5		1	
Dalbergia sissoo Roxb.*		1												1		2	15	1	1
Decorsea schlechteri (Harms) Verdc.		1														1	1	1	
Derris trifoliata Lour.		1														1	1	1	
Desmanthus virgatus (L.) Willd.															1	1	1	1	
Desmodium adscendens (Sw.) DC.		1														1		1	
Desmodium barbatum (L.) Benth.		1	1													2		1	
Desmodium gangeticum (L.) DC.		1														1		1	
Desmodium incanum DC.		1														1		1	
Desmodium repandum (Vahl) DC.		1														1		1	
Desmodium salicifolium (Poir.) DC.		1														1		1	
Desmodium tortuosum (Sw.) DC.		1														1		1	
Desmodium uncinatum (Sw.) DC.*														1		1		1	1
Desmodium velutinum (Willd.) DC.		1														1	10	1	
Dialium englerianum Henriq.	1	1		1						1						4		1	
Dialium schlechteri Harms	1	1		1												3	7	1	
Dichilus strictus E.Mey.		1	1													2	2	1	
Dichrostachys cinerea (L.) Wight & Arn.	1	1	1	1	1				1							6	6	1	
Dipogon lignosus (L.) Verdc.	1													1		2	2	1	
Dolichos angustissimus E.Mey.	1		1						1							3		1	
Dolichos pratensis (E.Mey.) Taub.			1													1		1	
Dolichos sericeus E.Mey.		1														1	5	1	
Dumasia villosa DC.		1														1	1	1	
Elephantorrhiza burkei Benth.		1				1										2		1	

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Appendix 1. (*continued*)

Indigenous and naturalised species with recorded uses in southern Africa	Food and drink	Medicine	Magic and charms	Timber	Firewood	Dyes, tans	Soap substitutes	Adhesives	Cordage	Beads	Weaving	Dental care	Fish poisons	Ornamentals	Pastures and cover crops	Total number of uses	Uses per genus	Number of useful spp.	Naturalised exotics
Elephantorrhiza elephantina (Burch.) Skeels	1	1	1			1										4		1	
Elephantorrhiza goetzei (Harms) Harms		1														1		1	
Elephantorrhiza praetermissa J.H.Ross		1			1					1						3		1	
Elephantorrhiza suffruticosa Schinz		1				1										2	12	1	
Entada natalensis Benth.		1								1						2		1	
Entada rheedii Spreng.		1	1						1	1						4	6	1	
Eriosema cordatum E.Mey.	1	1														2		1	
Eriosema distinctum N.E.Br.		1														1		1	
Eriosema ellipticifolium Schinz	1															1		1	
Eriosema nutans Schinz	1															1		1	
Eriosema parviflorum E.Mey.		1														1		1	
Eriosema psoraleoides (Lam.) G.Don	1	1														2		1	
Eriosema rossii C.H.Stirt.		1														1		1	
Eriosema salignum E.Mey.	1	1														2		1	
Eriosema squarrosum (Thunb.) Walp.		1														1	12	1	
Erythrina acanthocarpa E.Mey.			1						1							2		1	
Erythrina caffra Thunb.		1	1	1						1				1		5		1	
Erythrina decora Harms		1														1		1	
Erythrina humeana Spreng.		1														1		1	
Erythrina latissima E.Mey.		1	1													2		1	
Erythrina lysistemon Hutch.		1	1	1						1				1		5		1	
Erythrina zeyheri Harv.		1	1							1						3	19	1	
Erythrophleum africanum (Welw. ex Benth.) Harms				1	1											2		1	
Erythrophleum lasianthum Corbishley		1	1	1												3	5	1	
Euchlora hirsuta (Thunb.) Druce					1											1	1	1	
Faidherbia albida (Delile) A.Chev.	1	1	1	1	1							1		1		7	7	1	
Flemingia grahamiana Wight & Arn.		1														1	1	1	
Genista monspessulana (L.) Wight & Arn.*														1		1	1	1	1
Gleditsia triacanthos L.*	1	1												1		3	3	1	1
Glycyrrhiza glabra L.*	1	1														2	2	1	1
Guibourtia coleosperma (Benth.) J.Léonard	1	1		1	1											4	4	1	
Guilandina bonduc L.		1	1							1						3	3	1	
Indigastrum argyraeum (Eckl. & Zeyh.) Schrire		1														1		1	
Indigastrum fastigiatum (E.Mey.) Schrire		1	1													2	3	1	
Indigofera alternans DC.	1															1		1	
Indigofera arrecta Hochst. ex A.Rich.		1				1										2		1	
Indigofera astragalina DC.		1	1													2		1	
Indigofera bainesii Baker		1														1		1	
Indigofera circinnata Benth. ex Harv.		1														1		1	
Indigofera confusa Prain & Baker f.						1										1		1	
Indigofera cryptantha Benth. ex Harv.		1														1		1	
Indigofera daleoides Benth. ex Harv.			1									1				2		1	
Indigofera dimidiata Vogel ex Walp.		1	1													2		1	
Indigofera eriocarpa E.Mey.		1														1		1	
Indigofera flavicans Baker		1	1													2		1	
Indigofera frutescens L.f.		1														1		1	
Indigofera hedyantha Eckl. & Zeyh.		1	1													2		1	
Indigofera hilaris Eckl. & Zeyh.	1	1														2		1	
Indigofera hirsuta L.		1														1		1	
Indigofera jucunda L.		1												1		2		1	
Indigofera lupatana Baker f.		1														1		1	
Indigofera lyalli Baker		1														1		1	
Indigofera melanadenia Benth. ex Harv.		1														1		1	

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Appendix 1. (*continued*)

Indigenous and naturalised species with recorded uses in southern Africa	Food and drink	Medicine	Magic and charms	Timber	Firewood	Dyes, tans	Soap substitutes	Adhesives	Cordage	Beads	Weaving	Dental care	Fish poisons	Ornamentals	Pastures and cover crops	Total number of uses	Uses per genus	Number of useful spp.	Naturalised exotics
Indigofera micrantha E.Mey.		1														1		1	
Indigofera nigromontana Eckl. & Zeyh.		1	1													2		1	
Indigofera oxytropis Benth ex Harv.		1														1		1	
Indigofera sessilifolia DC.		1														1		1	
Indigofera spicata Forssk.		1														1		1	
Indigofera swaziensis Bolus		1														1		1	
Indigofera tenuissima E.Mey.		1														1		1	
Indigofera tinctoria L.		1				1										2		1	
Indigofera tristis E.Mey.		1														1		1	
Indigofera tristoides N.E.Br.		1	1													2		1	
Indigofera trita L.f.		1														1		1	
Indigofera velutina E.Mey.		1														1		1	
Indigofera vicioides Jaub. & Spach		1														1		1	
Indigofera zeyheri Spreng. ex. Eckl. & Zeyh.		1														1	44	1	
Lablab purpureus (L.) Sweet	1	1	1												1	4	4	1	
Lathyrus latifolius L.*														1		1	1	1	1
Leobordea carinata (E.Mey.) B.-E.van Wyk & Boatwr.		1														1		1	
Leobordea corymbosa (E.Mey.) B.-E.van Wyk & Boatwr.		1	1													2		1	
Leobordea decumbens (Thunb.) B.-E.van Wyk & Boatwr.		1														1		1	
Leobordea divaricata Eckl. & Zeyh.		1														1		1	
Leobordea eriantha (Benth.) B.-E.van Wyk & Boatwr.			1													1		1	
Leobordea foliosa (Bolus) B.-E.van Wyk & Boatwr.			1													1		1	
Leobordea lanceolata (E.Mey.) B.-E.van Wyk & Boatwr.		1						1								2		1	
Leobordea mucronata (Conrath) B.-E.van Wyk & Boatwr.		1														1	10	1	
Lessertia argentea Harv.		1														1		1	
Lessertia canescens Goldblatt & J.C.Manning	1	1														2		1	
Lessertia frutescens (L.) Goldblatt & J.C. Manning	1	1												1		3		1	
Lessertia inflata Harv.		1														1		1	
Lessertia macrostachya DC.		1														1		1	
Lessertia perennans (Jacq.) DC.		1	1													2		1	
Lessertia prostata DC.		1														1		1	
Lessertia stricta L.Bolus		1														1		1	
Lessertia tomentosa DC.		1														1	13	1	
Lespedeza cuneata (Dum. Lam.) G.Don*															1	1	1	1	1
Leucaena leucocephala (Lam.) de Wit*		1	1		1									1	1	5	5	1	1
Listia bainesii (Bak.) B.-E.van Wyk & Boatwr.															1	1	1	1	
Lotononis laxa Eckl. & Zeyh.		1														1		1	
Lotononis macrosepala Conrath		1														1		1	
Lotononis sericophylla Benth.		1														1		1	
Lotononis viminea (E.Mey.) B.-E.van Wyk			1													1	4	1	
Lotus corniculatus L.*		1													1	2		1	1
Lotus berthelotii Masf.*														1		1		1	1
Lotus discolor E.Mey.		1														1		1	
Lotus subbiflorus Lag.*															1	1	5		1
Lupinus angustifolius L.*															1	1		1	1
Lupinus luteus L.*															1	1		1	1
Lupinus pilosus L.*															1	1		1	1
Lupinus varius L.*															1	1	4	1	1
Macroptilium atropurpureum (DC.) Urb.*															1	1	1	1	1
Macrotyloma axillare (E.Mey.) Verdc.		1													1	2	2	1	
Medicago falcata L.*															1	1		1	1
Medicago laciniata (L.) Mill.*			1												1	2		1	1
Medicago lupulina L.*															1	1		1	1

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Appendix 1. (*continued*)

Indigenous and naturalised species with recorded uses in southern Africa	Food and drink	Medicine	Magic and charms	Timber	Firewood	Dyes, tans	Soap substitutes	Adhesives	Cordage	Beads	Weaving	Dental care	Fish poisons	Ornamentals	Pastures and cover crops	Total number of uses	Uses per genus	Number of useful spp.	Naturalised exotics
Medicago polymorpha L.*		1													1	2		1	1
Medicago sativa L.*	1	1													1	3		1	1
Medicago truncatula Gaertn.*															1	1	10	1	1
Melilotus albus (L.) All.*															1	1		1	1
Melilotus indica (L.) All.*		1													1	2		1	1
Melilotus officinalis (L.) Pall.*		1													1	2	5	1	1
Melolobium alpinum Eckl. & Zeyh.		1	1													2		1	
Melolobium calycinum Benth.		1														1		1	
Melolobium microphyllum (L.f.) Eckl. & Zeyh.		1	1													2	5	1	
Millettia grandis (E.Mey.) Skeels		1	1	1										1		4		1	
Millettia stuhlmannii Taub.		1	1	1												3	7	1	
Mimosa pigra L.*		1	1													2		1	1
Mimosa pudica L.*		1												1		2	4	1	1
Mucuna coriacea Baker		1														1		1	
Mucuna gigantea (Willd.) DC.		1														1		1	
Mucuna pruriens (L.) DC.		1	1													2	4	1	
Mundulea sericea (Willd.) A.Chev.		1	1	1									1			4	4	1	
Neonotonia wightii (R.Grah. ex Wight & Arn.) J.A.Lackey		1														1	1	1	
Neorautanenia mitis (A.Rich.) Verdc.	1	1	1										1			4	4	1	
Neptunia oleracea Lour.	1															1	1	1	
Newtonia hildebrandtii (Vatke) Torre		1	1													2	2	1	
Ormocarpum kirkii S.Moore		1	1													2		1	
Ormocarpum trichocarpum (Taub.) Engl.	1	1	1													3	5	1	
Ornitopus perpusillus L.*															1	1		1	1
Ornitopus pinnatus Brot.*															1	1		1	1
Ornitopus sativus Brot.*															1	1	3	1	1
Otholobium arborescens C.H.Stirt		1														1		1	
Otholobium bracteolatum (Eckl. & Zeyh.) C.H.Stirt		1														1		1	
Otholobium polystictum (Benth. ex Harv.) C.H.Stirt.		1	1													2		1	
Otholobium virgatum (Burm.f.) C.H.Stirt.		1														1	5	1	
Otoptera burchellii DC.		1														1	1	1	
Paraserianthes lophantha (Willd.) I.C.Nielsen*		1			1									1		3	3	1	1
Parkinsonia aculeata L.*		1	1	1										1		4		1	1
Parkinsonia africana Sond.	1	1														2	6	1	
Peltophorum africanum Sond.	1	1	1	1	1				1					1		7	7	1	
Philenoptera bussei (Schinz) Schrire		1														1		1	
Philenoptera nelsii (Schinz) Schrire	1	1		1								1	1			5		1	
Philenoptera sutherlandii (Harv.) Schrire		1														1		1	
Philenoptera violacea (Klotzsch) Schrire	1	1	1	1												4	11	1	
Piliostigma thonningii (Schumach.) Milne-Redh.	1	1	1	1	1	1	1		1							8	8	1	
Podalyria calyptrata (Retz.) Willd.														1		1		1	
Podalyria sericea (Andrews) R.Br.														1		1	2	1	
Pomaria burchellii (DC.) B.B.Simpson & G.P.Lewis	1	1	1													3		1	
Pomaria sandersonii (Harv.) B.B.Simpson & G.P.Lewis		1														1	4	1	
Prosopis chilensis (Molina) Stuntz*					1										1	2			1
Prosopis glandulosa Torr.*	1	1			1									1	1	5		1	1
Prosopis pubescens Benth.*					1										1	2			1
Prosopis glandulosa Wooton*					1										1	2	11		1
Pseudarthria hookeri Wight & Arn.		1														1	1	1	
Psoralea aphylla L.		1														1		1	
Psoralea glaucina Harv.		1														1		1	
Psoralea oligophylla Eckl. & Zeyh.		1														1		1	
Psoralea pinnata L.		1			1											2	5	1	

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Appendix 1. (*continued*)

Indigenous and naturalised species with recorded uses in southern Africa	Food and drink	Medicine	Magic and charms	Timber	Firewood	Dyes, tans	Soap substitutes	Adhesives	Cordage	Beads	Weaving	Dental care	Fish poisons	Ornamentals	Pastures and cover crops	Total number of uses	Uses per genus	Number of useful spp.	Naturalised exotics
Pterocarpus angolensis DC.		1	1	1		1										4		1	
Pterocarpus lucens Lepr. ex Guill. & Perr.		1		1												2		1	
Pterocarpus rotundifolius (Sond.) Druce		1		1												2	8	1	
Pterolobium stellatum (Forssk.) Brenan		1														1	1	1	
Rafnia acuminata (E.Mey.) G.J.Campbell & B.-E.van Wyk	1															1		1	
Rafnia amplexicaulis (L.) Thunb.	1	1														2		1	
Rafnia angulata Thunb.	1															1		1	
Rafnia perfoliata E.Mey.		1														1		1	
Rafnia triflora Thunb.	1															1	6	1	
Rhynchosia adenodes Eckl. & Zeyh.		1														1		1	
Rhynchosia angulosa Schinz		1														1		1	
Rhynchosia caribaea (Jacq.) DC.	1	1					1									3		1	
Rhynchosia hirsuta Eckl. & Zeyh.	1															1		1	
Rhynchosia hirta (Andrews) Meikle & Verdc.		1														1		1	
Rhynchosia holosericea Schinz		1														1		1	
Rhynchosia komatiensis Harms		1														1		1	
Rhynchosia minima (L.) DC.		1														1		1	
Rhynchosia monophylla Schltr.		1	1													2		1	
Rhynchosia nervosa Benth. & Harv.		1	1													2		1	
Rhynchosia resinosa (A.Rich.) Baker		1														1		1	
Rhynchosia sublobata (Schumach.) Meikle		1														1		1	
Rhynchosia totta (Thunb.) DC.	1	1	1													3		1	
Rhynchosia vendae C.H.Stirt.		1														1	20	1	
Robinia pseudoacacia L.*		1		1	1									1		4	4	1	1
Schotia afra (L.) Thunb.	1	1			1											3		1	
Schotia brachypetala Sond.	1	1	1	1	1	1								1		7		1	
Schotia capitata Bolle		1	1													2		1	
Schotia latifolia Jacq.	1															1	13	1	
Senegalia ataxacantha (DC.) Kyal. & Boatwr.	1	1	1	1	1						1					6		1	
Senegalia brevispica (Harms) Seigler & Ebinger		1														1		1	
Senegalia burkei (Benth.) Kyal. & Boatwr.		1		1	1											3		1	
Senegalia caffra (Thunb.) P.J.H.Hurter & Mabb.	1	1	1	1	1											5		1	
Senegalia erubescens (Welw. ex Oliv.) Kyal. & Boatwr.	1	1														2		1	
Senegalia fleckii (Schinz) Boatwr.	1	1							1							3		1	
Senegalia galpinii (Burtt) Davy Seigler & Ebinger				1	1				1					1		4		1	
Senegalia hereroensis (Engl.) Kyal. & Boatwr.		1														1		1	
Senegalia mellifera (Vahl) Seigler & Ebinger	1	1	1	1	1			1				1				7		1	
Senegalia nigrescens (Oliv.) P.J.H.Hurter	1	1	1	1	1	1			1							7		1	
Senegalia polyacantha (Willd.) Seigler & Ebinger	1	1	1													3		1	
Senegalia schweinfurthii (Brenan & Exell) Seigler & Ebinger		1														1		1	
Senegalia senegal (L.) Britton	1	1														2	45	1	
Senna bicapsularis (L.) Roxb.*		1												1		2		1	1
Senna corymbosa (Lam.) Irwin & Barneby*														1		1		1	1
Senna didymobotrya (Fresen.) Irwin & Barneby*		1												1		2		1	1
Senna × floribunda (Cav.) Irwin & Barneby*		1												1		2		1	1
Senna hirsuta (L.) Irwin & Barneby*		1												1		2		1	1
Senna italica Mill.		1														1		1	
Senna multiglandulosa (Jacq.) Irwin & Barneby*														1		1		1	1
Senna multijuga (Rich.) Irwin & Barneby*		1												1		2		1	1
Senna obtusifolia (L.) Irwin & Barneby*		1												1		2		1	1
Senna occidentalis (L.) Link.*	1	1	1											1		4		1	1
Senna petersiana (Bolle) Lock	1	1	1													3		1	
Senna septemtrionalis (Viv.) Irwin & Barneby*		1	1											1		3		1	1

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Appendix 1. (*continued*)

Indigenous and naturalised species with recorded uses in southern Africa	Food and drink	Medicine	Magic and charms	Timber	Firewood	Dyes, tans	Soap substitutes	Adhesives	Cordage	Beads	Weaving	Dental care	Fish poisons	Ornamentals	Pastures and cover crops	Total number of uses	Uses per genus	Number of useful spp.	Naturalised exotics
Senna siamea (Lam.) Irwin Barneby*		1												1		2		1	1
Senna singueana (Delile) Lock	1															1		1	
Senna sophera (L.) Roxb.*		1												1		2		1	1
Senna spectabilis (DC.) Irwin & Barneby*														1		1	31	1	1
Sesbania bispinosa (Jacq.) W.Wight*		1												1		2		1	1
Sesbania microphylla Harms	1															1		1	
Sesbania pachycarpa DC.	1															1		1	
Sesbania punicea (Cav.) Benth.*														1		1		1	1
Sesbania sesban (L.) Merr.		1	1				1									3		1	
Sesbania sphaerosperma Welw.	1															1		1	
Sesbania tetraptera Hochst. ex Baker		1														1		1	
Sesbania virgata (Cav.) Pers.*														1		1	11	1	1
Spartium junceum L.*														1		1	1	1	1
Sphenostylis angustifolia Sond.		1														1		1	
Sphenostylis marginata E.Mey.	1	1														2	3	1	
Stylosanthes fruticosa (Retz.) Alston		1	1													2	2	1	
Styphnolobium japonicum (L.) Schott*		1												1		2	2	1	1
Tamarindus indica L.*	1	1	1											1		4	4	1	1
Tephrosia acaciifolia Baker		1														1		1	
Tephrosia aequilata Baker		1														1		1	
Tephrosia capensis (Jacq.) Pers.		1														1		1	
Tephrosia dregeana E.Mey.	1															1		1	
Tephrosia elongata E.Mey.		1														1		1	
Tephrosia grandiflora (Aiton) Pers.		1											1	1		3		1	
Tephrosia kraussiana Meisn.		1	1													2		1	
Tephrosia linearis (Willd.) Pers.		1														1		1	
Tephrosia longipes Meisn.		1	1													2		1	
Tephrosia lupinifolia DC.		1	1									1				3		1	
Tephrosia macropoda (E.Mey.) Harv.		1											1			2		1	
Tephrosia marginella H.M.L.Forbes		1														1		1	
Tephrosia noctiflora Bojer ex Baker		1														1		1	
Tephrosia pumila (Lam.) Pers.		1														1		1	
Tephrosia purpurea (L.) Pers.*		1														1		1	1
Tephrosia radicans Baker		1														1		1	
Tephrosia semiglabra Sond.		1														1		1	
Tephrosia uniflora Pers.		1														1		1	
Tephrosia villosa (L.) Pers.		1														1		1	
Tephrosia vogelii Hook.f.		1											1			2		1	
Tephrosia zoutpansbergensis Bremek.		1														1	29	1	
Tipuana tipu (Benth.) Kuntze*														1		1	1	1	1
Trifolium africanum Ser.	1	1	1													3		1	
Trifolium angustifolium L.*															1	1		1	1
Trifolium arvense L.*		1													1	2		1	1
Trifolium burchellianum Ser.	1	1	1													3		1	
Trifolium campestre Schreb.*															1	1		1	1
Trifolium cernuum Brot.*															1	1		1	1
Trifolium clusii Godr. & Gren.*															1	1		1	1
Trifolium dubium Sibth.*															1	1		1	1
Trifolium glomeratum L.*															1	1		1	1
Trifolium hybridum L.*															1	1		1	1
Trifolium incarnatum L.*															1	1		1	1
Trifolium medium L.*															1	1		1	1
Trifolium pratense L.*		1													1	2		1	1

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Appendix 1. (*continued*)

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Trifolium repens L.*															1	1		1	1
Trifolium resupinatum L.*															1	1		1	1
Trifolium subterraneum L.*															1	1		1	1
Trifolium suffocatum L.*															1	1		1	1
Trifolium tomentosum L.*															1	1	24	1	1
Trigonella hamosa L.*															1	1		1	1
Trigonella foenum-graecum L.*		1													1	2	3	1	1
Tylosema esculentum (Burch.) A.Schreib.	1									1						2		1	
Tylosema fassoglense (Schweinf.) Torre & Hillc.	1	1								1						3	5	1	
Ulex europaeus L.*														1		1	1	1	1
Umtiza listeriana Sim		1	1	1												3	3	1	
Vachellia arenaria		1							1							2		1	
Vachellia erioloba (E.Mey.) P.J.H.Hurter	1	1	1	1	1					1						6		1	
Vachellia gerrardii (Benth.) P.J.H.Hurter		1	1													2		1	
Vachellia haematoxylon (Willd.) Seigler & Ebinger	1				1											2		1	
Vachellia hebeclada (DC.) Kyal. & Boatwr.	1	1								1						3		1	
Vachellia karroo (Hayne) Banfi & Gallaso	1	1	1	1	1	1			1					1		8		1	
Vachellia kirkii (Oliv.) Kyal. & Boatwr.	1	1														2		1	
Vachellia luederitzii (Engl.) Kyal. & Boatwr.	1	1				1			1							4		1	
Vachellia nebrownii (Burtt Davy) Seigler & Ebinger	1															1		1	
Vachellia nilotica (L.) P.J.H.Hurter & Mabb.	1	1	1	1	1	1			1							7		1	
Vachellia reficiens (Wawra) Kyal. & Boatwr.	1	1														2		1	
Vachellia rehmanniana (Schinz) Kyal. & Boatwr.		1			1				1							3		1	
Vachellia robusta (Burch.) Kyal. & Boatwr.	1	1	1	1	1	1			1							7		1	
Vachellia sieberiana (DC.) Kyal. & Boatwr.	1	1		1					1					1		5		1	
Vachellia tortilis (Forssk.) Gallaso & Banfi	1	1	1	1	1				1							6		1	
Vachellia xanthophloea Benth.		1	1	1										1		4	64	1	
Vicia benghalensis L.*															1	1		1	1
Vicia cracca L.*															1	1		1	1
Vicia hirsuta (L.) Gray*															1	1		1	1
Vicia sativa L.*															1	1		1	1
Vicia tetrasperma Moench*															1	1		1	1
Vicia villosa Roth.*															1	1	6	1	1
Vigna frutescens A.Rich.	1															1		1	
Vigna luteola (Jacq.) Benth.	1	1	1													3		1	
Vigna marina (Burm.) Merr.			1													1		1	
Vigna oblongifolia A.Rich.	1															1		1	
Vigna subterranea (L.) Verdc.	1															1		1	
Vigna unguiculata (L.) Walp.	1	1	1												1	4		1	
Vigna vexillata (L.) A.Rich.	1	1	1													3	14	1	
Virgilia oroboides (P.J.Bergius) T.M.Salter	1			1										1		3		1	
Virgilia divaricata Adamson	1			1										1		3	6	1	
Xanthocercis zambesiaca (Baker) Dumaz-le-Grand	1	1		1												3	3	1	
Xeroderris stuhlmannii (Taub.) Mendonça & E.C.Sousa	1	1		1		1										4	4	1	
Zornia capensis Pers.		1	1													2		1	
Zornia glochidiata DC.		1														1		1	
Zornia milneana Mohlenbr.		1														1	4	1	
Total number of species:	127	338	113	59	43	21	6	5	20	14	6	7	6	85	57			465	128