CLASSIFICATION AND DESCRIPTION OF A COLLECTION OF THE LEGUME GENUS *AESCHYNOMENE*

H. G. BISHOP[1], B. C. PENGELLY[2] and D. H. LUDKE[3]

[1] Queensland Department of Primary Industries, P.O. Box 668, Mackay, Qld 4740.
[2] CSIRO Division of Tropical Crops and Pastures, Samford Pasture Research Station, Samford, Qld 4250.
[3] 9 Ingram Street, Park Avenue, North Rockhampton, Qld 4701—previously Department of Primary Industries, Mackay.

ABSTRACT

A collection of 316 accessions, representing 29 species, of the tropical legume genus Aeschynomene *was grown and described at Mackay (21°10′S 140°10′E), Queensland, and classified on morphologic and agronomic attributes. The 2 largest species were* A. americana *(146 accessions divided into 6 groups) and* A. villosa *(58 accessions divided into 7 groups). Another 8 species were each represented by fewer than 4 accessions and 10 species each represented by only 1 accession. Most accessions were of American origin and only 10 accessions (from 7 species) were African. The classification techniques successfully divided a large collection of accessions into groups to aid further evaluation. A total of 55* Aeschynomene *groups were distinguished. The groups and main characteristics of individual accessions are tabulated. Wide diversity within and between the* Aeschynomene *species should provide more pasture cultivars from this genus, with accessions potentially adapted to high and low rainfall, seasonally waterlogged and swampy sites, and to heavy grazing.*

RESUMEN

Una colección de 316 accesiones, representando 29 especies, de la leguminosa tropical del género Aeschynomene *fue cultivada, descrita y clasificada por sus atributos morfológicos y agronómicos en Mackay (21°10′S-140°10′E), Queensland. Las 2 especies con más entradas fueron* A. americana *(146 accesiones divididas en 6 grupos) y* A. villosa *(58 accesiones divididas en 7 grupos). Otras 8 especies fueron representadas por menos de 4 accesiones y 10 especies fueron representadas solamente por 1 accesión. La mayoria de accesiones son de origen Americano y solo 10 accesiones (de 7 especies) provienen de Africa.*

Las técnicas de clasificación utilizadas exitosamente dividieron esta colección grande en grupos para facilitar evaluaciones futuras. Un total de 55 grupos de Aeschynomene *fueron distinguidos. La tabulación de las principales caracteristicas de las accesiones individuales y los grupos, muestra la amplia diversidad dentro y entre las especies de* Aeschynomene, *lo que debería ser base para seleccionar más cultivares forrajeros de este género adaptados a altas y bajas precipitaciones, inundaciones estacionales, sitios cenagosos y pastoreo pesado.*

INTRODUCTION

Aeschynomene is chiefly a tropical genus. In the Americas it occurs from 40°N to 35°S along the Atlantic coast and from 28°N to 17°S on the Pacific coast. Rudd (1955; 1959a) listed 67 *Aeschynomene* species of American origin in 2 sections and 8 series, as represented by Kretschmer *et al.* (1980) and shown in Table 1.

Greatest species diversity occurs in Africa (Rudd 1955) but a complete inventory of the African species is not available. Gillett *et al.* (1971) recorded 45 species occurring in East Africa, 43 of which are not found in the Americas. Seven species occur in Malaysia (Rudd 1959b), but only 1 (*A. aspera*) is truly native. In Australia, only *A. brevifolia* is regarded as native (Rudd 1955); *A. indica* and *A. villosa* are probably introduced. However, Verdcourt (1979) suggests *A. indica* is native to Papua New Guinea.

About half of the species within the genus are hydrophytes, occurring in marshes, rice paddies, wet meadows, and along stream banks (Rudd 1955). The others are more xeric, growing in savanna, pine barrens, oak woods, on rocky hillsides, sandy beaches or in dry waste places.

Although initially regarded as unimportant as forage plants (Rudd 1955), *Aeschynomene* has been used for hay in Ceylon (Paul 1951) and green manure in India (Sing 1968). A selection of *A. americana* is used as a pasture legume in Florida (USA) (Hodges *et al.* 1982) and collections of the genus have been grown, described and evaluated (Kretschmer *et al.* 1980; Quesenberry and Ocumpauch 1981; and Kretschmer and Snyder 1981). Two commercial cultivars, *A. falcata* cv. Bargoo (Wilson 1980) and *A. americana* cv. Glenn (Bishop *et al.* 1985a), are now in use in Australia.

A wide range of material from overseas collections has been introduced into Australia during the past 30 years. All available accessions were assembled and grown at Mackay, Queensland. This paper presents the agronomic and morphological data collected and discusses the characterisation and classification of the accessions into groups to aid future evaluation programmes.

TABLE 1

List of sections and series, major distribution, and brief description of American Aeschynomene *spp. Species grown at Mackay are listed in brackets () under series name*

Sections and series	No. of species	Major distribution	Brief description
Section: Aeschynomene (*A. aspera* is the genus and section type plant)			
Series 1. Americanae (*A. americana, A. villosa*)	4	Mexico	mostly amphibious, somewhat flexible adaphic requirements
Series 2. Fluminensis (*A. parviflora)*	2	Caribbean, east and central South America	wet soil areas
Series 3. Montevidensis (*A. filosa*)	8	Eastern Brazil to Buenos Aires	erect herbs or shrubs, swampy areas
Series 4. Sensitiva (*A. deamii, A. sensitiva*)	4	Guatemala to South Brazil	erect herbs, wet soil areas
Series 5. Indicae (*A. ciliata, A. denticulata, A. evenia, A. indica, A. scabra, A. rudis, A. virginica*)	11	Widespread from latitudinal extremes	erect herbs, predominantly coastal, tidal and other marshes and wet areas
Section: Ochopodium (*A. falcata* is the section type plant)			
Series 6. Viscidulae (*A. brasiliana, A. brevifolia, A. elegans, A. falcata, A. histrix*)	12	Mexico, eastern South America to Argentina	mesophytes, prostrate to suberect herbaceous or suffrutescent perennials
Series 7. Pleuronerviae (*A. brevipes, A. fascicularis, A. paniculata, A. pinetorum*)	15	California, Caribbean and Brazil highlands	shrubby, mesic to subxeric
Series 8. Scopariae	18	California, Mexico to Highlands of Peru, Brazil and Guiana	shrubby, mesic to subxeric

MATERIALS AND METHODS

Evaluation was in 2 stages. The major assessment of 284 accessions was grown in 1982 (Experiment A) and an additional 48 accessions were grown at a different site in 1986 (Experiment B).

Experiment A

Seedlings were raised in peat pots in the glasshouse and transplanted at 2 weeks into a cultivated seedbed during the first week of January 1982. The site (21°10′S, 149°10′E, elevation 5 m) was flat with a shallow, loamy-surfaced duplex soil (Dy 3.41), and an average annual rainfall of 1670 mm. Each plot was a single row of 5 plants spaced 40 cm apart with 1.5 m between rows and there were 2 replicates. A mixed *Aeschynomene* inoculum was watered on before transplanting and 20 kg/ha phosphorus applied 4 weeks after transplanting. Irrigation was applied to aid establishment, and plots were hand-weeded.

Characters recorded every 4 weeks included vigour, greenness, perenniality, insect and disease damage. Flowering (days from Jan. 1) was recorded twice per week. Morphological characters such as stem and leaf hairs, stem and leaf colour, stem thickness and hardness, plant habit, plant height and width, and rooting from lower branches, were recorded when the majority of accessions were flowering. Seed characters such as seed retention, potential seed yield and 1000-seed weight were recorded subsequently. Characters used in the classification analysis are shown in Table 2.

TABLE 2

Characters used in classification analysis

Character	Observation
Agronomic	
Days to first flower	Date when 50% of plants commenced flowering.
Days to first ripe seed	Date when 50% of plants carried ripe pods.
Seed set	Rating 1–4 scale; 1 = very poor, 4 = good.
Seed retention	Rating 1–4 scale; 1 = very poor, 4 = good.
1000-seed weight (g)	Air dried
Perenniation (%)	Percentage of crowns surviving 12 months after planting.
Leaf/stem ratio (%)	Visual estimate to nearest 5% at flowering.
Powdery mildew disease	Susceptibility rating 1–5 scale; 1 = no effect, 5 = very severe.
Anthracnose disease	Susceptibility rating 1–4 scale; 1 = no effect, 4 = dead.
Gross Morphology	
Habit	Erect, semi-erect, ascendent, decumbent, prostrate, shrubby, trailing.
Plant height (cm)	Maximum attained.
Plant width (cm)	Maximum attained.

Numerical Methods

The mixed data set was analysed using various programs available on the TAXON library (Ross 1983). The data set was converted to a matrix using the program MSED (Lance and Williams 1967). This matrix was then used in generating a hierachial classification using the intensely clustering strategy, SAHN (Lance and Williams 1966), and with program MST (Prim 1957) to generate a minimum spanning tree. The diagnostic program GCOM (Lance *et al.* 1968) was used to interpret the classification.

From previous experience, it was obvious that the initial set of 284 accessions would present problems in interpretation and presentation of the minimum spanning tree because of its size. It was difficult to decide on what basis to split the set. One option was to treat the 2 sections of the genus, Aeschynomene and Ochopodium, separately, but the section Aeschynomene would still be too large. It was finally decided to distinguish between *A. americana* accessions (126) and accessions of other species. (Nineteen *A. americana* accessions were also included in the latter group because they had similar attributes to some *A. villosa* accessions).

A hierachial classification and minimum spanning tree were constructed on each of the 2 data sets. As *A. villosa* was the best represented species in the 'other species' set of data, a hierachial classification and minimum spanning tree were also constructed on its 49 accessions.

Experiment B

In a second experiment in Mackay in January 1986, seedlings of 48 accessions were transplanted into a clay loam alluvial soil using unreplicated rows of 5 plants, 40 cm apart and 2.5 m between rows. Sufficient data was recorded for intuitive allocation of accessions to groups defined in the previous experiment and the accession data (annotated B) is included in Table 3.

RESULTS

A. americana

The SAHN dendogram for the 127 *A. americana* accessions is shown in Figure 1. Although SAHN is an agglomerative classification, we will, as is the convention, treat it as divisive in examining the groupings.

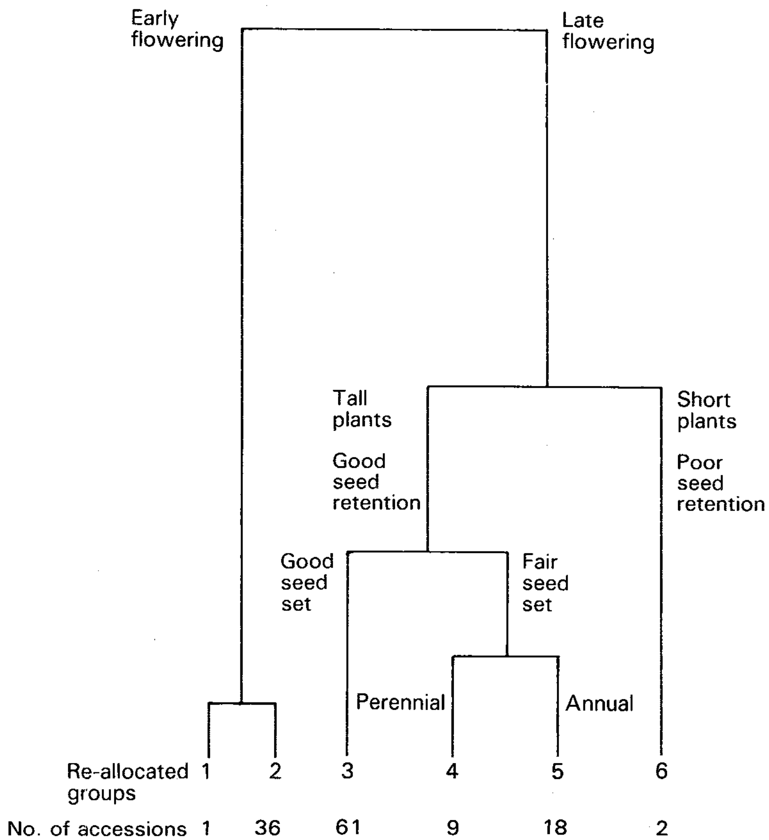

FIGURE 1

Hierachial Classifications of the *A. americana* accessions derived from SAHN analysis using attributes listed in Table 2. Main attributes contributing to SAHN divisions are listed on the dendrogram. Accessions in each group are identified in Table 3

The first division was on plant maturity with 37 members early maturing (mean first flowering < 80 days, mean first ripe seed < 113 days) and 90 members late maturing (mean first flowering > 122 days, mean first ripe seed > 170 days). Potential seed production also influenced this first division; early maturing members all had fair to good seed production potential. Subsequent splits were on attributes such as seed set and retention, perenniality and growth habit. Five groups were chosen as the most appropriate level of subdivision and this was increased to 6 groups after some re-allocation.

A minimum spanning tree was constructed to confirm the inter-relationships between the final groups. The tree revealed considerable diversity to Group 2 accessions and 1 accession with quite distinct features and located terminally on one of the Group 2 branches was re-allocated (Group 1), as in figure 1. The tree is not presented.

The *A. americana* groups and their distinguishing characteristics are: Group 1 (1 member)—very large seeded, early maturing with some perennation; Group 2 (36 members)—early flowering (mean 79 days), annuals; Group 3 (60 members)—good seed set and retention, mid season flowering (mean 118 days), annuals; Group 4 (9 members)—perennials, fair set and good seed retention, late flowering (mean 135 days); Group 5 (18 members)—poor or fair seed set and good retention, late flowering (mean 134 days), annuals; Group 6 (2 members)—low growing with poor seed retention, mid season flowering (mean 118 days), annuals. Of the 20 *A. americana* accessions grown in experiment B, 18 were allocated intuitively to Group 3, one to Group 2 and one to Group 5. Individual accessions showing group allocations and main characteristics are presented in Table 3.

Species other than A. americana

A minimum spanning tree of the 177 accessions from 23 species is shown in Figure 2. *A. villosa* is the best represented species (with 49 accessions) and is centrally situated on the tree, dividing a fairly loosely related group of early maturing, shrubby, mainly annual species on the left, from a closely related group of perennial species on the right. Accessions on the left are mainly Section Aeschynomene species and those on the right, Section Ochopodium species, as delineated in Table 1.

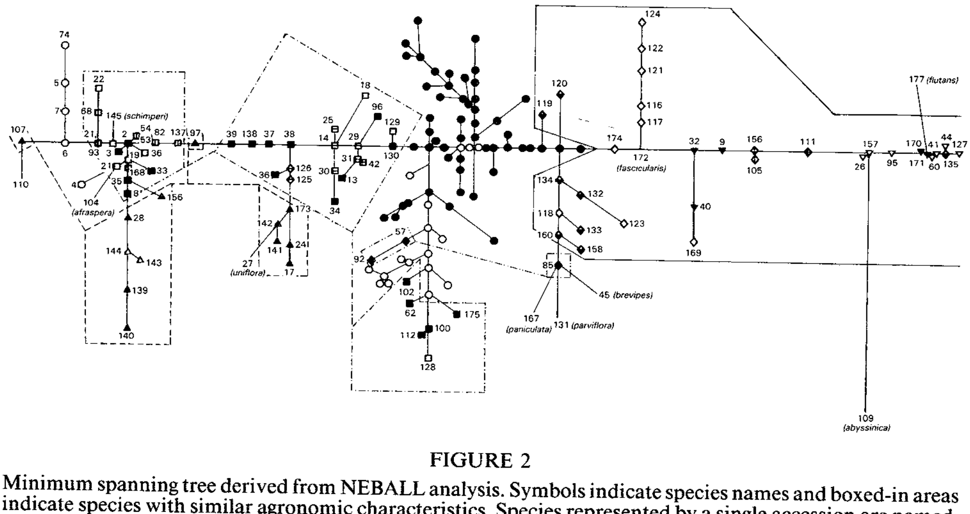

FIGURE 2
Minimum spanning tree derived from NEBALL analysis. Symbols indicate species names and boxed-in areas indicate species with similar agronomic characteristics. Species represented by a single accession are named. M-A groups within species are indicated in Table 3. *A. americana* (○) (accessions not identified); *A. brasiliana* (◇); *A. brevifolia* (◇); *A. ciliata* (◇); A. deamii (Δ); *A. denticulata* (□); *A. elegans* (▽); *A. evenia* (□); *A. falcata* (▼); *A. filosa* (◆); *A. histrix* (◇); *A. indica* (■); *A. scabra* (□); *A. sensitiva* (▲); *A. villosa* (●) (accessions not identified)

Of the Section Aeschynomene species, *A. indica* has 19 accessions; all are annuals but are diverse and scattered over 3 main areas of the tree. Closely related and inter-mingled with *A. indica* on the tree is *A. scabra* (7 accessions), *A. evenia* (8 accessions), *A. denticulata* (7 accessions), *A. ciliata* (2 accessions) and *A. filosa* (2 accessions). The other main species is *A. sensitiva* (11 accessions) and the closely related *A. deamii* (2 accessions). Most of the accessions from these 2 species are perennials but have similarities of plant habit (shrubby, thick stems), low leaf/stem ratios and early maturity. The 3 single accession species (*A. afraspera, A. uniflora* and *A. schimperi*) are annuals of African origin, have similar agronomic features, and are terminally located on branches on the left of the tree.

The perennial Section Ochopodium species (on the right of the tree) consist of *A. brasiliana* (9 accessions), *A. histrix* (8 accessions), *A. falcata* (5 accessions), *A. brevifolia* (3 accessions), *A. elegans* (8 accessions), *A. paniculata* (1 accession), *A. brevipes* (1 accession) and *A. fascicularis* (1 accession). Other perennial species on the right are 1 *A. filosa* accession, 1 *A. parviflora* accession (both Section Aeschynomene) and *A. flutans* and *A. abyssinica*, both of African origin. Allocation to groups and accession attributes are presented in Table 3.

A. villosa

The SAHN dendrogram of the *A. villosa* accessions is shown in Figure 3. The collection of this species also proved to be diverse. The classification was taken to 10 groups, but was subsequently reduced by re-allocation to 7 groups as indicated in Figure 3.

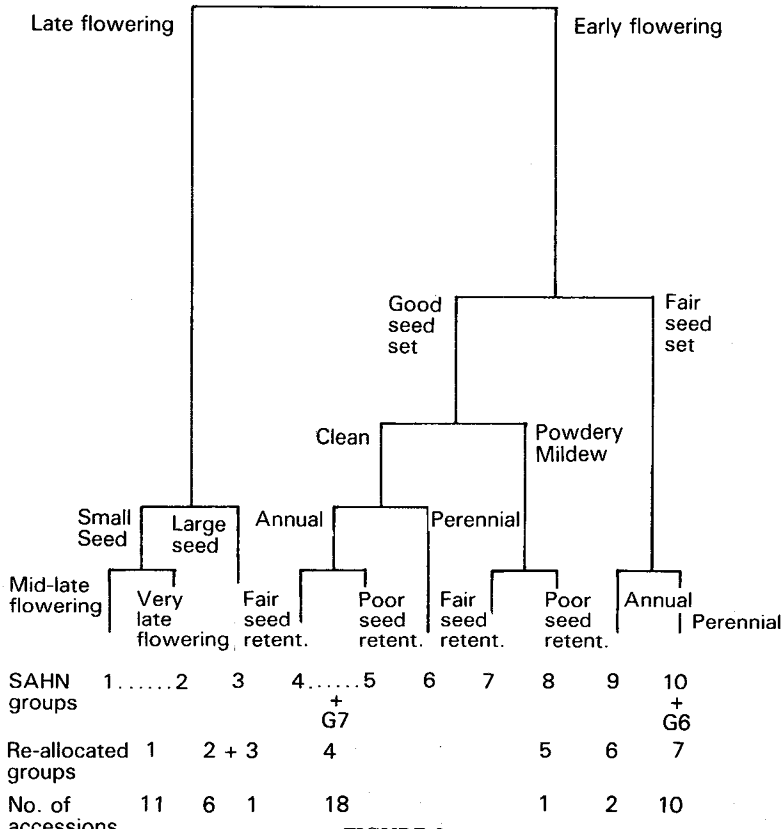

FIGURE 3

Hierachial Classification of the *A. villosa* accessions showing original SAHN 10 group level and (authors) re-allocation to 7 groups. Main attributes contributing to SAHN divisions are listed on the dendrogram. Accessions in each group are identified in Table 3

The first split was on plant maturity with 31 early maturing accessions (mean 90 days to first flowering, mean 120 days to first ripe seed) and 18 late maturing accessions (mean 113 days to first flowering, mean 153 days to first ripe seed). The early accessions tended to be ascendant and prostrate with thinner stems compared to the late accessions which were more semi-erect and prostrate forms with thicker stems; some tended towards shrubby types. Subsequent splits involved characteristics such as seed set and retention, perenniality, seed size, plant habit and vigour.

A minimum spanning tree was constructed (Figure 4) and the SAHN groups superimposed to check their pattern of distribution. A good correlation was achieved and this helped in the re-allocation and re-combination of the 10 groups to 7, as shown on the dendrogram (Figure 3).

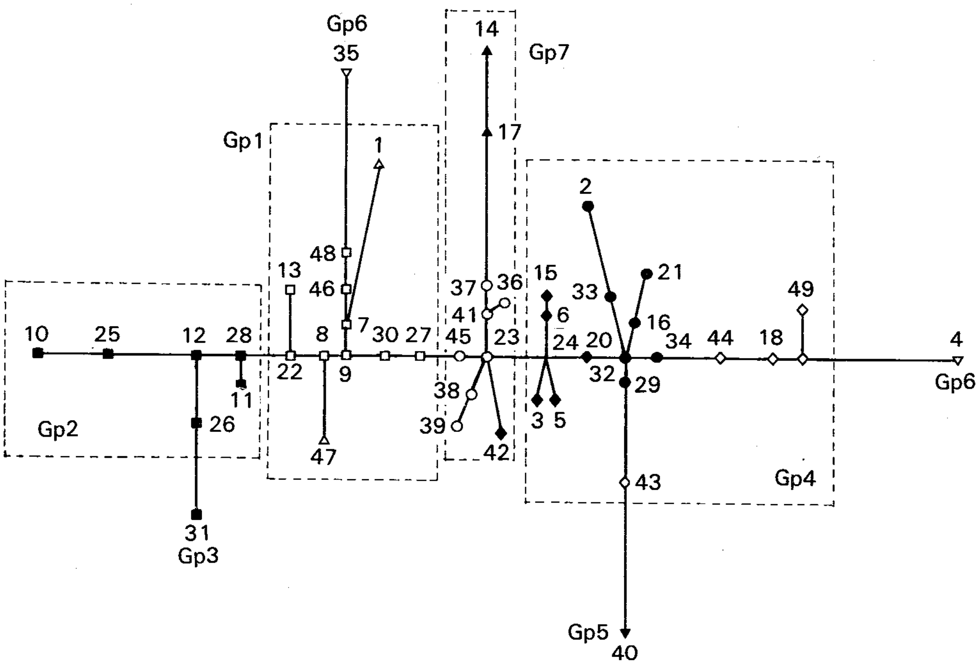

FIGURE 4

Minimum spanning tree for *A. villosa* derived from NEBALL analysis. Symbols indicate original SAHN groups and boxed-in areas indicate the re-allocated groups from Figure 3. Group 1 (Δ); Group 2 (□); Group 3 (■); Group 4 (●); Group 5 (◆); Group 6 (○); Group 7 (◇); Group 8 (▼); Group 9 (▽); Group 10 (▲)

The groups and their characteristics are: Group 1 (11 accessions)—late, short to medium height, small seeded annuals; Group 2 (6 accessions)—late, tall, large seeded annuals; Group 3 (1 accession)—tall, shrubby, perennial; Group 4 (18 accessions)—early, ascendent-prostrate annuals with good seed set and poor to fair retention; Group 5 (1 accession)—very small, compact, annual with high leaf-stem ratio but poor seed retention; Group 6—(2 accessions) short annuals (although terminally located and wide apart on the tree they have been left in the same group), accession 4 having best seed retention and accession 35, the only one with trailing growth habit; Group 7 (10 accessions)—strong perennials. The main characteristics of individual accessions and their allocated groups are shown in Table 3.

The accessions grown in experiment B contained 3 new species (*A. pinetorum*, *A. virginica* and *A. rudis*). There was also 1 accession from Madagasca (52332) not yet named. Data from all accessions in experiment B are presented in Table 3.

TABLE 3

Aeschynomene *species, their M-A Groups and main characteristics of accessions*

Accession	Code	Cry	Lat.	Annual-Perennial	Habit	Plant Dimensions Ht	Plant Dimensions Wdth	Stem thickness	L/S ratio	Days to flower-ripe seed (from Jan. 1)	Seed set retention	1000-seed wt
A. abyssinica Group 1												
52331A	B	ZIM	19.00	P	E	100	30	2– 5	20	240/270	F/F	NA
52331B	109	ZIM	19.00	P	E Sh	120	40	2– 5	25	320/ NA	F/F	10.0
52334	B	MWI	13.05	P	E	100	30	2– 5	20	240/270	F/F	NA
A. afraspera Group 1												
52333	158	ZMB		A	S Sh	130	140	> 10	25	68/ 88	G/G	10.3
A. americana Group 1												
93060		BRA	17.36	P	E A Sh	130	160	5–10	30	95/131	F/G	8.9
A. americana Group 2												
40016*		BOL	17.42	A	E A Sh	100	160	5–10	35	95/131	G/G	3.7
40017*		BOL	14.46	A	S A Sh	120	130	5–10	40	74/104	G/G	4.3
40021A*		BOL	18.08	A	A Sh	95	150	5–10	30	81/109	G/G	4.9
43997		USA		A	A Sh	130	170	5–10	30	74/104	F/F	3.5
43998*		LKA		A	E Sh	150	130	> 10	30	124/153	F/F	2.8
53950		ARG		A	S A Sh	100	140	5–10	35	46/ 65	G/G	4.2
70253		ZMB		A	A Sh	150	150	> 10	30	117/153	F/F	2.4
81958		BRA	20.24	A	S Sh	70	120	5–10	30	88/109	G/G	5.8
87814		MEX	18.10	A	S A Sh	90	130	5–10	30	54/ 81	G/G	4.0
90811		MEX	22.55	A	S A Sh	150	170	> 10	30	88/124	G/G	4.0
91070		MEX	24.12	A	S A Sh	130	160	5–10	25	60/ 81	G/G	3.9
91092		MEX	22.49	A	S A Sh	190	170	> 10	30	68/109	G/G	4.3
91096		MEX	22.40	A	E A Sh	160	170	> 10	30	68/104	G/G	4.3
91099A		MEX	22.25	A	S A Sh	155	170	5–10	30	95/131	G/G	4.9
91102		MEX	23.00	A	S	90	145	2– 5	30	54/ 81	G/G	4.3
91145		MEX	18.27	A	S A	110	160	5–10	35	88/117	G/F	3.6
91155		MEX	18.26	A	S A Sh	140	150	5–10	35	104/146	G/P	3.1
91160		MEX	18.24	A	S A	80	170	5–10	25	74/109	F/F	6.0
91235		MEX	18.50	A	S A	70	160	2– 5	40	88/117	G/P	2.6
91241		MEX	18.53	A	S A	120	160	5–10	35	95/124	G/G	3.1
92766	B			A	S	80	150	5–10	45	69/ 99	G/G	4.8
93556		BRA	21.25	A	S A Sh	140	160	> 10	30	74/109	G/G	3.5
93557		COL	4.10	A	S A Sh	130	160	5–10	30	65/ 95	G/G	4.1
93576		VEN		A	S A Sh	170	180	> 10	30	88/124	G/G	3.9
93579		BRA		A	E A Sh	170	130	5–10	30	68/104	G/G	4.4
93581		COL		A	E A Sh	150	150	5–10	30	88/124	G/G	3.9
93582		COL		A	E A Sh	135	145	> 10	30	81/109	F/G	4.4
93586		PAN		A	E A Sh	150	135	5–10	30	74/109	G/G	4.6
93588		COL		A	E A Sh	140	150	5–10	30	109/146	F/G	3.8
93589		MEX	18.00	A	E A Sh	120	150	5–10	25	60/ 95	G/G	4.1
93614A				A	E A Sh	105	160	5–10	25	95/131	F/G	3.9
93624		BRA	20.02	A	E A Sh	120	150	5–10	30	65/ 95	G/G	6.5
93632		COL		A	E A Sh	160	160	> 10	30	109/153	G/G	3.1
93660		MEX	18.00	A	E A Sh	100	130	5–10	25	54/ 88	G/G	3.9
93665		MEX	17.38	A	E A Sh	170	150	> 10	30	68/109	G/G	4.4
93668		MEX	18.32	A	S A Sh	120	140	5–10	30	104/146	G/F	4.9
93670		MEX	19.27	A	E A Sh	165	170	5–10	30	95/131	G/G	3.9
A. americana Group 3												
15287				A	E A Sh	200	160	> 10	35	117/153	G/G	3.0
18648				A	E A Sh	200	165	> 10	35	117/153	G/G	2.8
29549				A	E A Sh	210	160	> 10	35	117/153	G/G	3.4
30656				A	E A Sh	175	150	> 10	35	117/153	F/G	3.4
36373				A	S A Sh	175	150	5–10	40	117/153	F/G	2.6
36592*		GTM	14.07	A	E A Sh	160	160	5–10	40	117/153	F/G	2.8
36594*		GTM	14.07	A	E A Sh	180	190	> 10	40	117/153	F/G	4.3
37138		MEX	19.10	A	E Sh	190	160	> 10	35	109/153	G/G	3.9
37240		SLV	13.40	A	S A	130	150	5–10	35	162/251	G/G	3.0
37255*		SLV	13.40	A	S A	125	230	5–10	35	155/183	G/G	2.5
37264*		HND	14.10	A	S A	85	160	5–10	35	104/183	G/G	2.6
37327		NIC	12.06	A	A Sh	190	250	> 10	30	109/177	G/G	4.0
38308A		VEN	10.14	A	S A Sh	190	200	5–10	40	117/153	F/G	3.4
38566				A	E A Sh	170	130	> 10	30	124/166	P/G	3.8
40029		BRA		A	S A S	70	210	5–10	35	121/142	F/G	6.8
56282				A	E Sh	190	230	> 10	35	74/104	G/G	4.0
58491 (Glenn)		MEX	22.10	A	S A Sh	130	180	5–10	40	104/146	G/G	2.7
58522*		VEN	7.00	A	E A Sh	185	170	> 10	35	124/153	G/G	4.1
67763		VNM		A	S A	80	290	5–10	45	111/156		3.6
70244		IDN	6.34	A	E A Sh	170	170	5–10	40	117/153	G/G	2.4
85839		MEX	16.35	A	S A Sh	160	170	5–10	35	117/153	G/G	3.4
86168		MEX	19.27	A	S A Sh	150	160	5–10	35	95/138	G/G	3.6
87529		MEX	18.30	A	S A Sh	90	160	5–10	35	153/209	P/G	4.0
87545		MEX	18.28	P	S A Sh	120	150	5–10	35	117/166	F/G	3.8
87552		MEX	18.20	A	S A Sh	160	170	5–10	30	170/153	F/G	2.7

87556		MEX	18.28	A	E A Sh	140	180	5–10	35	117/153	P/G	3.4
91099B		MEX	22.25	A	S A Sh	155	170	5–10	35	88/131	G/G	4.1
91158		MEX	18.26	A	S A Sh	150	160	5–10	35	109/146	G/G	3.9
91327		MEX	16.09	A	E A Sh	160	150	5–10	35	104/146	G/G	3.0
91345		MEX	16.19	A	E A Sh	160	160	5–10	35	109/138	G/G	3.5
91458		MEX	19.45	A	E Sh	210	130	> 10	35	117/153	G/G	4.2
92506		COL		A	E A	100	160	5–10	30	128/162	G/G	2.9
92511		VEN		A	E S A S	200	250	> 10	45	101/150	G/G	5.4
93554		BLZ		A	S A Sh	100	150	5–10	35	124/166	F/G	3.3
93555		HND	15.55	A	S P Sh	120	160	5–10	30	124/176	P/G	3.3
93558		BLZ	17.25	A	S A P Sh	80	150	5–10	35	153/209	P/G	4.0
93567		ARG		A	S A P Sh	120	200	5–10	35	124/166	G/G	2.4
93569		PAN		A	S A Sh	125	190	5–10	35	117/153	G/G	3.1
93570		PAN		A	S A P	80	220	2– 5	30	131/166	P/G	2.3
93571		PAN		A	A P	80	230	2– 5	35	109/153	P/G	3.2
93572		PAN		A	S A P	130	220	5–10	35	117/153	F/G	3.6
93573		PAN		P	S A P	110	160	5–10	35	117/166	G/G	1.9
93577		VEN		A	E A Sh	170	160	5–10	35	109/138	G/G	3.5
93578		VEN		A	S A Sh	160	150	5–10	30	109/153	G/G	3.4
93587		VEN		A	S A P Sh	130	180	5–10	35	109/146	G/G	3.1
93591		MEX		A	S A Sh	170	180	> 10	30	117/153	F/G	2.9
93607				A	E S A Sh	170	200	5–10	35	153/209	F/G	4.4
93639		VEN		A	S A P Sh	150	180	5–10	35	117/153	F/G	3.6
93640		COL		A	S A Sh	110	140	5–10	35	117/153	F/G	3.7
93641		VEN	9.00	A	S A Sh	125	160	5–10	35	117/153	G/G	3.5
93642		VEN		A	S A P Sh	100	140	5–10	30	124/166	F/G	3.5
93651		MEX	18.30	P	S A Sh	120	180	5–10	30	153/166	P/G	4.2
93652		MEX	18.28	P	S A Sh	130	160	5–10	30	117/153	P/G	3.5
93656		MEX	18.25	A	S A Sh	150	180	5–10	30	117/153	P/G	3.4
93657		MEX	18.25	A	S A Sh	160	160	5–10	30	131/166	F/G	3.9
93658		MEX	18.25	A	S A Sh	140	160	5–10	30	109/153	P/G	3.3
93659		MEX		P	S A Sh	135	150	5–10	30	109/148	P/G	3.6
93664		MEX	17.50	P	S A Sh	150	150	5–10	25	124/202	P/G	3.9
105103	B	IDN		A	E A S	70	140	> 10	20	105/146	F/G	2.6
105120	B	IDN		A	A S	40	170	5–10	30	109/150	F/G	3.0
105215	B	IDN		A	A S	80	180	> 10	40	105/146	VG/G	3.1
105228	B	IDN		A	D S	70	200	> 10	35	109/150	G/G	3.2
105237	B	IDN		A	S A S	60	230	5–10	40	109/146	G/G	2.9
105243	B	IDN		A	S A S	60	200	5–10	30	100/146	G/G	2.7
105280	B	IDN		A	S A S	40	220	> 10	30	105/155	VG/G	2.8
105286	B	IDN		A	S A S	80	210	> 10	30	100/146	G/G	3.5
105305	B	IDN		A	E A S	60	180	> 10	30	100/121	G/G	3.3
105810	B	IDN		A	S A S	40	160	5–10	35	109/150	F/G	2.5
105868	B	IDN		A	E A S	60	200	> 10	30	109/146	F/G	4.0
105905	B	IDN		A	S A S	120	240	> 10	40	120/140	G/G	3.0
106906	B	IDN		A	S A	80	260	5–10	50	111/143	G/G	2.8
Q10854				A	E Sh	125	130	5–10	50	104/146	G/G	4.8
Q20737				A	E A	110	220	> 10	30	128/163	G/G	4.3
P6698		MEX	19.10	A	E A Sh	185	160	> 10	35	109/153	F/G	3.9
P6699*		MEX	19.10	A	E Sh	190	170	> 10	35	104/146	G/G	3.4
P6703*		NIC	12.16	A	E A Sh	200	160	> 10	35	109/177	G/G	3.3
P6704A*		NIC	12.52	A	A Sh	150	180	5–10	35	109/183	G/G	3.3
P6704B*		NIC	12.52	A	A Sh	150	180	5–10	35	117/183	G/G	3.0
A. americana Group 4												
87809	141	MEX	18.15	P	S A Sh	160	170	5–10	30	153/209	P/G	3.7
87815	142	MEX	18.10	P	E A Sh	110	160	5–10	30	117/166	F/G	4.0
87816	143	MEX	18.05	P	S A Sh	130	160	5–10	30	124/166	P/G	3.9
87824	144	MEX	17.38	P	E A Sh	150	160	5–10	35	153/209	P/G	4.3
87835	145	MEX	17.45	P	E A Sh	160	170	5–10	35	131/166	P/G	4.2
92689	280	COL	11.14	P	E A Sh	130	150	5–10	30	131/202	P/G	3.2
93574	180	PAN		P	S A Sh	110	160	5–10	35	153/209	P/G	2.4
93608	238	MEX	17.50	P	S A Sh	150	160	5–10	30	124/169	P/G	3.7
93667	275	MEX		P	S A Sh	130	130	5–10	30	131/209	P/G	3.3
A. americana Group 5												
38759		COL	4.12	A	E D Sh	110	130	> 10	30	138/202	P/G	3.1
38802		COL	4.11	A	E A Sh	90	110	> 10	30	138/202	P/G	3.4
85901		MEX	17.31	A	E A Sh	190	150	> 10	30	153/209	P/F	4.9
85927		MEX	18.20	A	E A Sh	180	160	> 10	30	153/209	P/G	5.3
87548		MEX	18.15	A	E Sh	90	170	5–10	30	153/209	P/G	3.5
92508	B	COL	5.55	P	S A	50	130	5–10	30	135/	F/G	1.3
92712		COL	11.18	A	S Sh	75	130	5–10	20	131/202	P/G	2.2
93575		VEN		A	E A Sh	130	150	> 10	30	131/202	P/G	3.7
93580		COL		P	E A Sh	120	140	5–10	30	138/202	F/G	1.6
93583		COL		A	E A Sh	205	150	> 10	30	117/153	F/G	3.3
93584		PAN		A	E A P Sh	160	100	5–10	30	109/153	F/G	3.4
93585				A	E A Sh	150	190	5–10	30	166/292	P/G	5.6
93590		MEX	18.00	A	E A Sh	150	150	5–10	30	138/202	P/G	4.3
93653		MEX	18.28	P	E A Sh	140	160	5–10	30	117/176	P/G	3.2

93654		MEX	18.26	A	E A Sh	170	170	> 10	30	131/166	P/G	3.1
93661		MEX	18.07	P	E A Sh	180	170	5–10	30	131/166	P/G	3.9
93662		MEX	18.07	A	E A Sh	170	180	5–10	30	124/166	P/G	3.8
93663		MEX	17.50	P	E A Sh	130	150	5–10	35	117/202	P/G	3.6
93672		COL		A	E A Sh	185	130	> 10	30	131/202	F/G	2.4
A. americana Group 6												
91132		MEX	18.26	A	A P	40	160	2– 5	35	109/146	G/P	2.9
91139		MEX	18.27	A	A P	40	140	2– 5	35	109/146	G/P	2.4
A. brasiliana Group 1												
93056	174	BRA	17.48	P	S Sh	80	110	5–10	20	74/117	F/P	2.6
92592	116	BRA	21.25	P	S	90	125	2– 5	25	48/ 74	F/G	3.3
93593	117	BRA	21.23	P	S	70	120	2– 5	25	48/ 68	F/F	2.4
93627	121	COL		P	S T	55	140	2– 5	25	60/ 88	F/G	1.6
93630	122	VEN		A	S D T	65	140	2– 5	30	65/ 88	F/G	1.7
93643	124	VEN		A	S D	80	150	2– 5	30	65/ 88	F/F	1.6
A. brasiliana Group 2												
92499	B	COL		A	S	80	220	2– 5	45	97/154	F/F	2.1
93594	118	VEN		P	S P	55	110	2– 5	30	109/146	F/F	1.6
93637	123	BRA		P	S Sh	110	110	5–10	40	131/202	F/F	3.5
A. brasiliana Group 3												
92519	169	BRA		P	P T	25	240	2– 5	30	48/ 88	F/F	4.9
A. brevifolia Group 1												
52335	111	MOG	19.04	P	P T	5	60	< 2	30	47/NA	F/F	3.0
52336	105	MDG	19.06	P	P T	5	40	< 2	30	54/NA	F/F	2.8
52337 #	106	MDG	15.40	P	P T	10	70	< 2	NA	54/ 68	NA	NA
A. brevipes Group 1												
34717	45	BRA	21.45	P	S	150	140	5–10	15	104/196	F/P	3.6
A. ciliata Group 1												
93597	125	CRI	10.00	A	S Sh	120	150	> 10	20	88/109	F/G	7.8
93666	126	MEX	18.00	A	S Sh	105	135	> 10	20	57/ 74	F/G	8.3
A. deamii Group 1												
93611	143	MEX	18.48	P	E Sh	170	60	> 10	15	81/104	P/G	12.0
93612	144	MEX	18.48	P	E Sh	170	70	> 10	15	88/117	P/G	10.4
A. denticulata Group 1												
37550	14	ARG	26.35	A	S Sh	60	90	5–10	15	24/ 41	F/F	5.6
38175	42	ARG	26.47	A	S Sh	80	120	5–10	20	24/ 39	G/G	5.2
39058	25	PRY	24.49	A	S	50	80	2– 5	15	20/ 39	G/F	6.1
53951	29	ARG		A	S Sh	80	120	5–10	20	24/ 41	G/F	6.2
78348	30	ARG	24.46	A	E Sh	60	70	5–10	20	24/ 39	F/F	5.3
78351	31	ARG	28.53	A	S Sh	75	115	> 10	20	19/ 39	G/G	5.9
93623		BRA	20.07	P	S A Sh	95	130	5–10	30	24/ 41	G/G	5.7
A. elaphroxylon Group 1												
46891 (occurs in Trop. East Africa, large perennial shrub with spiny stems; dug out before flowering)												
A. elegans Group 1												
90896	60	MEX	26.48	A	S P T	15	70	2– 5	NA	46/ 68	P/P	1.7
A. elegans Group 2												
37552 #	26	ARG	26.38	P	S P	15	70	2– 5	25	183/NA	NA/NA	2.0
40020	B	BOL	18.00	P	P	20	160	2– 5	45	77/127	G/F	
57978	B	BRA		P	P	25	110	2– 5	45	96/173	G/F	
92523	B	COL		P	S P	25	130	2– 5	45	97/169	G/F	2.0
93628	157	COL		P	S P	10	60	2– 5	NA	NA/290	P/P	1.5
A. elegans Group 3												
P6814 #	41	HND	14.09	P	NA	25	50	NA	NA	NA/NA	NA/NA	1.7
40019 #	44	BOL	17.20	P	S P	15	30	2– 5	NA	NA/NA	NA/NA	NA
93598 #	127	PAN		NA	P T	20	20	2– 5	NA	NA/NA	NA/NA	1.5
A. evenia Group 1												
28755	36	SEN	14.38	A	E S Sh	200	140	> 10	30	65/ 81	G/F	4.3
40026	22	BRA	8.10	A	E Sh	135	135	> 10	30	63/ 81	P/G	2.7
40027	21	BRA	8.06	A	E Sh	190	160	> 10	30	81/ 95	F/F	5.0
40028	20	BRA	3.41	A	E Sh	160	150	> 10	30	112/117	G/G	NA
40031	19	BRA	5.30	A	E Sh	190	150	> 10	30	74/117	G/G	4.2
A. evenia Group 2												
43192	18	BRA	12.40	A	S Sh	60	50	> 10	20	54/ 95	P/G	3.3
93674	129	BRA		A	S P	50	160	5–10	25	48/ 65	G/F	4.7
A. evenia Group 3												
93633	128	BRA		A	E S Sh	140	100	> 10	25	34/ 41	F/G	3.6
A. falcata Group 1												
11500 (Bargoo)	40	PRY	25.24	P	P T	20	230	< 2	20	41/ 54	F/P	2.4
43745	32			P	P T	15	110	< 2	20	41/ 60	F/P	2.4
74865	9	ARG		P	P	15	90	< 2	20	48/ 68	P/P	2.0
A. falcata Group 2												
92652 #	170	COL	3.33	NA	S P T	10	80	2– 5	NA	41/ NA	NA	NA
92685 #	171	COl	11.15	NA	S P T	15	80	2– 5	NA	NA/NA	NA	NA
A. fascicularis Group 1												
92748	172	COL	10.30	P	S	60	80	2– 5	20	50/ 95	F/P	4.4
A. filosa Group 1												
87516	92	MEX	16.30	A	S	130	160	5–10	15	88/131	G/P	5.1
90793	57	MEX	16.30	A	S Sh	160	170	> 10	25	85/117	G/F	5.6

A. filosa Group 2												
85843	85	MEX	16.30	P	S	100	120	2– 5	15	95/138	G/F	3.1
A. flutans Group 1												
52338	177	ZMB	15.44	NA	P T	5	100	> 10	5	NA	P/F	43.7
73047	B	ZMB		P	P T	10	130	5–10	10	97/128	P/P	65.8
A. histrix Group 1												
93599	132	BRA		P	S A	80	75	2– 5	40	104/153	F/F	1.4
93600	133	VEN		P	S A P	35	100	< 2	25	104/153	P/F	1.1
93636	134	BRA		P	S A P	40	105	2– 5	30	104/153	F/F	1.6
93638	160	BRA		P	S	70	125	2– 5	20	104/153	F/F	1.6
A. histrix Group 2												
92509	B	VEN		NA	S P	20	90	2– 5	50	111/162	F/F	2.4
93595	119	VEN		P	S	75	160	2– 5	40	88/117	G/F	2.2
93596	120	MEX		P	D P T	30	135	2– 5	40	109/146	F/F	1.6
93629	158	PAN		P	S	50	90	2– 5	30	117/153	P/F	1.5
A. histrix Group 3												
93673 #	135	BRA		NA	S P	10	30	< 2	NA	NA	NA	NA
A. indica Group 1												
43744	35	ZMB		A	E Sh	230	160	> 10	20	65/ 81	G/G	7.6
50967	33			A	E Sh	250	150	> 10	30	65/ 74	G/G	13.0
70254	8			A	E Sh	220	145	> 10	20	63/ 81	F/G	7.8
Q9147	3			A	E Sh	150	130	> 10	30	74/104	G/F	3.9
Q9845	2			A	E Sh	190	160	> 10	30	74/ 95	G/F	5.6
A. indica Group 2												
26709	37			A	S Sh	65	90	> 10	20	19/ 39	G/F	10.4
50792	34			A	E Sh	45	45	5–10	20	19/ 34	G/F	8.8
84122	96	IND	17.32	A	S Sh	100	130	5–10	30	34/ 65	F/F	4.4
93604	138	BRA	21.25	A	E S Sh	70	100	> 10	15	19/ 39	G/F	11.5
93675	130	BRA		A	S P	65	150	5–10	25	41/ 57	G/F	4.2
93677	136	COL		A	S Sh	110	150	5–10	20	65/ 88	G/G	9.9
104676	B	IND		A	E A	110	120	5–10	15	48/ 56	F/F	5.6
104798	B	IND		A	S A	60	120	5–10	20	52/ 78	F/F	4.9
106316	B	IND		A	E A	110	120	5–10	30	59/ 76	G/G	6.6
CQ541*	39	AUS	28.36	A	E Sh	100	130	> 10	20	19/ 48	F/F	9.9
CQ993*	13	AUS	26.10	A	S A	80	120	5–10	25	19/ 35	G/G	6.9
P4956*	38			A	S Sh	75	110	5–10	20	24/ 74	F/F	9.1
A. indica Group 3 (C)												
90919	62	MEX	23.56	A	E Sh	110	120	> 10	30	54/ 74	G/G	3.4
93553	112	COL		A	E Sh	150	110	5–10	25	76/ 95	F/G	6.5
CQ2704	102	AUS		A	S A Sh	120	100	5–10	20	88/104	G/G	3.8
CQ2962	175	AUS	21.35	A	E A Sh	150	150	5–10	20	74/ 95	F/F	4.3
CQ2964	100	AUS	17.12	A	E Sh	115	120	2– 5	25	57/ 88	F/G	5.4
A. paniculata Group 1												
93635	167	BRA		P	E	105	60	2– 5	15	95/146	F/F	2.1
107160	B	MEX		P	E	120	160	5–10	15	100/146	G/G	2.6
A. parviflora Group 1												
93631	131	COL		P	S A Sh	105	80	> 10	10	124/176	F/F	4.5
A. pinetorum Group 1												
107132	B	MEX		NA	E	40	25	2– 5	15	100/ NA	NA	NA
A. rudis Group 1												
78350	B	ARG	23.32	A	E Sh	100	90	5–10	25	30/ 40	G/F	5.2
78477	B	ARG	23.32	A	E Sh	100	90	5–10	25	32/ 42	G/F	6.1
A. scabra Group 1												
89285	53	MEX		A	E Sh	230	130	> 10	30	60/ 81	G/F	6.0
90298	54	MEX	18.53	A	E Sh	230	130	> 10	30	57/ 74	G/F	5.9
91096	68	MEX	22.40	A	E A Sh	140	120	> 10	30	57/ 74	F/G	3.6
91097	93	MEX	22.40	A	E Sh	160	120	> 10	25	68/ 95	F/F	3.4
91328	82	MEX	16.09	A	E Sh	160	150	> 10	30	41/ 60	G/G	6.4
92517	168	BRA	6.00	A	E Sh	250	170	> 10	25	65/ 95	G/G	5.5
93601	137	ZMB	17.55	A	E A Sh	170	140	> 10	20	46/ 54	G/G	6.8
A. sensitiva Group 1												
63920	28	SUR		P	E Sh	160	130	> 10	15	65/ 88	F/G	8.9
93605	139	BRA	21.21	P	E Sh	260	100	> 10	10	104/146	P/G	11.3
93606	140	BRA	20.02	P	E Sh	270	100	> 10	10	65/ 88	F/G	11.9
93625	156	CRI	10.00	P	S Sh	230	120	> 10	15	65/ 88	G/G	7.6
A. sensitiva Group 2												
81320	170	COL	3.53	P	E Sh	120	70	> 10	30	124/166	P/G	2.8
A. sensitiva Group 3												
34714	17	BRA	22.54	P	S Sh	50	70	5–10	10	74/146	P/F	8.8
40015	24	BRA	22.54	A	S Sh	100	110	5–10	10	81/104	P/F	8.3
92777	173	COL	3.40	A	S Sh	175	120	> 10	15	104/131	P/G	6.5
93609	141	MEX	17.50	P	S Sh	140	150	5–10	10	117/176	P/G	5.8
93610	142	MEX	17.38	A	S Sh	120	110	5–10	15	117/176	P/G	5.2
A. sensitiva Group 4												
CQ2705	96	AUS	16.30	A	E A Sh	160	130	> 10	20	34/ 50	G/G	9.1
A. schimperi Group 1												
93613	145	TZA		A	E Sh	200	130	> 10	25	54/ 98	P/F	5.7

A. uniflora Group 1												
60164	27	UGA	0.21	A	S A Sh	110	130	> 10	25	117/131	P/F	5.2
A. villosa Group 1												
85888	27	MEX	17.12	A	S A P	30	160	2– 5	35	109/146	P/F	2.4
86129		MEX	18.08	A	S P	50	180	2–5	40	153/202	P/F	3.1
87491*	30	MEX	16.27	A	S P	30	160	2– 5	40	117/153	G/P	2.5
87825	B	MEX	17.38	A	P	25	200	2– 5	55	178/ NA	NA	1.6
91117	22	MEX	23.26	A	S P	70	190	2– 5	35	109/138	P/F	2.9
91219	7	MEX	19.04	A	P	30	160	2– 5	30	109/146	G/P	1.9
91221	8	MEX	19.00	A	S P	60	200	2– 5	30	117/153	G/P	1.8
91231	9	MEX	19.02	A	S P	50	160	2– 5	30	117/153	G/P	2.0
93646	46	MEX	17.13	A	P T	30	160	2– 5	35	109/146	G/P	2.4
93649	47	MEX	16.21	A	S A P	70	250	2– 5	30	131/166	G/P	3.2
93650		MEX	16.19	A	S A P	40	180	2– 5	50	117/153	G/P	2.9
93655	48	MEX	18.18	A	P T	20	160	2– 5	45	117/153	G/P	2.0
93671		MEX	18.50		S P	40	180	2– 5	35	166/209	P/F	2.9
107104	B	MEX		A	A P	50	220	2– 5	55	128/174	G/P	2.1
107122	B	MEX		A	A P	30	230	5–10	50	105/146	G/P	3.1
107154	B	MEX		A	D P	25	200	2– 5	55	178/ NA	NA	2.4
CQ2966*	13			A	S P T	40	190	2– 5	45	95/124	G/P	3.2
P7376	1			A	A P	30	170	2– 5	30	117/253	G/P	1.8
A. villosa Group 2												
85587	26	MEX	17.10	A	S	100	190	2– 5	35	138/166	P/F	4.4
86132	28	MEX	20.50	A	S	70	160	2– 5	35	88/138	P/F	3.9
90490	10	MEX	18.53	A	S Sh	130	125	5–10	35	104/138	G/P	4.3
90778	11	MEX	26.40	A	S	75	130	5–10	30	88/109	G/P	4.1
90794	12	MEX	18.53	A	S A	90	160	5–10	40	109/138	G/P	4.1
91247	25	MEX	18.57	A	S A Sh	130	160	5–10	35	124/166	P/F	5.2
A. villosa Group 3												
87492*	31	MEX	16.18	P	S A Sh	90	200	5–10	30	131/166	G/P	3.5
A. villosa Group 4												
30110	6	LKA		A	A P	40	170	2– 5	50	88/109	G/P	2.2
37229	5	MEX	21.09	A	A P	50	150	2– 5	40	88/109	G/VP	2.4
86141	B	MEX	21.20	A	P	20	200	2– 5	45	97/121	G/P	2.5
86163	29	MEX	20.37	A	S A P	30	140	2– 5	35	88/117	G/F	1.9
91069	15	MEX	24.12	A	A P	30	180	2– 5	50	88/117	G/P	2.8
91071	16	MEX	24.20	A	S P	50	160	2– 5	40	88/117	G/F	2.7
91082	18	MEX	24.20	A	A P	75	160	2– 5	40	85/109	G/F	2.8
91093	19	MEX	22.49	A	A P	30	160	2– 5	40	81/109	F/F	3.1
91107	20	MEX	23.23	A	A P	55	175	2– 5	40	88/124	F/F	2.7
91113	21	MEX	23.23	A	P	20	150	2– 5	45	88/124	F/F	2.7
92630	B	COL	3.50	A	A P	35	240	2–5	45	97/132	F/P	2.1
93622	43	MEX	18.58	A	S A P	35	110	2– 5	40	109/138	G/F	1.0
93644	44	AUS		A	S A	70	150	2– 5	40	95/124	G/F	2.6
Q17395	34	AUS		A	S A	55	160	2– 5	40	95/117	G/F	2.5
CQ2703	32	AUS	17.26	A	S A P	60	160	2– 5	35	88/109	G/F	2.4
CQ2706	33	AUS	19.34	A	S A P	40	140	2– 5	30	54/ 81	G/F	2.5
CQ2708		AUS	17.50	A	S A P	40	110	2– 5	35	95/124	F/P	2.4
CQ2963*	49	AUS	21.35	A	A P	40	150	2– 5	35	60/ 88	G/F	2.2
CQ2965		AUS	17.12	A	A P	40	130	2– 5	25	95/124	F/P	NA
P6701*	3	HND	14.10	A	A P	40	180	2– 5	40	63/109	G/P	2.0
P6811	2	MEX	20.46	A	A P	70	150	2– 5	30	48/ 68	G/P	3.5
A. villosa Group 5												
93619	40	PAN		A	P	10	90	> 2	50	124/166	F/P	2.0
A. villosa Group 6												
37235	4	MEX	21.10	A	A P	20	170	2– 5	40	85/106	F/G	3.3
93614B	35			A	P T	20	170	> 2	40	117/ NA	NA	2.3
A. villosa Group 7												
90897	14	MEX	26.48	P	S P	30	110	2– 5	20	88/131	F/P	3.2
91081	17	MEX	24.20	P	S P	55	130	2– 5	35	94/146	F/P	3.1
91209	23	MEX	22.26	P	A P	30	150	2– 5	40	95/131	G/P	2.4
93615	36	BRA		P	S A P	50	140	2– 5	30	95/131	G/P	1.8
93616	37	COL	3.40	P	S P	30	130	2– 5	35	95/124	G/P	1.9
93617	38	COL	3.50	P	A P	60	150	2– 5	35	104/138	G/P	2.1
93618	39	COL	3.52	P	E A P	50	150	2– 5	40	104/138	G/P	1.9
93620	41	COL	2.00	P	S A P	30	130	2– 5	35	95/124	G/P	2.3
93621	42	MEX		P	A P	30	230	2– 5	40	104/138	G/P	2.1
93645	45	MEX	17.13	P	A P	30	140	2– 5	35	109/146	G/P	2.1
A. virginica Group 1												
84952	B			A	E Sh	230	200	> 10	30	86/ 99	F/G	18.3
A. species												
52332	B	MDG	15.75	A	P	5	80	2– 5	25	90/110	F/G	1.7

Notes:

M-A Group: Morphological-Agronomic Group (see Table 2).

Accession: Numbers indicate CPI designation unless otherwise stated; Q = Queensland DPI plant introductions; CQ = CSIRO Queensland plant introductions; P = NSW Ag. Dept. plant introductions.

Code: B = Experiment B (see text), all other accessions grown in Experiment A; numbers are for minimum spanning tree (see Figures 2 and 4).

* have duplicate introduction numbers
\# affected by anthracnose (*Colletotrichum gloeosporioides*)
Cry: country of origin (AUS = Australia; ARG = Argentina; BLZ = Belize; BOL = Bolivia; BRA = Brazil; COL = Colombia; CRI = Costa Rica; GTM = Guatamala; HND = Honduras; IND = India; IDN = Indonesia; LKA = Sri Lanka; MEX = Mexico; MDG = Madagasca; MWI = Malawi; NIC = Nicaragua; PAN = Panama; PRY = Paraguay; SEN = Senegal; SLV = El Salvador; SUR = Suriname; TZA = Tanzania; UGA = Uganda; USA = United States of America; VEN = Venezuela; VNM = Vietnam; ZIM = Zimbabwe; ZMB = Zambia).
Lat.: latitude, 19.0 = 19°00′
Annual-Perennial: A = annual; P = perennial.
Habit: A = ascendent; D = decumbent; E = erect; P = prostrate; S = semi-erect; Sh = shrubby; T = trailing.
Plant dimensions are in centimetres; Leaf/Stem ratio as a percentage; Seed weight is grams.
Seed set: G = good; F = fair; P = poor.
Duplicate introduction numbers: (the first number is the one used in this paper).
A americana CPI 43998 = 56283 = 93552; P6704A and P6704B = 37413; P6699 = 37139; 37264 = 93563; 37255 = 93562; 40021 = 93566; 40016 = 93564; 40017 = 93565; 36594 = 93560; 36592 = 93559; P6703 = 37373; 58522 = 93561.
A. indica P4956 = CPI 93603; CQ541 = 93602; CQ993 = 93626; CQ2962 = Q23300.
A. villosa 87491 = 93647; 87492 = 93648; P6701 = 37302; CQ2703 = Q17395; CQ2963 = Q23301; CQ2966 = Q23304.

DISCUSSION

Our classification techniques successfully divided a very large legume genus into manageable groups. Fifty-five *Aeschynomene* groups have been distinguished, representing 29 species.

The well represented species, *A. americana* and *A. villosa*, contain some large groups with considerable variation (*A. americana* groups 2 and 3 and *A. villosa*, group 4). One reason for having fewer and larger groups is the limited amount of morphological data used in the analysis (Table 2). We also felt that some minor differences in subjectively assessed attributes (seed retention and severity of disease attack), or small differences in flowering time (late and very late), were insufficient basis for group divisions (Figure 3). Previous and subsequent observations of *A. americana* and *A. villosa* indicate that agronomic performance of accessions within the large groups will be similar, and representative accessions can confidently be selected for regional evaluation.

The minimum spanning tree of all accessions, other than *A. americana* (Figure 2), allows a quick and easy assessment of variation within the collection. Although some species are poorly represented, the tree indicates a close relationship between accessions of different species and highlights accessions with distinctive features by placing them terminally on group branches. Similarly, the *A. villosa* tree (Figure 4) portrays the variation within the 49 accessions analysed and confirms the earlier SAHN groupings.

The appropriateness of the minimum spanning tree is dependent on the attributes used and the accuracy with which they are recorded (Burt *et al.* 1980). With this large collection, we experienced considerable difficulty in recording some morphological attributes. Stem and leaf colour and hairiness often varied on different parts of the same plant. Similarly, *A. americana* accessions displayed a wide range in flower size and colour. Colours included pale cream, mauve and bright yellow-orange, although most accessions displayed multi-coloured flowers. We decided that these morphological attributes were exerting a fairly meaningless influence on SAHN groups and masked them from the final analysis (see Table 2). If more detailed classifications of well represented species (*A. americana* and *A. villosa*) are required in the future a more comprehensive list of morphological attributes should be used.

The classification of such a large and diverse collection at one (wet tropical coast) site may have discriminated against species from the sub-tropics, high elevations or dry regions. In this study, accessions of *A. elegans*, a sub-tropical, high-elevation species, performed poorly in the classification experiment, but grew vigorously and without disease at Brisbane (latitude 27°22′S, altitude 56 m). However, Burt *et al.* (1971) found that, although the value of agronomic characteristics depended on location, combined agronomic and morphological analysis, with agronomic data derived from 2 different tropical environments, produces very similar groupings of accessions. We feel that future large diverse collections should be grown at sites with a more moderate climate or be divided and grown at several sites on the basis of the environment at their collection site.

Taxonomically, some of the species were difficult to separate using herbarium specimens alone. Difficulties occurred between *A. brasiliana* and *A. histrix*, *A. falcata* and *A. elegans*, and between *A. evenia*, *A. indica*, *A. rudis*, *A. scabra* and *A. virginica* and, to a lesser extent, between *A. americana* and *A. villosa* (G. Guymer, pers. comm.).

Most of the accessions in this collection are from the Americas but 5 species (*A. abyssinica*, *A. afraspera*, *A. flutans*, *A. schimperi*, *A. uniflora*) and 1 unidentified species are from Africa where most diversity occurs (Rudd, 1955). Another African species (*A. elaphroxylon*, CPI 46891) had spiny stems and was dug out before flowering. Ten species are each represented by 1 accession only and 8 species by fewer than 4 accessions. There is no doubt that these poorly represented species contain material of wide diversity.

The classification of experiment A accessions, and allocation to groups, now provides a basis for the allocation, to groups, of any *Aeschynomene* accessions subsequently introduced and described. In fact this was accomplished with the 48 accessions grown in experiment B.

Agronomic potential

Many of the *Aeschynomene* species appear to have accessions with agronomic potential. In Queensland, the naturalised *A. indica* and commercial Glenn jointvetch (*A. americana*) offer substantial benefits to animal production (Bishop *et al.* 1985b). Research workers in Florida are experimenting with artificial hybridisation (Hardy *et al.* 1984) to achieve genetic recombination of favourable agronomic attributes, such as resistance to root knot nematodes (Quesenberry *et al.* 1985).

Many species come from wet, waterlogged and swampy environments to which most commercial legumes are unsuited. Some Series Ochopodium species are mesic to subxeric perennials and should be evaluated in drier regions. A range of plant habits occur, including low, prostrate forms which may combine with stoloniferous grasses and withstand heavy grazing. *A. villosa* contains accessions that were collected from heavily grazed situations (R. Reid, pers. comm.). *A. brasiliana* also has perennial accessions with some potential; most have a sticky exudate on the stem hairs and will require evaluation under grazing to determine their commercial value.

Most *Aeschynomene* accessions are characterised by seed pods which break at maturity into 1-seeded sections. *A. villosa* pods tend to "shatter" but selection for types less prone to shattering may be possible. Section Ochopodium species (*A. brasiliana*, *A. falcata* and *A. histrix*) drop their pods at maturity while those of *A. americana* are retained after maturity.

Some species of *Aeschynomene* have the potential to become weeds. *A. virginica* is a weed of rice in south-eastern parts of USA (Smith *et al.* 1978) and *A. indica* (Budda pea) causes some problems in Queensland rice crops (Kleinschmidt and Johnston 1977). Species with similar early maturity and the ability to grow in water should be evaluated with caution.

Disease and insect problems

A range of diseases were identified on several species of *Aeschynomene*. Powdery mildew (*Oidium* sp.) occurred on *A. americana*, *A. villosa* and *A. indica*. Powdery mildew damage was rated but accessions recorded as 'clean' were subsequently affected at another site. Powdery mildew is common on cv. Glenn but has little effect on animal performance or on seed yields (Bishop *et al.* 1985a). Botrytis stem rot (*Botrytis cinerea*) on mature *A. americana*, Sclerotium (*Sclerotinium vollssii*) on mature *A. villosa* and anthracnose (*Colletotrichum gloeosporioides*) on some *A. elegans*, *A. falcata* and *A. histrix* accessions were identified. Botrytis stem rot occurs in some commercial seed crops of Glenn jointvetch but is not a problem under grazing.

Anthracnose has not been reported in commercial *A. americana* in Florida or in Australia, although Sonoda and Lenne (1986) report it as a problem of *Aeschynomene* spp. in central and south America.

Heliothis larvae damaged growing tips and green pods on Section Aeschynomene species. Nursery rows required spraying for maximum seed yields, while commercial seed crops of Glenn jointvetch sometimes require spraying. However, in grazed pastures *Heliothis* larvae have not been a problem.

CONCLUSIONS

Aeschynomene is a diverse and interesting legume genus. Representatives from most species require further evaluation with emphasis on their likely environmental adaptation. Species of particular interest are perennial *A. americana*, perennial and early annual *A. villosa*, (particularly for the moderately dry to dry subtropics), *A. brasiliana* and *A. histrix* (for moderately dry to dry areas on free-draining soils), *A. elegans* (for cooler high elevation and sub-tropical areas) and the strong perennial *A. abyssinica* (for arid areas).

ACKNOWLEDGEMENTS

We are indebted to the late W. A. T. Harding and A. Peacock for technical assistance, to Dr G. Guymer and Dr Sally Reynolds for taxonomic assistance, to L. and J. Williams for the use of their land, and to the AMLRDC for funding.

REFERENCES

BISHOP, H. G., LUDKE, D. H. and RUTHERFORD, M. T. (1985a)—Glenn jointvetch: a new pasture legume for Queensland coastal areas. *Queensland Agricultural Journal* **111**: 241–245.

BISHOP, H. G., WALKER, B. and LUDKE, D. H. (1985b)—*Aeschynomene*—A legume genus with potential for the Australian tropics. Proceedings of the XV International Grasslands Congress, Kyoto, Japan. pp. 160–61.

BURT, R. L., EDYE, L. A., WILLIAMS, W. T., GROF, B. and NICHOLSON, C. H. L. (1971)—Numerical analysis of variation patterns in the genus *Stylosanthes* as an aid to plant introduction and assessment. *Australian Journal of Agricultural Research* **22**: 737–57.

BURT, R. L., WILLIAMS, W. T., GILLAND, P. and PENGELLY, B. C. (1980)—Variation within and between some perennial *Urochloa* species. *Australian Journal of Botany* **28**: 343–56.

GILLETT, J. B., POLHILL, R. M. and VERDCOURT, B. (1971)—Leguminosae (Part 3), Sub-family Papilionoideae (1), Aeschynomene (28). Flora of Tropical East Africa, p. 364–406.

HARDY, S. R. and QUESENBERRY, K. H. (1984)—Artificial hybridization of *Aeschynomene americana* L. (a tropical forage legume). *Soil and Crop Science Society of Florida Proceedings* **43**: 163–166.

HODGES, E. M., KRETSCHMER, A. E., JR., MISLEVY, P., ROUSH, R. D., RUELKE, O. C. and SYNDER, G. H. (1982)—Production and utilisation of the tropical legume *Aeschynomene.* Circular S-290. Florida Agricultural Experimental Stations Institute of Foods and Agricultural Services, University of Florida, Gainsville.

KLEINSCHMIDT, H. E. and JOHNSON, R. W. (1977)—Weeds of Queensland. (Government Printer: Queensland) p. 281.

KRETSCHMER, ALBERT E., JR. and BULLOCK, ROBERT C. (1980)—*Aeschynomene* spp.: Distribution and potential use. *Soil and Crop Science Society of Florida Proceedings* **39**: 145–52.

KRETSCHMER, A. E., JR. and SNYDER, G. H. (1981)—Potential of *Aeschynomene* sp. for Pastures in the Tropics. Proceedings of the XIV International Grasslands Congress, Lexington, Kentucky, USA, p. 783–6.

LANCE, G. N. and WILLIAMS, W. T. (1966)—A generalised sorting strategy for computer classifications. *Nature* **212**: 218.

LANCE, G. N. and WILLIAMS, W. T. (1967)—Mixed-data classificatory programs I—Agglomerative Systems. *Australian Computing Journal* **1**: 15–20.

LANCE, G. N., MILNE, P. W. and WILLIAMS, W. T. (1968)—Mixed-data classificatory programs. III Diagnostic systems. *Australian Computing Journal* **1**: 178–181.

PAUL, W. R. C. (1951)—Notes on legumes 1. *Tropical Agriculturalist* **107**: 15–20.

PRIM, R. C. (1957)—Shortest connection networks and some generalisations. *The Bell Systems Technical Journal* **36**: 1389–1401.

QUESENBERRY, K. H. and OCUMPAUGH, W. R. (1981)—Forage potential of *Aeschynomene*—Species in North-central Florida. *Soil and Crop Science Society of Florida Proceedings* **40**: 159–62.

QUESENBERRY, K. H., HARDY, S. R. and DUNN, R. A. (1985)—Evaluating *Aeschynomene americana* L. Germplasm for response to *Meloidogyne* spp. Proceedings of XV International Grasslands Congress, Kyoto, Japan. pp 158–9.

ROSS, D. (1983)—"Taxon User's Manual", CSIRO Division of Computing Research, CSIRONET Manual No. 6.

RUDD, V. E. (1955)—American species of *Aeschynomene. U.S. National Herbarium* **32:** 1–72 (U.S. National Museum, Smithsonian Institution, Washington, D.C.).

RUDD, V. E. (1959a)—Studies of *Aeschynomene. Journal of the Washington Academy of Sciences* **49** (2) 45–52.

RUDD, V. E. (1959b)—The genus *Aeschynomene* in Malaysia (Leguminosa–Papilionatae). *Reinwardtia* 5 (1): 23–36. (Published by Herbarium Bogoriense, Kebun Raya, Indonesia).

SINGH, R. G. (1968)—Changes in the Physiochemical Properties of Soil on the Decomposition of *Aeschynomene americana. Tropical Agriculturalist.* **124:** 95–102.

SMITH, R. J., JR., TEMPLETON, G. E. and TEBEEST, D. D. (1978)—Field performance of a bioherbicide for control of northern jointvetch (*Aeschynomene virginica* (L.) in rice. Abstracts, 1977 Meeting of the Weed Science Society of America, (US Department of Agriculture: Stuttgart, Arkansas, USA).

SONODA, R. M. and LENNE, J. M. (1986)—Diseases of *Aeschynomene* species. *Tropical Grasslands.* **20:** 30–34.

WILSON, G. P. M. (1980)—Bargoo jointvetch: tough legume for tough country. *The Agricultural Gazette of NSW* **91:** 51–53.

VERDCOURT, B. (1979)—A manual of New Guinea Legumes. Botany Bulletin No. 11, Office of Forests, Lae, Papua New Guinea.

(Received for publication May 18, 1987; accepted March 10, 1988)