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PHYLOGENY AND CLASSIFICATION OF PAKISTANI LEGUMES

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Abstract

The latest subfamilial classifcation of the legumes is reviewed, and the genera of Pakistani legumes are arranged according to it. The tribal organization of the subfamilies is summarized and discussed for Pakistan. The Pakistani legume flora is compared with that of the central Brazilian savannas, and a correspondence between the Pakistani legume flora and the climate and vegetation of Pakistan is noted.

Introduction

A new subfamilial classifcation of legumes was presented in 1978 at the first International Legume Conference, Royal Botanic Gardens, Kew, England, by 28 of the leading taxonomists actively working on legume systematics. The foundations of this classification were laid down by Bentham (1865) and modified by Hutchinson (1964). If Bentham's subtribes are considered together with his individual tribes, they are strikingly similar in composition to the tribes accepted in the new classification. Hutchinson's modified system has a lesser degree of similarity.

The final decisions on the new classificaiton both supported many existing dispositions and made some new fundamental realignments. The majority opinion favored the maintenance of the grouping as one family, but a few still support its division into two or three families (El-Gazzar & El-Fiki, 1977; El-Gazzar, 1981). Between subfamilies the most significant decision was the firm placement of tribe Swartzieae in a basal position within subfamily Papilionoideae. This position is supported by data from wood anatomy, nodulation productivity, and chemistry, as well as morphology. The most apparent change has been the drastic reordering of taxa. This was done to reflect the idea that the most primitive member of a taxon should appear first and the most advanced last in a linear sequence. As a consequence, the subfamilies are presented in the following order: Caesalpinioideae, Mimosoideae, and Papilionoideae.

Sources and Methods

The legume treatments in the *Flora of Pakistan* (Ali, 1973, 1973a, 1977) were surveyed to compile a list of Pakistani genera and species. The list was modified to reflect current taxonomic opinions (Polhill & Raven, 1981; Irwin & Barneby, 1982; Podlech,

1983; Geesink, 1984; R.C. Barneby, pers. comm.), and the total number of species reported for each genus was added (Gunn, 1983). The list was then compared to world-wide (Allen & Allen, 1981; Halliday, 1984) and Pakistani (Athar & Mahmood, 1978, 1980, 1985; Mahmood, 1983, 1984) reports of legume nodulation or non-nodulation. The results of these surveys are presented in Table 1.

One hundred and six legume genera are known from Pakistan, of which 68 have one or more native species, and 539 legume species are reported to occur in Pakistan, of which 426 are native.

Discussion

1. *Subfamily Caesalpinioideae*

There are three lines of evolution in Caesalpinioideae without any surviving links between them, see Fig. 1. The basal groups for the three lines are: 1) the *Gleditsia* group of tribe Caesalpinieae, 2) subtribe Ceratoniinae of tribe Cassieae, and 3) subtribe Cercidinae of tribe Cercideae. *Gleditsia* and *Gymnocladus,* composing group *Gleditsia,* possess a number of primitive characters, including functionally unisexual flowers, scarcely differentiated tepals, bilobate stigma, and fruit dehiscing like a follicle. These genera are basal in the primary radiation that gave rise to the Mimosoideae and Papilionoideae (Polhill et al., 1981; Corby et al., 1983).

Ceratonia, the sole member of subtribe Ceratoniinae, has unisexual flowers lacking petals and with an exposed disc producing nectar. This genus is placed at the base of the radiation whose culmination is the assemblage of *Cassia,* s.l. (Polhill et al., 1981).

Cercideae are sharply distinguished from the rest of the family by their calyx tube and well-developed corolla, bilobed leaves with palmate venation, and lens of the seed above the micropyle, a character combination found nowhere else in the legumes. Also, *Cercis* is the only genus in the family to retain the base chromosome number n = 7 (Goldblatt, 1981). This restricted radiation has culminated in the genus *Bauhinia* (Polhill et al., 1981).

Tribe Caesalpinieae is first in the linear sequence (Table 2) because *Gleditsia* and *Gymnocladus,* considered the most primitive genea in the family, are both members of the tribe. In Pakistan, only two species of *Caesalpinia* are native out of 100 species in the genus (Table 1).

The next tribe is Cassieae. This radiation has led to *Cassia,* s.l. In Pakistan, it is represented only by native members of subtribe Cassiinae, the most advanced element in the tribe. *Cassia,* s.s., with 30 species, has but a single native species; *Senna,* a genus

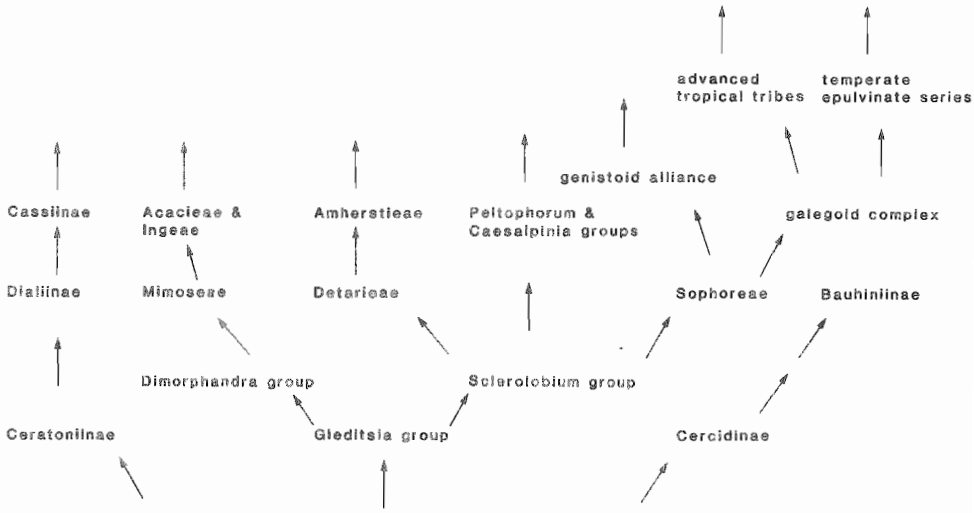

Fig. 1. The main evolutionary radiations in the legumes, adapted from Polhill et al. (1981).

of 240 species, has only six native species; and *Chamaecrista*, in excess of 250 species, has but four native species. This complex has been treated as a single genus, *Cassia*, s.l., but Irwin and Barneby's recent generic reorganization (1982), based on floral morphology, is supported by the presence or absence of nodules. *Cassia*, s.s. and *Senna* are non-nodulators, and *Chamacerista* is a nodulator.

The last tribe in linear order with native species in Pakistan is Cercideae. This distinctive group is represented by five native species of *Bauhinia*. *Bauhinia*, with 250 species, is reported to have 26 non-nodulating species and only one nodulator.

Caesalpinioideae has slightly more than 1,900 species, approximately 11% of the known legume species. Only 18 of these are native to Pakistan, that is 4% of the Pakistani legume flora. The origins of this subfamily were probably in tropical and subtropical forests (Polhill et al., 1981). They have persisted in these habitats and have penetrated only feebly into more temperate ones. The low penetration of the subfamily into the Pakistani legume flora points to the narrowness of their habitat preferences and the scarcity of wet tropical and subtropical flora in Pakistan.

2. *Subfamily Mimosoidaae*

Mimosoideae with approximately one-third as many genera and 50% more species than Caesalpinioideae is subdivided in a simpler manner, see Fig. 1. There are three principal groups, tribes Mimoseae, Acacieae, and Ingeae (Elias, 1981; Table 3). Mimoseae

Table 1. Pakistani genera of Leguminosae with their total number of species and the number in Pakistan, with the numbers of reported positive or negative nodulators world-wide and in Pakistan, and with their habit in Pakistan.

Genus	Number of Species			Nodulation Reports						
				World		Pakistan				
						Native		Introduced		
	World	Pakistan								
		Nat.	Intro.	Pos.	Neg.	Pos.	Neg.	Pos.	Neg.	Habit*
Abrus Adans.	17	1	0	5	–	1	–	–	–	V
Acacia Mill.	1,200	10	16	200	11	4	–	14	–	STV
Adenanthera L.	8	0	1	1	2	–	–	–	1	T
Aeschynomene L.	150	2	0	44	–	2	–	–	–	S
Albizia Durazz.	150	4	3	32	–	4	–	2	–	T
Alhagi Adans.	3	1	0	1	–	1	–	–	–	S
Alysicarpus Desv.	25	8	0	13	–	7	–	–	–	H
Amorpha L.	15	0	1	7	–	–	–	1	–	S
Arachis L.	22	0	1	10	–	–	–	1	–	H
Argyrolobium Eckl. & Zeyh.	70	3	0	25	–	2	–	–	–	H
Astracantha Podl.	250	1	0	1	–	–	–	–	–	HS
Astragalus L.	1,750	133	0	95	8	5	–	–	–	HS
Bauhinia L.	250	5	3	1	26	–	3	–	2	STV
Butea Roxb. ex Willd.	4	1	0	–	1	–	1	–	–	T
Caesalpinia L.	100	2	5	–	15	–	2	–	2	STV
Cajanus DC.	37	3	1	5	–	2	–	1	–	HSV
Calliandra Benth.	200	0	3	12	3	–	–	1	–	S
Campylotropis Bunge	65	3	0	–	–	–	–	–	–	S
Canavalia DC.	50	0	1	8	–	–	–	1	–	V
Caragana Fabr.	80	11	0	12	–	2	–	–	–	S
Cassia L., s.s.	30	1	3	1	5	–	1	–	2	T
Castanospermum A. Cunn.	1	0	1	–	1	–	–	–	1	T
Ceratonia L.	2	0	1	–	2	–	–	–	1	T
Cercis L.	6	0	1	–	–	2	–	–	1	ST
Chamaecrista (L.) Moench	250	4	0	38	1	3	–	–	–	HS
Chesneya Lindl. ex Endl.	20	5	0	–	–	–	–	–	–	H
Cicer L.	40	3	1	2	–	1	–	–	–	H
Clitoria L.	70	0	1	8	–	–	–	1	–	V
Colutea L.	28	3	0	3	–	–	–	–	–	S
Coronilla L.	20	0	1	12	–	–	–	1	–	H
Crotalaria L.	600	10	2	145	–	4	–	2	–	HS
Cullen Medik.	35	1	0	7	–	1	–	–	–	H
Cyamopsis DC.	3	1	0	1	–	1	–	–	–	H
Dalbergia L. f.	100	1	2	18	–	1	–	1	–	T
Delonix Rafin.	10	0	2	–	2	–	–	–	2	T
Derris Lour.	60	0	1	5	–	–	–	1	–	S
Desmanthus Willd.	25	0	1	5	–	–	–	1	–	S
Desmodium Desv.	300	10	1	78	–	7	–	–	–	HST
Dichrostachys (DC.) Wight & Arn.	12	0	1	3	–	–	–	1	–	S

Dumasia DC.	8	1	0	2	–	1	–	–	–	V
Ebenus L.	20	1	0	–	–	–	–	–	–	S
Erythrina L.	108	2	1	27	–	–	–	2	–	ST
Flemingia Roxb. ex Ait. f.	30	5	0	5	–	3	–	–	–	S
Galega L.	6	1	0	5	–	1	–	–	–	H
Gleditsia L.	14	0	2	–	5	–	–	–	2	T
Glycine Willd.	9	0	1	6	–	–	–	1	–	H
Glycyrrhiza L.	20	3	0	4	–	1	–	–	–	HS
Gueldenstaedtia Fisch.	10	1	0	–	–	–	–	–	–	H
Haematoyxlum L.	3	0	1	–	1	–	–	–	1	ST
Hardwickia Roxb.	1	0	1	1	–	–	–	–	–	T
Hedysarum L.	100	8	0	11	–	1	–	–	–	H
Hippocrepis L.	21	1	0	4	–	–	–	–	–	H
Indigofera L.	700	24	0	194	3	10	–	–	–	HS
Indopiptadenia Brenan	1	0	1	–	–	–	–	–	–	T
Lablab Adans.	1	1	0	1	–	1	–	–	–	HV
Laburnum Fabr.	2	0	1	4	–	–	–	1	–	T
Lathyrus L.	150	9	1	47	–	8	–	1	–	HV
Lens Mill.	5	0	1	2	–	–	–	1	–	H
Lespedeza Mich.	40	5	0	30	–	1	–	–	–	S
Leucaena Benth.	40	0	1	10	–	–	–	1	–	ST
Lotononis (DC.) Eckl. & Zeyh.	100	1	0	31	–	1	–	–	–	H
Lotus L.	100	4	0	58	–	1	–	–	–	H
Lupinus L.	200	0	3	56	–	–	–	3	–	HS
Macroptilium (Benth.) Urban	20	0	1	2	–	–	–	1	–	H
Macrotyloma (Wight & Arn.) Verdc.	24	1	0	11	–	1	–	–	–	HV
Medicago L.	50	8	0	40	–	7	–	–	–	H
Melilotus Mill.	20	3	1	16	–	3	–	1	–	H
Millettia Wight & Arn.	100	0	3	6	–	–	–	1	–	TV
Mimosa L.	400	2	1	22	3	1	–	1	–	S
Mucuna Adans.	100	2	0	17	–	2	–	–	–	V
Onobrychis Mill.	130	9	0	10	–	1	–	–	–	H
Ononis L.	75	2	0	18	–	1	–	–	–	HS
Oxytropis DC.	300	21	0	22	–	2	–	–	–	H
Paracalyx Ali	6	0	1	–	–	–	–	–	–	V
Parkinsonia L.	15	0	1	–	2	–	–	–	1	ST
Peltophorum (Vogel) Benth.	7	0	1	–	2	–	–	–	1	T
Phaseolus L.	50	0	3	21	–	–	–	3	–	V
Pisum L.	2	0	1	2	–	–	–	1	–	H
Pithecellobium Mart.	20	0	1	13	1	–	–	1	–	T
Prosopis L.	44	2	2	6	3	1	–	2	–	ST
Psophocarpus DC.	20	0	1	5	–	–	–	1	–	V
Psoralea L.	20	2	0	25	–	–	–	–	–	HS
Pueraria DC.	20	1	1	2	–	–	–	1	–	V
Rhynchosia Lour.	200	7	0	58	–	3	–	–	–	HSV
Robinia L.	10	0	1	6	–	–	–	1	–	T
Saraca L.	8	0	1	1	4	–	–	–	1	T
Schotia Jacq.	4	0	1	–	3	–	–	–	1	T

Table 1. (Cont'd.)

Genus	Number of Species			Nodulation Reports						
				World		Pakistan				
						Native		Introduced		
	World	Pakistan								
		Nat.	Intro.	Pos.	Neg.	Pos.	Neg.	Pos.	Neg.	Habit*
Senna Mill.	240	6	9	4	31	–	6	1	7	HST
Sesbania Scop.	50	3	1	34	–	3	–	1	–	HST
Shuteria Wight & Arn.	5	1	0	1	–	–	–	–	–	V
Smithia Ait.	30	1	0	12	–	3	–	–	–	H
Sophora L.	45	3	3	16	1	1	–	2	–	ST
Spartium L.	1	0	1	1	–	–	–	1	–	S
Stracheya Benth.	1	1	0	–	–	–	–	–	–	H
Tamarindus L.	1	0	1	–	1	–	–	–	1	T
Taverniera DC.	10	4	0	2	–	2	–	–	–	HS
Tephrosia Pers.	400	9	1	95	–	4	–	1	–	HS
Teramnus P. Br.	8	1	0	7	–	–	–	–	–	V
Thermopsis R. Br.	23	2	0	5	–	–	–	–	–	H
Trifolium L.	250	4	4	142	–	4	–	4	–	H
Trigonella L.	80	16	0	20	–	8	–	–	–	H
Uraria Desv.	20	1	0	2	–	–	–	–	–	S
Vicia L.	140	12	2	65	–	9	–	2	–	HV
Vigna Savi	150	7	1	46	–	6	–	1	–	HV
Wisteria Nutt.	6	0	1	8	–	–	–	1	–	V
Zornia J.F. Gmel.	80	1	0	12	–	1	–	–	–	H

*H = herb; S = shrub; T = tree; V = vine or climber.

is the most primitive of the three and shares various phenetic characters with more advanced members of Caesalpinoideae. It is separated from Acacieae and Ingeae by it staminal number of ten or less. The more advanced and closely related Acacieae and Ingeae are separated from each other only by the degree of connation exhibited by their filaments, free in Acacieae and united in Ingeae. There are two other tropical tribes, Parkieae with two genera, and Mimozygantheae with one, whose composition and placement are controversial; none of their members are found in Pakistan.

Mimoseae is represented in Pakistan by *Prosopis* with two native species and *Mimosa* also with two. Acacieae consists of the genus *Acacia* with 10 native species, and Ingeae is represented by *Albizia* with 4 native species.

Mimosoideae has slightly less than 3,000 species, approximately 17.5% of the known legume species. Only 18 of these species are native to Pakistan, that is 4% of the Pakistani legume flora. Again this subfamily, also predominately tropical, has not assumed a position in the Pakistani legumes commensurate with its overall size in relation to the legumes. This is surprising considering the size and broad diversity found in such genera as *Acacia* with 1,200 species and *Mimosa* with 400-450.

Table 2. Pakistani genera of subfamily Caesalpinioideae (Leguminosae) in systematic order and numbered according to Polhill & Raven (1981).

1.	tribe	CAESALPINIEAE	3.	tribe	CERCIDEAE
		1a. *Gleditsia* group			subtribe Cercidinae
	1.2	*Gleditsia* Linnaeus*		3.1	*Cercis* Linnaeus*
		1d. *Peltophorum* group			subtribe Bauhiniinae
	1.14	*Peltophorum* (Vogel) Bentham*		3.4	*Bauhinia* Linnaeus
	1.18	*Delonix* Rafinesque*			
		1e. *Caesalpinia* group			
	1.25	*Caesalpinia* Linnaeus	4.	tribe	DETARIEAE
	1.34	*Haematoyxlum* Linnaeus*			4a. *Cynometra* group
	1.35	*Parkinsonia* Linnaeus*		4.8	*Schotia* Jacquin*
					4b. *Hymenostegia* group
2.	tribe	CASSIEAE		4.16	*Saraca* Linnaeus*
		2a. subtribe Ceratoniinae			4d. *Crudia* group
	2.1	*Ceratonia* Linnaeus*		4.33	*Hardwickia* Roxburgh*
		2d. subtribe Cassiinae			
	2.16	*Cassia* Linnaeus, s.s.	5.	tribe	AMHERSTIEAE
	2.17	*Senna* Miller			5c. *Amherstia* group
	2.18	*Chamaecrista* (Linnaeus) Moench		5.18	*Tamarindus* Linnaeus*

*Introduced.

3. *Subfamily Papilionoideae*

The Papilionoideae has twice as many genera and two and a half times as many species as the Caesalpinoideae and Mimosoideae together. They have been undergoing a geologically more recent and rapid generic evolution than the other two subfamilies. Consequently, the subfamily has a more complex and ramified existing radiation. Recently there has been an informal grouping of tribes into five main clusters: the tribes Sophoreae and Swartzieae, the galegoid complex, the genistoid alliance, the advanced tropical tribes, and the temperate epulvinate series, see Fig. 1 (Polhill et al., 1981; Polhill, 1981; Corby et al., 1983).

The Sophoreae group is a diverse basal element connecting the bulk of the Papilionoideae through the Swartzieae to the Caesalpinioideae. Swartzieae floral morphology is equal to that of Caesalpinioideae, but its wood anatomy, nodulation types, and chemistry are similar to those of Papilionoideae (Cowan, 1981; Polhill, 1981, 1981a; Polhill et al., 1981). The Swartzieae and Sophoreae groups comprise the papilionoid genera with free stamens. In Sophoreae, corolla and androecial structures vary from that typical of Caesalpinioideae to that typical of Papilinoideae with all intermediate stages present. No

Table 3. Pakistani genera of subfamily Mimosoideae (Leguminosae) in systematic order and numbered according to Polhill and Raven (1981).

3.	tribe	MOMOSEAE			
		3d. *Newtonia* group		3.34	*Dichrostachys* (de Candolle) Wight & Arnott*
	3.5	*Indopiptadenia* Brenan*			
		3e. *Adenanthera* group		3.36	*Desmanthus* Willdenow*
	3.8	*Adenanthera* Linnaeus*			
		3h. *Prosopis* group	4.	tribe	ACACIEAE
	3.15	*Prosopis* Linnaeus		4.2	*Acacia* Miller
		3i. *Piptadenia* group			
	3.27	*Mimosa* Linnaeus	5.	tribe	INGEAE
		3k. *Leucaena* group		5.4	*Albizia* Durazzini
	3.32	*Leucaena* Bentham*		5.7	*Calliandra* Bentham*
		3l. *Dichrostachys* group		5.8	*Pithecellobium* Martius*

*Introduced.

members of Swartzieae occur naturally in Pakistan, and only *Sophora* of Sophoreae is found there with three native species (Tables 1 and 4).

The huge galegoid complex is the central radiation through the subfamily. It is distinguished from the Sophoreae-Swartizeae by staminal fusion, presence of canavanine, and general stabilization of the base chromosome number at X = 11 or 10 in tropical woody members (Polhill et al., 1981; Corby et al., 1983). This group is scarcely represented in Pakistan only by *Dalbergia* and *Abrus*, each having one native species (Tables 1 and 4).

The genistoid alliance is a lateral group that has evolved in areas of Mediterranean climate throughout the world with two principal lines, one in the northern hemisphere and the other in the southern hemisphere (Polhill et al., 1981; Polhill, 1981; Corby et al., 1983). Many of the advanced characters found in other groups occur here, but the trends in these characters do not resemble those in the other groups. In Pakistan *Crotalaria*, with 10 native species, and *Lotononis* with one, of Crotalarieae, *Thermopsis* with two of Thermopsideae, and *Argyrolobium* with three of Genisteae, are found (Tables 1 and 4). Only *Crotalaria*, a very advanced genus within the group, has expanded in Pakistan, incdicating that the area is probably not well suited to the group climatically.

The advanced tropical tribes forming the remainder of the pulvinate members of the subfamily are best arranged with the Millettieae, formerly known as Tephrosieae, as a core element and a series of advanced, principally tropical tribes, clustered about it. The entire group demonstrates strong tendencies towards increased floral specialization and variation and reduced variation in root nodules, leaves, inflorescences, fruits, seeds, and

Table 4. Pakistani genera of subfamily Papilionoideae (Leguminosae) in systematic order and numbered according to Polhill and Raven (1981).

2. tribe SOPHOREAE
2c. *Angylocalyx* group
2.16 *Castanospermum* A. Cunningham*
2h. *Sophora* group
2.47 *Sophora* Linnaeus

4. tribe DALBERGIEAE
4.6 *Dalbergia* Linnaeus filius

5. tribe ABREAE
5.1 *Abrus* Adanson

6. tribe MILLETTIEAE
Derris Loureiro*
Millettia Wight & Arnott*
Tephrosia Persoon
Wisteria Nuttall*

7. tribe ROBINIEAE
7.4 *Robinia* Linnaeus*
7.20 *Sesbania* Scopoli

8. tribe INDIGOFEREAE
8.2 *Indigofera* Linnaeus
8.4 *Cyamopsis* de Candolle

9. tribe DESMODIEAE
subtribe Desmodiinae
9.9 *Desmodium* Desvaux
9.16 *Uraria* Desvaux
9.19 *Alysicarpus* Desvaux
subtribe Lespedezinae
9.24 *Campylotropis* Bunge
9.25 *Lespedeza* Michaux

10. tribe PHASEOLEAE
10a. subtribe Erythrininae
10.1 *Erythrina* Linnaeus
10.3 *Mucuna* Adanson
10.4 *Butea* Roxburgh ex Willdenow
10b. subtribe Diocleinae
10.13 *Canavalia* de Candolle*
10c. subtribe Glycininae
10.26 *Pueraria* de Candolle
10.29 *Glycine* Willdenow*
10.30 *Teramnus* P. Browne
10.35 *Shuteria* Wight & Arnott
10.36 *Dumasia* de Candolle
10f. subtribe Clitoriinae
10.47 *Clitoria* Linnaeus*
10g. subtribe Phaseolinae
10.50 *Psophocarpus* de Candolle*
10.60 *Lablab* Adanson
10.64 *Macrotyloma* (Wight & Arnott) Verdcourt
10.65 *Vigna* Savi
10.70 *Macroptilium* (Bentham) Urban*
10.71 *Phaseolus* Linnaeus*
10h. subtribe Cajaninae
10.72 *Cajanus* de Candolle
10.78 *Flemingia* Roxburgh ex W.T. Aiton
10.81 *Rhynchosia* Loureiro
10.83 *Paracalyx* Ali*

11. tribe PSORALEEAE
11.1 *Psoralea* Linnaeus
11.4 *Cullen* Medikus

12. tribe AMORPHEAE
12.4 *Amorpha* Linnaeus*

14. tribe AESCHYNOMENEAE
14b. subtribe Aeschynomeninae
14.8 *Aeschynomene* Linnaeus
14.11 *Smithia* W. Aiton
14d. subtribe Poiretiinae
14.20 *Zornia* J.F. Gmelin

		14e. subtribe Stylosanthinae
	14.25	*Arachis* Linnaeus*
16.	tribe	GALEGEAE
		16a. subtribe Coluteinae
	16.5	*Colutea* Linnaeus
		16b. subtibe Astragalinae
	16.11	*Caragana* Fabricius
	16.13	*Chesneya* Lindley ex Endlichler
	16.14	*Astragalus* Linnaeus
	16.15	*Oxytropis* de Candolle
	16.17	*Gueldenstaedtia* Fischer
	16.18	*Alhagi* Adanson
		16c. subtribe Galeginae
	16.19	*Galega* Linnaeus
		16d. subtribe Glycyrrhizinae
	16.20	*Glycyrrhiza* Linnaeus
18.	tribe	HEDYSAREAE
	18.2	*Hedysarum* Linnaeus
	18.3	*Taverniera* de Candolle
	18.4	*Stracheya* Bentham
	18.6	*Onobrychis* Miller
	18.7	*Ebenus* Linnaeus
19.	tribe	LOTEAE
	19.4	*Lotus* Linnaeus
20.	tribe	CORONILLEAE
	20.1	*Coronilla* Linnaeus*
	20.2	*Hippocrepis* Linnaeus
21.	tribe	VICIEAE
	21.1	*Vicia* Linnaeus
	21.2	*Lathyrus* Linnaeus
	21.3	*Lens* Miller*
	21.4	*Pisum* Linnaeus*
22.	tribe	CICEREAE
	22.1	*Cicer* Linnaeus
23.	tribe	TRIFOLIEAE
	23.1	*Ononis* Linnaeus
	23.2	*Melilotus* Miller
	23.4	*Trigonella* Linnaeus
	23.6	*Medicago* Linnaeus
	23.7	*Trifolium* Linnaeus
29.	tribe	CROTALARIEAE
	29.6	*Crotalaria* Linnaeus
	29.8	*Lotononis* (de Candolle) Ecklon & Zeyher
31.	tribe	THERMOPSIDEAE
	31.4	*Thermopsis* R. Brown
32.	tribe	GENISTEAE
		32a. subtribe Lupininae
	32.1	*Lupinus* Linnaeus*
		32b. subtribe Genitstinae
	32.2	*Argyrolobium* Ecklon & Zeyher
	32.4	*Laburnum* Fabricius*
	32.14	*Spartium* Linnaeus*

*Introduced.

seedlings (Polhill et al. 1981; Corby et al, 1983). The Millettieae, represented only by *Tephrosia* with nine native species in Pakistan (Tables 1 and 4), present one of the more difficult problems of generic delimitation in the legumes. After intensive study (Geesink, 1981, 1984), it still can not be orgaized in a satisfactory phylogenetic manner. Of the advanced tribes surrounding it, six are native to Pakistan: Indigofereae, Desmodieae, Phaseoleae, Psoraleeae, Robinieae, and Aeschynomeneae (Table 4). The first four are centered in the eastern hemisphere, with the understanding that Phaseoleae are pantropical, and the last two in the western himisphere. Robineae, represented in Pakistan by

Sesbania with three native species, and Aeschynomeneae, represented by *Aeschynomene, Smithia,* and *Zornia* with 2, 1, and 1 native species respectively (Table 1), are minor elements in the Pakistani legume flora (Table 1). The remaining four tribes are well represented in Pakistan by 23 of their more advanced genera with 89 species. The largest genera are *Indigofera* with 24 native species and *Desmodium* with 10 (Table 1).

The last and most important group is the temperate epulvinate series. It is sharply delimited by lack of a basal foliar pulvinus, closure of the vascular system, and leaves tending to be distichous and with phloem transfer cells (Polhill et al., 1981; Corby et al., 1983). These characteristics are linked to the herbaceous habit predominating in the group which is mainly temperate. The Galegeae, the most important legume tribe in Pakistan with 180 native species (Tables 1 and 4), link this group directly to the Millettieae; it is an Old World temperate offshoot of this tribe but well separated from it by the distinct characters given above. *Astragalus,* the largest native genus in Pakistan with 133 species (Table 1) and often mentioned as the largest genus of angiosperms in the world, resides here. It has undergone explosive evolution into all habitats, and comprises 31% of the native Pakistani legumes. Other significant genera, such as *Oxytropis* with 21 native species, are also members of Galegeae (Tables 1 and 4). About the Galegaae are a series of satellite tribes all but one of which are represented in Pakistan. Hedysareae and Loteae are closest to subtribe Astragalinae of the Galegeae. *Cicer* has been separated off from the Vicieae as a monotypic tribe and has more in common with the Trifolieae. Trifolieae are agriculturally the most important of the group with the genera *Medicago, Trifolium,* and others, all important soil improvement and fodder plants.

The Papilionoideae show a continuation of the trend clerly demonstarated in the Caesalpinioideae and the Mimosoideae: the most primitive members are poorly represented in Pakistan or not at all, and the most advanced, more recent radiations are well represented. This trend has been carried to its climax with almost all of the advanced temperate tribes represented in Pakistan, and the explosive development of *Astragalus.*

Comparison with a Tropical Flora

Comparison of the Pakistani legume flora with that of a seasonally wet tropical area will support the hypotheses presented above; the savannas of central Brazil are such an area. They cover a zone more than twice as large as Pakistan, and the legumes are represented there by 72 genera with 527 native species (Kirkbride, 1984). The Mimosoideae are represented equally in both areas. Differences are found in Caesalpinioideae and Papilionoideae. Whereas Caesalpinioideae are poorly represented in Pakistan, in Brazilian savannas they are the dominant legume subfamily, with explosive radiation in *Chamaecrista* with 137 species. In Papilionoideae the more primitive elements are represented in the Brazilian savannas, and many of the more advanced groups are poorly represented or totally absent, such as the temperate epulvinate series. The situation is reversed in

Pakistan where the temperate epulvinate series dominate with 133 species of *Astragalus*, and the primitive groups are poorly represented.

Legume representation in Pakistan reflects climate and resulting vegetation types. The rainfall and temperature patterns approximately coincide, with the more tropical southern areas drier and the temperate northern areas wetter. Consequently there has been greater development of Papilionoideae and much poorer representation of the Caesalpinioideae, especially of its primitive members.

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