Chapter 7

SUMMARY AND CONCLUSION

The present study embodies detailed palynological and taxonomical studies of 60 Indian endemic taxa of the family Leguminosae found in the political boundary of Kerala state. These 60 taxa belonged to 3 subfamilies, namely Papilionoideae (8 tribes, 16 genera and 42 species), Caesalpinioideae (5 tribes, 9 genera and 17 species) and Mimosoideae (1 tribe, 1 genus and 1 species).

An assessment of the present population status of the 60 endemic taxa based on IUCN criteria (2001 & 2010) is carried out in relation to the present study which revealed that out of the 60 taxa studied, 28 are threatened, of which 12 belongs to the vulnerable category, 11 belongs to the Endangered category and the rest 5 are under the high risk Critically Endangered category.

Leguminosae is ± eurypalynous in nature. The pollen grains are free in the subfamily Papilionoideae and Caesalpinioideae (except in *Buhinia phoenicea* Wight & Arn.) and in compound units in Mimosoideae. The grains are radially symmetrical, isopolar and about 80% of the presently studied taxa are comparatively advanced 3-zonocolporate type. Primitive colpate type grains are represented in the tribe Aeschynomeneae (Benth.) Hutch. and highly advanced 3-zonoporate and pantoporate pollen grains are also observed in the tribes Phaseoleae DC. of Papilionoideae and Detarieae DC. of Caesalpinioideae respectively. However, inaperturate pollen grains are noticed in the tribe Ingeae Benth. of Mimosoideae.

The exine stratification in Leguminosae is of typical angiosperm type, with a well developed endexine continuous around the grain and a prominent ektexine which is differentiated into an outer tectum, middle columellae and well developed foot layer. The exine thickness varies from 0.5–4.5 μm and almost 70% of the taxa possess an exine of thickness between 1–3 μm.
The exine ornamentation types observed in Leguminosae can be broadly categorized into 2, the excrescence type (granulate, scabrate, verrucate etc.) and the depression type (punctuate, foveolate, reticulate, regulate, striate etc.). The most common type of tectum ornamentation in Papilionoideae is reticulate and psilate types. Excrescence types are more frequent in Caesalpinioideae. However, the polyads of Mimosoideae shows 2 types pollen, the middle grain with alveolate tectum and the peripheral grains with psilate tectum.

The pollen size of the presently studied taxa ranges from 15 μm to 65 μm. Comparatively smaller pollen grains are observed in the subfamily Papilinoideae and Mimosoideae and larger grains are seen in the subfamily Caesalpinioideae. The shape also showed a range of variation and among them prolate-spheroidal and sub-prolate shapes are the most common. Sub-prolate and prolate-spheroidal shapes are common in Papilinoideae and oblate-spheroidal and prolate-spheroidal shapes are frequent in Caesalpinioideae. Angular pollen grains are seen only in the subfamily Mimosoideae.

Tribe Sophoreae Sprengel is stenopalynous in terms of aperture type, i.e. 3-zonocolporate. However, significant variations are observed among genera in tectum ornamentation and are of taxonomic value at generic level.

Aperture and tectum ornamentation based palynological variations are less marked in the tribe Dalbergieae Brunn ex DC. and are highly stenopalynous. Pollen grains of smallest size range in the present study are observed in this tribe (14–16.5 μm). Pollen shape, exine thickness etc. found to be systematic significance at specific level separation.

Tephrosieae (Benth.) Hutch. is a stenopalynous tribe in terms of apertures, but tectum ornamentations showed a range of variations and are of great systematic value at generic level. Secondary characters like shape and size of pollen grain, exine thickness etc. relevant only at specific level.
Tribe Indigofereae (Benth.) Rydberg is varied and eurypalynous with colporoidate and colporate pollen types are reported to be occurred. The single species in the present study showed 3-zonocolporate pollen.

In the tribe Desmodieae (Benth.) Hutch., pollen grains are generally 3-zonocolporate with a thick endexine and a very thin foot layer which are characteristics of the tribe. The 2 genera in the present study shows significant variation in pollen morphology, and are of taxonomic relevance. The former is with operculate aperture and foveolate tectum while the latter is without operculum and reticulate tectum.

Phaseoleae DC. is highly eurypalynous group with 3-zonocolporate (Spatholobus Hassk., Cajanus DC. and Flemingia Roxb. ex Ait. & Ait. f.) and 3-zonoporate (Vigna Savi) pollen grains. Endoaperture characters, exine thickness and ornamentation etc are also varied and are of high diagnostic value in systematic considerations.

Tribe Aeschynomeneae (Benth.) Hutch. is considered as a eurypalynous group with tricolpate, tricolporate, tricolporoidate pollen grains with a range of variation in tectum ornamentation. However, the subtribe Aeschynomeninae in the present study displays notable uniformity in aperture characters, i.e. all are 3-zonocolpate with operculate aperture and reticulate tectum. Secondary characters like pollen size and shape, colpus membrane characters, exine thickness etc. are found to be useful in systematic considerations at specific level.

Crotalarieae (Benth.) Hutch. is a eurypalynous tribe with tricolporate and tricolporoidate pollen grains. The pollen morphology of 15 species of the genus Crotalaria L. in the present study showed variations mainly in tectum ornamentation, pollen size and shape characters.

The pollen grains of the tribe Caesalpinieae Polhill & Vidal are characterized by a broad granular surface called margocolpus surrounding a weekly developed
colpus. This ‘Caesalpinia type’ pollen is observed in *Pterlobium hexapetalum* (Roth) Sant. & Wagh, while the other member of this tribe, *Moullava spicata* (Dalz.) Nicols. showed totally different type pollen which suggest a separate treatment of this genus under the tribe.

The taxa under the tribe Cassieae Bronn showed close similarity in primary pollen characters. However, the tectum ornamentation shows a range of variation among species and is found to be of great taxonomic value at specific level separation.

Tribe Cercideae Bronn in the present study is solely represented by *B. phoenicea* Wight & Arn. which is a unique member in Indian Caesalpinioideae due to the presence of pollen tetrads, a character quite uncommon in Caesalpinioideae.

Tribe Detarieae DC. showed eurypalynous nature with tricolporate and pantoporate pollen types. The tectum shows notable diversity in ornamentation ranging from reticulate to scabrate and striate and are of high systematic value at generic delimitation. The advanced pantoporate pollen in *Hardwickia binata* Roxb. is very unique in Caesalpinioideae, reported from only 2 genera under the same tribe Detarieae.

Tribe Amherstieae Benth. Emend. J. Leon is represented in the present study by the genus *Humboldtia* Vahl. Pollen morphology of all the 6 species and 2 varieties reported from Kerala state were studied and the genus is found stenopalynous in terms of pollen aperture (all are tricolporate) and eurypalynous in terms of tectum ornamentation which varies from regulate to verrucate or striate. Tectum ornamentation type and aperture features are found useful in taxonomic separation at specific level.

Tribe Ingeae Benth. and the whole subfamily Mimosoideae in the present study is represented by a single species, *Albizia lathamii* Hole which showed 16-
celled polyads with heteromorphic grains. Each grain is inaperturate with psilate tectum.

The 3 major systematic treatments of Leguminosae, viz. the classical Bentham and Hooker's system (1865), the phylogenetic system of Hutchinson (1964) and the more comprehensive Polhill and Raven's system (1981) are critically analyzed at tribal level in the light of palynological observations from the present as well as previous studies. Tribes like Sophoreae, Phaseoleae, Crotalarieae, Caesalpinieae, Amherstieae, Ingeae etc. are treated almost in the similar way by the 3 systems of classification. However, Hutchinson’s most of the newly added tribes do not hold much palynological support. Similarly, Polhill and Raven’s transfer of Lonchocarpeae to Tephrosieae also lacks tangible palynological reasons. Bentham and Hooker treated Desmodieae and Aeschynomeneae under the tribe Hedysareae, which is against the palynological composition of these tribes since both are having characteristic pollen morphology. Polhill and Raven’s treatment of the genus *Spatholobus* Hassk. under the subtribe Erythrininae is found palynologically relevant due to the presence of massive endexine and small ektexine in both *Erythrina* L. and *Spatholobus* Hassk.

In evolutionary perspective, about 80% of the presently studied taxa are belonged to the comparatively advanced 3-zonocolporate type. The fundamental 3-zonocolpate type is observed only in the tribe Aeschynomeneae, while the highly advance triporate pollen were observed in the tribe Phaseoleae and Pantoporate in the tribe Detarieae.

Pollen morphological information of 60 endemic leguminous taxa acquired during the present study is found to be useful in confirming the systematic circumscription and position of some of the taxa included in the present study. Segregation of the genus *Aganope* Miq. from the genus *Derris* Lour. is found to be relevant in palynological perspectives since the taxa belonged to *Aganope* Miq. in
the present study showed some pollen characters like scabrate tectum are quite uncommon in the genus *Derris* Lour. Similarly, the specific status of *Desmodium waynaadense* Bedd. ex gamble is confirmed with the help of palynological data. The status of *V. wightii* Benth. ex Beddome is reinstated with the support of significant pollen morphological changes noticed from *Vigna vexillata* (L.) A. Rich. *Geissaspis tenella* Benth. var. *malabarica* Sivar. and Babu is reduced as a synonym of *Geissaspis tenella* Benth., since the former do not hold significant changes in general morphology and pollen characters from the variety proper.

A new taxon, *Smithia venkobarowii* Gamble var. *gabra* Anoop and Predeep is distinguished based on general morphological as well as pollen grains characteristics.

*Crotalaria subperfoliata* Wight ex Wight & Arn. and *Crotalaria shevaroyensis* Gamble, are reduced as synonyms to *Crotalaria longipes* Wight & Arn due to the lack of tangible palynological as well as macromorphological differences to consider the three taxa as different.

Tewari and Nair (1979) supported Hutchinson’s treatment of Leguminosae into 3 separate families, namely, Papilionaceae, Caesalpiniaceae and Mimosaceae based on their palynological studies in Indian Papilionaceae. They opinioned that the compound pollen units in Mimosaceae, mixed apertural and tectum ornamentation types in Caesalpiniaceae and the predominant 3-zonocolporate and 3-zonoporate pollen grains in Papilionaceae are characteristics of each family and are relevant enough to treat them as 3 different families. However, in the present study it has been found that the 3 subfamilies shared most of the primary and secondary pollen characters and the characters highlighted by Tewari and Nair (1979) are also found to be overlapping. Apart from pollen morphology, the 3 subfamilies are very closely related to each other on the basis of flower, fruit and
seed characters and there are no compelling reasons to treat them as independent families.

Since significant palynological differences are less marked in Leguminosae above the tribal level and also due to the occurrence of similar pollen types in taxonomically unrelated groups, a single pollen key for the separation of whole leguminous taxa is not possible. Hence, a pollen key is prepared to separate the taxa within the tribes at inter or intra generic level.

Palynology based systematic treatments are mostly associated with the apertural characters. However, the present study revealed that secondary pollen characters like exine ornamentation, pollen size and shape etc. are of significant role in the systematic considerations of Leguminosae especially at lower levels. Since Leguminosae is a highly eurypalynous group with colpate, colporoidate, colporate and porate pollen types and similar type pollen grains are often present in taxonomically unrelated groups, the application of palynology is difficult at higher levels. The tremendous diversity and the widespread occurrence of parallelism in the macromorphology of leguminous taxa are well represented in its pollen morphology also. Therefore, an assumption based on a single pollen character like aperture type or tectum ornamentation is often misleading. From the present study it can be concluded that the highly conservative morphological details of this ‘tiny wonders’ can effectively be used as a solution in systematic disagreements only when they are in accordance with the morphological sequences drawn from other characters like general morphology, anatomy, cytology, molecular biology etc. and are thereby more reliable than the pollen characters themselves.