

A MICROMORPHOLOGICAL STUDY OF *POGOSTEMON* DESF. SPECIES (LAMIACEAE) FROM BANGLADESH

SYEDA S. TAHIR*, MAHBUBA KHANAM AND SYED Z. HUSAIN

*School of Plant Sciences, University of Reading,
P.O. Box 221, Reading, RG6 2AS, England.*

Abstract

An investigation of leaf, calyx and nutlet microcharacters of 13 species of the genus *Pogostemon* found in Bangladesh was conducted using the SEM and their reliability as taxonomic markers is discussed. Leaf surfaces are mostly covered with glandular and non-glandular trichomes. Stomata are paracytic mostly levelled with epidermal surface or rarely elevated. In some species leaf surface is rough and have undulating ridges under which sessile glandular hairs are sunken. Calyx surface of all the species have trichomes. Nutlet sculpturing shows mostly reticulate or irregular shallow discoid pattern with undulating ridges.

Introduction

Genus *Pogostemon* of the tribe Pogostemoneae in the family Lamiaceae contains about 70 species mainly in South East Asia, a few in the Himalayas and southern tropical Africa (Hedge, 1990) with 15 species found in Bangladesh (Khanam, 1989). In systematic revisions of any group of taxa, micromorphological characters of leaf, calyx indumentum and nutlet surfaces are either totally ignored or only seldom mentioned inspite of their stability as characters (Davis & Heywood, 1963). Most of the species of *Pogostemon* are aromatic (Cantino, 1990). Essential oils accumulate in distinct glandular hairs. Anatomical structure of glandular hairs and the structure of volatile compound of essential oil were used to divide Lamiaceae into groups of 8 species (Werker *et al.*, 1985). The taxonomic value of nutlet characters has been described in many genera of the Lamiaceae (Hedge, 1968, 1970; Husain *et al.*, 1990). The structure of stomata and trichome were used for the phylogenetic significance in the Labiatae and Verbenaceae (Cantino, 1990). During the last two decades, the application of scanning electron microscope has greatly increased our knowledge of plant surfaces. The present report describes the micromorphological characters of leaf, calyx and nutlet surface of the genus *Pogostemon* from Bangladesh using SEM.

Materials and Methods

For the SEM survey of leaf, calyx and nutlet surface, 3-4 samples of herbarium were examined, but only one Voucher is cited in Appendix-1. The voucher specimens are deposited in Bangladesh National Herbarium and the Dhaka University Herbarium. Mature leaves cut into c. 1 cm pieces along the midrib and complete calyx and nutlet were directly fixed onto the stub with double sided cellophane tape. After coating with

*Present address: Department of Botany, University of Sindh, Jamshoro, Sindh, Pakistan.

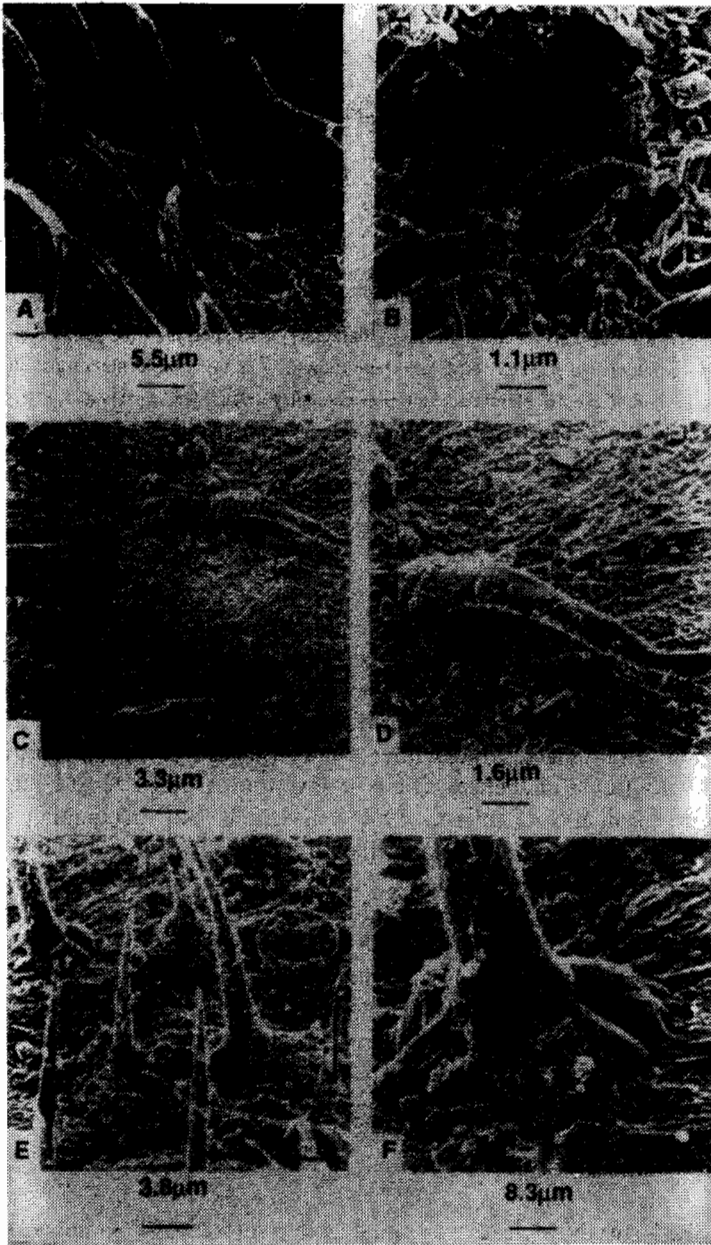


Fig. 1. Scanning electron micrographs of leaf adaxial surfaces.

(A) *P. strigosus*, showing uniseriate multicellular non-glandular trichomes, (B) *P. crassicaulis* showing glandular trichomes, stomata and undulating epidermal surface, (C & D) *P. hispidus* showing unicellular non-glandular trichomes, (E) *P. paniculatus*, distribution of trichomes, (F) *P. paniculatus*, leaf, having trichomes with characteristics base.

c. 30 nm of gold in a polaron E 5150 sputter coater they were examined with a JEOL JSM T20 Scanning Electron Microscope in Plant Science Laboratories at Reading University. The terminology used to describe the nutlet surface pattern is that of Stearn (1983) and Barthlot (1981), and for stomata types of Van Cotthem (1970).

MICROMORPHOLOGICAL OBSERVATIONS

Leaf surface: In all the species of *Pogostemon*, the abaxial and adaxial leaf surfaces have trichomes which are glandular and non-glandular. The leaf surface of *P. auricularis* is covered with sparsely to densely distributed long swollen based non-glandular trichomes and sessile glandular trichomes which are levelled with the surface of the epidermis. *P. crassicaulis* has faintly dispersed short non-glandular trichomes and also have sessile glandular hairs which are sunken in the epidermal surface. The epidermal surface is rough and undulating (Fig.1B). This type of pattern is similar to *P. pumilus*. In *P. stellatus*, the adaxial epidermal surface forms a rough undulating pattern in which sessile glandular hairs and stomata are sunken. Abaxial surface is rough and covered with undulating ridges under which sessile glandular hairs are sunken and have raised stomata. *P. hispidus* and *P. suavis* have similar type of trichome in which trichome base are not swollen but the distribution of trichome are more dense in the latter than the former. *P. paniculatus* has simple swollen long stiff trichomes in which the trichome base forms a podium like structure with sessile glandular hairs are present on the epidermal surface which are not sunken (Fig.1E & F). *P. villosus* has densely distributed multicellular non-glandular trichome, and sessile glandular trichomes which are present above on the uneven epidermal surface. *P. quadrifolius* has densely distributed long multicellular non-glandular trichomes and sessile glandular trichomes. *P. parviflorus* has sparsely distributed simple multicellular non-glandular trichome which have prominent striate pattern (Fig.2F). *P. plectranthoides* has multicellular simple based non-glandular trichome and sessile glandular trichomes which are present on the uneven undulating epidermal surface with stomata slightly elevated from the surface. The epidermal surface in *P. benghalensis* is mostly rough and uneven (Fig.2E) and has appressed multicellular simple based trichomes which have striate surface pattern.

Calyx surface: In most of the species of *Pogostemon* calyx surface are densely tomentose with non-glandular trichomes (Fig.3A). *P. auricularis* has sessile glandular hairs which are densely arranged on the calyx tube and on the calyx teeth, trichomes on the margin of the calyx teeth are usually long non-glandular (Fig.3B). *P. strigosus* has non-glandular multicellular long trichomes all over the calyx surface and calyx teeth with few sessile glandular hairs. In *P. quadrifolius* trichomes are present only on calyx teeth with calyx tube almost glabrescent. *P. hispidus* has short and medium trichomes with sessile glandular hairs. *P. villosus* var. *macrophylla* has prominent midnerve in each calyx teeth with lateral stripes after regular interval. *P. benghalensis* has short, medium and long multicellular non-glandular trichomes and also have glandular hairs which are slightly raised from the surface. *P. parviflorus* has medium and short multicellular non-glandular trichomes with a few oil glands. *P. plectranthoides* and *P. suavis* has short, medium and long non-glandular trichomes and among them sessile

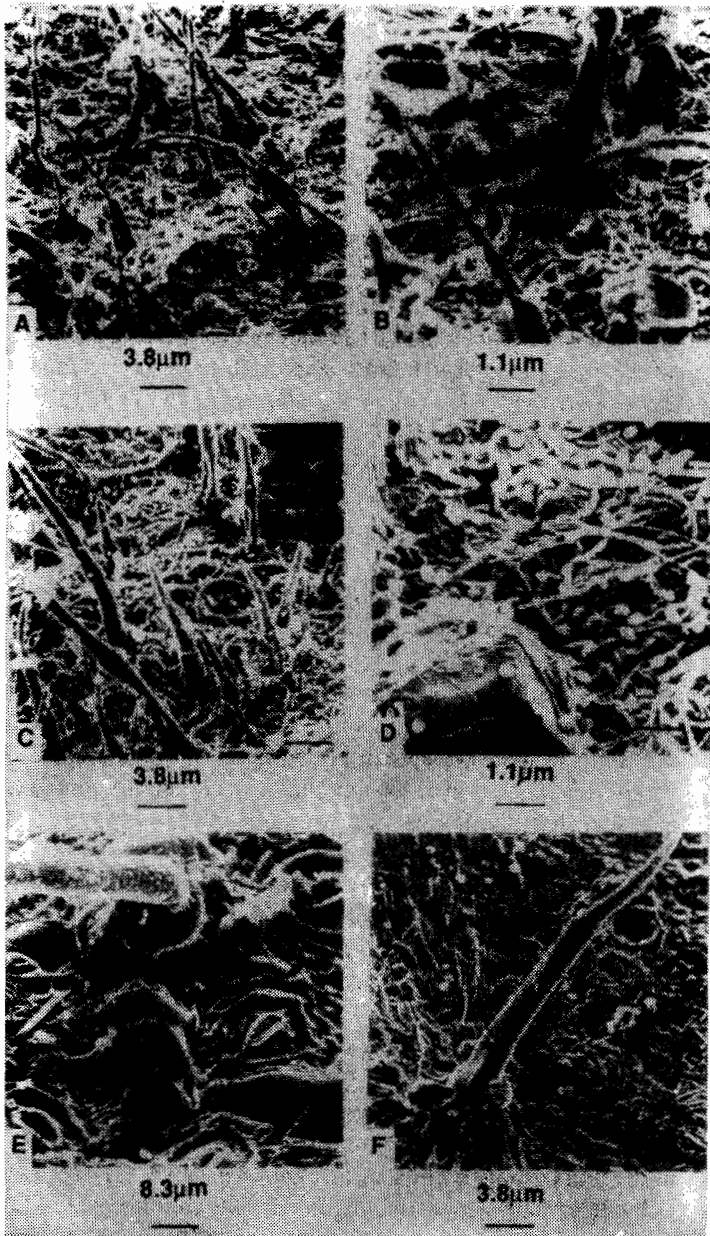


Fig.2. Scanning electron micrographs of leaf adaxial surfaces.

(A) *P. villosus* showing trichomes with sharply pointed terminal cell, (B) *P. villosus* showing small round glandular and long pointed non-glandular trichomes. (C) *P. quadrifolius*, showing the distribution of non-glandular trichomes, (D) *P. quadrifolius*, showing rounded small glandular trichomes, (E) *P. parviflorus* showing stomata and non-glandular trichomes with granulate surface pattern, (F) *P. benghalensis* showing a few small round glandular and long non-glandular trichomes with granulate surface pattern.

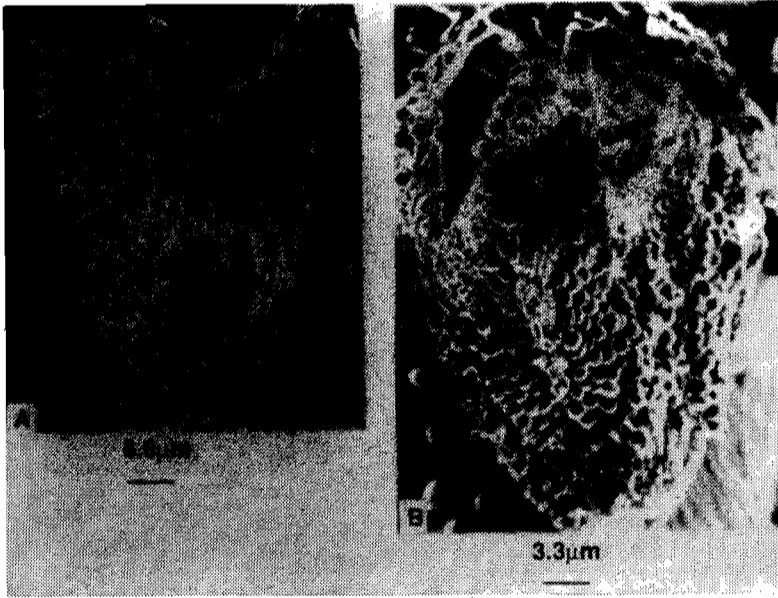


Fig.3. Scanning electron micrographs of calyx.

(A) *P. crassicaulis* showing calyx with non-glandular trichomes which are densely arranged, (B) *P. auricularis* showing calyx with small spherical glandular trichomes, which forms more or less tuberculate pattern.

glandular trichomes are located. Trichomes of *P. stellatus* are similar to *P. crassicaulis* but located only on the calyx teeth.

Nutlet surface: Most of the species or group of species is characterized by a particular type of sculpturing of nutlets which gives the micromorphology of the nutlets a good taxonomic value. The nutlet sculpturing of *P. auricularis* showed irregular, shallow discoid patterns with undulating ridges (Fig.2A & B). *P. strigosus*, *P. quadrifolius*, *P. benghalensis*, *P. plectranthoides* and *P. crassicaulis* have reticulate pattern (Fig.4 C-D) and (Fig.6 A-D). *P. villosus* var. *macrophylla* and *P. stellatus* have very characteristic protuberance which are arranged in an irregular way (Fig.5 A & B). *P. paniculatus* has round swellings which are irregularly arranged. In all other species of the genus *Pogostemon*, nutlet sculpturing are nearly smooth to uneven.

Discussion

The present study confirms previous reports that the structure of glandular hairs are of different kinds in some species of the Lamiaceae (Werker *et al.*, 1985; Husain *et al.*, 1990). Glandular trichomes are sunken in *P. crassicaulis*, but mostly raised on the surface in almost all the species of *Pogostemon*. Some trichomes have characteristic bases and are usually erect (*P. paniculatus*, *P. parviflorus*) whereas others have a simple base and are appressed (*P. hispidus*, *P. suavis*). *P. crassicaulis* and *P. stellatus*

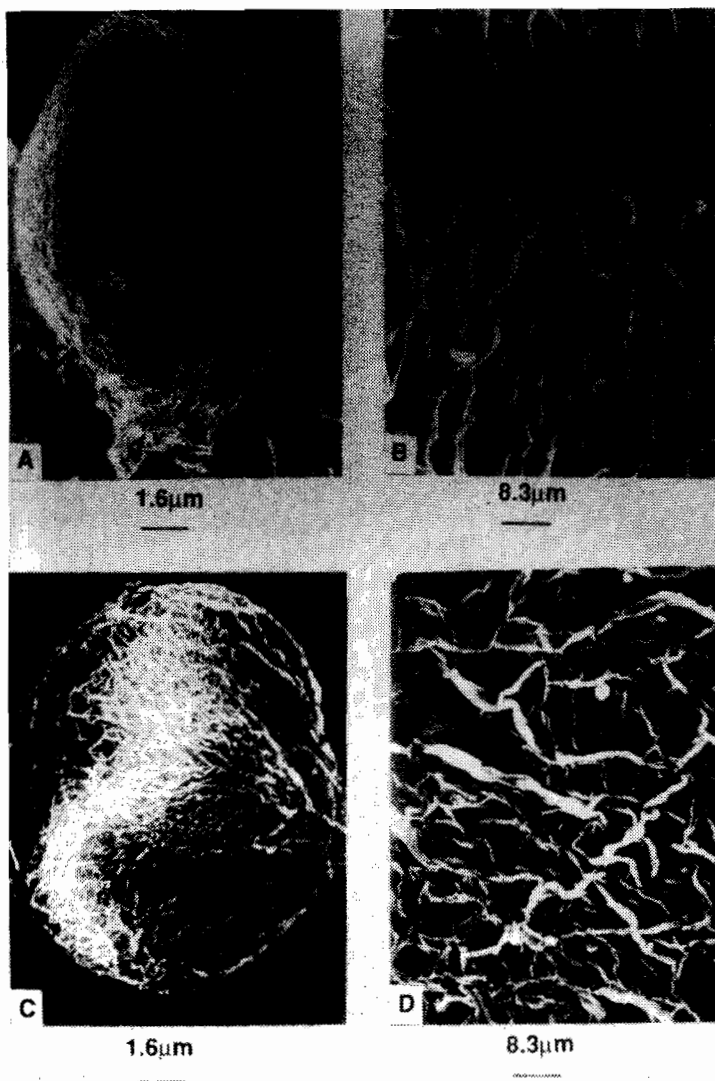


Fig. 4. Scanning electron micrographs of nutlets.

(A) *P. auricularius*, a nutlet, (B) *P. auricularius*, nutlet surface showing irregular shallow discoid pattern, (C) *P. strigosus* a nutlet, (D) *P. strigosus*, nutlet surface pattern, showing irregular discoid to undulating surface pattern.

can easily be distinguished on the basis of their epidermal surface with sunken sessile glandular hairs. Neighbouring cells of stomata are smooth in most of the species, whereas in *P. quadrifolius* few striate are present. In most of the species stomata are levelled with the surface but in *P. plectranthoides* stomata are slightly elevated above the surface. The undulation of leaf epidermis is more pronounced in the *Pogostemon* species collected from the forest.

The distribution of trichomes on the surface of calyx can be used as diagnostic characters as these are present all over the surface in most of the species and only along the margin of the calyx teeth in *P. quadrifolius* and *P. auricularius*. *P. auricularius* show typical arrangement of sessile glandular hairs which gives more or less granulate appearance. Studies on nutlets in the family Lamiaceae have proved useful at different levels of the taxonomic hierarchy. Iseley (1947) was able to distinguish the three tribes viz., Ajugoea, Scutellarieae and Stachyae, using only nutlet characters. He also noted that most of the American species can be recognized by nutlet characters. The significance of nutlet in identification of taxa at different taxonomic level has been highlighted (Hedge, 1967; Husain *et al.*, 1990). The sculpturing of nutlet can be used

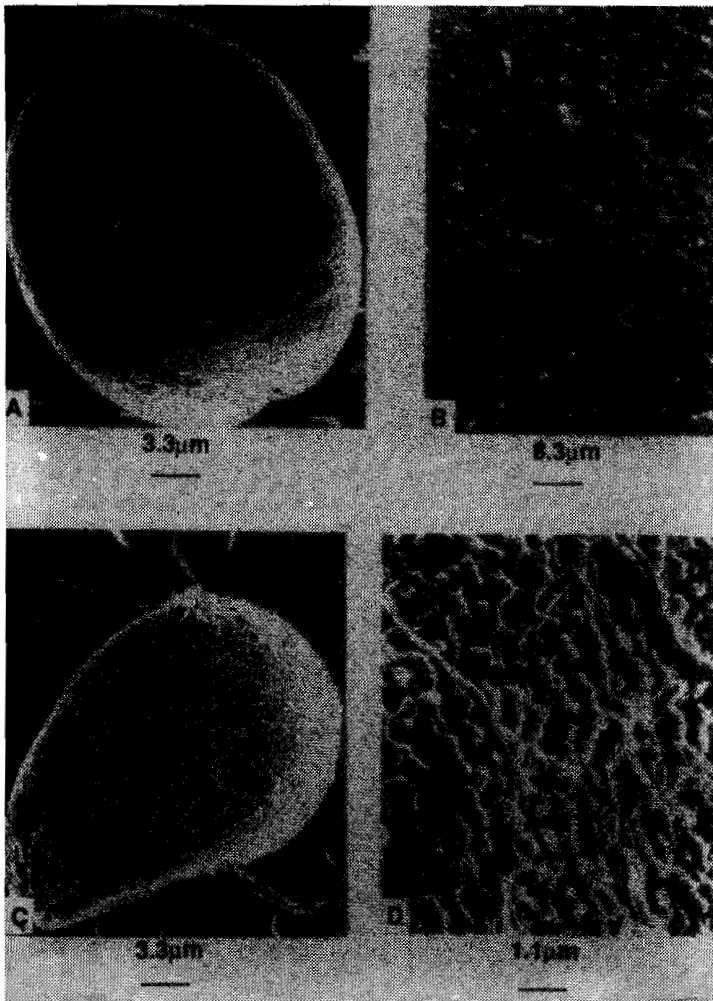


Fig. 5. Scanning electron micrographs of nutlets.

- (A) *P. stellatus*, a nutlet, (B) *P. stellatus*, nutlet surface pattern with undulating surface having protuberance, (C) *P. plectranthoides*, a nutlet, (D) *P. plectranthoides*, showing granulate surface pattern.

as diagnostic character for separating the taxa in *Pogostemon*. *P. stellatus*, *P. villosus* var. *macrophylla* can easily be identified by the presence of protuberance on the nutlet surfaces. *P. crassicaulis*, *P. quadrifolius*, *P. plectranthoides*, *P. strigosus* can be separated from other species by having nutlet with reticulate surface sculpturing. The present survey of micromorphology of leaf, calyx and nutlet surface in genus *Pogostemon* indicates that they have taxonomic significance and can be used as an important taxonomic marker in the identification of species.

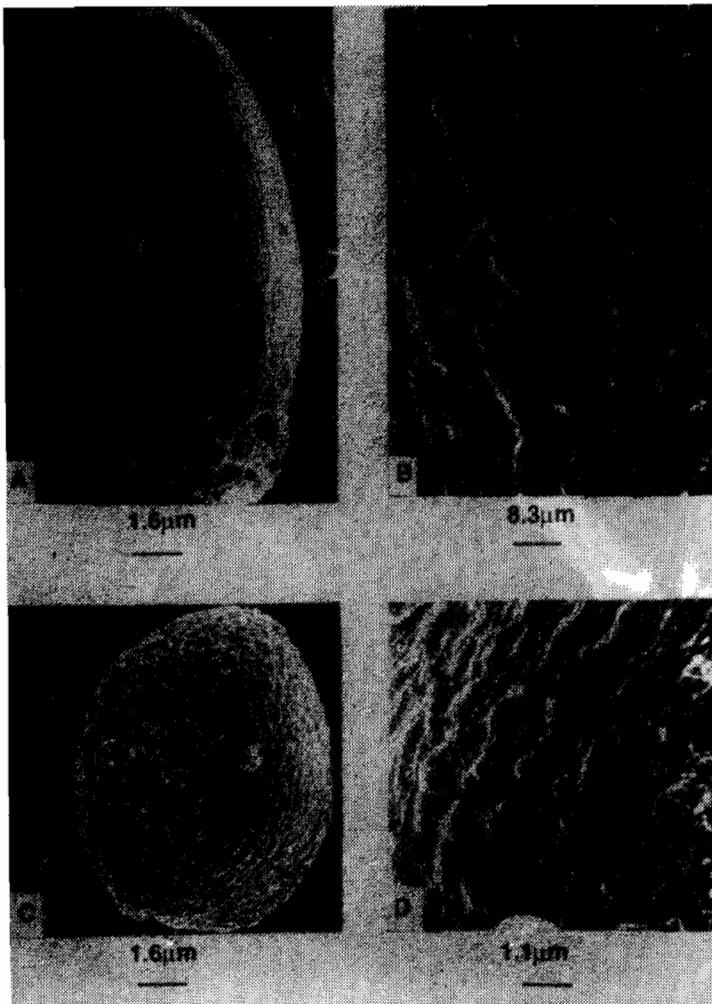


Fig.6. Scanning electron micrographs of nutlets.

(A) *P. benghalensis*, a nutlet, (B) *P. benghalensis*, showing nutlet surface pattern, (C) *P. quadrifolius*, a nutlet, (D) *P. quadrifolius*, showing nutlet surface pattern.

Appendix-1. List of Voucher specimens

Taxon	Collector no. or reference	Locality and habitat
<i>P. auricularis</i>	Khan K. 7477	Nilphamari; Saidpur, in open paddy field.
<i>P. pumilus</i>	Huq 1120	Dhaka, Hemayetpur.
<i>P. benghalensis</i>	Mia M. 1040	Panchagarh, Tetulia, on dry soil.
<i>P. benghalensis</i>	Khan K. 4863	Chittagong; Moheskhal, herb, usually on dry soil.
<i>P. crassicaulis</i>	Din Mohammed 20	Noakhali; Maizdee, on the side of roadside ditches.
<i>P. parviflorus</i>	Tea Research Institute Collector Sn.	Sylhet, Sree Mangal Tea Research Institute.
<i>P. suavis</i>	Khan 983	Chittagong Hill Tracts, Ruma, near a stream.
<i>P. hispidus</i>	Huq 4245	Sylhet; Sree Mangal to Habigong, in forest area.
<i>P. paniculatus</i>	Huq H. 6497	Mymensingh; Bijoypur, in slope of 'tilla'.
<i>P. plectranthoides</i>	Huq H. 9243	Panchagarh, on dry soil.
<i>P. quadrifolius</i>	Khan 877, 887	Chittagong Hill Tracts; on sandy soil to sandy loam.
<i>P. villosus</i>	Golam Mustafa	Barrsal, Babugunj.
<i>P. strigosus</i>	Wallich 1549	Sylhet.
<i>P. stellatus</i>	M. Huque 138	Sylhet, on damp drained low land.
<i>P. villosus</i> var. <i>macrophylla</i>	Khan & Mia	Chittagong, in Forest Research Institute.

References

- Barthlot, W. 1981. Epidermal and seed surface characters of plants: Systematic applicability and some evolutionary aspect. *Nord. J. Bot.*, 1: 345-355.
- Cantino, P.D. 1990. The phylogenetic significance of stomata and trichomes in the Labiatae and Verbenaceae. *J. Arnold Arbor.*, 7: 323-367.
- Davis, P.H. and V.H. Heywood. 1963. *Principles of Angiosperm Taxonomy*. Oliver and Bryd, Edinburgh & London.
- Hedge, I.C. 1967. Studies in the Flora of Afghanistan VI. *Lamium* end. *Notes from the Royal Botanic Garden, Edinburgh*, 28: 149-173.
- Hedge, I.C. 1978. *Labiatae*. In: *Flowering Plants of the World* 238-239. (Ed.) V.H. Heywood, Oxford University Press, Oxford.
- Hedge, I.C. 1990. Labiatae in S.I. Ali & E. Nasir (Eds.). *Fl. Pak.*, 192: 275.
- Husain, S.Z., P.D. Marin, C. Silic, M. Qaser and B. Petcovic 1990. A micromorphological study of some representative genera in the Tribe *Saturejeae* (Laminaceae). *Bot. J. Linn. Soc.*, 103: 59-80.
- Iseley, D. 1947. Investigation in seed classification by family characteristics. *Iowa Agric. Exp. Univ. Jour. Res.*, 12: 247-260.
- Khanam, M. 1989. *Taxonomical studies of Pogostemon Desf in relation to Phytochemistry*. M.Sc. Thesis. University of Reading, U.K.
- Stearn, W. 1983. *Botanical Latin*. Hanfer Publishing Co. London.
- Van Cotthem, W.R.J. 1970. A classification of stomatal types. *Bot. J. Linn. Soc.*, 63: 235-246.
- Werker, E., U. Ravid and E. Putievsky. 1985. Structure of glandular hairs and identification of the main components of their secreted material in some species of the Labiatae. *Israel J. Bot.*, 34: 31-45.

(Received for Publication 7 July 1993)