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TAXONOMIC SIGNIFICANCE OF FOLIAR MICROMORPHOLOGY AND THEIR SYSTEMATIC RELEVANCE IN THE GENUS *SOLANUM* (SOLANACEAE)

V. S. ANIL KUMAR and K. MURUGAN
Department of Botany, University College, Thiruvananthapuram-34, Kerala, India.

Micromorphology of vegetative and reproductive plant organs is the object of research to resolve the taxonomic problems of critical species and genera. Trichomes are distributed at the surface of aerial plant parts, having various functions and are extremely variable in their presence across plant, location on plant organs, density, form, etc., and, therefore, their morphology and structure can be used as taxonomic markers in the infrageneric classification of the genus. The purpose of this investigation was to analyze the degree of differentiation in micromorphological characters between the six species and to assess the expression of these characters in individuals with intermediate macromorphology. Of the several traits on leaf surface, the stomata are perhaps the most significant from the point of view of systematics and phylogeny. Stomata that are highly characteristic of the epidermis occur in widely divergent parts of the plants including common foliage leaves. Stomatal size is an ecologically important attribute. The size, distribution and frequency of stomata have been recognized to be specific to the taxa below the family and these characters were used as significant parameters in the angiosperm taxonomy as well as phylogeny. Qualitative and quantitative micromorphological characters, distribution and systematic relevance of both glandular and eglandular foliar trichomes using Scanning Electron Microscope (SEM) in species of genus *Solanum* (Solanaceae) including *S. melongena var. incanum, S. aculeatissimum, S. erianthum, S. macrocarpon, S. mammosum* and *S. virginianum* were characterized. Both the abaxial and adaxial surfaces were characterized by anisocytic stomata which were more prevalent on the abaxial surface than the adaxial surface. Glandular trichomes were capitate while non-glandular trichomes were stellate with many arms or linear fingerlike. Glandular trichomes play important roles in protecting plants from biotic attack by producing defensive compounds. The trichomes in the family Solanaceae vary from unicellular to multicellular, conical to elongated, smooth to ridges, with or without flattened disk at base. Glandular capitate trichomes were the most unique on leaf surfaces of the examined taxa. In summary, the variation in morphology and distribution of foliar trichomes emerged as an important supportive taxonomic tool in delimiting species of genus *Solanum.*

Keywords : Capitate glands; Leaf epidermal anatomy; *Solanum;* Trichomes.

Introduction

Epidermal micromorphology of the leaves is used in emphasizing the interrelationships and segregation into major clades[1,2] have supported the earlier grouping for various taxa from different families of plant systematics. Epidermal micro characters are quite important to delineate the different taxa in terms of phylogenetic and taxonomic considerations. Angiosperms leaves are the most suited and studied for these purpose[3]. Several authors recognized the importance of these epidermal features in recognizing the different taxa belonging to different families[4-6]. More importantly this study may be usedful to locate the markers present within the circumcision of the micromorphology[7] utilized epidermal characters for understanding the interrelationship of the various taxa. Indeed the foliar epidermal characters of the angiosperms depict the sufficient diversity of details due to its genetic and environmental makeup. Since the micromorphological characteristics of foliear trichomes have played an important role in plant taxonomy, especially of particular groups at generic and specific levels, more and more studies in this field have attracted the attention of plant morphologists and systematists to resolve the taxonomic conflicts. Similarly, of the several traits on leaf surface,

the stomata are perhaps the most significant from the point of view of systematics and phylogeny. Stomata that are highly characteristic of the epidermis occur in widely divergent parts of the plants including common foliage leaves[8]. Stomatal size is an ecological important attributes. The size, distribution and frequency of stomata have been recognized to be specife to the taxa below the family and these characters were used as significant parameters in the angiosperm taxonomy as well as phylogeny. The importance of epidermal cell characters is now well established in taxonomic considerations of angiosperms[5]. Therefore, in the present paper, the micromorphological characteristic of foliar trichomes in *Solanum* was studied by means of scanning electron microscopy (SEM). The specific objectives of this paper was to compare the micromorphological characteristics of foliar nature in different species of this genus.

Material and Methods

Leaf materials used in this study were obtained from freshly collected plants during the expeditions to various parts of Kerala. The plants were identified at the Department of Botany, University of Calicut and a voucher specimen was prepared and deposited in the Herbarium of the Department of Botany, University College, Thiruvananthapuram.

Scanning electron microscopy : Fresh leaf pieces (10 x 10 mm^2) from all the species such as *S. melongena var. incanum, S. aculeatissimum, S. erianthum, S. macrocarpon, S. mammosum* and *S. virginianum* were immersed in a fixative solution of 3% glutaraldehyde in 0.1 M phosphate buffer for 24 h. Samples were washed for 15-30 min with the buffer and dehydrated in graded ethanol series. Samples were then critical-point dried using CO_2, sputter coated with gold under vacuum and viewed with Hitachi (S-450) scanning electron microscope operating at 15 kV. Images were captured digitally with an Image Slave computer programme for Windows.

Results and Discussion

SEM study of the leaf reveals the following features :

(i) *Surface of leaf : S. aculeatissimum* adaxial leaf surface shows irregular ridges and furrows appearing like chains of hillocks. Each ridge is shallowly undulated and striated. Flakes of wax particles are randomly distributed throughout the surface (Fig. 1A). In the case of *S. erianthum* both surfaces were densely pubescent with short stalked multiradiate stellate non glandular hairs (Fig. 1B and C). In *S. melongena var. incanum* both the surfaces were sparsely pubescent with sessile multiradiate stellate non glandular hairs. Short stalked multicellular glandular hairs was dense in the upper surface (Fig. 1D and E). *S. macrocarpon* leaf was ridged with short stalked multicellular glandular hairs on both surfaces whereas, unicellular non glandular pointed hairs are restricted along the margin of the leaf (Fig. 1F and G). *S. mammosum* both the leaf surfaces were studded with long stalked multicellular glandular hairs intermingled with long multicellular non glandular hairs (Fig. 1H and I). Interestingly, the lower leaf surface showed the presence of short stalked multicellular glandular hairs along the veins. *S. virginianum* upper leaf surface showed the presence of long multicellular non glandular hairs with bulbous tip, short stalked multicellular glandular hairs and multicellular non glandular stalked hairs with pointed tip (Fig. 1J). Lower leaf surface showed few stellate hairs, long multicellular non glandular hairs with bulbous tip and multicellular non glandular stalked hairs with pointed tip (Fig. 1K).

Generally the abaxial surface is uneven due to differential cuticularization. The cuticular striations are rib-like with variable curvatures and apparent interlocking or articulations. *S. aculeatissimum* showed glandular trichomes all along the surface with sparse distribution of long multicellular non glandular hairs with pointed tip (Fig. 2A).

The ribs are in somewhat parallel orientation forming groups many of which radiate in different directions from stomatal rim. Each rib is differentially thickned, curved and has undulated surface. The leaf is amphistomatic with anomocytic stomata.

(ii) *Stomata :* Each stoma is lodged in a shallow depression. It is oval in shape, the apeture being elliptic with an outline of waxy deposition. Guard cells slightly protuberant and the lateral walls of the guard cells are with uneven waxy coating (Figs. 3A-D).

The epidermal cells have sinuous anticlinal walls on the adaxial surface and waved on the abaxial surface. In cross section, the epidermis is 1-layered with rounded cells and the stomata are located on the same level as the other epidermal cells. The analysis of epidermal prints has shown that the epidermal tissue consisted of cells with rugose anticlinal walls, especially abaxially. Indumentum, made of non-glandular and glandular hairs, was sparse on both epidermal sides. Hairs were more numerous along veins and on the abaxial lamina side. There were two types of glandular haris. The hairs of one type consisted of a short, multicellular stalk and a multicellular secretory head, round to oval in shape (Fig. 1F). The hairs of second type had a longer stalk, made of two, three or four cells, and a unicellular secretory head at the top (Fig. 1H). The stalk cell under the head was narrow. It has been noticed that

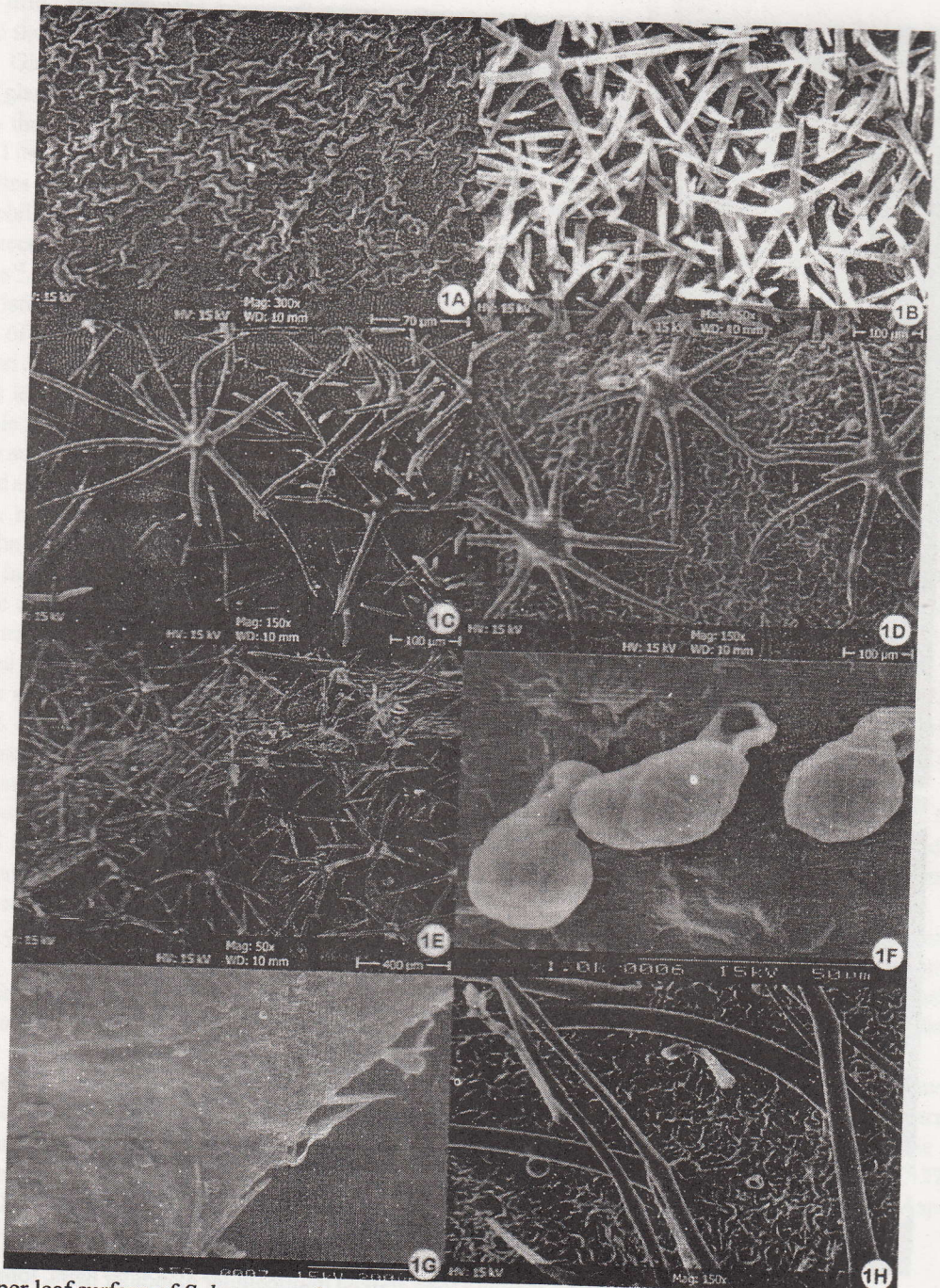

Fig.1A. Upper leaf surface of *Solanum aculeatissimum* showing ridges and furrows. Fig. 1B&C. Upper and lower leaf surfaces of *Solanum erianthum* showing multiradiate nongladular stellate haris. Fig. 1D. Upper leaf surface of *Solanum melongena var. inconum* showing multiradiate nonglandular stellate hair and short stalked glandular hairs. Fig. 1E. Lower leaf surface of *Solanum melongena var. incanum* showing multiradiate stellate nonglandular hairs. Fig. 1F. Leaf surface of *Solanum macrocarpon* showing shortstalked multicellular glandular hairs. Fig.1G. Leaf margin of *Solanum macrocarpon* showing unicellular nonglandular pointed hairs along with glandular hairs. Fig. 1H. Upper leaf surface of *Solanum mammosum* showing long stalked multicellular glandular hairs along with long multicellular non glandular hairs.

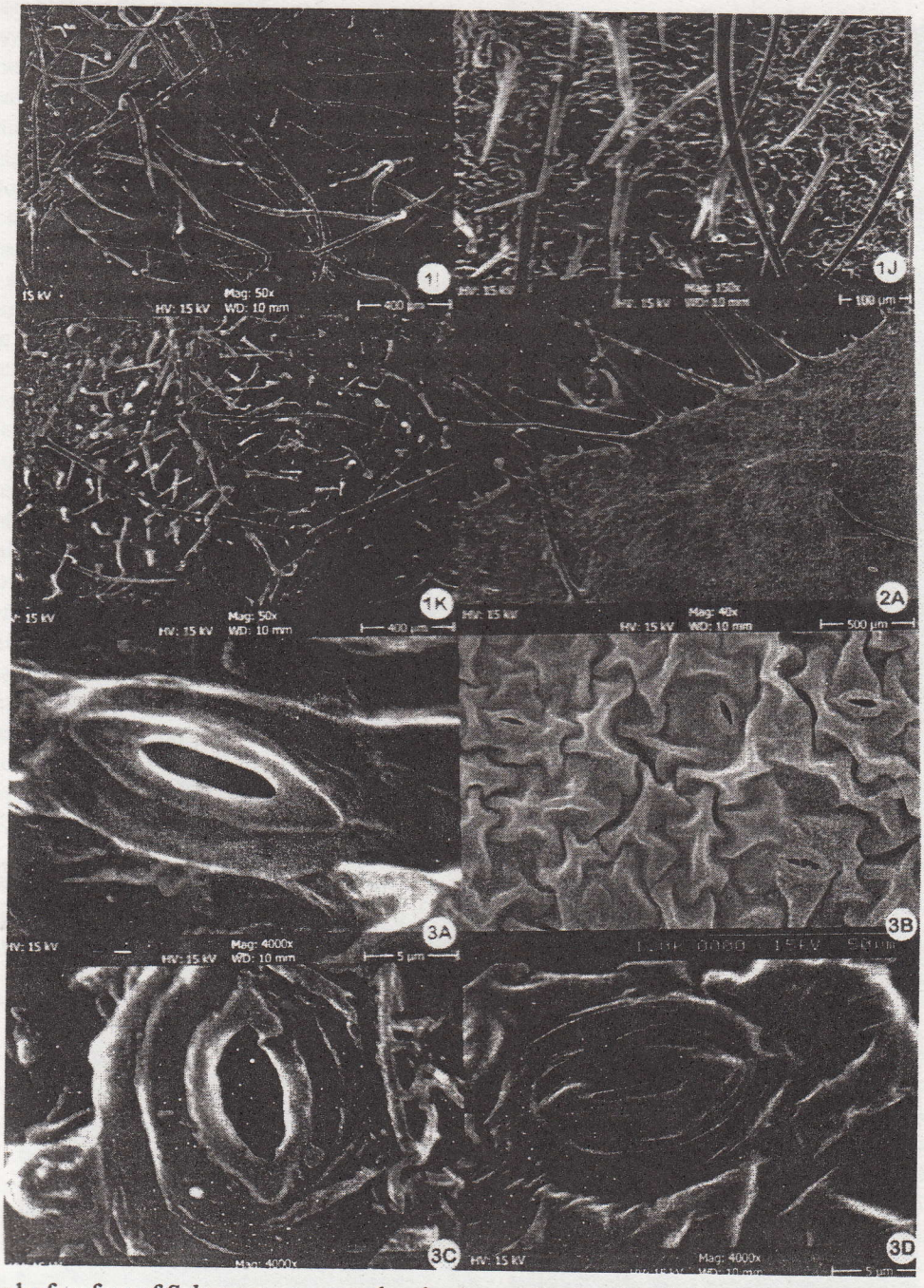

Fig.1I. Lower leaf surface of *Solanum mamosum* showing long stalked multicellular glandular hairs, long multicellular non glandular hairs and short stalked multicellular glandular hairs along the veins. Fig. 1J. Upper leaf surface of *Solanum virginianum* showing multicellular nonglandular hairs with bulbous tip, short stalked multicellular glandular hairs and multicellular nonglandular hairs with pointed tip. Fig. 1K. Lower leaf surface of *Solanum virginianum* showing stellate hair, long multicellular nonglandular hairs with bulbous tip and multicellular nonglandular hairs with pointed tip. Fig. 2A. Leaf surface of *Solanum aculeatissimum* Showing glandular hairs with sparse distribution of multicellular nonglandular hairs with pointed tip. Fig. 3A. Stoma of *Solanum aculeatissimum*. Fig. 3B. Stoma of *Solanum macrocarpon*. Fig. 3C. Stoma of *Solanum melongena var. incanum* . Fig. 3D. Stoma of *Solanum virginianum*.

this cell dried faster than the other stalk cells. Stalk cells closer to the hair base were widened.

Glandular trichomes are characterized by having 'heads' (glands) that relase, on contact, sticky and/or toxic exudates that may entrap, irritate or potentially kill some pests[9]. These glands contain important secondary metabolites including terpenes, essential oils, flavonoids and lipophilic components[10,11]. In most species, the source of these secondary metabolites has been attributed to the trichomes[12]. The possession of glandular trichomes is characteristic of the genus *Solanum* and of many other members of Solanaceae, with the exception of *Nicotiana glauca* and *Solandra nitida*[13]. The two types of glandular trichomes identified on the leaves of *Solanum* might be responsible for the production, accumulation and release of volatile and secondary metabolites such as the saponins and steroid alkaloids reported by Drewes and Van Staden[14]. Although, micro-morphological studies alone do not provide the information required to establish sites of synthesis in cells[10], it is plausible to assume that the therapeutic compounds in *Solanum* are produced by the glandular trichomes. The leaf epidermis surfaces were investigated to evaluate their taxonomic significance to be used for separation and delimitation of the species of the section. Micro-morphological characters of the leaf epidermis, such as density, distribution and type of stellate trichomes, and the anticlinal walls of epidermal cells, and also the type and distribution of stomata proved to be the most useful and distinctive characters for the separation and delimitation of the species, and also may contribute as an additonal support to the interspecific taxonomy and systematics of *Solanum*.

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