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STOMATAL TYPES OF MONOCOTS WITHIN FLORA OF KARACHI, PAKISTAN

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Abstract

Stomatas of 54 monocot species belonging to 42 genera in 10 families were examined by light and scanning electron microscopy. Three types of stomata viz., tetracytic, paracytic and anomocytic were recognized. In the family Commelinaceae tetracytic type is present and in the family Liliaceae both tetracytic and anomocytic types are found. While,Typhaceae, Gramineae, Cyperaceae, Palmae and Juncaceae are characterized by paracytic type. In the remaining three families i.e., Potamogetonaceae, Najadaceae and Hydrocharitaceae stomatas are absent.

Introduction

Stomata is usually termed for the opening in the epidermis through which gaseous interchange takes place between the intercellular spaces of the subepidermal cells and the atmosphere (Eames & MacDaniels, 1947). There are three main types of stomata in monocots based on the arrangement of subsidiary cells. The stomata is tetracytic when the two guard cells are surrounded by four subsidiary cells and the subsidiary cells are in all four directions. The stomata is paracytic when the two guard cells are accompanied by two subsidiary cells one on each side. But the stomatas are anomocytic when the guard cells are not associated with any subsidiary cells (Metcalfe, 1961; Stebbins & Khush, 1961). The stomata was first studied by Strasburger (1866), followed by Vesque (1889) who recognized four broad categories of stomata based on the presence and arrangement of accessory cells as well as their mode of development. Subsequently several studies have been made on stomata of dicots (Metcalfe, 1961; Stace, 1965; Payne, 1970; 1979; Fryns- Claessens & Van Cotthem, 1973; Dilcher, 1974; Stevens & Martin, 1978; Patel, 1979; Rasmussen, 1981; Inamdar *et al*., 1986; Baranova, 1987; 1992). Besides this there are very few reports on stomata of monocots such as Cheadle (1953) examined stomatas in Agavaceae, Alismataceae, Amaryllidaceae, Butomaceae, Araceae and Cannaceae. Similarly, Stebbins & Khush (1961) and Fahn (1965) also studied stomata of some members of Gramineae and Cyperaceae. It is therefore evident that several informations are available on stomatal types but no specific report is available on stomatas of monocots from Karachi. Studies were therefore undertaken to provide the information for the stomatal type for the monocots from the area under consideration.

Materials and Methods

Stomatal types of 54 species belonging to the families Typhaceae, Potamogetonaceae, Najadaceae, Hydrocharitaceae, Gramineae, Cyperaceae, Commelinaceae, Palmae, Juncaceae and Liliaceae were studied. Fresh leaves were collected from different localities in the vicinity of Karachi. However, in case of non availability of fresh

materials, herbarium specimens were also used (Table 1). To study the stomatal types, the technique known as Impression Technique was used (Hilu & Randall, 1984). A film of clear nail polish was directly applied to the leaf surface. After drying, the impression left on the polish film produce an excellent detailed image of the epidermis. Sometimes, stomata were directly observed in fresh leaves under compound microscope (Nikon Type-102). For Scanning electron microscopy leaves were mounted on a metallic stub with the help of double adhesive tape and coated with gold with a thickness of 300 A° in ion sputtering device and examined on a Jeol scanning microscope (JSM–6380 A).

Table 1. Stomatal types of monocotyledonous taxa.

Name of Taxa	Type of stomata	Voucher specimen collector, number, herbarium
Aloe vera L.	Tetracytic	S. Sharmeen 15 (KUH); S. Sharmeen 12 (KUH); S. Sharmeen 1 (KUH).
Aristida adscensionis L.	Paracytic	S. I. Ali s.n. (KUH); Abrar Hussain s.n. (KUH); Khush Gul s.n. (KUH).
A .hirtigluma Steud. ex Trin. & Rupr.	Paracytic	S. Sharmeen 21 (KUH); S. Sharmeen 13 (KUH); S. Sharmeen 31 (KUH).
A. mutabilis Trin & Rupr.	Paracytic	Tahmeena Siddiqui 49 (KUH).
Asparagus dumosus Baker.	Anomocytic	S. Sharmeen 5 (KUH); S. Sharmeen 34 (KUH); S. Sharmeen 40 (KUH).
Brachiaria eruciformis (J.E.Sm.) Griseb.	Paracytic	S. Sharmeen 3 (KUH); S. Sharmeen 23 (KUH); S. Sharmeen 10 (KUH).
B. ramose (L.) Stapf	Paracytic	S. Sharmeen 4 (KUH); S. Sharmeen 7 (KUH); S. Sharmeen 9 (KUH).
Cenchrus biflorus Roxb.	Paracytic	S. Sharmeen 19 (KUH); S. Sharmeen 25 (KUH); S. Sharmeen 16 (KUH).
C .pennisetiformis Hochst. & Steud.	Paracytic	S. Sharmeen 41 (KUH); S. Sharmeen 45 (KUH); S. Sharmeen 20 (KUH).
C .setigerus Vahl	Paracytic	S. Sharmeen 33 (KUH); S. Sharmeen 26 (KUH); S. Sharmeen 6 (KUH).
Chloris barbata Sw.	Paracytic	S. Sharmeen24 (KUH); S. Sharmeen 11 (KUH); S. Sharmeen 27 (KUH).
Chrysopogon aucheri (Boiss.) Stapf.	Paracytic	S. Sharmeen 65 (KUH); S. Sharmeen 28 (KUH); S. Sharmeen 29 (KUH).
Commelina albescens Hasskar.	Tetracytic	S. Sharmeen 30 (KUH); S. Sharmeen 37 (KUH); S. Sharmeen 49 (KUH).
Cymbopogon jwarancusa (Jones) Schult.	Paracytic	Shamim Akhter s.n. (KUH); Bushreen & Nadeem 55 (KUH).
Cynodon dactylon (L.) Pers.	Paracytic	Moin, Zeenat & Bushreen 12 (KUH); Khush Gul s.n. (KUH).
Cyperus atkinsoni C.B.Clarke	Paracytic	S. Sharmeen 36 (KUH); S. Sharmeen 71 (KUH); S. Sharmeen 52 (KUH).
C. rotundus L.	Paracytic	S. Sharmeen 61 (KUH); S. Sharmeen 85 (KUH); S. Sharmeen 39 (KUH).
Dactyloctenium aegyptium (L.) P. Beauv.	Paracytic	S. Sharmeen 32 (KUH); S. Sharmeen 67 (KUH); S. Sharmeen 70 (KUH).
Desmotachya bipinnata (L.) Stapf	Paracytic	S. Sharmeen 90 (KUH); S. Sharmeen 38 (KUH); S. Sharmeen 57 (KUH).
Dicanthium annulatum (Forssk.) Stapf.	Paracytic	S. Sharmeen 42 (KUH); S. Sharmeen 44 (KUH); S. Sharmeen 62 (KUH).
Digitaria nodosa Parl.	Paracytic	S. Sharmeen 76 (KUH); S. Sharmeen 47 (KUH); S. Sharmeen 88 (KUH).
Echinochloa colonum (L.) Link	Paracytic	Abida Shamim s.n. (KUH); S.I. Ali & Students 303 (KUH).

Table 1. (Cont'd.)

Name of Taxa	Type of stomata	Voucher specimen collector, number, herbarium
Eragarostis tenella (L.) P. Beauv. ex R. & S.	Paracytic	S. Sharmeen 73 (KUH); S. Sharmeen 95 (KUH); S. Sharmeen 84 (KUH).
Eriochloa procera (Retz.) C. E. Hubb.	Paracytic	S. Omer 151 (KUH).
Hackelochloa granularis (L.) O. Ktze.	Paracytic	Abrar Hussain 152 (KUH); Abrar Hussain s.n. (KUH).
Halopyrum mucronatum (L.) Stapf	Paracytic	Abrar Hussain s.n. (KUH); Tahmeena Siddiqui 58 (KUH); S.M.H. Jafri 1540 (KUH).
Hydrilla verticillata (L. f.) L.C. Rich.	Absent	S. Sharmeen 89 (KUH); S. Sharmeen 100 (KUH); S. Sharmeen 115 (KUH).
Juncellus laevigatus (L.) C.B. Clarke	Paracytic	S.I. Ali s.n. (KUH).
Juncus maritimus Lam.	Paracytic	S. Sharmeen 94 (KUH); S. Sharmeen 93 (KUH); S. Sharmeen 99 (KUH).
Lasiurus hirsutus (Forssk.) Boiss.	Paracytic	S. Sharmeen 96 (KUH); S. Sharmeen 101 (KUH); S. Sharmeen 105 (KUH).
Melanocenchris abbyssinica (R. Br.) Hochst.	Paracytic	Abrar Hussain s.n. (KUH); Khadija Aziz s.n. (KUH); Abrar Hussain s.n. (KUH).
Najas minor L.	Absent	Rizwan Yusuf & Abrar Hussain 100 (KUH).
Panicum antidotale Retz.	Paracytic	S. Sharmeen 125 (KUH); S. Sharmeen 126 (KUH); S. Sharmeen 140 (KUH).
P. turgidum Forssk.	Paracytic	S. Sharmeen 103 (KUH); S. Sharmeen 117 (KUH); S. Sharmeen 111 (KUH).
Paspalidium geminatum (Forssk.) Stapf.	Paracytic	S. Sharmeen 120 (KUH); S. Sharmeen 142 (KUH); S. Sharmeen 109 (KUH).
P. punctatum (Brum. f.) A. Camus	Paracytic	S. Sharmeen 135 (KUH); S. Sharmeen 127 (KUH); S. Sharmeen 139 (KUH).
Paspalum distichum L.	Paracytic	S. Sharmeen 118 (KUH); S. Sharmeen 129 (KUH); S. Sharmeen 136 (KUH).
Pennisetum glaucum (L.) R. Br.	Paracytic	S. Sharmeen 145 (KUH); S. Sharmeen 112 (KUH); S. Sharmeen 113 (KUH).
Pharagmites karka (Retz.) Trin.	Paracytic	S. Sharmeen 106 (KUH); S. Sharmeen 104 (KUH); S. Sharmeen 114 (KUH).
Phoenix dactylifera L.	Paracytic	S. Sharmeen 107 (KUH); S. Sharmeen 108 (KUH); S. Sharmeen 119 (KUH).
Polypogon monspeliensis (L.) Desf.	Paracytic	Abrar Hussain s.n. (KUH).
Potamogeton pectinatus L.	Absent	S. Khatoon & Raiha Qadri 306A (KUH).
P. perfoliatus L.	Absent	S. Khatoon & Raiha Qadri 306 (KUH).
Saccharum officinarum L.	Paracytic	S. Sharmeen 159 (KUH); S. Sharmeen 150 (KUH); S. Sharmeen 167 (KUH).
Scripus littoralis Schrad.	Paracytic	S. Sharmeen 165 (KUH); S. Sharmeen 152 (KUH); S. Sharmeen 141 (KUH).
S. tuberosus Desf.	Paracytic	S. Sharmeen 149 (KUH); S. Sharmeen 147 (KUH); S. Sharmeen 166 (KUH).
Sehima ischaemoides Forssk.	Paracytic	S.A. Ali 10 (KUH); S.M.H. Jafri 4120 (KUH).
Setaria verticillata (L.) P. Beauv.	Paracytic	S. Sharmeen 175 (KUH); S. Sharmeen 151 (KUH); S. Sharmeen 169 (KUH).
Sporobolus coromandelianus (Retz.) Kunth	Paracytic	S. Sharmeen 161 (KUH); S. Sharmeen 176 (KUH); S. Sharmeen 168 (KUH).
S. helvolus (Trin.) Dur. & Schinz	Paracytic	S. Sharmeen 154 (KUH); S. Sharmeen 163 (KUH); S. Sharmeen 162 (KUH).
S. marginatus Hochst. ex. A. Rich.	Paracytic	S. Sharmeen 164 (KUH); S. Sharmeen 170 (KUH); S. Sharmeen 153 (KUH).
Tetrapogon villosus Desf.	Paracytic	J.R. Kazmi s.n. (KUH); Rizwan Yusuf & Abrar Hussain 72A (KUH).
Typha angustata Bory & Chaub.	Paracytic	S. Sharmeen 172 (KUH); S. Sharmeen 182 (KUH); S. Sharmeen 183 (KUH).
Vallisneria spiralis L.	Absent	S.M.H. Jafri 2642 (KUH).

Fig. 1. Light micrographs showing stomatal types: A, Anomocytic; B, Paracytic; C, Tetracytic (X = 10).

Results and Discussion

Monocotyledonous flora of Karachi clearly reveals the presence of three major types of stomata such as paracytic, tetracytic, and anomocytic type (Figs. 1, 2). Previously these types were also reported in numbers of monocots (Cheadle, 1953; Stebbins & Khush, 1961). Stebbins & Khush (1961) suggested that anomocytic type is limited only

Fig. 2. Scanning electrons micrographs showing stomatal types: A, Paracytic; B, Tetracytic. (Scale bar: A, B = 10μ m).

to the orders closely related to Liliales. These findings are also reported presently in *Asparagus dumosus* which has anomocytic type but in case of *Aloe vera* results are contradictory due to the presence of tetracytic type. Similarly in Gramineae, Cyperaceae,

Palmae, Juncaceae and Typhaceae stomata are paracytic with two subsidiaries cells. Tetracytic type of stomata is found in Commelinaceae, previously it was also reported by Raunkiaer (1937). In the remaining species belonging to the families Potamogetonaceae, Najadaceae, Hydrocharitaceae leaves are submerged or immersed and they are devoid of stomata. These findings also correlate with those of Fahn (1965) in which he reported that immersed leaves are usually without stomata. In connection to the shape of guard cells, Fahn (1965) reported that the guard cells of Gramineae and Cyperaceae are elongated and dumble shaped. However, the present findings reveal that in addition to Gramineae and Cyperaceae, Typhaceae is also having dumble shaped and elongated guard cells.

Out of 54 taxa belonging to 42 genera distributed in 10 different families viz., Typhaceae, Potamogetonaceae, Najadaceae, Hydrocharitaceae, Gramineae, Cyperaceae, Palmae, Commelinaceae, Juncaceae and Liliaceae only one species namely *Asparagus dumosus* has anomocytic type. Whereas, the tetracytic type is found in two taxa such as *Commelina albescens* and *Aloe vera,* while in the 46 taxa paracytic type is found. In the remaining five species stomatas are absent (Table 1). For the stomatal types it is believed that paracytic type is primitive within the angiosperms (Cronquist, 1968; Takhtajan, 1969). However, present findings clearly indicate that among the monocots of Karachi the paracytic type is most common irrespective of advance and primitive taxa (Table 1).

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