

## STOMATAL TYPES OF SOME DICOTS WITHIN FLORA OF KARACHI, PAKISTAN

ANJUM PERVEEN, RUBINA ABID AND RABAB FATIMA

Department of Botany, University of Karachi,  
Karachi-75270, Pakistan

### Abstract

Stomatal morphology of 69 dicot species distributed in 64 genera and 28 families was examined by light and scanning electron microscopy. In all 6 types of stomata i.e., anomocytic, paracytic, diacytic, parallelocytic, cyclocytic and anisocytic were recognized. Within the dicot flora, anomocytic type is most dominant found in 54 taxa, followed by paracytic and diacytic type, represented by 9 and 3 taxa respectively. Whereas, parallelocytic, cyclocytic and anisocytic types are found only in one species each.

### Introduction

The stomata are apertures in the epidermis, each bounded by two guard cells. Their main function is to allow gases such as carbon dioxide, water vapours and oxygen to move rapidly into and out of the leaf. In green leaves they occur either on both surfaces (amphistomatic leaf) or on one only, either the upper (epistomatic leaf) or more commonly the lower i.e., hypostomatic leaf.

On the basis of arrangement of the epidermal cell neighbouring the guard cell, more than 25 main types of stomata in dicots have been recognized (Metcalfe & Chalk, 1979). Besides this there are various reports available on stomata of dicots such as Shah *et al.*, (1972), described the stomatal ontogeny of 21 species of Mimosoideae and found paracytic type alongwith several derived configurations. Similarly, Pettigrew & Watson (1973) studied 23 Australian *Acacia* species and reported paracytic and cyclocytic types along with variants of these two types. Binns & Blunden (1980) reported paracytic and anomocytic types in *Salix* species. In the family Chloranthaceae, Kong (2001) reported various types of stomata such as paracytic, laterocytic, encyclocytic and anomocytic and in the genus *Ficus*, Sonibare *et al.*, (2005) also reported the paracytic type of stomata. No information is available on stomata from Pakistan except that of the stomata of monocots from Karachi (Abid *et al.*, 2007). Present study is the first attempt based on stomatal survey of dicots from Karachi.

### Materials and Methods

Fresh materials of 69 species were collected from the different localities of Karachi. For stomatal studies leaves were kept in methanol for about half an hour to 72 hours depending upon the texture of leaves and observed under compound microscope (Nikon Type-102). Sometimes, leaves were directly observed for stomata without any treatment. In few cases, impression technique (Hilu & Randall, 1984) was used. In this technique a film of clear nail polish was directly applied to the lower surface of leaf. After drying, the impression left on the polish film produce an excellent detailed image of the epidermis. For scanning electron microscopy, a piece of dried leaf was mounted on a metallic stub

with the help of double adhesive tape and coated with gold with a thickness of 300A° in ion sputtering chamber and examined under Joel scanning electron microscope (JSM-6380A).

### Results and Observations

**Anomocytic:** The stomata are anomocytic in which the guard cells are not surrounded with any subsidiary cell.

**Species included:** *Zaleya pentandra* (L.) Jeffrey (Aizoaceae), *Achyranthes aspera* L., *Aerva javanica* (Burm.f.) Juss., *Amaranthus graecizans* L., *Amaranthus viridis* L., *Digera muricata* (L.) Mart., *Pupalia lappacea* (L.) Juss. (Amaranthaceae), *Aristolochia bracteata* Retz. (Aristolochiaceae), *Heliotropium curassavicum* L., *Heliotropium ophioglossum* Stocks, *Trichodesma amplexicaule* Roth. (Boraginaceae), *Cassia holosericea* Fres., *Parkinsonia aculeata* L. (Caesalpiniaceae), *Cadaba fruticosa* (L.) Druce, *Cleome viscosa* L., *Gynandropsis gynandra* (L.) Briq., *Maerua arenaria* (DC.) Hook.f. et. Thoms. (Capparidaceae), *Salsola imbricata* Forssk., *Suaeda fruticosa* (L.) L. (Chenopodiaceae), *Eclipta prostrata* (L.) L., *Iphionia grantioides* (Boiss.) Anderb., *Lactuca remotiflora* DC., *Launaea resedifolia* (L.) O.Ktze., *Pluchea lanceolata* DC. (C.B. Clarke), *Pulicaria angustifolia* DC., *Sonchus aspera* (L.) Hill., *Tridax procumbens* L., *Vernonia cinerea* (L.) Less. (Compositae), *Euphorbia hirta* Forssk., *Phyllanthus niruri* L. (Euphorbiaceae), *Enicostemma verticillatum* (L.) Engler (Gentianaceae), *Salvia santolinaefolia* Boiss. (Labiatae), *Malvastrum coromandelianum* (L.) Garcke, *Senra incana* Cav. (Malvaceae), *Cocculus pendulus* (Forssk.) Diels. (Menispermaceae), *Boerhaavia verticillata* L. (Nyctaginaceae), *Alysicarpus monilifer* (L.) DC., *Melilotus indicus* (L.) All., *Rhynchosia minima* (L.) DC., *Taverniera lappacea* (Forssk.) DC., *Tephrosia strigosa* (Dalz.) Sant. & Mah. (Papilionaceae), *Anagallis arvensis* L. (Primulaceae), *Ochradenus baccatus* Del. (Resedaceae), *Zizyphus nummularia* (Burm.f.) Wt. & Arn. (Rhamnaceae), *Cardiospermum halicacabum* L. (Sapindaceae), *Schweinfurthia papilionacea* (Burm.f.) Boiss. (Scrophulariaceae), *Datura alba* Nees, *Lycium europium* L., *Withania somnifera* (L.) Dunal. (Solanaceae), *Corchorus trilocularis* L., *Grewia tenax* (Forssk.) Fiori (Tiliaceae), *Fagonia cretica* L., *Tribulus terrestris* L., *Zygophyllum simplex* L. (Zygophyllaceae).

**Anisocytic:** In anisocytic type the guard cells are surrounded by three unequal sized subsidiary cells, the common wall of which is at right angle to the longitudinal axis of stoma.

**Species included:** *Farsitia jacquemontii* Hook.f. et. Thoms. (Cruciferae)

**Cyclocytic:** In cyclocytic type two or more subsidiary cells form one or two narrow rings around the guard cells.

**Species included:** *Ipomoea carnea* Jacq. (Convolvulaceae)

**Diacytic:** Diacytic stomata are those in which one or more pairs of subsidiary cells enclose the stoma and the common wall of subsidiary cells are at right angles to the guard cells.

**Species included:** *Blepharis sindica* Stocks ex T. Anderson., *Ruellia tuberosa* L., *Ruellia patula* Jacq. (Acanthaceae).

**Paracytic:** In the paracytic type guard cells are accompanied by two subsidiary cells, the longitudinal axis of which are parallel to that of the guard cells and aperture.

**Species included:** *Peristrophe bicalyculata* (Vahl) Nees, (Acanthaceae), *Calotropis procera* (Willd.) R.Br., *Pergularia daemia* (Forssk.) Blatt. & Mc Cann., (Asclepiadaceae), *Cleome brachycarpa* Vahl (Capparidaceae), *Convolvulus glomeratus* Choisy, *Convolvulus microphyllus* Sieb. (Convolvulaceae), *Andrachne aspera* Spreng. (Euphorbiaceae), *Oxalis corniculata* L. (Oxalidaceae), *Phaseolus trilobus* (L.) DC. (Papilionaceae).

**Parallelocytic:** In parallelocytic stomata, an alternating complex of three or more c-shaped subsidiary cells is present.

**Species included:** *Portulaca oleracea* L. (Portulacaceae).

### Discussion

In dicotyledonous flora of Karachi 6 major types of stomata are recognized such as anomocytic, paracytic, diacytic, anisocytic, parallelocytic and cyclocytic types (Figs. 1-3). Among all of the stomatal types anomocytic type is dominated in 54 species out of 69 taxa, followed by paracytic and diacytic types by 9 and 3 taxa respectively. While, parallelocytic, cyclocytic and anisocytic stomata are found only in one species each. In the family Acanthaceae diacytic type of stomata was reported by Watson & Dallwitz (1992), presently this type is also found in *Blepharis sindica* (Fig. 2A) and *Reullia* spp., but in *Peristrophe bicalyculata* paracytic type is observed. These findings are also in agreement with those of Metcalfe & Chalk (1979) who have reported both types of stomata for the family Acanthaceae. Similarly, anisocytic type of stomata is found in *Farsetia jacquemonti* (Fig. 2B). Previously this type was also reported in the family Brassicaceae (Metcalfe & Chalk, 1979; Zhao & Sack, 1999; Berger & Altmann, 2000). Parallelocytic type of stomata is observed in *Portulaca oleracea* (Fig. 3A) it is similar to those of the findings of Paliwal (1967) and Metcalfe & Chalk (1979). However, Inamdar (1969) also observed the similar structure of stomata in Portulacaceae and despite of using the term parallelocytic he mentioned the paracytic type.

*Ipomoea carnea* is characterized by the presence of cyclocytic type of stomata (Fig. 3B). Metcalfe & Chalk (1950) reported that the orders Centrospermae and Polygonales have usually anomocytic type of stomata. Presently anomocytic type is found in most of the dicot species irrespective of the specific orders or families except that of the family Amaranthaceae in which all taxa having anomocytic type but there are some other reports on the stomata of Amaranthaceae (Sen, 1958; Padmini & Rao, 1995) in which it was observed that this family has various types of stomata like anomocytic, anisocytic, diacytic and paracytic. Similarly, the paracytic type is also found in various taxa of different families. It is concluded that only stomatal types are not enough for delimiting the taxa with the exception of two species of *Cleome*, where, *C. brachycarpa* is distinguished by having paracytic type and *C. viscosa* is characterized by the presence of anomocytic type.

### Acknowledgement

We are thankful to the Director of Karachi University Herbarium University of Karachi for providing the facilities of scanning electron microscope.

Fig. 1. Scanning electron micrographs of stomatal types: (A) Anomocytic, *Rhynchosia minima* (L.) DC.; (B) Paracytic, *Oxalis corniculata* L.

Fig. 2. Scanning electron micrographs of stomatal types: (A) Diacytic, *Blepharis sindica* stocks ex. T. Anders., (B) Anisocytic, *Farsetia jacquemontii* Hook.f. et. Thoms.

Fig. 3. Scanning electron micrographs of stomatal types: (A) Parallelocytic, *Portulaca oleracea* L., (B) Cyclocytic, *Ipomoea carnea* Jacq.

### References

- Abid, R., S. Sharmin and A. Perveen. 2007. Stomatal types of monocots within Flora of Karachi, Pakistan. *Pak. J. Bot.*, 39(1): 15-21.
- Berger, D. and T. Altmann. 2000. A subtilisin-like serine protease involved in the regulation of stomatal density and distribution in *Arabidopsis thaliana*. *Genes Dev.* 14: 1119-1131.
- Binns, W.W. and G. Blunden. 1980. Comparative leaf anatomy of *Salix* species and hybrids. *Bot. J. Linn. Soc.*, 81: 205-214.
- Hilu, K.W. and J.L. Randall. 1984. Convenient method for studying grass leaf epidermis. *Taxon*, 33(3): 413-415.
- Inamdar, J.A. 1969. Epidermal and stomatal ontogeny in some Polygonales and Centrospermae. *Ann. Bot.*, 33: 541-552.
- Kong, H.Z. 2001. Comparative morphology of leaf epidermis in the Chloranthaceae. *Bot. J. Linn. Soc.*, 136: 279-294.
- Metcalf, C.R. and L. Chalk. 1950. *Anatomy of the Dicotyledons*, Vol. I. Clarendon Press, Oxford.
- Metcalf, C.R. and L. Chalk. 1979. *Anatomy of the Dicotyledons, Systematic Anatomy of the leaf and stem*. Vol. I. 2<sup>nd</sup> Ed. Clarendon Press, Oxford.
- Padmini, S. and S.S.R. Rao. 1995. Structure, distribution and taxonomic importance of foliar stomata in some Indian Amaranthaceae. *Bot. J. Linn. Soc.*, 118: 149-161.
- Paliwal, G.S. 1967. Ontogeny of stomata in some Cruciferae. *Can. J. Bot.*, 45: 495-500.
- Pettigrew, C.J. and L. Watson. 1973. On the identification of sterile Acacia's and the feasibility of establishing and automatic key-generating system. *Aust. J. Bot.*, 21: 141-150.
- Sen, S. 1958. Stomatal types in Centrospermae. *Current Science*, 27: 65-67.
- Shah, G.L., M.H. Parabia and M.J. Kothari. 1972. Epidermal structure and stomatal ontogeny in some Mimosaceae. *Ann. Bot.*, 36:832-835.
- Sonibare, M.A., A.A. Jayeola, A. Egunyomi and J. Murala. 2005. A survey of epidermal morphology in *Ficus* Linn. (Moraceae) of Nigeria. *Bot. Bull. Acad. Sinica*, 46: 231-238.
- Watson, L. and M.J. Dallwitz. 1992. The families of flowering plants: descriptions, illustrations, identification and information retrieval. Version 1<sup>st</sup> June 2007. <http://delta-intkey.com>
- Zhao, L. and F.D. Sack. 1999. Ultrastructure of stomatal development in *Arabidopsis* (Brassicaceae) leaves. *Amer. J. Bot.*, 86: 929-939.

(Received for publication 12 December 2006)