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ANTHER TYPES OF DICOTS WITHIN FLORA OF KARACHI, PAKISTAN

M. SAAD UL ISLAM, RUBINA ABID AND M. QAISER*

Department of Botany, University of Karachi, Karachi, Pakistan
**Federal Urdu University of Arts, Science and Technology, Karachi, Pakistan*

Abstract

The present studies of anther types (based on their mode of dehiscence) accounted for 206 angiospermic species belonging to 140 genera of 45 families. Two main types of anther dehiscence were observed viz., longitudinal and poricidal. Among the subtypes of longitudinal dehiscence, latrorse type is most common found in 114 species, followed by extrorse and introrse types in 49 and 28 taxa respectively. There are only 15 species which dehisce their anthers by apical pores. The families Amaranthaceae, Apocynaceae and Compositae have introrse anther dehiscence, whereas, poricidal type is specific for the genera *Cassia, Pedalium, Polygala, Senna* and *Solanum*.

Introduction

Typically the stamen consists of a filament and anther. The anther is divided into two locular thecae, which are joined together by the connective. Two locular anthers dehisce by one line, while four locular anther or bithecate anthers generally dehisce by two lines (Eliassan, 1988; D'Arcy, 1996). The anthers generally open with the aid of mechanical tissue called endothecium by creating tension in the maturing anthers and help in pollen dispersal (Esau, 1977, D'Arcy, 1996; Tebbitt & Maciver, 1999; Abid & Qaiser, 2004), There are four anther types based on their splitting lines by which pollen are released viz. (i) Longitudinal (anthers dehisce by longitudinal slits), (ii) Poricidal (anthers dehisce by apical pore) (iii) Valvular (anther dehiscence occurs through pore but pores are covered by a flap of tissues) and (iv) Transverse (anthers dehisce transversely or at right angle to the axis of thecae). Longitudinal type is further divided into three sub types (a) Extrorse: where anthers dehisce longitudinally outward to the centre of flower (b) Introrse: in this type anthers dehisce longitudinally inward to the centre of flower (c) Latrorse: the type in which anthers dehisce longitudinally from side walls (Radford *et al*., 1974). Various workers have studied the anther types based on their dehiscence for dicot taxa (Sedgley, 1982; Buchmann, 1983; Boland *et al*., 1987; Neff & Simpson, 1988; Dickison, 1990; Decraene & Smet, 1991; Boumgratz *et al*., 1995; D'Arcy, 1996). Apart from the above information of anther types there are exclusively no reports on anther types for entire flora of any region. In view of this an attempt has been made to provide the information of anther types for the dicots of Karachi region.

Materials and Methods

Flowers of 206 dicot species belonging to 140 genera of 45 families prior and after anther dehiscence were collected from different localities within vicinity of Karachi. Anthers were observed for their mode of dehiscence under Stereo (Nikon XXI model) and scanning electron microscopes (JSM-6380A). For scanning electron microscopy, anthers were mounted on a metallic stub with the help of double adhesive tape and coated with gold for a period of 6 minutes in sputtering chamber and observed in SEM.

Observations

Latrorse: It is the type in which anthers dehisce longitudinally from side walls of the thecae (Fig. 2A-C).

Species included: *Barleria acanthoides* Vahl, *Barleria prionitis* L., *Blepharis sindica* Stocks ex T. Anders., *Peristrophe paniculata* (Forssk.) Brummit, *Ruellia patula* Jacq. (Acanthaceae), *Corbichonia decumbens* (Forssk.) Exell, *Gisekia pharnaceoides* L., *Glinus lotoides* L., *Limeum indicum* Stocks ex T. Anders.,*Sesuvium sesuvioides* (Fenzl) Verdc., *Trianthema portulacastrum* L., *Zaleya pentandra* (L.) Jeffrey (Aizoaceae), *Cordia gharaf* (Forssk.) Ehren. ex Asch., *Heliotropium europaeum* L., *Heliotropium ophioglossum* Boiss., *Heliotropium ovalifolium* Forssk., *Heliotropium strigosum* Willd., *Heliotropium subulatum* (DC.) Vatke, *Sericostoma pauciflorum* Stocks ex Wight (Boraginaceae), *Parkinsonia aculeata* L., *Peltophorum pterocarpum* (DC.) Backer ex K.Heyne, *Tamarindus indica* L. (Caesalpinaceae), *Cleome brachycarpa* Vahl ex DC., *Cleome viscosa* L., *Crataeva adansonii* DC.(Capparidaceae), *Stellaria media* (L.) Vill., *Spergula fallax* (Lowe) E.H.L.Krause (Caryophyllaceae), *Arthrocnemum indicum* (Willd.) Moq., *Salsola imbricata* Forssk., *Suaeda fruticosa* Forssk. ex J.F. Gmelin, *Suaeda monoica* Forssk. ex J.F.Gmelin, (Chenopodiaceae), *Convolvulus arvensis* L., *Convolvulus glomeratus* Choisy, *Convolvulus pluricaulis* Choisy, *Convolvulus microphyllus* Sieb.ex Spreng., *Convolvulus rhyniospermus* Hochst. ex Choisy, *Cressa cretica* L., *Evolvulus alsinoides* (L.) L., *Ipomoea aquatica* Forssk., *Ipomoea pes-caprae* (L.) R.Br., *Ipomoea pes-tigridis* L., *Ipomoea rumicifolia* Choisy (Convolvulaceae), *Coronopus didymus* (L.) Sm., *Farsetia jacquemontii* Hook.f. & Thoms.(Cruciferae), *Bergia ammannioides* Roth, *Bergia suffruticosa* (Delile) Fenzl (Elatinaceae), *Andrachne aspera* Spreng., *Euphorbia dracunculoides* Lamk., *Phyllanthus amarus* Schum.& Thonn. (Euphorbiaceae), *Fumaria indica* (Haussk.) Pugsley (Fumariaceae), *Enicostemma hyssopifolium* (Willd.) Verdoon (Gentianaceae), *Monsonia heliotropioides* (Cav.) Boiss., *Monsonia senegalensis* Guill. & Perr. (Geraniaceae), *Leucas nutans* (Roth) Spreng., *Leucas urticifolia* (Vahl) R. Br. (Labiatae), *Ammannia baccifera* L., L*agerstroemia indica* L. (Lythraceae), *Callistemon citrinus* (Curt.) Stapf (Myrtaceae), *Nelumbo nucifera* Gaertn.(Nelumbonaceae), *Boerhaavia diffusa* L., *Commicarpus boissieri* (Heimerl) Cufod. (Nyctaginaceae), *Oxalis corniculata* L., *Oxalis corymbosa* DC.(Oxalidaceae), *Argemone mexicana* L.(Papaveraceae), Alhagi *maurorum* Medic., *Alysicarpus monolifer* (L.) DC., *Alysicarpus ovalifolius* (Schumach.) J. Leonard, *Astragalus fatmensis* Hochst. ex Blatt., *Clitoria ternatea* L., *Crotalaria burhia* Buch.-Ham. ex Benth., *Crotalaria medicaginea* Lamk., *Cyamopsis tetragonoloba* (L.) Taub., *Indigofera argentea* Burm.f., *Indigofera caerulea* Roxb. var. *caerulea*, *Indigofera cordifolia* Heyne ex Roth, *Indigofera hochstetteri* Baker, *Indigofera linifolia* (L.f.) Retz., *Indigofera oblongifolia* Forssk., *Indigofera sessiliflora* DC., *Lotus garcinii* DC., *Medicago lupulina* L., *Medicago sativa* L., *Melilotus alba* Desr., *Melilotus indica* (L.) All., *Rhynchosia minima* (L.) DC., *Tephrosia strigosa* (Dalz.) Sant. & Maheshw., *Tephrosia subtriflora* Baker, *Tephrosia uniflora* Pers., *Taverniera cuneifolia* (Roth) Arnott, *Taverniera lappacea* (Forssk.) DC., Vigna *trilobata* (L.) Verdc.(Papilionaceae), *Passiflora foetida* L. (Passifloraceae) , *Anagallis arvensis* L.(Primulaceae), *Ochradenus baccatus* Del.(Resedaceae), *Ziziphus jujuba* Mill, *Ziziphus nummularia* (Burm.f.) Wight & Arn. (Rhamnaceae), *Salvadora persica* L. (Salvadoraceae), *Cardiospermum halicacabum* L. (Sapindaceae), *Bacopa monnieri* (L.) Wettstein (Scrophulariaceae), *Datura fastuosa* L., *Lycium edgeworthii* Dunal, *Physalis divaricata* D. Don, *Withania somnifera* (L.) Dunal (Solanaceae), *Corchorus depressus* (L.) Stocks, *Corchorus olitorius* L., *Corchorus tridens* L., *Corchorus trilocularis*

L. (Tiliaceae), *Clerodendrum phlomidis* L.f. (Verbenaceae), *Fagonia indica* Burm.f., *Guaicum officinale* L. , *Peganum harmala* L., *Tribulus terrestris* L., *Tribulus longipetalus* Viv., *Zygophyllum simplex* L. (Zygophyllaceae).

Introrse: In this type anthers dehisce longitudinally inward to the centre of flower (Fig.1A-C).

Species included: *Achyranthes aspera* L., *Aerva javanica* (Burm.f.) Juss.ex Schultes, *Amaranthus viridus* L., *Celosia argentea* L., *Digera muricata* (L.) Mart., *Pupalia lappacea* (L.) Juss. (Amaranthaceae) *Rhus mysurensis* Heyne ex wight (Anacardiaceae), *Nerium oleander* L., *Rhazya stricta* Decene (Apocynaceae), *Arnebia hispidissima* (Lehm.) A.DC.,*Trichodesma indicum* (L.) R. Br.(Boraginaceae), *Cadaba fruticosa* (L.) Druce, *Capparis decidua* (Forssk.) Edgew.,*Gynandropsis gynandra* (L.) Briq., *Maerua arenaria* (DC.) Hook.&Thoms. (Capparidaceae), *Atriplex stocksii* Boiss., *Chenopodium album* L., *Haloxylon persicum* Bunge ex Boiss. & Buhse (Chenopodiaceae), *Conyza aegyptiaca* Ait., *Eclipta prostrata* (L.) L., *Echinops echinatus* Roxb., *Launaea procumbens* (Roxb.) Ramayya & Rajagopal, *Oligochaeta ramosa* (Roxb.)Wagenitz, *Pulicaria angustifolia* DC., *Sonchus aspera* (L.) Hill, *Tridax procumbens* L., *Vernonia cinerascens* Schultz Bip.(Compositae), S*chweinfurthia papilionacea* (Burm.f.) Boiss. (Scrophulariaceae).

Extrorse: In this type anthers dehisce longitudinally outward to the centre of flower (Fig.1D-F).

Species included: *Aristolochia bracteata* Retz.(Aristolochiaceae), *Caesalpinia bonduc* (L.) Roxb.(Caesalpinaceae), *Citrullus colocynthis* (L.) Schrad, *Coccinia grandis* (L.) Voigt, *Cucumis melo* L. var.*agrestis* Naudin, *Cucumis prophetarum* L., *Momordica balsamina* L. (Cucurbitaceae), *Ocimum basilicum* L., *Salvia santolinifolia* Boiss.(Labiatae), *Abelmoschus esculentus* (L.) Moench, *Abutilon bidentatum* A. Rich., *Abutilon fruticosum* Guill. & Perr., *Abutilon hirtum* (Lamk.) Swt., *Abutilon pakistanicum* Jafri & Ali, *Abutilon pannosum* (Forst. f.) Schl., *Abutilon ramosum* (Cav.) Guill. & Perr., *Gossypium stocksii* Mast., *Hibiscus aristivalvis* Garcke, *Hibiscus micranthus* L.f., *Hibiscus rosa-sinensis* L., *Malva parviflora* L., *Pavonia arabica* Hochst.& Stued. ex Boiss., *Pavonia zeylanica* (L.) Cav., *Pavonia procumbens* (Wall.ex Wight & Arn.) Wallp., *Senra incana* Cav., *Sida ovata* Forssk. , *Sida pakistanica* S.Abedin, *Thespesia populnea* (L.) Sol. ex Corr.(Malvaceae), *Acacia nilotica* Delile., *Acacia senegal* (L.)Willd., *Prosopis cineraria* (L.) Druce, *Leucaena leucocephala* (Lam.) de Wit., *Mimosa hamata* Willd., *Pithecellobium dulce* (Roxb.) Benth., *Prosopis glandulosa* Torr., *Prosopis juliflora* (Swartz) DC. (Mimosaceae), *Moringa oleifera* Lamk. (Moringaceae), *Sesbania sesban* (L.) Merrill (Papilionaceae), *Pteropyrum olivieri* Jaub. & Spach., *Rumex dentatus* L.(Polygonaceae), *Anticharis linearis* (Benth.) Hochst. ex Asch., *Lindenbergia indica* (L.) Vatke (Scrophulariacea), *Tamarix aphylla* (L.) Karst., *Tamarix dioica* Roxb., *Tamarix indica* Willd., *Tamarix stricta* Boiss.(Tamaricaceae), *Grewia asiatica* L., *Grewia tenax* (Forssk.) Fiori, *Grewia villosa* Willd.(Tiliaceae).

Poricidal: In this type anther dehiscence occurs through apical pores of the thecae (Fig.2D-F).

Fig. 1. Scannig electron micrographs of anther types. Introrse: A, *Arnebia hispidissima*; B, *Digera muricata*; C, *Cadaba fruticosa*. Extrorse: D, *Salvia santolinifolia*; E, *Abutilon indicum*; F, *Caesalpinia bonduc* (Scale bar: A, B, D, E = 100µm; C = 500µm; F=1000µm).

Fig. 2. Scanning electron micrographs of anther types. Latrorse: A, *Convolvulus glomeratus*; B, *Farsetia jacquemontii*; C, *Tribulus terrestris*. Poricidal: D, *Solanum nigrum*; E, *Pedalium murex*; F, *Senna holosericea* (Scale bar: A, F = 200µm; B, C, E = 100µm; D = 500µm).

Table 1. *Dicotyledonous* families and their anther types.

S. No.	Families	Type of anther			
		Latrorse	Extrorse	Introrse	Poricidal
1.	Acanthaceae	+	-	-	-
2	Aizoaceae	+	-	-	-
3.	Anacardiaceae	+	-	-	-
4.	Aristolochiaceae	-	+	-	-
5.	Amaranthaceae	-	-	+	-
6.	Apocynaceae	-	-	+	-
7.	Boraginaceae	+	+	+	-
8.	Caryophyllaceae	+	-	-	-
9.	Convolvulaceae	+	-	-	-
10.	Cruciferae	+	-	-	-
11.	Cucurbitaceae	-	+	-	-
12.	Compositae	-	-	+	-
13.	Capparidaceae	+	-	+	-
14.	Chenopodiaceae	+	-	+	-
15.	Caesalpiniaceae	+	-	-	+
16.	Elatinaceae	+	-	-	-
17.	Euphorbiaceae	+	-	-	+
18.	Fumariaceae	+	-	-	-
19.	Gentianaceae	+	-	-	-
20.	Geraniaceae	+	-	-	-
21.	Lythraceae	+	-	-	-
22.	Labiatae	+	+	-	-
23.	Malvaceae	-	+	-	-
24.	Mimosaceae	-	+	-	-
25.	Moringaceae	-	+	-	-
26.	Nelumbonaceae	+	-	-	
27.	Nyctaginaceae	+	-	-	-
28.	Oxalidaceae	+	-	-	-
29.	Papaveraceae	+	-	-	-
30.	Papilionaceae	+	+	-	-
31.	Polygonaceae	-	+	-	-
32.	Polygalaceae	-	-	-	+
33.	Passifloraceae	+	-	-	-
34.	Pedaliaceae	-	-	-	+
35.	Primulaceae	+	-	-	-
36.	Resedaceae	+	-	-	-
37.	Rhamnaceae	+	-	-	-
38.	Salvadoraceae	+	-	-	-
39.	Sapindaceae	+	-	-	-
40.	Scrophulariaceae	+	+	+	-
41.	Solanaceae	+	-	-	+
42.	Tamaricaceae	-	+	-	-
43.	Tiliaceae	+	+	-	-
44.	Verbenaceae	+	-	-	-
45.	Zygophyllaceae	+	-	-	-

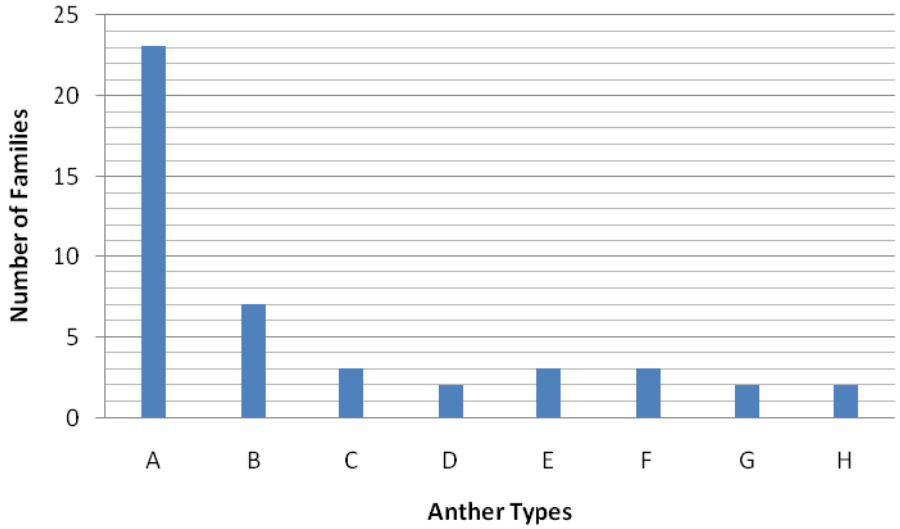

Fig. 3. Bar graph between anther types and number of families
A= latrorse; B= extrorse; C= introrse; D= poricidal; E= latrorse+extrorse; F= latrorse+poricidal; G= latrorse+introrse; H= latrorse+extrorse+introrse

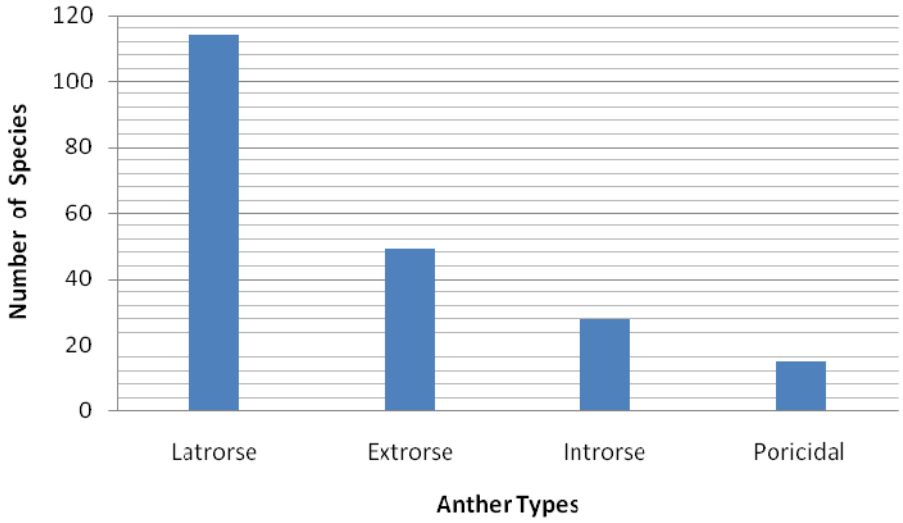

Fig. 4. Bar graph between anther types and number of species.

Species included: *Cassia fistula* L., *Senna alata* (L.) Roxb., *Senna alexandrina* Miller, *Senna holosericea* (Fresen.) Wagenitz, (Caesalpinaceae), *Chrozophora obliqua* (Vahl) Adr. Juss. ex Spreng., *Euphorbia clarkeana* Hook.f., *Euphorbia hirta* L. (Euphorbiaceae), *Pedalium murex* L. (Pedaliaceae), *Polygala erioptera* DC. (Polygalaceae), *Solanum albicaule* Kotschy., *Solanum gracilipes* Decne, *Solanum incanum* L., *Solanum nigrum* L., *Solanum surattense* Burm.f., *Solanum tuberosum* L. (Solanaceae).

Result & Discussion

Dicotyledonous flora of Karachi reveals the presence of two main types of anther dehiscence such as longitudinal and poricidal. Within the longitudinal dehiscence all three sub types viz., latrorse, introrse and extrorse have been observed. Out of 45 families 23 families have latrorse anther dehiscence while extrorse, introrse and poricidal types were found in 7,3 and 2 families respectively. On the other hand the two families like Boraginaceae and Scrophulariaceae show maximum variation in mode of dehiscence of anthers such as latrorse, extrorse and introrse all types were found within these families. Only three families like Amaranthaceae, Apocynaceae and Compositae have introrse type of dehiscence. Present findings are also in agreement to those of Eliasson (1988) in which introrse type was reported in the family Amaranthaceae (Table 1; Fig. 3). However, the poricidal anther type was specific for only few genera rather than the entire family such as in *Cassia*, *Pedalium*, *Polygala,* S*enna* and *Solanum* and this type of anther dehiscence was also previously reported in *Solanum* and *Cassia* (Dulberger, 1981; Buchmann, 1983). As far as the species concerned, out of 206 species 114 species have latrorse type of anther dehiscence and 49 species dehisce their anthers extrorsely.While only 28 and 15 species have introrse and poricidal anther types respectively (Fig. 4). From the ongoing discussion it can be concluded that amongst all of the dicot taxa of Karachi region longitudinal dehiscence is most common and secondly to some extent this data can be utilized for taxonomic delimitation at generic and family levels as exemplified by Amaranthaceae, Apocynaceae and Compositae which have introrse anther dehiscence and the poricidal dehiscence is exclusive for the genera *Cassia, Pedalium, Polygala, Senna* and *Solanum*.

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