



Full Length Article

Palyno-taxonomic study of some plant taxa of Fabaceae from Arambagh region of Hooghly district, West Bengal, eastern India

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ABSTRACT

The aim of the present investigation is to study different pollen parameters such as shape, size, colpa and exine ornamentation for the taxonomic assessment of the groups of plants. The pollen morphology of some plant taxa of the family Fabaceae growing in the area of Arambagh of Hooghly district, West Bengal, India were studied using light microscopy (LM) and scanning electron microscopy (SEM) during the period of September 2012 to July 2013. The pollen grains of *Cassia sophera*, *Cassia alata*, *Cassia occidentalis*, *Cassia fistula*, *Cassia tora*, *Cassia siamea*, *Butea monosperma*, *Bauhinia purpurea*, *Crotalaria retusa*, *Delonix regia*, *Peltophorum pterocarpum*, *Sesbania grandiflora* and *Tamarindus indica* are 3-colporate type. The polyad types of pollen grains consisting of 12 cells were observed in *Acacia auriculiformis* and *Acacia arabica*. The polyad type of pollen grain consisting of 16 cells is observed in *Albizzia lebbek*. The flowering period of the investigated taxa are recorded.

Key Words: Pollen, Taxonomic assessment, 3-colporate, Eurypalynous

INTRODUCTION

The family Fabaceae (Leguminosae) is the third largest family of the flowering plants (Mabberley, 1997), being the sources of gums, dyes, oils, insecticides, fibre, fuel, timber, medicinals and pulses (Wojciechowski, 2003). Nearly all species of the family exhibit the formation of root-nodulation with symbiotic bacteria to fix atmospheric nitrogen and thereby improving the soil fertility (Sprent and McKey, 1994; Sprent, 2001). Apart from economic importance, ecologically the family is also important as the plant species of this family grow on earth from tropical rain forests to deserts and alpine tundra. Most of the species of the family grow in wild in Arambagh region of Hooghly district, West Bengal from Eastern India.

Many investigators studied different plant taxa of this broad group to find out the phylogenetic relationships of the family Fabaceae on the basis of morphological, anatomical, cytological, biochemical

and molecular gene sequencing data (Kass and Wink, 1996; Doyle *et al.*, 1997, 2000; Kajita *et al.*, 2001; Wojciechowski, 2003). Still now the family Fabaceae is continuing to attract the attention of scientists from diverse disciplines of plant sciences.

Now a day's study of pollen is an important area of research. Various pollen morphological features such as symmetry, shape, apertural pattern and exine configuration are very conservative features for the taxonomic assessment of the plants (Perveen, 2006; Bera *et al.*, 2007; Keshavarzi *et al.*, 2012). Moreover, some plants growing in the surroundings causes respiratory troubles or allergy in human beings (Singh and Kumar, 2004; Chauhan and Goyal, 2006). It has been reported that there are many plants growing in the surroundings such as rice, mustard, coconut, grasses etc., the pollen grains of which are responsible for allergy (Singh, 2012).

These plants also grow in Arambagh region of Hooghly district, West Bengal. It is supposed that similar allergenic activity will be observed from the plants of this region.

Some plant taxa e.g. *Cassia tora*, *Cassia fistula*, *Cassia occidentalis*, *Delonix regia* and *Peltophorum pterocarpum* of this family are important allergenically (Mandal *et al.*, 2009; Hussian, 2012). In fact, during teaching and research experiences, it has been found that a large number of patients of different parts of Hooghly district, West Bengal are suffering from bronchial asthma and other respiratory troubles. There may be several causes such as pollutants, dusts, industrial dusts, fungal spores, pollen grains etc. for bronchial asthma and related respiratory troubles. One of the most important reasons of these diseases is pollen allergy.

Keeping in view the sufferings of the people due to allergic disorders in this district, primarily detailed pollen morphological study of some plants growing in Arambagh region of Hooghly district, India during the period of September 2012 to July 2013 was undertaken. Pollen morphological study is related with pollen viability tests. A comparative pollen viability study of two species of *Jatropha* was made by Gam, 2014.

MATERIALS AND METHODS

In the present investigation 10 genera including 16 plant species of the family Fabaceae were investigated. Out of 16 taxa investigated, the genus *Cassia* comprises six species namely *Cassia sophera*, *Cassia alata*, *Cassia occidentalis*, *Cassia fistula*, *Cassia tora* and *Cassia siamea*. The genus *Acacia* comprises two species namely *Acacia auriculiformis* and *Acacia arabica*. The remaining eight investigated genera were *Butea monosperma*, *Bauhinia purpurea*, *Crotalaria retusa*, *Delonix regia*, *Peltophorum pterocarpum*, *Sesbania grandiflora*, *Albizia lebbek* and *Tamarindus indica*. The mature flowers of the above plant taxa were collected and pollen morpho types studied by Acetolysis method (Erdtman, 1952). The microphotographs of the pollen grains were taken in a microscope (Make- Olympus & Model- CX21i and number 12M268). The measurement of the pollen grains were taken with the help of an Ocular Stage Division (Erma) and the measuring unit converted into μm (micrometre). The terminology of pollen is in accordance with Bhattacharya *et*

al., 2009; Erdtman, 1952; Faegri and Iversen, 1964; Kremp, 1965 and Moore and Webb (1978).

Scanning Electron Microscopic (SEM) study was carried out for the observation of pollen grains in detail. For this purpose fresh polliniferous material (non-treated pollen grains) was taken for microphotographs. The fresh pollen material was placed on stub and gold coating was made by IB₂ ion coater before taking microphotographs.

RESULTS AND DISCUSSION

The flowering period of the investigated taxa was recorded (Table 1). The pollen morphology of the investigated taxa was studied critically. Out of 16 plant species studied, tri-colporate (3-colporate) type of pollen grains were observed in 13 species namely *Cassia sophera*, *Cassia alata*, *Cassia occidentalis*, *Cassia fistula*, *Cassia tora*, *Cassia siamea*, *Butea monosperma*, *Bauhinia purpurea*, *Crotalaria retusa*, *Delonix regia*, *Peltophorum pterocarpum*, *Sesbania grandiflora* and *Tamarindus indica* (Figure 1 & Figure 2). The polyad types of pollen grains were found in *Acacia auriculiformis*, *Acacia arabica* and *Albizia lebbek*. The polyad of *Acacia auriculiformis* and *Acacia arabica* showed 12 celled configurations, whereas it was 16 celled structures in *Albizia lebbek*. Each cell of the polyad is sub-globose in periphery and square in centre in *A. auriculiformis* and *A. Arabica*. All 16 cells of polyad are rectangular in shape in *Albizia lebbek* (Figure 2). The shape of the 3-colporate pollen grains varied from Oblate-spheroidal to Prolate on the basis of value of P/EX100. The shape of the grains, exine ornamentation, length of colpa, diameter of pore, exine thickness and the value (P/EX100) for determining the shape of the grains are given below (Table 2).

The pollen sample i.e. anthers of collected flowers was acetolysed for clear observations of exine layers. Different parameters of the pollen grains like colpa, exine ornamentation etc. was determined from acetolysed grains. Microphotographs of the acetolysed grains were taken by Light Microscopy (LM). The SEM microphotographs were taken from fresh pollen grains (Figure 3 and 4). Some roundish structures called gemma were found on exine layer in *Bauhinia purpurea*. In *Peltophorum pterocarpum* some honey-comb like hexagonal meshes with muri and lumen were found on the surface of exine (Figure 4). The honey-comb like meshes was also observed in *Delonix regia*.

Table 1: Investigated plant taxa with their common names, respective families and flowering period

Name of the plants	Common name	Family	Flowering period
<i>Cassia sophera</i>	Kalkashunda	Caesalpinaceae	Throughout the year
<i>Cassia alata</i>	Dadmurdan	Caesalpinaceae	June-September
<i>Cassia occidentalis</i>	Kalkashunda	Caesalpinaceae	June-September
<i>Cassia fistula</i>	Bandar lati / Shondal	Caesalpinaceae	June-September
<i>Cassia tora</i>	Chakunda	Caesalpinaceae	June-August
<i>Cassia siamea</i>	Siamese senna (Siamese cassia)	Caesalpinaceae	June-August
<i>Bauhinia purpurea</i>	Kanchan	Caesalpinaceae	Throughout the year
<i>Delonix regia</i>	Gulmohor	Caesalpinaceae	March-May
<i>Peltophorum pterocarpum</i>	Radhachura	Caesalpinaceae	March-May
<i>Tamarindus indica</i>	Tentul	Caesalpinaceae	June-August
<i>Acacia auriculiformis</i>	Sonajhuri	Mimosaceae	July-November
<i>Acacia arabica</i>	Babla	Mimosaceae	Throughout the year
<i>Albizia lebbek</i>	Sirish	Mimosaceae	April-May
<i>Crotalaria retusa</i>	Atashi	Papilionaceae	July- September
<i>Butea monosperma</i>	Palash	Papilionaceae	February- March
<i>Sesbania grandiflora</i>	Bakphul	Papilionaceae	July-August

The family Fabaceae (Leguminosae) is the third largest family of the flowering plants (Mabberley, 1997), below the rank of Orchidaceae and Asteraceae (Ghosh and Keshri, 2007). Fabaceae (Leguminosae) – bean or pea family (after faba, Latin name for broad bean) consists of 720-730 genera and 19,500 species (Michael, 2010). The Fabaceae are traditionally classified into three sub-families :Caesalpinioideae, Mimosoideae and Papilionoideae (Faboideae). These are, however often treated as three separate families known as Papilionaceae/Fabaceae (Article 18.5 of the code, final sentence), Mimosaceae and Caesalpinaceae (Mc Neil and Brummitt, 2003). The sub-families Mimosoideae and Papilionoideae have both been resolved as monophyletic, nested within a paraphyletic Caesalpinioideae, in all recent molecular studies (Kass and Wink, 1996; Doyle *et al.*, 1997, 2000; Kajita *et al.*, 2001; Wojciechowski *et al.*, 2004).The two sub-families Mimosoideae and Papilionoideae are derived from the third sub-family Caesalpinioideae, which is basal and paraphyletic (Doyle, 1975). Many workers carried

out research for determining phylogenetic relationships among different groups of the family Fabaceae. In the present study, an attempt was made for the taxonomic assessment of the investigated taxa from the point of view of pollen morphological data.

A botanical survey of flowering plants growing in the area of Arambagh, West Bengal (India) during the period of September 2012 to July2013 was made for the purpose of collection of the pollen materials from plants growing in the field and to study different pollen parameters such as shape, size, and colpa and exine ornamentation. The present study is useful in the preparation of a complete pollen calendar in different seasons of the area under investigation. A pollen calendar is useful for allergy clinics (Tilak, 2012). Pollen calendar is compiled based on data and knowledge obtained from field botanical survey of the area under investigation combined with data from aeropalynological survey (Agashe, 2012; Bhattacharya-Sasmal and Pal, 2013).

Table2: Pollen parameters of the investigated plant taxa by light microscopic study

Name of plants	Pollen type	Polar axis (P) (µm)	Average (µm)	Equatorial axis (E) (µm)	Average (µm)	Length of colpa (µm)	Diameter of pore (µm)	Exine thickness (µm)	Exine ornamentation	P/E X 100	Shape of pollen
<i>Cassia sophera</i>	3-colporate	20.00-33.00	26.50	22.00-34.50	28.25	7.50-10.00	2.50-5.00	3.75-4.50	Punctitegillate	93.80	Oblate-spheroidal
<i>Cassia alata</i>	3-colporate	22.50-27.50	25.00	17.50-22.50	20.00	15.00	10.00	±1.25	Punctitegillate	125.00	Sub-prolate
<i>Cassia occidentalis</i>	3-colporate	22.50-30.00	26.25	20.00-27.50	23.75	10.00-12.50	5.00-7.50	3.75-5.00	Punctitegillate	110.52	Prolate-spheroidal
<i>Cassia fistula</i>	3-colporate	17.50-27.50	22.50	15.00-25.00	20.00	7.50-8.00	5.00-7.50	5.00-6.25	Punctitegillate	112.50	Prolate-spheroidal
<i>Cassia tora</i>	3-colporate	20.00-25.00	22.50	25.00-30.00	27.50	17.50	1.25-2.50	±1.25	Punctitegillate	81.81	Sub-oblate
<i>Cassia siamea</i>	3-colporate	32.50	32.50	35.00	35.00	15.00	5.00	±2.50	Punctitegillate	92.85	Oblate-spheroidal
<i>Bauhinia purpurea</i>	3-colporate	55.00-100.00	77.50	50.00-92.50	71.25	45.00-90.00	17.50	±2.50	Reticulate	108.77	Prolate-spheroidal
<i>Delonix regia</i>	3-colporate	52.00-65.00	58.75	45.00-62.50	53.75		1.25-7.50	±5.00	Reticulate	109.30	Prolate-spheroidal
<i>Peltophorum pterocarpum</i>	3-colporate	57.50-70.00	63.75	47.50-60.00	53.75		1.25-7.50	±5.00	Reticulate	118.60	Sub-prolate
<i>Tamarindus indica</i>	3-colporate	27.00	27.00	30.00	30.00	20.00	5.00-10.00	±1.25	Striato-reticulate	90.00	Oblate-spheroidal
<i>Acacia auriculiformis</i>	Polyad-12 celled	----	---	---	---	----	---	---	Psilate	----	---
<i>Acacia arabica</i>	Polyad-12 celled	----	---	----	---	----	---	---	Psilate	----	----
<i>Albizzia lebbek</i>	Polyad-16 celled	----	----	----	---	----	----	---	Psilate	----	----
<i>Crotalaria retusa</i>	3-colporate	22.00-27.50	24.75	20.00-25.00	22.50	12.50	5.00	±1.25	Finely reticulate	110.00	Prolate-spheroidal
<i>Butea monosperma</i>	3-colporate	37.00-40.50	38.75	29.50-30.00	29.75	33.50	7.50-12.50	±2.50	Obscure pattern	130.25	Sub-prolate
<i>Sesbania grandiflora</i>	3-colporate	20.00-40.00	30.00	12.50-22.50	17.50	17.50-37.50	5.00-7.50	1.25-2.50	Finely reticulate	171.42	Prolate

A considerable variation in pollen morphology was observed among the investigated taxa of the family Fabaceae, particularly exine ornamentation and apertural pattern. This observation supports the

eurypalynous characteristics of the family Fabaceae. In the present study 10 genera including 16 species were studied.

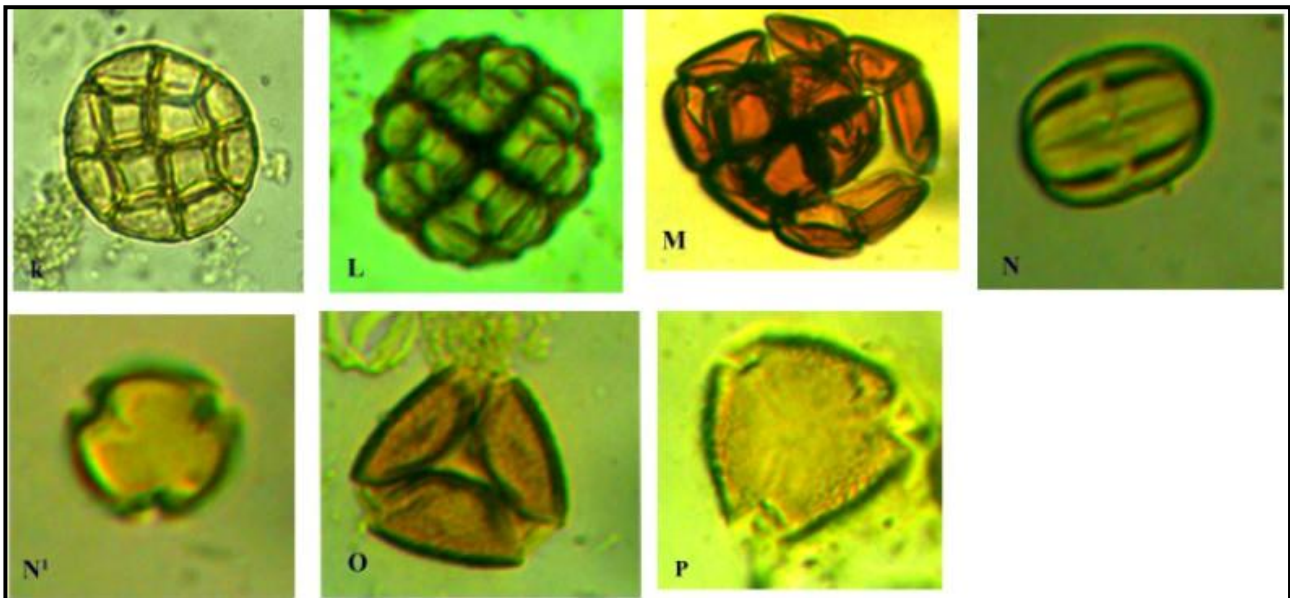
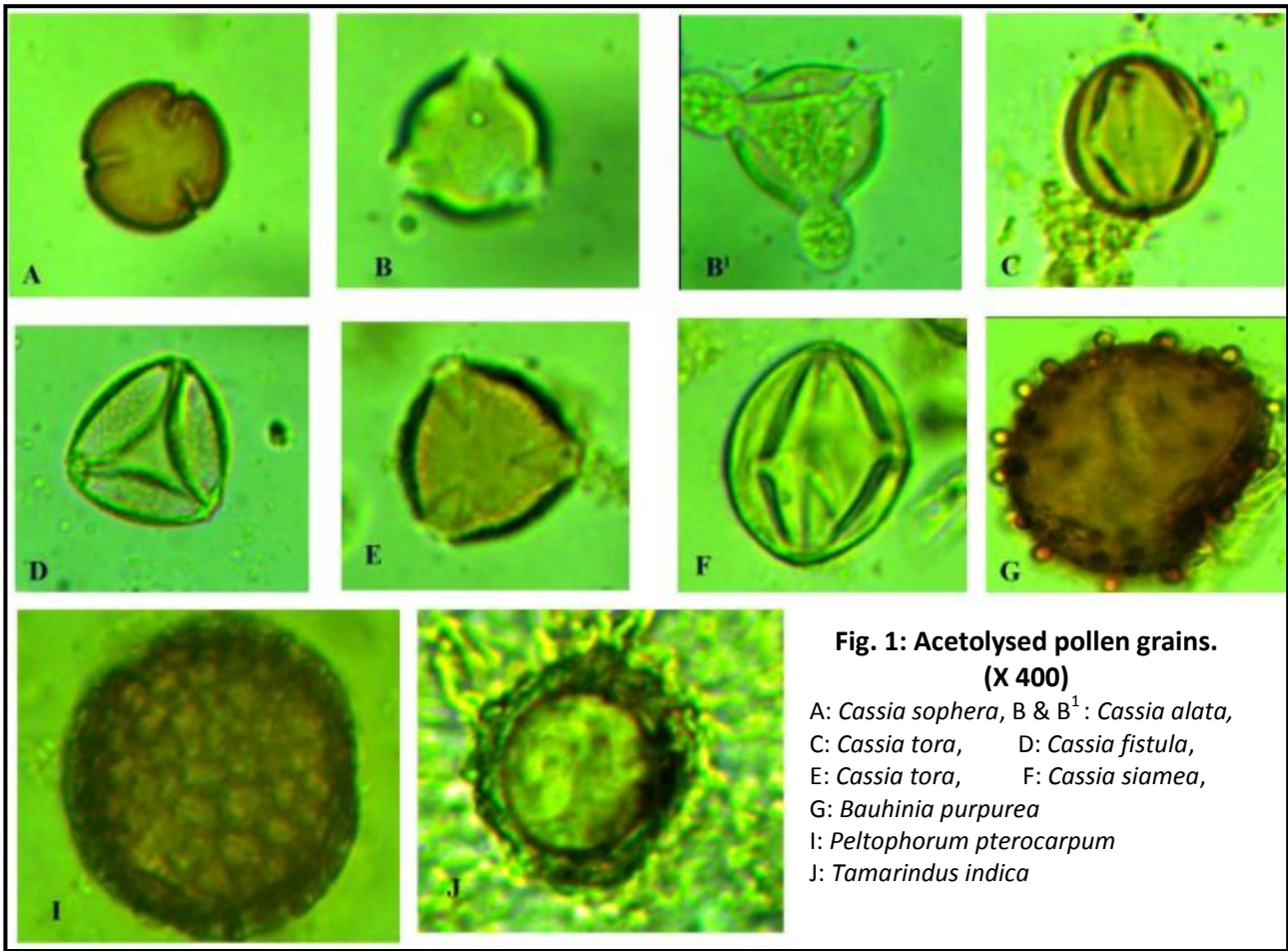


Fig. 2: Acetolysed pollen grains. (X 400)

K: *Acacia auriculiformis*, L: *Acacia arabica*, M: *Albizia lebbek*, N: *Crotolaria retusa* (Equitorial view),
 N¹: *Crotolaria retusa* (Polar view), O: *Butea monosperma*, P: *Sesbania grandiflora*

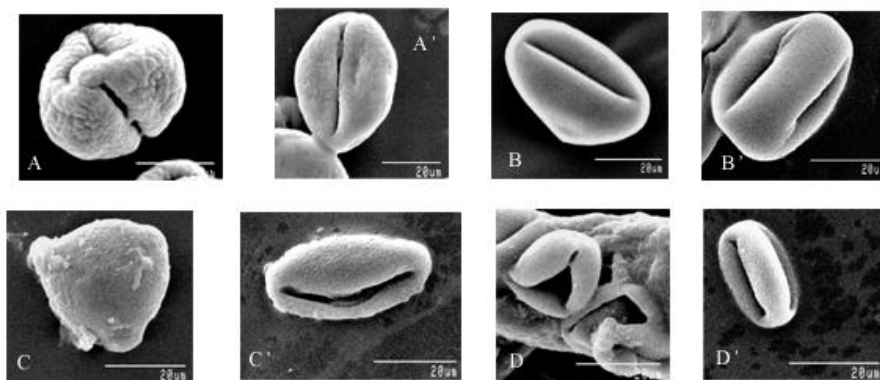


Figure 3 SEM Microphotographs of pollen grains of some plant taxa investigated

A. *Cassia siamea* (Polar view), A'. *C. siamea* (Equatorial view),
 B & B'. *C. occidentalis* (Equatorial view),
 C. *C. tora* (Polar view), C'. *C. tora* (Equatorial view),
 D. *C. alata* (Polar view), D'. *C. alata* (Equatorial view).

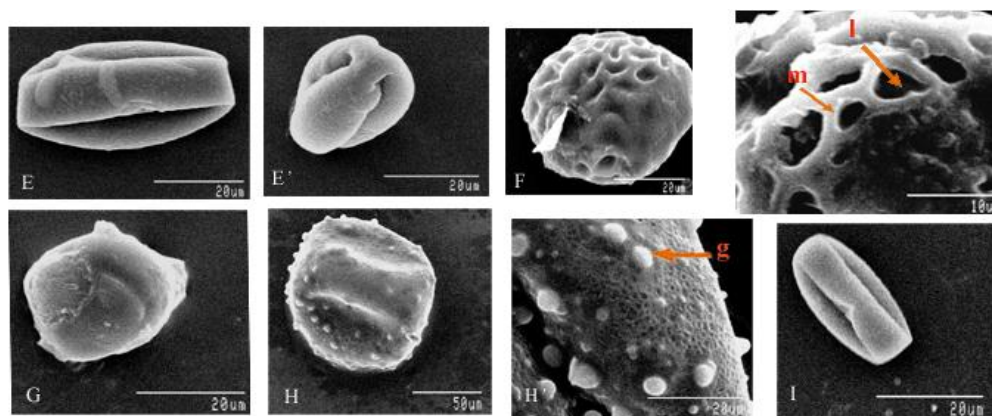


Figure 4 SEM Microphotographs of pollen grains of some plant taxa investigated

E. *Cassia sophera* (Equatorial view), E'. *C. sophera* (Polar view),
 F. *Peltophorum pterocarpum* (Polar view), F'. *Peltophorum pterocarpum*
 (Surface view showing Muri and Lumen), G. *Tamarindus indica* (Polar view),
 H. *Bauhinia purpurea* (Polar view),
 H'. *Bauhinia purpurea* (Surface view showing Gemma), I. *Crotalaria retusa* (Equatorial view).

l= Lumen, m= Muri, g= Gemma.

Most of the genera such as *Cassia sophera*, *Cassia alata*, *Cassia occidentalis*, *Cassia fistula*, *Cassia tora*, *Cassia siamea*, *Butea monosperma*, *Bauhinia purpurea*, *Crotalaria retusa*, *Delonix regia*, *Peltophorum pterocarpum*, *Sesbania grandiflora* and *Tamarindus indica* shows 3-colporate type of pollen grains. The polyad type of pollen grains is found in *Acacia auriculiformis*, *Acacia Arabica* and *Albizia lebbek*. In the previous study (Pal 1992, Pal et al., 1993a; 1993b) it has been found that the

taxa having tricolporate pollen grains reveals their advanced status whereas taxa with polyad or colpate type of pollen grains shows its primitive status in the evolutionary scale. Tricolpate pollen is the main and basic type found in most eudicots while other aperture types such as 5-colpate, 6-colpate, porate, colpate and pororate are regarded as derived among eudicots (Walker and Doyle, 1975).

Thus the taxonomic assessment of the species investigated is possible considering the pollen parameters. However, the data from other field of study like cytological, serological, biochemical and immunological might strengthen this taxonomic assessment of the species. On the basis of pollen parameters, the present investigated taxa like *Cassia sophera*, *Cassia alata*, *Cassia occidentalis*, *Cassia fistula*, *Cassia tora*, *Cassia siamea*, *Butea monosperma*, *Bauhinia purpurea*, *Crotalaria retusa*, *Delonix regia*, *Peltophorum pterocarpum*, *Sesbania grandiflora* and *Tamarindus indica* having tricolporate pollen grains may be considered as in advanced status whereas *Acacia auriculiformis*, *Acacia Arabica* and *Albizia lebbek* has primitive status in scale of evolution. This observation is also supported from pollen morphological study of some plant taxa of Hooghly district, India (Bhattacharya-Sasmal et al., 2013). The prepared pollen slides of the taxa investigated may be used as reference slides for identifying the pollen grains captured from air.

CONCLUSION

A taxonomic assessment of some plant taxa of the family Fabaceae growing in wild condition of the Arambagh region, India was made on the basis of different parameters of pollen grains. The plant taxa having tricolporate (3-colporate) pollen grains like *Cassia sophera*, *Cassia alata*, *Cassia occidentalis*, *Cassia fistula*, *Cassia tora*, *Cassia siamea*, *Butea monosperma*, *Bauhinia purpurea*, *Crotalaria retusa*, *Delonix regia*, *Peltophorum pterocarpum*, *Sesbania grandiflora* and *Tamarindus indica* may be considered as in advanced status whereas *Acacia auriculiformis*, *Acacia arabica* and *Albizia lebbek* has primitive status in the scale of evolution. This study will be helpful in the preparation of a complete pollen calendar of a particular geographical area. A complete pollen calendar of different seasons throughout the year and the concentration of respective pollen grains in air may help for proper diagnosis and treatment of allergic patients.

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