



## Impact of air pollutants on reproductive biology: Effect of air pollution on pollen of plants

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**Abstract:** The paper describes the pollen morphology of five species viz. *Hibiscus rosa-sinensis*, *Moringa oleifera*, *Lagenaria siceraria*, *Brassica campestris* and *Dolichos lablab*, growing in areas which are highly effected by air pollutants. An attempt has been made to compare the pollen grains affected by air pollutants to those of the grains of the plants growing in healthy areas.

**Key words:** Air pollutants, pollen morphology, Lucknow city

### Introduction

Lucknow was the city of Nawabs and gardens. During the last three decades, due to urbanization and industrialization in many folds, it is one of the highly polluted cities. Air pollutant, dust particles, gases and automobile exhaust play significant role in polluting the entire environment of the city. The environment of the state capital Lucknow has degraded year after year. Almost all parameters describing the states of pollution, concentration of sulphur dioxide, oxides of nitrogen, suspended particulate matter (SPM) have registered an increased over years. It has been reported that all commercial and industrial areas, there is an increase in pollution load. Residential areas even well developed colonies of the state capital; the pollution load was increased at alarming rates. Gases and particulate specially dust pollutant are causing serious hazards to mankind, and also great damage to crop plants and vegetation including forests.

Pollen morphology and their usefulness in plant taxonomy have been studied by various workers (Erdtman 1943, 1952; Nair 1960, 1965; Wodehouse 1943). Experimental aspects, specially pollen – pistil relationship have been studied by Shivanna (1982, 1985).

Effects of air pollution on the plants have been studied by various workers. Foliar surfaces by virtue of their position and exposed to atmosphere are effected maximum by the air pollutants. Foliar surfaces of the plants of the Lucknow district, affected by the air pollutants have been paid considerable attention and interesting results have been observed by many workers (Ahmad et. al. 1991; Younis et. al. 1985; Khan et. al. 1989).

However, little attention has been paid on reproductive structures. A few plants have been studied which are growing in

acute polluted areas. Flowers of these plants have been collected and their pollen grains have been examined under SEM.

### Material and Methods

The material for the present study was collected from industrial areas of the Lucknow city; Talkatora, Alambagh and heavy polluted areas by vehicular traffic at Charbagh loco - workshop and Auto-Riskshaw stand.

Five plants viz *Hibiscus rosa-sinensis* Linn, *Dolichos lablab* Linn., *Lagenaria siceraria* (Mol) Standl, *Brassica campestris* Linn and *Moringa oleifera* Lam. have been studied for their pollen morphology. Pollen grains have been compared with the plants growing in healthy areas.

***Hibiscus rosa - sinensis***: Charbagh loco workshop and Auto/ Bus stand – heavy vehicular traffic round the day.

***Dolichos lablab***: Talkatora industrial area.

***Brassica campestris***: Talkatora industrial area.

***Lagenaria siceraria***: Charbagh loco workshop and Auto / Bus stand.

***Moringa oleifera***: Alambagh industrial area Alambagh crossing – highly dust effected and vehicular traffic effected area.

Pollen grains of both healthy and polluted areas have been examined by Light Microscope and Scanning Electron Microscope.

Procedure for preparation of pollen grains under SEM has been followed, as suggested by Bajpai and Ambwani (2003).

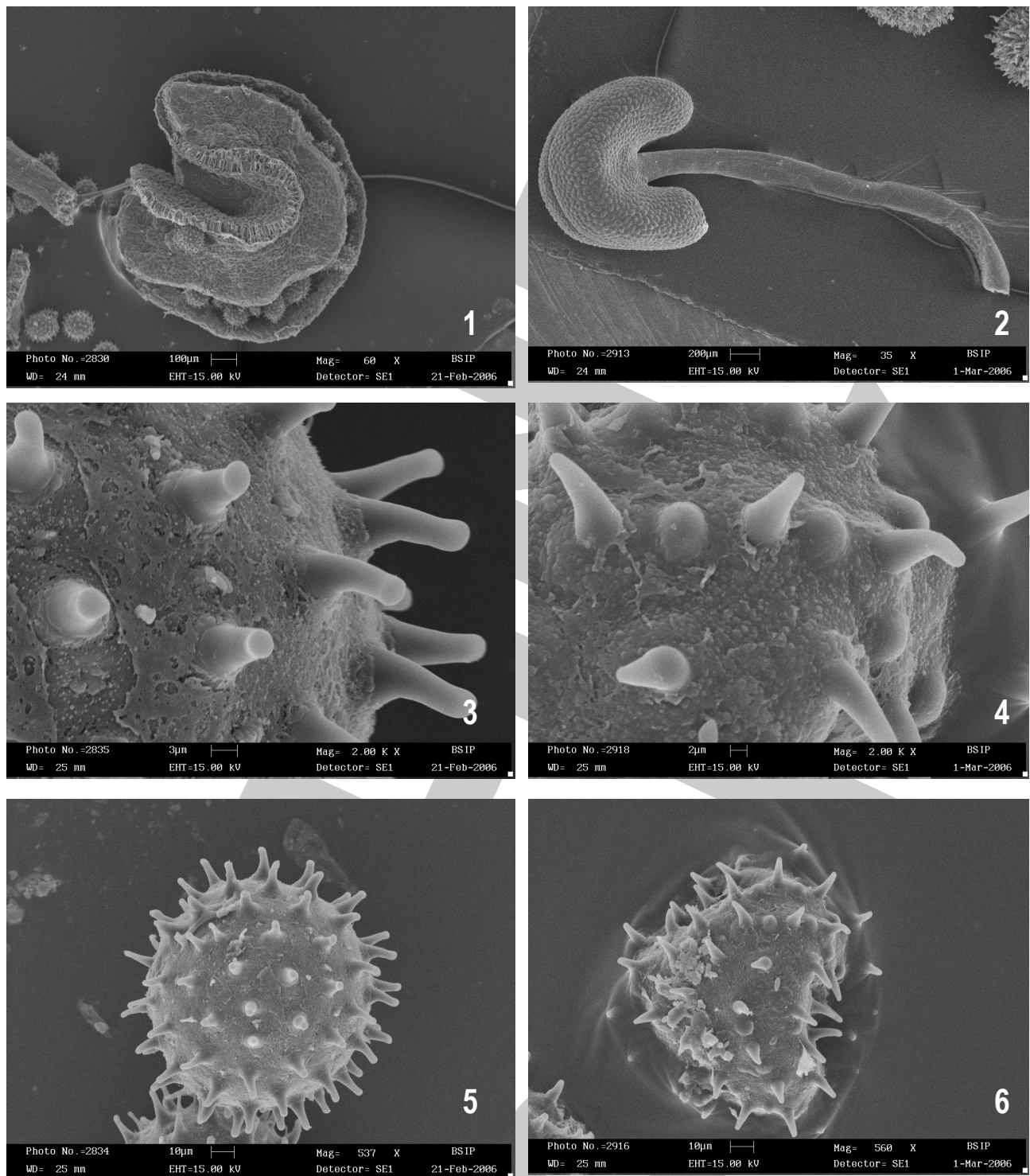


PLATE – 1 *Hibiscus rosa – sinensis* Linn.

- Fig. 1 - An anther of normal plant × 60  
 Fig. 2- An anther of polluted plant × 35  
 Fig. 3- A part of normal grain showing spines × 2.00K  
 Fig. 4- A part of pollen grain of polluted plant showing curved spine tips × 2.00 K  
 Fig. 5 - A normal grain showing spines on the surface × 537 K  
 Fig. 6 - A pollen grain of polluted plant showing arrangement of spine on the surface × 560 K

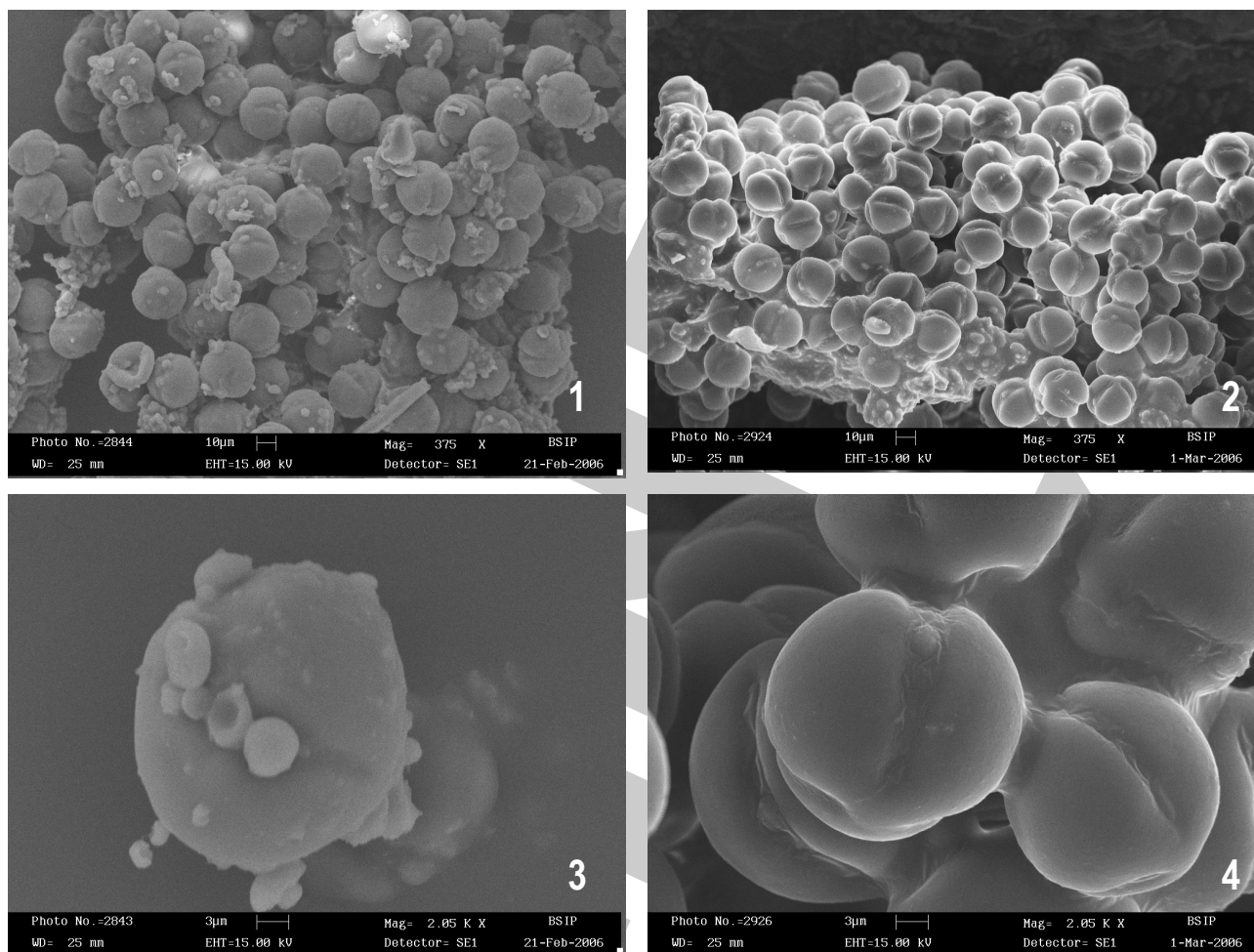


PLATE – 2 *Moringa oleifera* Lam.

Fig. 1 - A group of pollen grain of normal plant  $\times 375$

Fig. 2- A group of pollen grain of polluted plant  $\times 375$

Fig. 3 - A single pollen grain of normal plant showing smooth wall and granular structures  $\times 2.05K$

Fig. 4 - A few pollen grain of polluted plant enlarged to show colpi and fine reticulation of exine  $\times 2.05K$

### Observations and Results

#### *Hibiscus rosa – sinensis* Linn. (Plate 1, Figs. 1- 6)

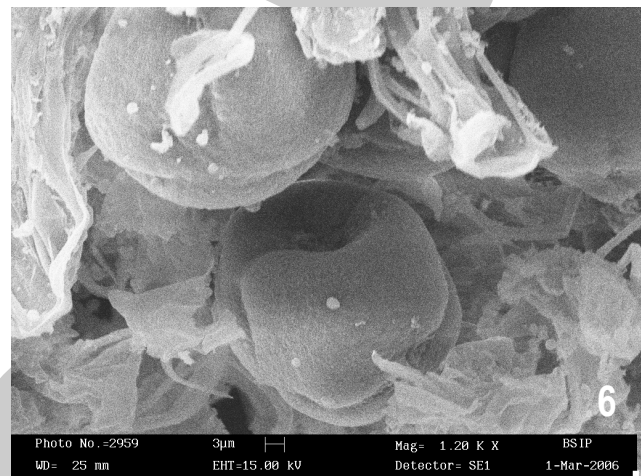
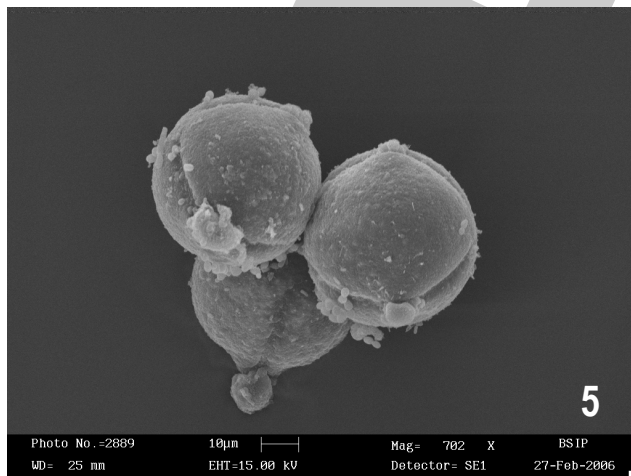
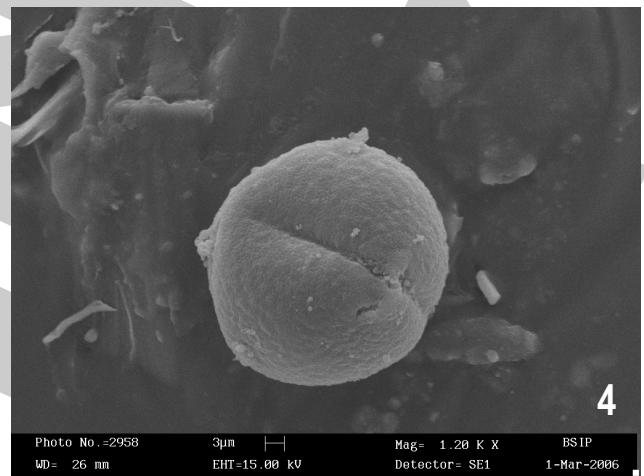
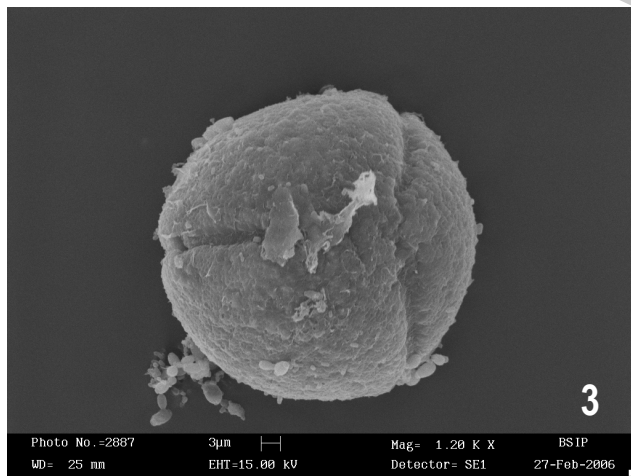
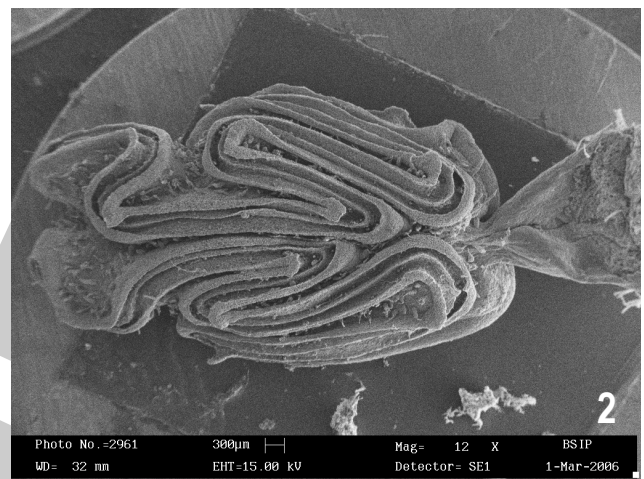
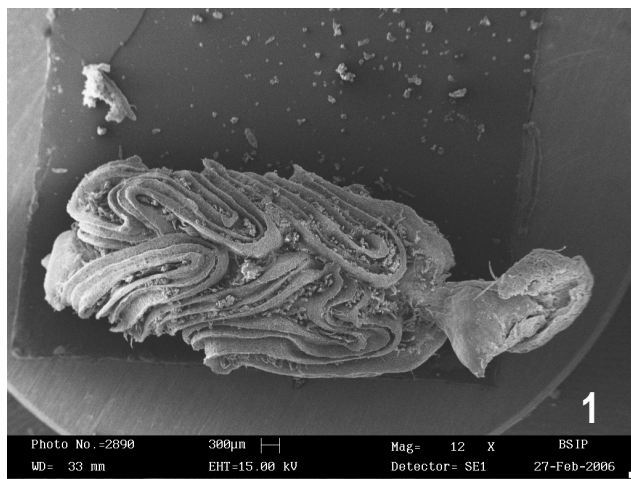
Flowers are large and bright red in colour. Stamen numerous, monadelphous, anthers large, reniform monothealous. The plant has number of varieties based on size and colour of the flowers. Common wild plants with numerous large, red colored flowers have been selected for the present study.

Panporate pollen grains, spheroidal, average size  $96 \times 96 \mu\text{m}$ , pores circular (diameter  $8.4 \mu\text{m}$ ) or slightly elliptical, interporal distance  $23 \mu\text{m}$ , ectine much thicker than endine. Exine thick, spine height  $24 \mu\text{m}$ , tip rounded, base straight, callose at joint between column and base, collumella of ectine free, some grains spine show bifurcation at the tip, exine  $1.5 \mu\text{m}$ .

Spine bases are quite broad with almost rounded tips. Bases in surface view are rounded. Spines arranged closely with rounded tips and broad or rounded bases in pollen grain affected by air pollutants. It has also been noticed that in these grains spines are sharply curved (Plate 1, Fig. 4). Size of anthers, pollen and length of spines (plants effected by air pollutants) have decreased considerably, as compare to normal grains (normal healthy plants). Pollen per anther appears more in effected grains then the normal ones.

#### *Moringa oleifera* Lam. (Plate 2, Figs. 1 - 4)

Flowers, white, medium size, open. Androecium : 5+5 (stamens in two rows), the outer (antesep) staminode; anthers 1 locule; calyx, corolla and androecium shortly connate at base in to copular disk.



**PLATE – 3 *Lagenaria siceraria* (Mol.) Standl**

- Fig. 1 - An anther of normal plant  $\times 12$   
 Fig. 2 - An anther of polluted plant  $\times 12$   
 Fig. 3 - Single pollen grain of normal plant showing colpi  $\times 1.20K$   
 Fig. 4 - Single pollen grain of polluted plant showing exine  $\times 1.20K$   
 Fig. 5 - Group of pollen grains of normal plant showing exine structure  $\times 702$   
 Fig. 6 - Group of pollen grains of polluted plant showing dust particle on the surface  $\times 1.20K$

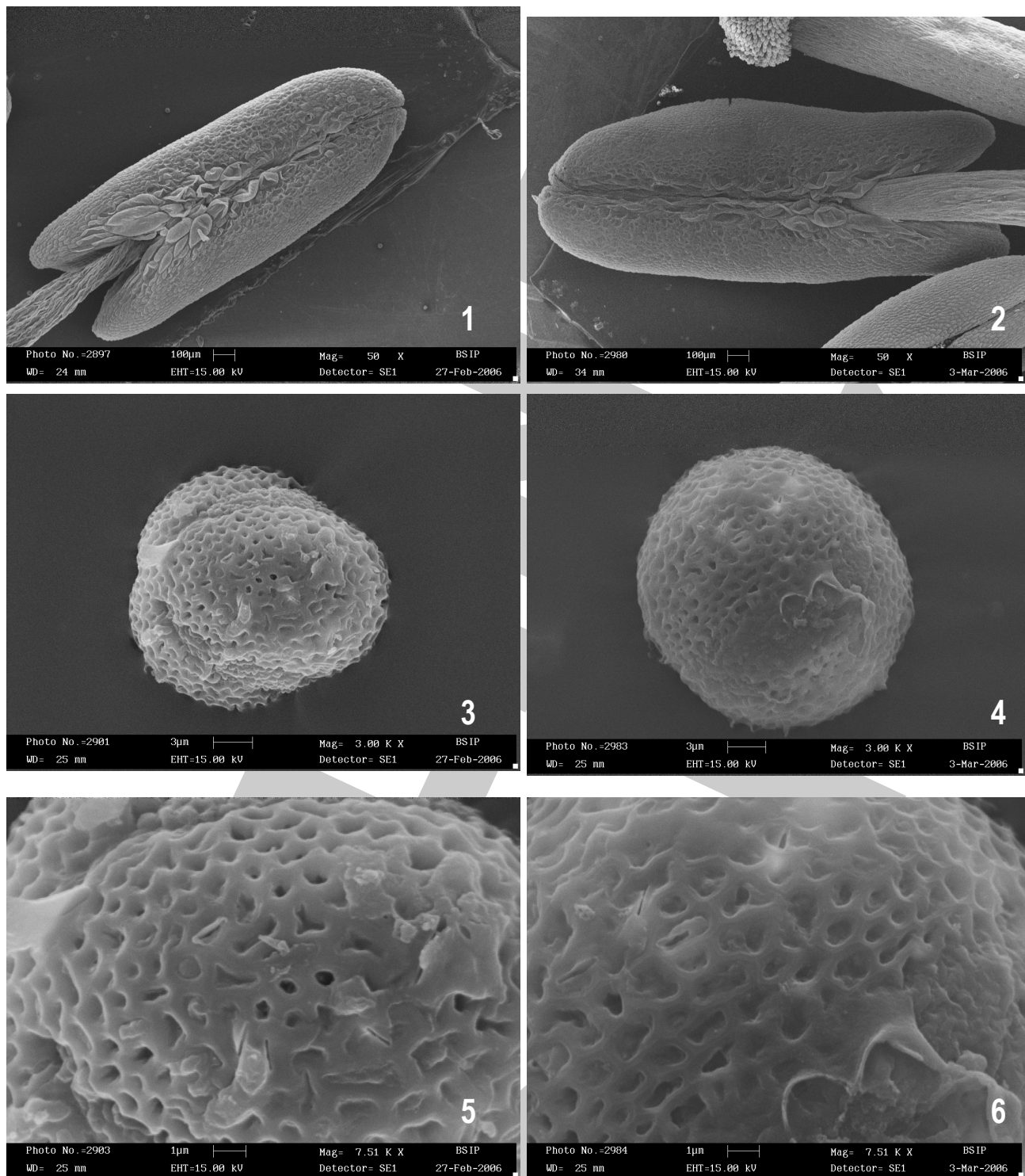
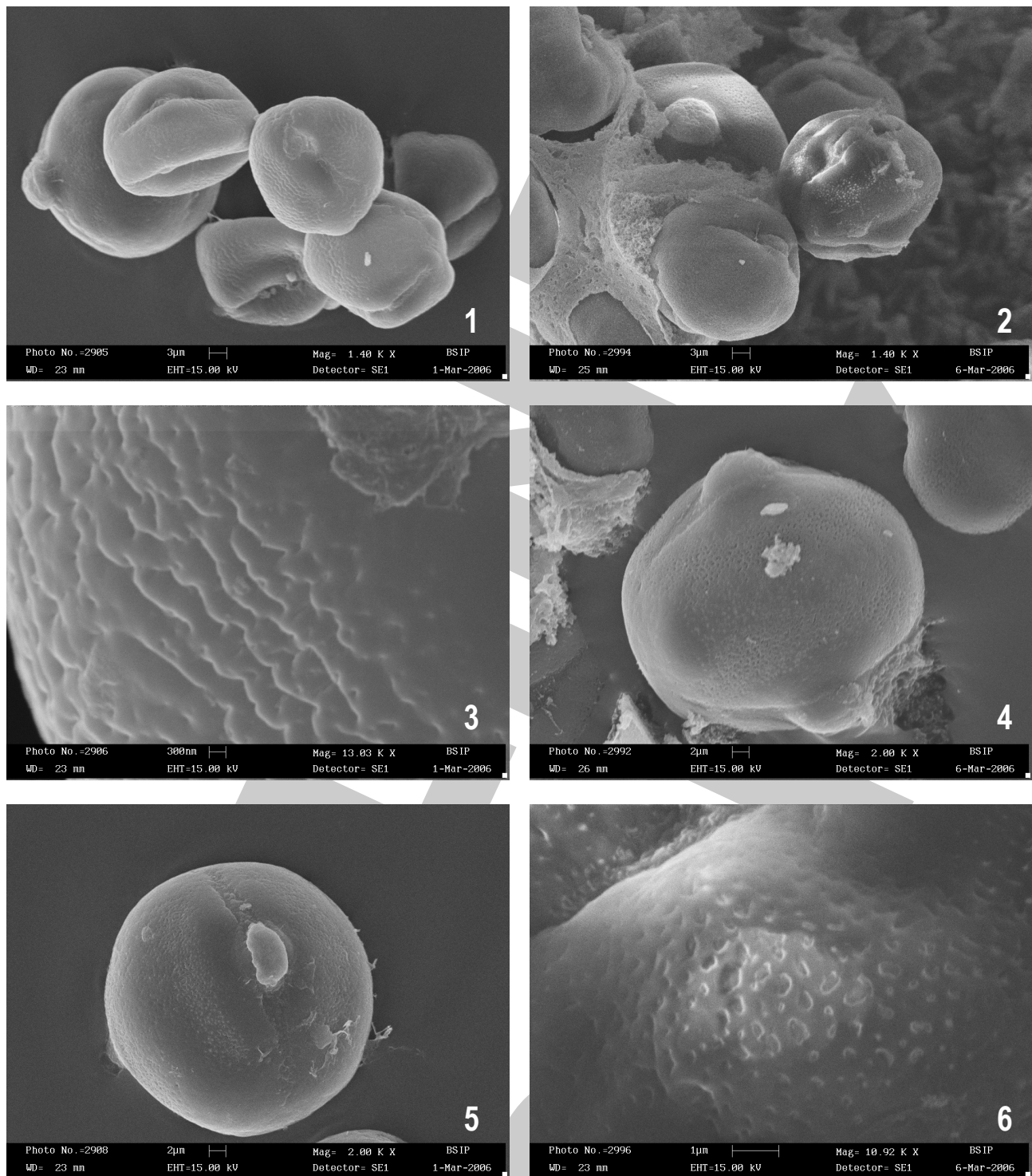


PLATE – 4 *Brassica campestris* Linn.

- Fig. 1 - An anther of normal plant ×50  
 Fig. 2 - An anther of polluted plant ×50  
 Fig. 3 - A pollen grain of normal plant showing heavy reticulation ×3.00K  
 Fig. 4 - Single pollen grain of polluted plant showing exine ×3.00K  
 Fig. 5 - A portion of a grain of normal plant enlarged to show reticulated ×7.51K  
 Fig. 6 - A portion of polluted grain enlarged to show loosely arranged reticulation on the exine ×7.51K



**PLATE -5 *Dolichos lablab* Linn.**

- Fig. 1 - A few pollen grain of normal plant×1.40K  
 Fig. 2 - A group of pollen grains of polluted plant ×1.40K  
 Fig. 3 - A portion of healthy grain enlarged to show loosely arranged reticulation on the exine×13.03K  
 Fig. 4 - A grain of polluted plant enlarged to show compact reticulation arrangement on the surface ×10.92K  
 Fig. 5 - A grain of polluted plant showing some dust particle on the surface ×2.00K  
 Fig. 6 - A grain of normal plant×2.00K

3-zonicolporate, subrolate, small size, 26 x 29  $\mu\text{m}$ , Exine 1.5  $\mu\text{m}$  thick colpi, wide at the equatorial zone, long and narrow towards the end. Ectine thicker than endine and reticulate. It shows micro-reticulated exine.

Pollen size is variable in the plants affected by various air pollutants 20 x 21 – 22 x 25  $\mu\text{m}$  which is smaller than the normal grains.

**Ligenaria siceraria (Mol.) Standl** (Plate 3 Figs. 1 - 6)

Flowers are large and white in colour. Flowers on the long peduncles, usually in clusters (Male flowers). Stamens five, adnate to petals at base, filaments medium size thick; anthers extrose, conduplicate.

3-zonicolporate, pollen grains, subrobrate– spheroidal, diamorphism in pollen grains observed. Small grains 45 x 49  $\mu\text{m}$ , large grains 58 x 58  $\mu\text{m}$ , ectine 2.2  $\mu\text{m}$  thick, endine thin 1.2  $\mu\text{m}$  thick, colpus 30  $\mu\text{m}$  in length and show wavy surface.

Pollen grains are smaller 28 x 28–33 x 37  $\mu\text{m}$  and anther size is quite large in polluted plants. Fine reticulum is also seen in these grains. Surface of the grains probably show dust particles.

**Brassica campestris Linn.** (Plate 4 Figs. 1 - 4)

Flowers medium sized and normally yellow coloured. Stamens six, tetradynamous; anthers two-celled introse, dehisced longitudinally.

3-zonicolporate pollen grain, subrolate, small, 19 x 19  $\mu\text{m}$ . Exine 1.5  $\mu\text{m}$  thick, acute tip, sculpturing reticulate, lumina small near the colpus, pore circular, on every furrow, annulus prominent. It shows highly reticulated exine.

Grain structure is almost similar both in healthy and polluted plants. Size of anthers and grains (18 x 20  $\mu\text{m}$ –19 x 22  $\mu\text{m}$ ) are slightly larger in the plant growing in air polluted areas. It is noteworthy feature as the size usually smaller in air polluted plants. Grains show small granules on the exine; in normal grains it is almost smooth.

**Dolichos lablab Linn.** (Plate 5 Figs. 1 – 6)

Flowers medium sized, white or purple, stamens 10, diadelphous, anthers introse, 2 celled.

3-zonicolporate pollen grains, subrobrate– spheroidal, grains small average size 24 x 24  $\mu\text{m}$ ; exine thin 1.2  $\mu\text{m}$ . Few grains are sub-prolate (36 x 30  $\mu\text{m}$ ) ranges from 30-40 x 25-36  $\mu\text{m}$ , colpi wide at the equatorial zone, long about 3/4 of the grain, exine uniform, reticulate and wavy.

Pollen highly variable in the plants effected by air pollutants and are distinct, small grains 20 x 23–23 x 23  $\mu\text{m}$  and large grains 25 x 30 – 30 x 36  $\mu\text{m}$ . Exine is reticulated forming fine mesh.

**Table - 1:** Comparative account of healthy and polluted (air pollutants) grains

| Name of Species               | Pollen grains of healthy plants  |                                  |                                   |                                | Pollen grains of polluted plants |                                  |                                   |                                | Remarks  |
|-------------------------------|----------------------------------|----------------------------------|-----------------------------------|--------------------------------|----------------------------------|----------------------------------|-----------------------------------|--------------------------------|--|
|                               | Size of Anther ( $\mu\text{m}$ ) | Size of Grains ( $\mu\text{m}$ ) | Exine Thickness ( $\mu\text{m}$ ) | Spine Length ( $\mu\text{m}$ ) | Size of Anther ( $\mu\text{m}$ ) | Size of Grains ( $\mu\text{m}$ ) | Exine Thickness ( $\mu\text{m}$ ) | Spine Length ( $\mu\text{m}$ ) |  |
| <b>Hibiscus-rosa-sinensis</b> | 1033x1033                        | 96x96                            | 1.5                               | 12.25                          | 1051x942                         | 90x78                            | 1.5                               | 11.4                           | Size of anthers, pollen and spines smaller in polluted plants. |
| <b>Moringa oliefera</b>       | 2541x1125                        | 29x26                            | 1.5                               | –                              | 2000x100                         | 25x22                            | 1.5                               | –                              | Size of grains variable in polluted plants.                    |
| <b>Lagenaria-siceraria</b>    | 6428x3171                        | 49x45                            | 2.2                               | –                              | 7285x3857                        | 35x33                            | 2.2                               | –                              | Large size of anthers and smaller grains in polluted plants.   |
| <b>Brassica-compestris</b>    | 1820x700                         | 19x19                            | 1.5                               | –                              | 2218x763                         | 21x19                            | 1.5                               | –                              | Large size of anthers and pollen grains in polluted plants.    |
| <b>Dolichos-lablab</b>        | 1500x500                         | 24x24                            | 1.2                               | –                              | 1244x366                         | 23x23                            | 1.2                               | –                              | Grain size variable in polluted plants.                        |

### Discussion

Pollen morphology is distinct and characteristic to a taxon, its exine structures hardly changes due to Sporo-pollin, a complex substance (Erdtman, 1943; 1952). The plants which are growing through the life in the areas which are continuously affected by various air pollutants have definitely caused certain pollen structures (Bharti et al., 2002). Air pollutants effect are maximum on the foliar surface, as they are exposed to the nature by virtue of their position. Reproductive parts specially flowers, which are effected by these air pollutants for short period, even though they show certain abnormalities (Joshi and Sikka, 2002).

In the present investigation, five plants have been studied for their pollen morphology, growing in the areas which are effected maximum by various air pollutants. Results obtained, have been compared with the grains of normal healthy plants. It has been observed that the anther and pollen size are more in healthy plants as compared to polluted ones in *Hibiscus rosa-sinensis*, whereas in *Brassica campestris*, anther and pollen size are more in polluted plants in comparison with normal ones. *Hibiscus rosa-sinensis* grains are characterized by having spines on the exine, they are also smaller in size in polluted plants. In *Lagenaria siceraria*, size of anthers is large and grains smaller in polluted plants as compare to normal ones. In *Moringa oleifera* and *Dolichos lablab*, however, size of pollen is variable in polluted plants (Demchick and Day 1996).

The present study through light on the pollen morphology and variable nature of pollen and anther size. Basic structure of the grains is almost constant both in healthy and polluted plants. Whatever, the changes have been recorded, it is only in the size. Comparative pollen morphology of healthy and polluted plants are given in Table-1.

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