



Short communication

Entomophilous pollen incidence with reference to atmospheric dispersal in eastern India

Ashoke Bhattacharya, Subrata Mondal & Sudhendu Mandal*

Department of Botany, Visva-Bharati, Santiniketan – 731 235, West Bengal, India

(*author for correspondence, e-mail: root@vbharat.ernet.in; fax: +91 03463 42751)

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Abstract

This paper presents atmospheric pollen concentrations of fifteen entomophilous trees of Eastern India. The period of anthesis and anther dehiscence varied from morning to evening. Insects and other flower visitors were found to accelerate the mechanism of pollen dispersal. The highest pollen concentration was for 267/m³ in *Aegle marmelos* followed in decreasing order by *Eucalyptus globosus* (207/m³), *Cassia siamea* (186/m³), *C. fistula* (180/m³), *Delonix regia* (171/m³), *Butea monosperma* (159/m³), *Bombax ceiba* (156/m³), *Tectona grandis* (144/m³), *Terminalia arjuna* (138/m³), *Moringa oleifera* (126/m³), *Anthocephalus chinensis* (114/m³), *Syzygium cumini* (96/m³), *Dillenia indica* (30/m³), *Syzygium jambos* (27/m³), and *Kleinhovia hospita* (2/m³).

Introduction

Pollen grains can cause allergic disease in humans and animals and there is an increasing awareness of the importance of bioparticles. In contrast to the common belief that entomophilous pollen does not become airborne, there are some reports (Mandal and Chanda, 1981; Tilak, 1984; Agashe, 1989) of aeropalynological survey in which such pollen has been detected in various parts of India. Clinical investigation of certain entomophilous pollen showed allergic responses from which it is evident that even an insignificant emission of entomophilous pollen in the air, can potentially cause an allergic reaction in a sensitive individual (Tilak, 1984). Agashe (1989) studied airborne entomophilous pollen with its potential source of allergy. McCartney (1994) reported about the dispersal mechanism of entomophilous pollen of some crop plants. Ong et al. (1995) showed the occurrence of some entomophilous pollen in atmosphere. Mondal et al. (1992, 1997) observed the distribution of entomophilous pollen of some tropical plants in Eastern India.

The present paper presents atmospheric concentration of pollen of fifteen entomophilous trees of Eastern India. The selected plants are: *Aegle marmelos*, *Anthocephalus chinensis*, *Bombax ceiba*, *Butea monosperma*, *Cassia fistula*, *C. siamea*, *Delonix regia*, *Dillenia indica*, *Eucalyptus globosus*, *Kleinhovia hospita*, *Moringa oleifera*, *Syzygium cumini*, *S. jambos*, *Tectona grandis* and *Terminalia arjuna*.

Materials and methods

Anthesis was studied using the methods of Reddi and Janaki Bai (1981) and Mathur and Mohan Ram (1986). To study pollen release, ten flowers/inflorescence were tagged and observed every 2 hr during a 24 hr period for 10 days on different plants. Dehiscent anthers were counted using a hand lens. The pollen released for each hr was expressed as percentage of the total number of anthers dehiscent for that day (Reddi et al., 1988). Pollen production was measured using the method of Mandal and Chanda (1981). According to this method fully developed and undehiscent anthers were collected from flower buds. Then a single

anther was taken on a microscopic slide with a drop of 10% glycerine and was crushed and covered with a cover glass (22 × 18 mm). Then it was scanned thoroughly under microscope and the pollen grains were counted. Ten observations were made taking the anthers of different flowers from different plants of same species to get an absolute average number of pollen grains per anther which was multiplied by the total number of anthers of a flower to get the absolute average number of pollen grains per flower. Atmospheric pollen concentration was measured using a 'Rotorod' sampler (Perkins, 1957). The battery operated 'Rotorod' sampler relies upon the high efficiency with which small airborne particles are deposited on narrow cylinders oriented at right angles to high velocity winds. Collecting arms of the model are made up of 0.159 cm square section brass rods slightly bent inwards. The vertical arms are 6 cm long and 4 cm from the axis and it rotates at 2500 rpm. The sampling rate of the sampler is 120 litres/min with its conversion factor 3. The total catch of pollen grains for each specific taxa were multiplied by 3 to get the number of pollen grains/m³ of air. The sampler was operated for 10 days for 15 minutes at every 2 hrs interval one metre above the inflorescence or flower during peak flowering period. Pollen grains were collected on safranin stained glycerine jelly coated celotape (300 mm²) attached to the rotorod. The tape was removed and mounted on a microscope slide and covered with cover glass, it was scanned thoroughly using light microscope and the pollen grains were counted. The scanning width was 230 μ with number of scan 20 and total scanned area was 55.2 mm²/slide. Then the total concentration of pollen grains for each taxa on the slide was calculated (Mondal et al., 1992, 1997).

Results and discussion

Circadian periodicity of anthesis

The periodicity of anthesis of the plant taxa were categorised as follows (Gregory, 1973).

- (i) Post middle of the night (1.00–4.00 hrs) e.g. *Bombax ceiba* Linn.
- (ii) Early morning (4.00–6.00 hrs) e.g. *Anthocephalus chinensis* (Lamk.) A. Rich.
- (iii) Forenoon (6.00–10.00 hrs) e.g. *Kleinhovia hospita* Linn., *Delonix regia* (Boj.) Raf., *Cassia siamea* Lamk., *Aegle marmelos* (Linn.) Correa., *Butea monosperma* Lamk. (Taub.), *Tectona*

grandis L.f., *Moringa oleifera* Lamk., *Terminalia arjuna* (Roxb. ex DC.) Wt & Arn. and *Dillenia indica* Linn.

- (iv) Middle of the day (10.00–12.00 hrs) e.g. *Eucalyptus globosus* Smith. and *Syzygium jambos* (Linn.) Alston.
- (v) Evening (17.00–20.00 hrs) e.g. *Cassia fistula* Linn. and *Syzygium cumini* (Linn.) Skeels.

Pattern and periodicity of pollen release

Anther dehiscence took place prior to anthesis in *Eucalyptus globosus*, *Butea monosperma*, *Anthocephalus chinensis* and *Syzygium jambos*. In *Aegle marmelos* and *Kleinhovia hospita*; anther dehiscence coincided with anthesis. In remaining 9 taxa anther dehiscence took place after anthesis. Two types of anther dehiscence, i.e. poral and longitudinal slit were observed. Anthers of *Cassia fistula*, *C. siamea* and *Dillenia indica* had poral as well as longitudinal dehiscence while the remaining 12 taxa had longitudinal dehiscence. Thus, it can be stated that duration of anthesis, anther dehiscence and pollen dispersal varied from plant to plant. Bhattacharya and Datta (1992) showed the variations of anthesis and pollen release in some angiosperms.

Different types of insects, for example *Apis*, *Xylocopa*, *Ceratina*, *Danus*, Thrips and some other members of Lepidoptera, Coleoptera and Hymenoptera and birds visited the flowers to collect pollen, nectar and flower petals. These visitors accelerated pollen dispersal by making rapid movements of flowers/inflorescences.

After dehiscence, the pollen grains were found in clumps on the surface of anther or in some cases pollen clumps released into atmosphere by insects activity which was observed visually. Most of the studied plants had pollen clumps due to the presence of sticky substances and/or rough surfaces. In *Delonix regia*, *Moringa oleifera*, *Aegle marmelos*, *Butea monosperma*, *Bombax ceiba* and *Tectona grandis* pollen clumps adhered to insects body surface.

Productivity and atmospheric incidence of pollen

The highest number of pollen grains per flower were produced by *Bombax ceiba* (8,863,000) and maximum atmospheric incidence was 156/m³ at 10.00 hrs, following in decreasing order: *Syzygium jambos* (1,825,850) and 27/m³ at 14.00 hrs, *Aegle marmelos* (613,150) and maximum atmospheric incidence was

Table 1. Pollen incidence of the investigated plant taxa.

Name of the plants	Family	Pattern of anthesis	Name of the flower visitors	Maximum atmospheric pollen concentration /m ³	Time of maximum pollen release (in hrs)
<i>Aegle marmelos</i>	Rutaceae	Forenoon	<i>Apis</i> , <i>Vespa</i> , Butterflies	267	12.00
<i>Anthocephalus chinensis</i>	Rubiaceae	Early morning	<i>Apis</i> , <i>Megachile</i> , Thrips, Butterflies	114	10.00
<i>Bombax ceiba</i>	Bombacaceae	Post middle night	<i>Apis</i> , Birds, Squirells	156	10.00
<i>Butea monosperma</i>	Fabaceae	Forenoon	Birds, Thrips, Butterflies	159	13.00
<i>Cassia fistula</i>	Caesalpiniaceae	Evening	Thrips, <i>Xylocopa</i> , <i>Eumenes</i>	180	10.00
<i>C. siamea</i>	Caesalpiniaceae	Forenoon	<i>Xylocopa</i> , Ants, Thrips	186	12.00
<i>Delonix regia</i>	Caesalpiniaceae	Forenoon	Thrips, Butterflies	171	14.00
<i>Dillenia indica</i>	Dilleniaceae	Forenoon	<i>Apis</i> , <i>Megachile</i> , <i>Eumenes</i>	30	12.00
<i>Eucalyptus globosus</i>	Myrtaceae	Middle day	<i>Apis</i> , <i>Vespa</i> , Ants	207	14.00
<i>Kleinhovia hospita</i>	Sterculiaceae	Forenoon	<i>Apis</i> , <i>Ceratina</i> , Butterflies	2	12.00
<i>Moringa oleifera</i>	Moringaceae	Forenoon	<i>Xylocopa</i> , <i>Vespa</i> , Thrips	126	12.00
<i>Syzygium cumini</i>	Myrtaceae	Evening	<i>Apis</i> , <i>Megachile</i> , Butterflies	96	20.00
<i>S. jambos</i>	Myrtaceae	Middle day	<i>Apis</i> , <i>Megachile</i> , <i>Ceratina</i>	27	14.00
<i>Tectona grandis</i>	Verbenaceae	Forenoon	<i>Apis</i> , <i>Megachile</i> , <i>Ceratina</i> Butterflies	144	11.00
<i>Terminalia arjuna</i>	Combretaceae	Forenoon	<i>Apis</i> , <i>Vespa</i> , Butterflies	138	12.00

Table 2. Pollen biology of the investigated plant taxa.

Name of the plants	Flowering period	Pollen character			Average number of absolute pollen productivity per flower
		Aperture	Shape	Size (μm)	
<i>Aegle marmelos</i>	May–July	3-colporate	spheroidal	47.5×40.6	613,150
<i>Anthocephalus chinensis</i>	July–Sept.	3-colporate	spheroidal	19.3×20.2	4,566
<i>Bombax ceiba</i>	Jan.–Mar.	3-colporate	triangular	64	8,863,000
<i>Butea monosperma</i>	Feb.–Apr.	3-colporate	spheroidal	23×23.4	59,960
<i>Cassia fistula</i>	Mar. July	3-colporate	spheroidal	33.7×34.9	148,345
<i>C. siamea</i>	Sept.–Dec.	3-colporate	spheroidal	32.1×32.4	130,400
<i>Delonix regia</i>	Apr.–June	3-colporate	spheroidal	62×56.7	30,000
<i>Dillenia indica</i>	May–Sept.	3-colpate	spheroidal	26.2×23.1	106,584
<i>Eucalyptus globosus</i>	Dec.–Mar.	3-colporate	triangular	21.7	108,720
<i>Kleinhovia hospita</i>	Aug.–Nov.	3-colporate	triangular	28.7	6,790
<i>Moringa oleifera</i>	Feb.–Mar.	3-colporate	spheroidal	47×41	23,525
<i>Syzygium cumini</i>	Mar.–May	3-colporate	triangular	23.5	54,965
<i>S. jambos</i>	Dec.–Apr.	3-colporate	triangular	25.8	1,825,850
<i>Tectona grandis</i>	July–Sept.	3-colpate	spheroidal	39.5×31	7,500
<i>Terminalia arjuna</i>	Apr.–June	3-colporate	spheroidal	22.1×19.1	57,658

267/m³ at 12.00 hrs, *Cassia fistula* (148,345) and 180/m³ at 10.00 hrs, *C. siamea* (130,400) and 186/m³ at 12.00 hrs, *Eucalyptus globosus* (108,720) and maximum atmospheric pollen incidence was 207/m³ at 14.00 hrs, *Dillenia indica* (106,584) and 30/m³ at 12.00 hrs, *Butea monosperma* (59,960) with 159/m³ at 13.00 hrs, *Terminalia arjuna* (57,658) and 138/m³ pollen incidence at 12.00 hrs, *Syzygium cumini* (54,965) and 96/m³ pollen incidence at 20.00 hrs, *Delonix regia* (30,000) and 171/m³ at 14.00 hrs, *Moringa oleifera* (23,525) and 126/m³ atmospheric incidence at 12.00 hrs, *Tectona grandis* (7,500) and 144/m³ at 11.00 hrs, *Kleinhovia hospita* (6,790) and 2/m³ at 12.00 hrs and *Anthocephalus chinensis* (4,566) and maximum atmospheric pollen incidence was 114/m³ at 10.00 hrs (Tables 1 & 2).

Pollen production may vary from plant to plant and within the different species of same plant. It may be due to different anther length and size of pollen

grains and that is concomitant to the findings of Reddi and Reddi (1986). Vaish (1973) reported that pollen productivity also varies among different flowers of same plant. Beside that, regarding pollen productivity the present investigation is in accordance with the data found by Subba Reddi (1976), Obtulowicz et al. (1990), Mondal et al. (1992) and Bhattacharya et al. (1997) who showed the variation of pollen production among different members of angiosperms. Besides, the occurrence of some entomophilous pollen in the atmosphere found in the present study is in full accordance with the findings of other researchers. Tilak (1987–1988) and Sathes et al. (1993) showed the distribution of entomophilous pollen in different parts of India. Ong et al. (1995) suggested that a considerable amount of pollen of Myrtaceae occurs in the atmosphere. Actually, no direct correlation between pollen production and atmospheric pollen concentrations could be found in the present observation. An

explanation could be found in the fact that some plants produce high quantities of pollen per flower and consequently high concentration of airborne pollen is to be monitored. Other plants instead produce low amounts of pollen, but still the concentration remains high. As a matter of fact the atmospheric pollen concentration depends on the pollen production of an entire plant and on different pollen behaviour. Agashe (1989) reported about the distribution of pollen grains in the air of Western India pointing out no relevance between pollen productivity and incidence in entomophilous trees. Even, Singh et al. (1996) carried out the work to know the incidence of pollen and revealed that pollen production and incidence were not related directly in entomophilous trees.

Conclusions

From present investigation it can be concluded that the biological rhythm of anthesis, anther dehiscence and mode of pollen release differ from each other. Some entomophilous taxa produce huge numbers of pollen per flower consequently releasing a considerable number of pollen grains in the air. By contrast some plants produce a lower amount of pollen grains but its atmospheric incidence is still high. This high incidence might be due to a widened dehiscent surface or colonial release of pollen from the anther by the activity of insects. Besides, it may be due to the fact that most of the investigated plants are avenue trees growing on road sides, gardens, etc. During their flowering period pollen emission may occur in the atmosphere may be due to strong air currents.

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