STUDIES ON AIRBORNE PALYNOMORPHS OF JALPAIGURI, WEST BENGAL, INDIA TO IDENTIFY THE CAUSATIVE FACTOR FOR NASOBRONCHIAL ALLERGY

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DEDICATION

In the memory of my revered father

Late Mr. Byomkesh Gupta

TO WHOM IT MAY CONCERN

This is to certify that **Tusher Subhra Gupta** has carried out his work under our joint supervision. His thesis entitled "**Studies on the airborne palynomorphs of Jalpaiguri, West Bengal, India to identify the causative factor for nasobronchial allergy"** is based on his original work and is being submitted for the award of **Doctor of Philosophy (Science)** degree in **Botany** in accordance with the rules and regulations of the **University of North Bengal**.

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INTRODUCTION

Aerobiology, which deals with airborne bioparticles, is a scientific and multidisciplinary approach focused on the transport of organism and biologically significant material. The term "aerobiology" came into use during 1930s as a collective term for studies of airspora, like airborne fungal spores, pollen grains and other micro-organisms in terms of their source, release, dispersal, deposition and impact on other living organisms. In case of human immune system, the respiratory organ is the direct target of inhaled airborne bioparticles, resulting into a variety of adverse effects, e.g. infection and allergic disorders including bronchial asthma, seasonal rhinitis, conjunctivitis, atopic dermatitis etc. The term "allergy" was first introduced by von Pirquet (1906) as a changed responsiveness in individuals who had previously been exposed to allergenic substance. About 15% of the world population is known to suffer from major allergic diseases. In India, nearly 10% population suffers from allergic disorder (Vishwanathan 1964). A normal adult inhales about 14-15 cubic meters of air per day, which contains a good number of bioparticles including pollen grains. Pollen grains, an important cause of respiratory allergy (Blackley 1873) are at present the major sources of morbidity among atopic subjects (Kjellman, 1993), Allergenic extracts have been used for the diagnosis and treatment of allergy for over 80 years. Despite this, little is known about the nature of these materials, neither in terms of allergen or antigen contents, nor in terms of their ability to desensitize patients. So the study of allergenic pollen is very useful for proper diagnosis and treatment of respiratory allergy.

From medical specially, clinical point of view, it is important to know the details about the occurrence of the pollen load in the atmosphere. The correlation between the onset of different airborne pollen seasons and occurrence of a patient's symptom is now well known. Pollen grains causing allergy are quite variable in different ecological and climatic conditions. This makes it very important to identify pollinosis - causing species from every region and to prepare aqueous sterile extracts from them for diagnosis and immunotherapy. That is why an aerobiological survey is needed to make a pollen calendar of a particular area. Pollen calendar of an area is essential to rest the relevant antigens on the patients, and to correlate the seasonal occurrence of the pollen types to the patients' allergic symptoms.

The aerobiological survey of an area involves aeropalynological study, identification of airborne pollen grains, and determination of atmospheric pollen count. Although the atmosphere consists of a large number of pollen grains, only a few of them are responsible for allergic manifestations. To know the details about the occurrence and concentration of these allergenic pollen which can be inferred from the pollen calendar is very essential for the clinicians. A pollen calendar of a region is a prerequisite for the immunological treatment of pollen allergies. For identification of airborne pollen grains surveyed from a particular area, it is necessary to know the floral distribution of that area through ecofloristic survey and the morphology of common pollen grains of the study area.

Dispersal of pollen grains into the air gets affected by meteorological factors and this relationship has to be defined before the identification of allergenic pollen (Antepara *et. al.* 1995). So, the aeropalynological survey in relation to meteorological parameters is needed as weather factors have great influence on the occurrence and distribution of pollen in the atmosphere.

The diagnosis and treatment of allergic disorders caused by pollen grains, require preparation of allergen extract which is a complex mixture of proteins, lipids, carbohydrates, nucleic acids and lectins. The allergenic extracts used in clinical allergy, contain non-allergic protein antigents and some times irritant components as well as active allergenic proteins. The allergen content and composition of extracts prepared by different companies may vary, resulting in unreliable diagnosis and immunotherapy of patients. So, the standardization of the crude allergen extracts is required for proper diagnosis and immunotherapy of patients. The work in the field of aerobiology in relation to allergy remained unexplored for long time in the developing countries, such as India and allergic diseases were considered to be uncommon in these countries (Turner 1989). From the last three decades it was found that allergic disorders caused by pollen grains are quite common in India (Chanda and Sarkar 1972; Shivpuri and Agarwal, 1982; Jaggi and Gangal, 1987; Agarwal and Jhumbs, 1995; Malik *et. al.* 1991a, Singh *et. al.*, 1993, 1995, Chakraborty *et.al.* 1996, 1998a, 2001, Boral and Bhattacharya 2000). Inspite of this, there are many areas that remained unexplored for quantification of aeroallergen load in the atmosphere, their identification and proper standardization. That's why the present study was undertaken. The main objectives of this study are :

1. An ecofloristic survey of the Jalpaiguri town of West Bengal was carried out to make a list of angiospermous plants showing their mode of pollination, habit, flowering period, etc., with the object of identifying the airborne pollen grains. All these data are essential prerequisites for aerobiological investigation.

2. The pollen morphological study of common pollen grains of Jalpaiguri was done supplemented by a pollen key for identifications of the airborne pollen grains.
3. The volumetric aerobiological survey for two consecutive years of Jalpaiguri town, yet unexplored biozone, was carried out with reference to meteorological parameter to make a pollen calendar of the area which will be helpful to correlate the seasonal occurrence of the pollen types with the patients allergic symptoms.
4. To identify the allergic pollen types and to prepare the allergenic pollen calendar in the study area.
5. To study the allergenic significance of some common pollen types of Jalpaiguri town by clinico-immunological tests.

REVIEW OF LITERATURE

Ecofloristic Survey

Systematic studies on the flora of West Bengal was done by several workers (Voigt, 1842; Prain, 1903, 1905; Cowan, 1929, etc.). Botanical Survey of India (BSI) published the first volume of the '*Flora of West Bengal*' in 1997 (Anonymous, 1997). For the Northern part of the state, Biswas (1966) started publishing the flora of Darjeeling. Hara (1966, 1971), Matthew (1981), Ohashi (1975), Das (1986), Bhujel (1996) contributed much to the floristics of the region. Very recently some workers have started surveying the district floras of West Bengal and have enumerated the plant species of the respective regions (Dutta & Majumdar 1966, Bhattacharya *et al.*, 1984; Bishayee and Bhattacharya, 1992). The flora of Jalpaiguri district has been studied earlier by Sikdar and Samanta (1984), Sikdar (1984) and Bhattacharya *et al.* (1988). But a detailed flora of the district is yet to be published.

Aeropalynological Survey

Aeropalynology deals with airborne pollen grains. Pollen grains are the carriers of male genetic materials of higher plants. In the matter of plant reproduction pollen grains have to be transmitted from flower to flower, for which they utilize a range of different vectors, of which air is an important agent for dispersal. For this reason, pollen grains are important airborne bioparticulates and now a days, these are also recognized as important aeroallergens. Bostock (1819) was the first to suspect that pollen grains caused hay fever but it was Blackley (1873) who established the fact. Scheppegrell (1916) from U.S.A. felt the need of field exploration and aerial survey to record aero-allergens. F.C. Meirs (1935) coined the terms 'aerobiology' as the scientific discipline focused on the aerial biomass consisting of pollen grains, spores, insect debris and other biological material, also referred to as the bioaerosol. Therefore, aerobiology is a multidisciplinary subject deals with the origin, release, transport and surface impact of wind borne particles.

For study an aerobiological pollen survey in a particular area, it is first necessary to make an eco-floristic survey of that area and to study the detailed pollen morphology of the species found to enable proper identification of airborne pollen grains. Such studies on pollen morphology were started by Wodehouse (1935) followed by the immense contribution by Prof. G. Erdtman, summarized in 'Pollen Morphology and Plant Taxonomy' (Erdtman, 1952) and in '*Handbook of Palynology*' (Erdtman, 1969).

Initiation of aerobiological survey was made by Durham (1946) by devising a sampler which was based on principle of simple gravity deposition on the gelatin coated slides and this was followed by other workers (Hyde and Williams, 1944). Subsequently, volumetric samplers based on aerodynamic principles were designed, among them the Hirst trap. Andersen sampler, Rotorod sampler, and Burkard volumetric sampler are the most versatile collectors of pollen grains and spores.

In Abroad :

Pollen grains constitute a significant fraction of airborne biopollutants. Systematic aeropalynological surveys were carried out in various parts of the World at different times. Durham initiated aerobiological survey in the U.S.A. in 1925. In 1944 a survey was done at Cardiff by Hyde and Williams which was later extended to several other stations in Great Britain. Based on the data, Hyde published an atlas of airborne pollen grains of the U.K. (Hyde and Adams, 1958; Hyde, 1969). Emberlin *et. al.* (1994) analysed the annual variation in grass pollen in London during 1961-1990. Annual variation of grass pollen in London was carried out by Emberlin *et.al.* (1993).

In France, studies carried out at Montpellier, Marseilles, Paris, Lyon have shown Chenopodiaceae, Compositae, Cupressaceae, *Pinus*, Plantain, Poaceae, *Alnus, Betula, Quercus* as the pollen species encountered in large numbers (Charpin *et.al.* 1966; Michel *et.al.* 1976). Airborne pollen of *Ambrosia* was reported from Burgundy of France by Laaidi and Laaidi (1999). Another important center was in Basel, Switzerland, where Leuschner (1974) carried out survey using individual pollen collectors and found *Aesculus, Artemisia* and *Salix* as important pollen contributors to the atmosphere. Airborne brich pollen was recorded from Neuchatel (Switzerland) by Clot (2001).

In Germany survey carried out at Darmstadt revealed 70% of the total pollen catch consisted of birch, grasses, nettle, oak and pine (Stix, 1977). The dominant airborne pollen grains in Italy were originated from Cupressaceae, *Fraxinus*, Urticaceae, *Parietaria*, Poaceae, Betulaceae, Corylaceae, Oleaceae (Caramiello *et. al.* 1990; Famularo *et.al.*, 1992; Fornaciari *et.al.*, 1996, Filon *et.al.*, 2000). Whereas several workers have observed *Parietaria, Artemisia* and *Olea* as the most important airborne pollen (Eriksson *et.al.*, 1984; D' Amato and Spieksma, 1991, Spieksma *et. al.* 2000). The most abundantly encountered pollen types in Sweden were *Pinus*, *Betula, Urtica, Ulmus, Quercus,* members of Poaceae, *Alnus* and some others (Kutzamanidou and Nilsson, 1977; El-Ghazaly *et.al.*, 1993). Extensive studies on airborne pollen and the mode of sampling has been carried out by Kapyla (1984) in Finland. In the air of Denmark the important pollen contributing species are *Alnus, Artemisia, Betula, Corylus,* Poaceae and *Ulmus* (Goldberg *et.al.*, 1988). In Norway the survey was carried out by Johansen (1991).

In other European countries like Portugal, Yugoslavia, Spain and Poland the important airborne pollen grains were *Alnus,* Cheno-Amaranth group, *Corylus, Cupressus, Morus, Olea, Pinus,* Poaceae, *Populus, Quercus* and *Taxus* (Kantoor *et.al.*, 1996; Galan *et.al.*, 1989; Belmonte and Roure, 1991, Zawisza *et.al.* 1993, Weryszko-Chmielewska *et.al.*, 2001).

In the U.S.A. most of the investigators have recorded Gramineae, *Ambrosia, Quercus,* Chenopodiaceae, Amaranthaceae, Pinaceae, *Artemisia, Xanthium* as important constituents of the atmosphere (Anderson *et.al.*, 1978) In Canada the pollen survey was carried out by Bassett (1964). In South Africa aerobiological studies were initiated by Ordman (1970). Later other workers (Hawke & Meadows, 1989; Cadman & Dames, 1993) revealed the members of aeropalynoflora consisting of *Morus, Cannabis,* Poaceae, Asteraceae, Fabaceae, *Pinus, Cynodon* etc. Smart and Knox (1979) had shown that *Lolium* and *Phalaris* were major sources of atmospheric pollen in Australia. In Japan palynological survey was started in the 1960s. The most important pollen being Japanese Cedar followed by pine (Higuchi *et.al.*, 1977, Ishizaka *et.al.*, 1987). Artemisia, Casuarinaceae, Euphorbiaceae, Graminae, Moraceae and Pinaceae are the major contributors to the atmosphere of China (Chen and Zhang, 1985; Chen *et.al.*, 1988). Chen and Huang (1980) recorded 56% contribution of tree species to the total pollen load of Taiwan.

In India :

The first report of a comprehensive aerobiological work in India was published in 1873 by Cunningham dealing with the atmosphere of Calcutta, the then capital of India. There was no co-ordinated national programme in India till 1979. In 1980 aeribiologists from different parts of India assembled to attend the Workshop on "Modern Trends in Aerobiology with particular refrence to Plant Pathology and Medicine" held at the Bose Institute, Calcutta, where the Indian Aerobiological Society (IAS) was formed and started functioning from 31st January 1980.

Following is a brief account of aerobiological researches done in India and the results so far obtained. In view of the climatic, topographical and ecological diversities and for the sake of convenience, the country has been divided into four biozones, namely, Eastern, Western, Northern and Southern regions.

Eastern Region :

After a long gap after the first report by Cunningham (1873) Baruah and Chettia (1966) reported the occurrence of 17 pollen types from the atmosphere of Gauhati. Bora and Baruah (1980) recorded a high number of pollen in winter season. Singh (1981, 1983) investigated the aeropalynomorphs of Shillong and reported 53 types of pollen grains. Singh (1985) further investigated the indoor aerospora of a hospital where grass pollen was found to be present throughout the year. Chanda and Nandi (1971) reported the incidence of large number of pollen grains from the air of Calcutta. Chanda and Sarkar (1972) reported the presence of grass pollen grains from the same place throughout the year. Chanda (1973) later reported a still high frequency of grass pollen, i.e. 32.5% from the atmosphere of Falta, followed by Arecaceae (10.2%) and Amaranthaceae/Chenopodiaceae jointly 15.7%. Similar results were obtained from Kalyani, semi-urbanised township about 35 km. north of Calcutta (Chanda, and Mandal, 1980, 1981), where 32 pollen types were identified, out of which the maximum contribution was made by grass pollen (38.9%) followed by weeds (33.6%) and trees (19.0%).

In other parts of West Bengal, e.g. Digha, Durgapur and Jhalda, grass pollen grains were recorded in highest frequency (Bhattacharya *et.al.* 1981). Identical results were obtained from earlier investigation in other places of West Bengal (Mandal and Chanda, 1979, 1981). Nandi *et al.* (1985) presented a preliminary report on the incidence of atmospheric pollen of Krishnapur, Calcutta, where pollen grains of *Cassia fistula, Azadirachta indica, Chenopodium ambrosioides*, etc. were found to occur. Banik and Chanda (1987) did a survey work in Tripura. Aerobiological investigation in Darjeeling, the Eastern Himalayas was done by Kundu *et.al.* (1982). A total of 51 pollen types were recorded of which *Cryptomeria japonica* was recorded with a highest frequency followed by Poaceae, Cupressaceae, *Betula, Pinus, Alnus*, etc. In Eastern Himalaya pollen survey was also done by Gupta and Chanda (1989) and Singh and Devi (1992).

A more detailed atmospheric pollen survey of Kurseong, was done by Gupta *et.al.* (1985), Gupta and Chanda (1994). Tree pollen grains dominated over grasses and weeds. The common tree pollen originated from *Alnus, Betula, Engelhardtia, Quercus, Bucklandia, Acer, Salix, Ilex, Cryptomeria, Pinus, Cupressus*, etc. A survey compilation of Indian aerobiological works was published by Nair *et.al.* (1986) and Gupta and Chanda (1994). Aeropalynological investigation of Coochbehar town, West Bengal was done in detail by Mazumder, *et.al.* (1988). Later, Banik and Chanda (1992) recorded 65 pollen types in the air of Central Calcutta with *Trema orientalis* as the most numerous followed by grasses. A total of 46 pollen types were identified by Chakraborty *et.al.* (1998, 2001) of a farm in West Bengal. Airborne pollen concentration in Berhampur was carried out (Boral and Bhattacharya 1999, 2000, Boral *et al.* 2004).

Western Region :

Karla and Dumbrey (1957) reported 30 airborne pollen type from a survey at the Army Medical Campus at Poona. A three year survey work of the air of the same place was done by Chaubal and Deodikar (1964). They reported the occurrence of pollen grains of 20 monocotyledons and 21 dicotyledons. Karnik (1962) reported some airborne pollen grains from the air of Jalgaon. Aeropalynological survey of Kolhapur was done by Chaubal and Gadve (1978). Doshi and Kulkarni (1981) worked on aeropalynology of Bombay and reported the presence of 13 pollen types. Tripathi *et.al.* (1977) recorded a comprehensive atmospheric pollen assemblage from Bhopal with a pollination calendar. Tripathi (1978) reported that the frequency of tree pollen was higher (51.1%) followed by herbs (46.0%) and shrubs (3.0%).

A pollen flora of Nagpur along with a pollen calendar as an aid to aerobiology was prepared by Deshpande and Chitaley (1976) and later by Chitaley (1977). They reported grass pollen as the most dominating type followed by trees and weeds. Patil (1981) also did aeropalynological studies in Nagpur. Aeropalynological survey at Jabalpur was done by Agarwal *et.al.* (1987) which reflected general vegetational association of the area.

Tilak and Vishwe (1979 & 1980) reported 33 pollen types from the air of Aurangabad. Tilak *et.al.* (1981) reported 12 aeroallergenic pollen types from the atmosphere of Aurangabad where *Parthenium* contributed 12.47% followed by grass pollen (8.79%). Vishwe (1979) presented an annual average of pollen grains of the atmosphere of Aurangabad. Grass pollen in India was revived by Chaturvedi *et.al.* (1992) and have observed that the highest percentage was reported from Aurangabad (80.64%) followed by Bhavnagar (70.26%) and Raipur (66.73%).

Northern Region :

Aeropalynological survey of Jaipur was done for the first time by Sanghvi *et.al.* (1957). Thirty pollen types were recorded from the air of Lucknow by

Lakhanpal and Nair (1958). In 1960 they studied the pollen incidence of Almora atmosphere recording maximum pollen incidence during March to April and minimum in July and December. Vishnu-Mittre and Khandelwal (1993) recorded 48 pollen types from the air of Lucknow. A fresh survey of airborne pollen of Lucknow was done by Chaturvedi *et.al.* (1987-88), where a total of 128 pollen types were identified.

Nautiyal and Midha (1978) estimated the frequency of airborne pollen in Allahabad and concluded that majority of the trapped grains were from anemophilous plants, Shukla and Mishra (1980) made a tree pollen survey at Kanpur and that of Bareilly was done by Kumar (1986) where grass pollen dominated followed by *Azadirachta, Pisum, Mimusops, Brassica, Eucalyptus, Holoptelea,* etc. The airflora of Bhabnagar was reported by Dutta (1989). Out of 49 types recorded there, the maximum contribution came from trees. Gaur (1978) also studied the airborne pollen grains of Meerut mostly dominated by grasses, *Holoptelea, Azadirachta, Ailanthus* etc.

Dua and Shivpuri (1962), Shivpuri *et. al.* (1960) and Singh and Shivpuri (1971) investigated the air of Delhi. Singh *et.al.* (1978) studied the diurnal and seasonal periodicities of the atmospheric pollen of Delhi. Singh *et al.* (1979) reported that the grass pollen constitute the highest amount of pollen in the air of Delhi followed by *Morus* and Chenopod-Amaranthaceae group. Singh and Babu (1980a) again recorded a high amount of grass pollen in the atmosphere of Delhi area. Later Singh (1984), Singh and Babu (1980b, 1982) studied aeroallergens of Delhi with their seasonal periodicities. Singh and Gangal (1986) recorded an account of the sampling and distribution pattern of allergens in the atmosphere. Jain and Mishra (1988) surveyed atmospheric pollen grains and other biocomponents of Gwalior. Singh *et.al.* (1987) recorded the pollen types from the foot hills of the Himalayas (Dehra Dun). Malik *et.al.* (1991) reported the dominant pollen types of Delhi as Poaceae, Cheno-Amaranthaceae, *Ailanthus, Ricinus, Holoptelea* etc. Munshi (1997) reported the pollen of *Platanus orientalis, Narcissus, Salix,* etc. to be the major airborne types in Srinagar.

Southern Region :

Saha and Kalyansundaram (1962) prepared a pollination calender of the potentially allergenic plants in Pondicherry. Nair (1963) revealed the presence of 17 types of airborne pollen from Vellore. Ramalingam (1966) and Sreeramulu and Ramalingam (1966) recorded some atmospheric pollen grains over a paddy field at

Visakhapatnam. Reddi (1970, 1973) performed aerobiological survey in Anakapalle and Visakhapatnam and recorded the occurrence of ten types of pollen. Ramalingam (1971) reported the presence of some pollen grains, from the air of Mysore. Shenoi and Ramalingam (1976) published the air spora of a sorghum field from Mysore. Reddy and Janakibai (1978) and Janakibai and Reddi (1982) studied the airborne pollen types of Visakhapatnam. A preliminary aerobiological study of Vijaywada was carried out by Apanna and Reddi (1978). Reddi and Ramanujam (1989) studied the aerobiology of Hyderabad.

Agashe and Vinay (1980), Agashe *et.al.* (1983) studied aero-palynoflora of Bangalore and reported the dominance of the pollen grains of *Parthenium hysterophorus,* Agashe and Chatterjee (1987) did sampling using an aircraft of the upper airspora of Bangalore. Airborne pollen having allergenic significance in Bangalore was recorded by Agashe and Anand (1982). A pollen calendar of Bangalore city was prepared by Agashe and Abraham (1988). Occurrence of grass pollen under the influences of meteorological factors in Hyderabad was recorded by Kanta and Chapla (1987). Bhat and Rajasab (1985, 1988) did survey works on the airborne pollen for a period of two years in a commercial location at Gulbarga. Seetharam *et.al.* (1989) recorded the atmospheric pollen grains of Gulbarga. Alturi *et.al.* (1992) reported site to site variations in airborne pollen grains at Visakhapatnam. Anupama (1992) studied the airborne pollen of Pondicherry.

Airborne Pollen in relation to meteorological parameters

Variation in the airborne pollen distribution depended upon climatic factors as revealed by various workers. Different regions like deserts, forests, temperate and tropical regions etc. constitute different plant species resulting in considerable variation in the airborne pollen types. Meteorological parameters like temperature, rainfall, relative humidity, wind velocity and direction are also responsible for fluctuations in pollen concentration (Andersen, 1980; Bricche *et.al.*, 1992; Hjelmroos, 1992, Subiza *et.al.* 1992; Puc and Wolski, 2002, Vega-Maray, 2003). Wind direction and velocity play an important role in the long-distance transport of pollen grains (Keynan *et al.*, 1986; Wallin *et al.*, 1991). It was found by Norris-Hill and Emberlin (1993) that increased pollen concentration in London was associated with increased rainfall.

From India, Agashe and Alfadi (1989), Boral *et.al.* (2004) have correlated atmosphere biopollutants with meteorological parameters such as temperature, relative humidity, wind speed and cloud cover. They have observed that high temperature and low relative humidity enhances the liberation and distribution of pollen in the atmosphere. The pollen counts were drastically reduced during the rains. It was found that pollen concentration was positively correlated with temperature and negatively correlated with rainfall and humidity.

Pollen allergy – a clinical approach :

Pollen of plants provide a source of aeroallergens. The term allergy was introduced in 1906 by von Pirquet. Allergy, also termed immediate hypersensitivity, is defined as an altered and accelerated reaction of a person to a second or subsequent exposure of a substance to which he has been sensitized during the first exposure, so it is an altered immune response. The immune system has developed to protect the human body against the harmful effect of environmental bioparticulates. Gell and Cooms (1963) described four types of allergic reactions, as follows :

Type I (Anaphylactic reaction) :

This reaction is initiated by the antigen reacting with tissue mast cells passively sensitized by antibodies elsewhere, leading to pharmacologically active mediator release. The reaction is manifested within seconds or minutes after exposure and referred as immediate hypersensitivity. It includes general anaphylaxis and local manifestation of symptoms in various organs or systems. The examples include bronchial asthma, rhinitis, urticaria, vomiting, diarrhoea etc.

Type II (Antibody dependent cytotoxic/cytolytic reaction) :

In this case the antibody is directed against the antigen on an individuals' own cells (target cells) or foreign antigen e.g., transfused red blood cells. This may lead to cytotoxic action by killer cells or by complement mediated lysis. The examples are mismatched blood transfusion, transplant rejection etc.

Type III (Arthus/Immune Complex reaction) :

In a type III reaction, the immune complexes are deposited in the tissue. The complement cascade is activated and polymorphos are attracted to the site of deposition causing local damage. The examples include the Arthus reaction, serum sickness etc.

Type IV (Delayed/Tuberculin Type reaction) :

This type of reaction is initiated by the action of antigen sensitized T-lymphocytes, releasing lymphokines following a secondary contact with the same antigen. Lymphokines induce inflammatory reaction and activate macrophages which release mediators. The reaction takes more than 12 hours to develop. The examples are tuberculin hypersensitivity, graft rejection, contact dermatitis etc.

The type I reaction, characterized by an allergic reaction occurs due to contact with allergic substance is called antigen/allergen. Pepys (1973) referred allergy as type I and type III reaction. Such restricted meaning was not originally introduced by von Pirquet. It is only in recent years that 'allergy' has become synonymous with type I hypersensitivity (Roitt *et.al.*, 1993). Allergic reactions are dependent on the specific triggering of the unique antibody, i.e., immunoglobulin E (IgE) sensitized mast cell, which release mediators to produce inflammatory reactions. The common allergens have been classified according to the route of exposure into the following types :

1) Inhalants (e.g., bioaerosols including pollen and spores)
2) Ingestants (e.g., food substances)
3) Injectants (e.g. insect venom, injected medicines)
4) Contactants (e.g. cosmetics)

Among these inhalants are most important as the causative agents of respiratory allergic disorders due to systematic nasodilation and smooth muscle contraction in the lungs. In general it is considered that particles larger than 5μm. initiate type-I allergy, particles smaller than 5μm. cause type-III allergy.

Type I are mediated by Immunoglobulin E (IgE). IgE-mediated hypersensitivity is disorders of the respiratory system and that is why it is very relevant to the present study. So, it is necessary to describe it in details. It includes allergic branchial ashma and allergic rhinitis, affecting people of all age groups.

Diagnosis of Allergey

The idea of skin test for the diagnosis of allergic disorders came after the introduction of a cutaneous test for tuberculosis by von Pirquet (Feinberg, 1946). An intradermal skin test is more sensitive and reliable, while the skin prick test is more convenient and has least chance of systemic reactions (Hejjaoui *et.al.*, 1992; Lin *et al.*, 1993). Several *in vitro* techniques are also used for allergy diagnosis which include Radio Allergo Sorbent Test (RAST), Enzyme Linked Immuno-Sorbent Assay (ELISA). At present, diagnosis should be based on careful clinical history supported by documentation of IgE-mediated sensitivity by the skin prick test.

Clinical Study :

In Abroad :

Based on clinico-immunological studies with pollen antigens, important allergenic pollen have been identified for different countries. In the U.S.A., Lewis (1975) reported that vernal and orchard grass were skin test positive in 43.7% patients tested, followed by red top (36.6%) and june (35.4%). Some of the species whose pollen plays an important role in respiratory allergic diseases in the U.S.A. and Canada are *Acer, Agrostis, Ambrosia, Artemisia, Alnus, Betula, Cannabis, Cynodon, Dactylis glomerata, Juniperus, Morus* and others (Lewis *et,al.*, 1984; Daniel, 1984). In European countries grasses are considered to be the most important cause of pollinosis (Bagni *et,al.*, 1976; D' Amato and Spieksma, 1991; Clayton *et.al.*, 1989). In England, 6% of hay fever patients were reported to be sensitive to *Pinus* pollen (Kalliel & Settipane, 1988). In Sweden birch pollen is the major cause of allergy (Eriksson *et,al.*, 1984). Bousquet *et.al.* (1984) found that in France, almost 85% of pollinosis was caused by grasses. In Italy, occupational allergy to the pollen of *Acacia floribunda* among floriculturists has been recorded (Ariano *et.al.*, 1991). Only 2% of patients from the general population gave a positive skin test, while it was 31% in the case of floriculturists. In a study of skin reactivity among unselected Danish population it was found that almost 17.6% were positive to pollen antigens (Nielsen *et.al.*, 1994).

In South Africa, the principle cause of pollinosis are *Cupressus, Prosopis, Cyperus* and grasses (Ordman, 1970). In Saudi Arabia, *Phoenix dactylifera* effects 25% of respiratory allergic patients (Harfi *et,al.*, 1992, Kwaasi *et.al.*, 1993). The important aeroallergens in Japan are the pollens of *Artemisia, Cryptomeria, Erigeron, Pennisetum* (Ishizaka *et.al.*, 1987).

In India :

In India work on pollen allergy was initiated by Shivpuri (1962) in Delhi and continued by his co-workers (Shivpuri and Prakash, 1967; Shivpuri *et.al.*, 1979; Singh and Dahiya, 2002; Singh and Kumar, 2003). The important allergenic pollen identified are *Ageratum, Ailanthus, Amaranthus, Cassia, Ipomea fistulosa, Putranjiva roxburghii, Ricinus communis*.

In Southern India, Acharya (1980) and Agashe and Anand (1982) have reported *Cassia, Ageratum, Salvadora, Ricinus, Albizzia lebeck, Artemisia* and *Scoparia* as important aeroallergens. The allergenic potential of the pollen grains of *Parthenium hysterophorus* (Subbarao *et.al.*, 1984) and *Casuarina equisetifolia*

(Agashe and Soucenadin, 1992) have been emphasized especially in patients in Bangalore.

The major allergenic pollen grains of Central India are *Parthenium, Argemone, Cassia, Brassica, Azadirachta* and grasses (Tiwari, 1970; Chaubal and Gadve, 1979).

The important allergenic pollen grains from West Bengal include *Acacia auriculiformis, Madhuca indica, Eucalyptus citriodora, Cassia siamea, Lantana, Cucurbita maxima, Cassia fistula, Cocos nucifera, Calophyllum inophyllum, Azadirachta* and *Phoenix* (Chanda *et.al.*, 1978; Banik and Chanda, 1992; Karmakar *et.al.*, 1994; Gupta-Bhattacharya *et.al.*, 1994; Chowdhury *et.al.* 1998; Boral and Bhattacharya 1999, 2000; Boral *et al.*, 1999, 2004).

Thus, pollen species causing allergy are quite variable in different ecozones which makes it very important to identify pollinosis causing species from every region for proper diagnosis, immunotherapy and should be considered in environmental planning.

MATERIALS & METHODS

Ecofloristic Survey

In order to evaluate the aerobiological assemblage of Jalpaiguri town of Jalpaiguri district, West Bengal, a good knowledge of its ground flora and their pollen grains are of prime importance. Accordingly a detailed and systematic ecofloristic survey was carried out. The frequency of occurrence is based on visual observation carried out during the survey period from October 1995 to September 1997, covering forest floras, agriculture fields, scrub jungles, roadsides, barren lands etc. inside and in the periphery of the town of Jalpaiguri. Plants were identified basically in the Taxonomy and Environmental Biology laboratory of the Department of Botany, North Bengal University using available literatures and then matched at NBU – Herbarium and at CAL. The recorded flora has been enumerated with families, genera and species alphabetically as the work may find its use, mostly, among the non-taxonomists and for future reference in case of disputed identifications. For the methodology Jain and Rao (1977) has been followed.

Pollen Morphology

Pollen morphological study was done by microscopical observation of some permanent and temporary slides of common plant species. For terminology and description Erdtman (1952). Chanda (1963) and Faegri and Iversen (1975) have been followed.

Permanent Slide Preparation :

Both herbarium and fresh material collected were acetolysed and a part or the material was chlorinated after acetolysis following the method of Erdtman (1952, 1969) and Chanda (1966).

Dry polliniferous material from Herbarium sheets were carefully crushed on a finely meshed stainless steel brass sieve (0.11 sq.mm.) resting on a funnel set on hard glass centrifuge tube. After each treatment the brass sieve was exposed to a flame until it became red hot in order to avoid sample to sample contamination. Acetolysis mixture was prepared in a measuring cylinder by slowly adding one volume of concentrated sulphuric acid to nine volume of acetic acid anhydride. Then 10 ml of this acetolysis mixture was added drop by drop to test tubes containing powdered material and stirred carefully with a glass rod. After thoroughly mixing, the mixture was heated to boiling point (100^{0}C) in a water bath for 2-3 minutes until it became slightly brown in colour. The mixture was allowed to stand for a few minutes, then centrifuged at 5000g. in room temperature and finally decanted. After adding a little distilled water, the sediment was shaken thoroughly, again centrifuged and decanted. The process was repeated for two to three times. Then the foam of the mixture was removed by adding a few drops of alcohol (95%) or acetone and the mixture was sieved twice through a finely meshed brass net to eliminate foreign particles and again centrifuged. After decanting, distilled water was added to the sediment. Half of the mixture was kept for chlorination and 50% glycerine was added to the other half.

To effect chlorination 5 ml of glacial acetic acid, a few drops of concentrated sodium chlorate solution and a few drops of concentrated hydrochloric acid were added and the mixture was then centrifuged, decanted and washed thoroughly to remove all traces of chlorine in it. After centrifuging and decanting, 50% glycerine was added to it. Then the two parts (non-chlorinated and chlorinated) were mixed, centrifuged and decanted. Then the tubes containing acetolysed pollen materials were kept in inverted condition on filter paper for a few hours in order to dry the material. Chlorination was avoided in case of thin walled and delicate pollen grains.

For the preparation of permanent slides, a small piece of glycerine jelly (prepared by Kisser's method) was taken on a clean platinum needle (sterilizing after each treatment burning in a flame), touched carefully to the bottom of the centrifuge tube (where the pollen are precipitated) and transferred on a clean slide. Then the slide was heated gently and after that the jelly was spread evenly by the platinum needle. A round cover glass was placed on the material and sealed off with chips of paraffin (melting point 60^{0}C – 62^{0}C). In case of air-bubble encroachment within the paraffin, the slides were kept in an incubator (temperature not more than 60^{0}C) for a few hours to get rid of the air-bubbles.

For fresh material, the flowers and anthers containing pollen were fixed in glacial acetic acid, then transferred directly to the brass sieve, crushed and washed down to the centrifuge tube with 70% alcohol. The mixture was then centrifuged, decanted and acetolysis mixture added to the residue and the procedure was adopted as in case of herbarium material. The delicate pollen grains (e.g. Cannaceae) which do not survive the acetolysis procedure, are refrained from such treatment. Such grains were placed in 70% alcohol, stained with safranine, and mounted in glycerine jelly.

Preparation of Safranine Stained Glycerine Jelly :

Gelatin 50 gms, glycerine 150ml, distilled water 175 ml, phenol crystals 7 gms and a few drops of safranine are the requisites for the preparation or the jelly. The first three constituents were mixed thoroughly and boiled in a water bath for one to two hours. The phenol crystals and appropriate amount of concentrated solution of safranine should be added and mixed thoroughly. While still warm and molten, the glycerine jelly should be poured on a petridish making a thin, uniform layer of about 0.5 cm thick. It was then cooled and preserved in refrigerator.

Temporary slide preparation :

For ready identification of airborne pollen, fresh and pure pollen samples were mounted on a small amount of safranine stained glycerine jelly placed on the clean glass slides. The slides were sealed in DPX by placing cover slip. This was allowed to dry and then scanned.

Aeropalynological Survey

Aeropalynological sampling methods are very diverse and vary according to individual interests in the component of airspora to be studied. Early methods of air sampling were summarized by Cunningham (1873). After a long gap the various methods of sampling have been summarized by the Committee on Aerobiology of the National Council, Washington (1941). Then the International Biological Programme (1972) also provided data on the various air sampling techniques.

This investigation deals with airborne pollen grains. The several pollen sampling devices currently used are based on some basic principles and categorized according to physical processes by which they remove the particles from the air spora are :

Sedimentation	-	Impaction by wind
Filtration	-	Impaction by suction
Centrifugal sedimentation	-	Impaction by rotation

Gravity slide sampler :

In this method sticky coated (glycerine/petroleum jelly) microslides are used for free deposition on its horizontal surface and then the slide is examined microscopically for analysis of pollen. It is a cheapest and simple routine method, which provides qualitative data for 24 hours but requires daily changing of slides.

Rotorod Sampler :

The Rotorod sampler was originally devised by Perkins (1957) and has been somewhat modified by Harrington *et.al.* (1959). The sampler consists of a small, constant speed battery operator motor, which makes the sticky coated brass rods to whirl around its axis. The volume of air sampled can be calculated. It is very suitable for field sampling and a number of rods can be carried to effect it.

The Sampling Site and the Duration of Airborne Pollen Monitoring

One Gravitational sampler was placed on the roof of a domestic house at Jalpaiguri town, West Bengal about 4m. above ground level. Sampling was carried out for two years from October, 1995 to September, 1997. The sampler was run for 24 hours. Safranine stained glycerine jelly was smeared on two slides and exposed every 24 hours at an angle of 45^0. The trapping devise had a windvane and horizontally placed hollow tube in which the slides were mounted on a platform. The tube protected the slides from rain, which was fixed over a pivot fitted with a ball bearing so that the tube rotated in accordance with the wind direction.

Sampling Methods :

Two clean slides coated with safranine stained melted glycerine jelly were inserted. The trapped slides were removed, mounted in Canada balsam by placing a 18 mm microscopic cover slips. This was allowed to dry for 2-3 days then scanned.

Rotorod Sampler :

Air was sampled volumetrically using a Rotorod sampler which was placed 4 m above ground level in vertical position on the roof of a domestic house at Jalpaiguri district. The sampler was run for 30 mins. between 13 hr and 14hr at fortnightly intervals. The sampler was powered by a 6v battery giving a rotation speed of 2500 rpm. After sampling, the cellotape strips bearing the pollen catches were removed and remounted on clean glass slide using Canada balsam as mountant. The counts were converted to concentration m^{-3} of air by multiplying with an appropriate conversion factor (4) as suggested in the guide book of the British Aerobiological Federation (1995).

Calculation of Conversion factor (C) :

Counts were converted to concentration/m^3 using the formula :

$$C = \frac{N}{W(nw)\,\pi drt} = \frac{N}{0.264} = 3.79\ N = 4\ N\ \text{(Approximately)}$$

Where,

W	is breadth of the trace (2mm.)
w	is width of each scan (350 μm)
n	is number of scans (20)
t	is duration of sampling (30 minutes)
r	is speed of rotation (2500 rpm.)
d	is distance between rotorod arms (8 cm.)

Immuno-chemical technique

Collection of Pollen Sample :

The pollen samples were collected from mature anthers of relevant plants growing around the study area. The floral parts were dried at 37^{0}C, mildly crushed and passed through sieves (120, 200 and 300 mesh/cm^2) to remove the antherial tissues and other floral practicles. The purity of the isolated pollen material was checked under microscope. The batches used throughout the work contained <5% non-pollen impurities.

Preparation of Pollen Extracts :

The pollen was defatted with diethyl ether and extracted in sodium phosphate buffer (0.2 M monobasis & Na-phosphate, pH-7.4) continuous stirring at 4^{0}C for 24 hours in 1:50 (wt./vol. Ratio) by following the modified methods of Shivpuri (1962), Sheldon *et.al.* (1967) and Gupta and Chanda (1991). After centrifugation at 15,000g for 30 minutes the supernatant was taken and dialyzed in buffer and passed through 0.22 μm Millipore filter (Millipore Corp. Bedford, MA, U.S.A.). The filtrate was then lyophilized and stored at –20^{0}C in aliquots of known volume in sterile vials. The samples were sent to the Institute of Child Health, Calcutta for further study and clinical application.

Preparation of Ammonium Sulphate [$(NH_4)_2SO_4$] Cut Fractions :

The whole extract was fractionated in the range of 0% - 30%, 30% - 60% and 60% - 90% saturation of $(NH_4)_2SO_4$. 5 ml. homogenized supernatant (allergen suspension) was taken in a beaker and $(NH_4)_2SO_4$ was added slowly as required to the supernatant with magnetic–stirer. After making homogeneous solution, the precipitate got settled and centrifuged at 12,000g rpm for 30 minutes for first cut (0% to 30%). Then more $(NH_4)_2SO_4$ (as required) was added to the supernatant for second cut (30% - 60%) and similarly for third cut (60% - 90%).

Skin Prick Test (SPT) :

Skin Prick Tests were carried out with the crude pollen extract (1:50 wt/vol) on adult respiratory allergic patients with relevant case report attending the Institute of Child Health, Calcutta. Histamine di-phosphate (1 mg./ml.) and PBS (Phosphate buffer saline) were used as positive and negative controls respectively. Tests were performed with 20 μl of aliquots of allergen solution placed on the ventral side of the forearm and each site was pricked with a disposable hypodermic (No.26) needle. The wheal responses were measured after 20 minutes and grades nil to 4^+ according to Stytis *et.al* (1982).

Gradation according to Stytis *et.al.* (1982) :

Reaction	Grade
No. wheal, no erythema	Nil
No. wheal, erythema <20 mm in diameter	1^+
No. wheal, erythema > 20 mm in diameter	2^+
Wheal and erythema	3^+
Wheal and pseudopod, erythema	4^+

ECO-FLORISTIC SURVEY OF JALPAIGURI TOWN

Jalpaiguri is a district situated with northern part of West Bengal in the Duars (Fig.1 & 2). Duars is famous for its wide range of forested vegetation (Champion and Seth, 1968) which are floristically extremely rich (Chaudhuri, 1969; Mukherjee, 1972) and include a large number of endemics (Das, 1986).

Tropical humid climate is characeristic for this district. The east wind which blows during the greater part of the year is full of moisture. The dry west wind sets in with the spring and prevails from March to May. In general the weather is pleasant with heavy rainfall (annually an average of 108 days), abundant humidity on an average from 80.0% with a range of 68.0 – 88.0% at 8.30 hrs. to 66.0% with a range of 43.0 – 81.0% at 17.30 hrs., the temperature never exceeding 31.6^{0}C during the summer season (Table 1). The mean temperature for the district is 24.1^{0}C ranging between 10.8^{0}C (January) minima and 31.6^{0}C (April) maxima. The mean rainfall has been recorded as 271.6 mm, which prevails round the year with a maxima during the following months – May, 349.6mm; June 661.6mm; July 968.1mm; August 662.3mm and September 470.6mm; and minimum in between November-March and exceeding low (5.0mm) in February (Table 1).

Table 1 : Average Meteorological data of Jalpaiguri from 1995-1997.

	Temperature (^{0}C)		Rainfall	Relative humidity (%)	
Months	**Minimum**	**Maximum**		**0830 Hrs.**	**1730 Hrs.**
January	10.8	23.4	12.8	87	59
February	12.7	25.2	5.0	82	50
March	16.4	29.6	19.0	69	43
April	20.4	31.6	22.2	68	50
May	22.9	30.9	349.6	80	69
June	24.3	30.6	661.6	87	79
July	25.0	30.6	968.1	88	81
August	24.9	30.8	662.3	87	81
September	24.4	30.7	470.6	87	79
October	21.4	30.0	60.5	82	71
November	16.2	27.7	14.5	82	66
December	12.1	25.0	13.1	86	63

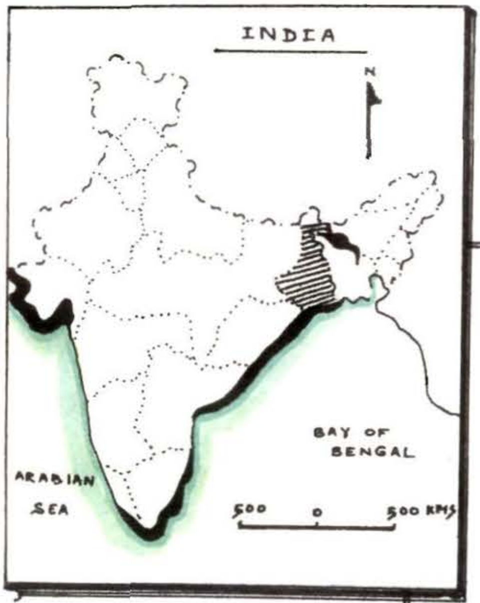


Fig 1: Map of West Bengal showing Jalpaiguri district

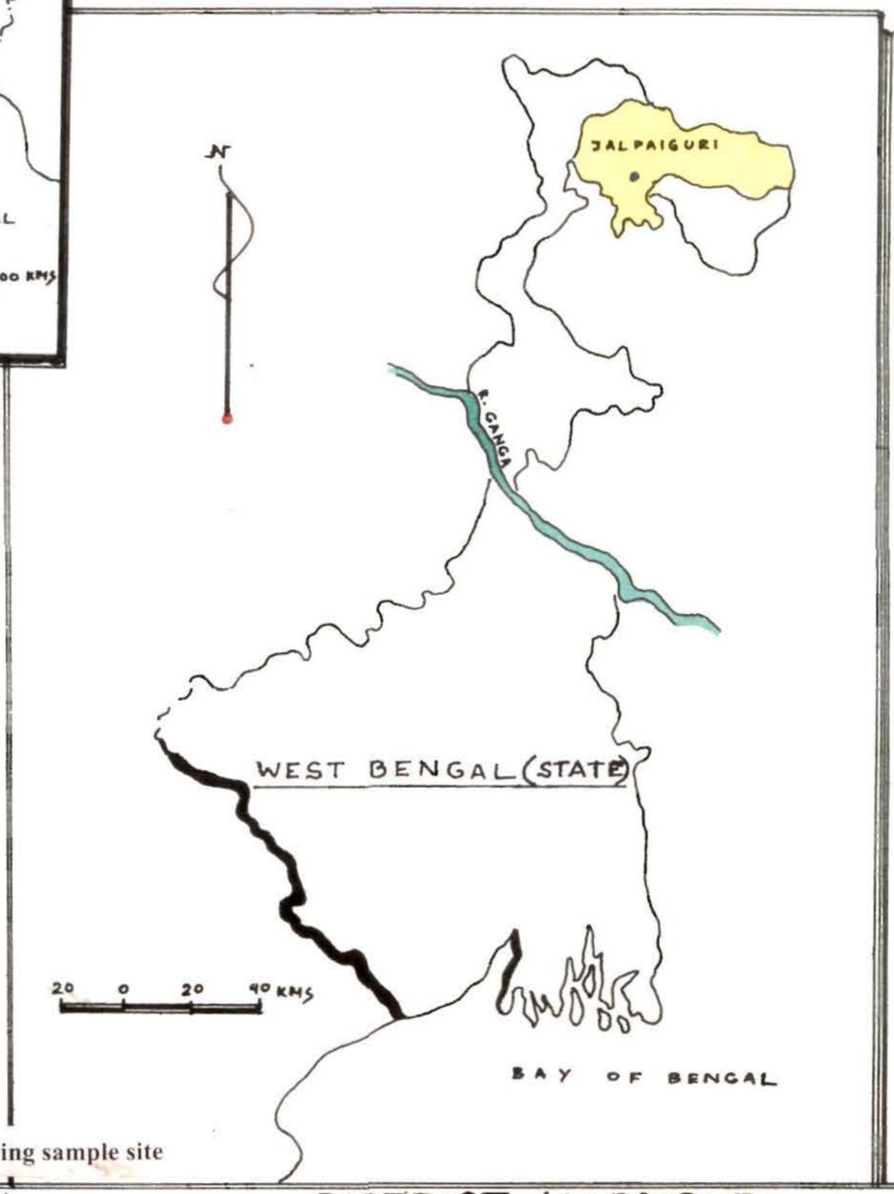
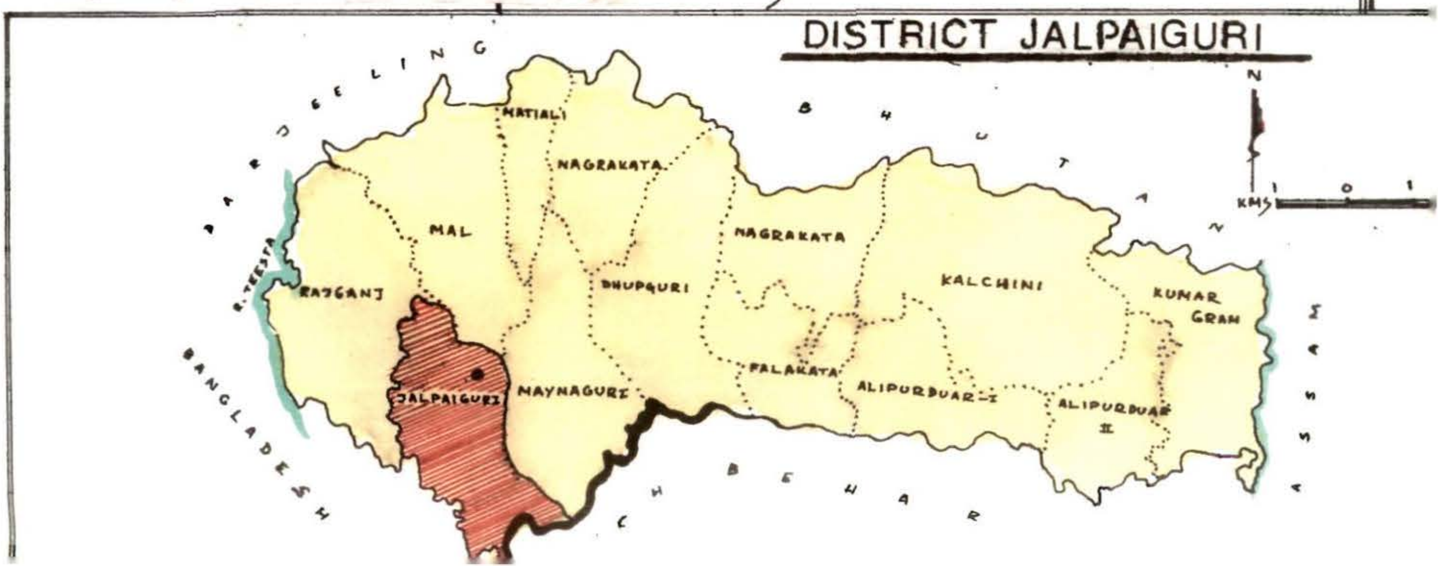


Fig 2: Map of Jalpaiguri district showing sample site



Considering the duration of the rainfall and temperature, the climate of Jalpaiguri district can be broadly divided into two seasons – Summer (which is monsoon dominated), and Winter. However, looking into the different phases of the life-cycles of plants and the meteorological parameters (Table 1) five seasons can be recognized, e.g.

1. **Summer (May-June)**, characterized for temperature ranging from 22.9^{0}C – 30.9^{0}C, average RH range between 69-87.0, average rainfall of 505mm and accompanied by dusty high winds.
2. **Rains (July-September),** is known for heavy rainfall with an average of 760mm, maximum in July (968.1mm) which is almost 46% of the total rainall, average temperature during the period ranges between 24.4^{0}C to 30.8^{0}C and RH between 79-88.
3. **Autumn (October),** is known for moderate temperature 30.0^{0}C maximum and 21.4^{0}C minimum, moderate RH and rainfall.
4. **Winter (November-February),** is distinguished by low temperature ranging from 10.8 – 23.4^{0}C, low rainfall and moderate humidity.
5. **Spring (March-April),** is the season of moderate temperature ranging from 16.4 – 31.6^{0}C, low RH and rainfall.

The township of Jalpaiguri is the headquarter for the district of Jalpaiguri. This is a very old settlement initiated probably in the last part of eighteenth century. The population structure of the area was extremely low at that time. However, presently townshisp is quite large with an area of 503.06 hectares and population is 2,80,927.

The township has developed replacing a very rich forested vegetation of Duars and at the same time, there are large number of introduced plants. Progress of habitation induced the introduction of numerous exotic plants (Das 1995, 2002) and that in one hand enrich the flora of a place and on the other hand extend much pressure on the local biodiversity.

The effects of urbanization are generally easily visible if its flora is analyzed properly. Different people have different types of likings on preferences for plants. This generally goes in favour of ornamental and fruit plants. In addition, the recently increasing interest on medicinal plants is also causing the introduction of many new species.

The habit, habitat preference, phenology, mode of pollination, abundance, etc of the plants are variable. The mode of pollination (in other words the method of pollen dispersal) and the flowering period have direct impact on the aeropalynology of a place. Keeping this in mind, the flora of the township area of Jalpaiguri with a radius of roughly 10 km. was studied round the year. The flowering calendar was prepared from the direct observation in the field.

The flowering calendar of Jalpaiguri town is presented in Table 2 along with *habit, abundance, flowering period and mode of pollination.* Families of Magnoliopsida (Dicotylendons) and Liliopsida (Monocotyledons) are presented and the genera and species under those families are presented alphabetically in the table 2. Realising that the list will be used mostly by non taxonomists, no particular system of classification was followed. However, correct nomenclature along with proper author citation for all the recorded plants have been provided.

Table 2 : Enumeration of the Flora of Jalpaiguri Township Area in West Bengal

Abbreviations used (except Author Citation): **Habit:** AH = Annual Herb, PH = Perennial Herb, GH = Geophytic Herb, SH = Saprophytic Herb, Sf = Suffrutescent Herb, US = Undershrub, S = Shrub, L = Liana, SC = Shrubby Climber, AC = Annual Climber, GC = Geophytic Climber, T = Tree, E = Epiphyte, RP = Root Parasite, SP = Stem Parasite; **Abundance:** A = Abundant, C = Common, LC = Less Common, R = Rare; **Flowering Period:** 1 = January to 12 = December; **Mode of Pollination:** An = Anemophilous, E = Emtomophilous, A/E = Amphiphilous, O = Ornithophilous, M = Melachophilous. [**Some of the photographs of the common plants of Jalpaiguri has been provided in Photograph I**]

TAXA	Habit	Abundance	Flowering period	*Mode of pollination*
MAGNOLIOPHYTA				
Magnoliopsida				
Acanthaceae				
Andrographis paniculata (Burm.f.) Wall. ex Nees	AH	A	1 – 12	*E*
Indoneesiella echioides (L.) Sreem.	AH	LC	1 – 12	*E*
Barleria cristata L.	AH	LC	10 – 12	*E*
Dicliptera roxburghiana Nees	AH	A	10 – 4	*E*
Gendarussa vulgaris Nees	S	A	10 – 2	*E*
Hygrophila auriculata (Schum.) Heine	AH	C	10 – 2	*E*
Hygrophila phlomoides Nees	AH	C	9 – 1	*E*
Hygrophila polysperma (Roxb.) T. Anderson	AH	A	10 – 4	*E*
Adhatoda justicia Medic.	S	A	4 -6, 10-11	*E*
Justicia diffusa Willd.	AH	A	1 – 12	*E*
Justicia japonica Thunb.	AH	LC	6 – 10	*E*
Lepidagathis incurva Buch.-Ham. ex D.Don	Sf	C	9 – 4	*E*
Nelsonia canescens (Lam.) Sprengel	AH	R	10 – 3	*E*
Phaulopsis imbricata (Forsk.) Sweet	AH	A	10 – 5	*E*
Rungia pectinata (L.) Nees	AH	A	9 – 5	*E*
Amaranthaceae				
Alternanthera paronichioides St. Hil.	AH	R	1 – 12	*A*
Alternanthera pheloxeroides (Mart.) Griseb.	PH	A	10 – 3	*A*
Alternanthera sessilis (L.) R.Br. ex DC.	AH	C	1 – 12	*A*
Amaranthus hybridus L.	AH	A	7 – 10	*A*
Amaranthus spinosus L.	AH	A	1 – 12	*A*
Amaranthus tricolor L.	AH	A	11 – 12	*A*
Amaranthus viridis L.	AH	A	1 – 12	*A*
Achyranthes aspera L.	AH	A	9 – 4	*A*
Achyranthes bidentatus Bl.	AH	A	9 – 4	*A*
Celosia argentia L.	AH	LC	10 – 2	*A*
Celosia cristata L.	AH	C	1 – 12	*A*
Deeringia amaranthoides (Lamk.) Merrill	SC	LC	9 – 12	*A*
Gomphrena celosioides Mart.	AH	LC	8 – 5	*A*
Gomphrena globosa L.	AH	C	12 – 4	*A*
Pupalia lappacea (L.) Juss.	PH	LC	10 – 3	*A*
Anacardiaceae				
Anacardium occidentale L.	T	R	3 – 4	*E*
Choreospondias axillaris (Roxb.) Burtt. & Hill	T	A	2 – 4	*E*
Lannea coromendelica (Houtt.) Merrill	T	C	12 – 4	*E*
Mangifera indica L.	T	A	2 – 4	*E*

Annonaceae

Anona reticulata L.	S	A	5 – 7	*A*
Anona squamosa L.	S	A	5 – 7	*A*
Artabotrys hexapetalus (L.f.) Bhandari	T	LC	4 – 8	*A*
Polyalthia longifolia (Sonn.) Thw.var. *longifolia*	T	A	2 – 3	*A*

Apiaceae

Centella asiatica (L.) Urb.	AH	A	3 – 5	*A*
Coriandrum sativum L.	AH	A	2 – 5	*A/E*
Daucus carrota L.	AH	LC	NR	*A/E*
Foeniculum vulgare Mill.	AH	A	12 - 3	*A/E*
Hydrocotyle sibthorpioides Lamk.	AH	A	1 – 12	*A*
Oenanthe javanica (Blume) DC.	AH	LC	4 – 10	*A*
Seseli indicum Wt. et Arn.	AH	LC	4 – 5	*A/E*

Apocynaceae

Aganosma caryophylla G. Don	L	LC	4 – 6	*E*
Allamanda cathertica L.	L	C	4 – 6	*E*
Alstonia scholaris (L.) R.Br.	T	A	10 – 2	*E*
Catharanthus roseus (L.) G. Don	US	A	1 – 12	*E*
Holarrhena pubescens (Buch.-Ham.) G. Don	T	C	4 – 6	*E*
Ichnocarpus frutescens (L.) R.Br.	SC	C	9 – 11	*E*
Nerium indicum Mill.	S	A	1 – 12	*E*
Plumeria rubra L.	T	A	1 – 12	*E*
Rauvolfia tetraphylla L.	Sf	R	1 – 12	*E*
Tabernaemontana divaricate (L.) R. Br.	S	A	1 – 12	*E*
Tabernaemontana gamblei Subr. Ex Henry	S	A	6 – 11	*E*
Thevetia peruviana (L.) Lippold	T	A	1 – 12	*E*
Wrightia arborea (Dennstaedt) Mabberley	T	R	4 – 6	*E*

Aristolochiaceae

Aristolochia tagala Cham.	GC	R	5 – 6	*E*

Asclepiadaceae

Calotropis gigantean (L.) R. Brown	S	A	3 – 11	*E*
Hemidesmus indicus R. Br.	GC	R	12 – 2	*E*
Hoya longifolia Wight	E	C	5 – 6	*E*
Hoya parasitica (Roxb.) Wight	E	C	5 – 6	*E*
Marsdenia tenacissima (Roxb.) Moon.	T	LC	5 – 6	*E*

Asteraceae

Acmella calva (DC.) Jansen	AH	A	1 – 12	*E*
Ageratum conyzoides L.	AH	A	1 – 12	*A/E*
Ageratum haustonianum (D. Don) DC.	AH	A	8 – 4	*A/E*
Artemisia vulgaris Clarke	PH	LC	9 – 1	*A/E*
Bidens pilosa L.	AH	A	1 – 12	*E*
Blumea hieracifolia (D. Don) DC.	AH	A	10 – 2	*E*
Blumea lacera (Burm.f.) DC.	AH	A	2 – 5	*E*
Caesulia axillarae Roxb.	AH	A	11 – 2	*E*
Chromolaena odoratum L.	Sf	A	10 – 1	*A/E*
Conyza leucantha (D. Don) Ludlow & Raven	AH	R	7 – 8	*E*
Cotula anthelmoides L.	AH	LC	7 – 8	*E*
Echinops echinatus Roxb.	AH	LC	8 – 1	*A/E*
Eclipta prostrata (L.) L.	AH	A	1 - 12	*E*
Elephantopus scaber L.	AH	A	10 – 2	*E*
Emilia sonchifolia (L.) DC.	AH	A	1 – 12	*E*
Enydra fluctuens Lour.	AH	A	11 – 3	*E*
Erigeron canadensis L.	AH	A	1 – 12	*A/E*

Galinsoga parviflora Cav.	AH	A	11 – 3	*E*
Grangea maderaspatana (L.) Poiret	AH	A	12 – 5	*E*
Gynura nepalensis DC	US	R	12 – 2	*E*
Ixeris polycephala Cass.	AH	A	7 – 12	*E*
Laggera alata (D. Don) Sch.-Bip. ex Oliver	AH	A	12 – 4	*E*
Mikania micrantha Kunth	SC	A	8 – 2	*A/E*
Pseudoconyza viscosa (Miller) d'Arcy	AH	A	12 – 4	*A/E*
Pseudognaphalium affine (D. Don) Anderberg	AH	A	12 – 3	*A/E*
Pulicaria foliolosa DC.	AH	LC	1 – 3	*E*
Senecio nudicaulis Buch.-Ham. ex D. Don	AH	LC	4 – 6	*E*
Siegesbeckia orientalis L.	AH	C	9 – 2	*E*
Sonchus asper (L.) Hill	AH	C	9 – 5	*E*
Sonchus wightianus DC.	AH	C	10 – 5	*E*
Synedrella nodiflora (L.) Gaertn.	AH	A	10 – 5	*E*
Tagetes patula L.	AH	A	1 – 12	*E*
Tithonia diversifolia (Hemsl.) A. Grey	Sf	LC	11 – 2	*E*
Tridax procumbens L.	AH	A	1 – 12	*E*
Vernonia cinerea (L.) Less.	AH	A	1 – 12	*A/E*
Vernonia silhetensis (DC.) Kerr.	AH	LC	10 – 4	*A/E*
Vicoa vestita (Wall. ex DC.) Ling	AH	LC	12 – 3	*E*
Wedelia chinensis (Osbeck.) Merr.	PH	C	7 – 11	*E*
Xanthium strumerium L.	AH	A	10 – 2	*E*
Youngia japonica L.	AH	A	12 – 4	*E*
Zinnia elegans Jacq.	AH	A	1 – 12	*E*
Balsaminaceae				
Impatiens balsamina L.	AH	A	1 – 12	*E*
Bignoniaceae				
Jacaranda mimosifolia D. Don	T	A	3 – 5	*E*
Millingtonia hortensis L.	T	C	12 – 3	*E*
Oroxylum indicum L.	T	C	7 – 9	*E, O*
Pyrostegia venusta (Ker-Grawl.) Miers	L	C	4 – 5	*E, O*
Spathodea campanulata P. Beauv.	T	A	4 – 6	*O*
Stereospermum colais (Dillwyn) Maberley	T	LC	5 – 7	*E*
Tabebuia argentea Britton	T	LC	5	*E, O*
Tecoma gaudichaudi DC.	S	LC	4 – 6	*E*
Tecoma stans (L.) Humboldt, Bonpland & Kunth	S	C	4 – 6	*E*
Bombacaceae				
Bombax ceiba L.	T	A	4 – 5	*O*
Ceiba pentandra L.	T	LC	5 – 6	*E*
Boraginaceae				
Cyanoglossum lanceolatum Forsk.	AH	A	11 – 3	*E*
Heliotropium indicum L.	AH	A	10 – 5	*E*
Brassicaceae				
Brassica juncea L	AH	A	2 – 5	*E*
Brassica rapa L.	AH	A	4 – 5	*E*

Cardamine flexuosa Withering	AH	A	12 – 5	*E*
Raphanus sativus L.	AH	A	2 – 4	*E*
Rorippa indica L.	AH	A	9 – 4	*E*
Buddlejaceae				
Buddleia asiatica Lour.	S	LC	1 – 5	*E*
Burseraceae				
Garuga pinnata Roxb.	T	C	4 – 5	
Cactaceae				
Cereus hexagonus L.	S	LC	6	
Opuntia dillenii (Ker-Gawl.) Hains.	S	LC	6 – 7	
Caesalpiniaceae				
Bauhinia acuminata L.	S	C	6 – 7	*E*
Bauhinia purpurea L.	T	C	4 – 5	*E*
Bauhinia vahlii Wt. et Arn.	L	C	5 – 6	*E*
Bauhinia variagata L.	T	C	3 – 5	*E, O*
Caesalpinia bonduch (L.) Roxb.	S	R	8 – 9	*E*
Caesalpinia pulcherrima (L.) Swartz	S	C	5 – 11	*E*
Cassia alata L.	S	LC	7 – 2	*E*
Cassia grandis L.f.	AH	C	3 – 4	*E*
Cassia fistula L.	T	A	1 – 12	*E*
Cassia mimosoides L.	AH	A	8 – 11	*E*
Cassia nodosa Buch.-Ham. ex Roxb.	T	A	3 – 4	*E*
Cassia occidentale L.	AH	A	5 – 9	*E*
Cassia siamea Lamk.	T	A	8 – 11	*E*
Cassia sophera L.	AH	A	6 – 9	*E*
Cassia tora L.	AH	A	7 – 12	*E*
Delonix regia (Boj.) Raf.	T	A	3 – 9	*E*
Peltophorum pterocarpum (DC.) Baker ex K. Heyne	T	A	4 – 10	*E*
Tamarindus indica L.	T	A	6 – 7	*E*
Campanulaceae				
Wahlenbergia gracilis (Forst.) DC.	AH	C	11 – 2	*E*
Capparaceae				
Capparis zeylanica L.	AH	R	5 – 6	*E*
Crataeva nurvala Buch.-Ham.	T	LC	4 – 5	*E*
Caprifoliaceae				
Sambucus canadensis L.	S	R	2 – 8	*E*
Caricaceae				
Carica papaya L.	S	A	1 – 12	*E*
Caryophyllaceae				
Cerastium glomeratum Thuill	AH	R	12 – 3	*A*

Drymaria diandra Blume	PH	A	8 – 3	*A*
Drymaria villosa Cham. et Schult.	AH	C	11 – 2	*A*
Polycarpon loeflingiae (Wt..et Arn.) Benth.	AH	A	5 – 11	*A*
Stellaria alsinae Hoffm.	AH	R	12 – 2	*A*
Stellaria wallichii Benth.	AH	A	1 – 3	*A*
Casuarinaceae				
Casuarina equisetifolia L.	T	C	3 – 5	*A*
Cannabinaceae				
Cannabis sativa L.	AH	A	5 – 10	*A*
Ceratophyllaceae				
Ceratophyllum demersum L.	AH	LC	9 – 12	*W*
Chenopodiaceae				
Chenopodium album L.	AH	A	1 – 5	*A*
Chenopodium ambrosoides L.	AH	A	2 – 7	*A*
Spinacea oleracea L.	AH	A	3 – 5	*A*
Cleomaceae				
Cleome rutidosperma DC.	AH	A	1 – 12	*E*
Cleome speciosa Jacq.	AH	LC	3 – 5	*E*
Cleome viscosa L.	AH	A	1 – 12	*E*
Clusiaceae				
Mesua ferrea L.	T	LC	3 – 4	*A/E*
Cochlospermaceae				
Cochlospermum religiosum L.	T	R	4 – 5	*E*
Combretaceae				
Combretum decundrum Roxb.	L	A	3 – 5	*E*
Quisqualis indica L.	L	A	5 – 10	*E*
Terminalia arjuna (Roxb. *ex* DC.) Wt. *et* Arn.	T	A	4 – 5	*E*
Terminalia belerica (Gaertn.) Roxb.	T	R	7 – 8	*E*
Terminalia catappa L.	T	R	7 – 8	*E*
Terminalia chebula Retz.	T	R	6 – 7	*E*
Terminalia tomentosa Roxb. *ex* DC.	T	C	4 – 5	*E*
Convolvulaceae				
Argyreia roxburghii Choisy	SC	A	9 – 11	*E*
Evolvulus nummolarius (L.) L.	AH	C	1 – 12	*E*
Ipomoea aquatica Forsk.	PH	A	6 – 10	*E*
Ipomoea carnea Jaque.	S	A	7 – 11	*E*
Ipomoea eriocarpa R. Brown	AC	C	9 – 2	*E*
Ipomoea hederifolia L.	AC	C	9 – 1	*E*
Ipomoea obscura (L.) Ker-Gawl.	AC	LC	10 – 1	*E*
Ipomoea quamoclit L.	AC	A	7 – 12	*E*
Merremia tridentata (L.) Hallier f.	AC	LC	10 – 3	*E*

Merremia hirta (L.) Merrill	AC	C	9 – 1	*E*
Merremia vitifolia (Burm.f.) Hallier f.	AC	C	1 – 4	*E*
Crassulaceae				
Kalanchoe integra (Medikus) Kuntze	PH	A	12 – 3	*E*
Kalanchoe pinnata (Lamk.) Pers.	PH	A	12 – 3	*E*
Sedum multicaulis Wall. *ex* Lindl.	PH	R	4 – 5	*E*
Cucurbitaceae				
Bryonopsis laciniosa (L.) Naud.	AC	C	7 – 9	*E*
Citrullus vulgaris Schrad. ex Eckl. Et Zryh	AC	LC	5 – 6	*E*
Coccinea grandis (L.) Voigt	SC	A	1 – 12	*E*
Cucumis melo L.	AC	C	5 – 8	*E*
Cucurbita maxima Duch ex Poiret	AC	A	1 – 12	*E*
Luffa acutangula (L.) Roxb.	AC	A	5 – 10	*E*
Luffa aegyptiaca Mill.	AC	A	7 – 9	*E*
Momordica charantia L.	AC	A	1 – 12	*E*
Momordica dioica Willd.	GC	A	7 – 9	*E*
Trichosanthes cordata Roxb.	GC	LC	8 – 9	*E*
Mukia maderaspatana (L.) Roem.	AC	A	7 – 10	*E*
Trichosanthes cucumerina L.	L	LC	7 – 8	*E*
Trichosanthes dioica Roxb.	GC	C	3 – 9	*E*
Trichosanthes lepiniana (Naud.) Cogniaux	GC	A	7 – 9	*E*
Zanonia indica L.	GC	A	7 – 10	*E*
Cuscutaceae				
Cuscuta chinensis L.	SP	R	9 – 2	*E*
Cuscuta reflexa Roxb.	SP	A	10 – 2	*E*
Dilleniaceae				
Dillenia indica L.	T	R	6	*E*
Dillenia pentagyna Roxb.	T	LC	3 – 4	*E*
Dipterocarpaceae				
Shorea robusta Gaertn. f.	T	LC	2 – 3	*E*
Droseraceae				
Drosera burmanii Vahl	AH	LC	11 – 5	*E*
Ebenaceae				
Diospyros sp	T	R	NR	*E*
Ehretiaceae				
Cordia myxa Forst.f.	T	LC	9 – 10	*E*
Ehretia serrata Roxb.	T	C	4 – 5	*E*
Elatinaceae				
Bergia ammanoides Roth.	AH	C	8 – 9	*E*
Euphorbiaceae				
Acalypha indica L.	AH	A	1 – 12	*A*

Baccurea ramiflora Loureiro	T	LC	NR	*A*
Breynia vitis-idaea (Burm.f.) Fischer	S	LC	4 – 7	*A*
Bridelia retusa (L.) Sprengel	T	LC	4 – 5	*A*
Codaeum variegatum (L.) Blume	S	A	4 – 7	*A*
Croton bonplandianum Baill.	AH	A	1 – 12	*A*
Croton caudatus Geischer	SC	R	5 – 7	*A*
Drypetes roxburghii (Wall.) Hurusawa	T	C	5 – 6	*A*
Embelica officinale Gaertn.	T	A	4 – 5	*A*
Euphorbia antiquorum L.	S	LC	12 – 2	*A*
Euphorbia heterophylla L.	AH	LC	7 – 10	*A*
Euphorbia hirta L.	AH	A	1 – 12	*A*
Euphorbia hypericifolia L.	AH	LC	1 – 12	*A*
Euphorbia millii Ch.-des-Moulins	US	LC	3 – 6	*A*
Euphorbia heyneana Sprengel	AH	A	1 – 12	*A*
Euphorbia tirucallii Forsk.	S	C	NR	*A*
Fluggea virosa (Roxb. ex Willd.) Voigt	S	LC	4 – 6	*A*
Jatropha curcus L.	S	LC	5 – 6	*A*
Jatropha gossypifolia L.	AH	C	8 – 4	*A*
Jatropha panduraefolia Andr.	S	LC	1 – 12	*A*
Manihot esculenta Crantz	S	C	NR	*A*
Pedillanthus tethymeloides (L.) Poiret	S	A	2 – 4	*E*
Phyllanthus amarus Schum. et Thonn.	AH/P	VC	1 – 12	*A*
Phyllanthus asperulatus Hutch.	PH	A	1 – 12	*A*
Phyllanthus reticulata Poiret	SC	LC	6 – 7	*A*
Phyllanthus simplex Retz.	AH	A	6 – 9	*A*
Phyllanthus urinaria L.	AH	A	1 – 12	*A*
Poinsettia pulcherrima R. Grah	S	C	9 – 5	*E*
Ricinus communis L.	S	A	1 – 12	*A*
Trewia polycarpa Benth.	T	C	4 – 5	*A*

Flacourtiaceae

Casearia graveolens Dalz.	S	LC	5	*E*

Fumariaceae

Fumaria indica (Haussk.) Pugsley	AH	R	12 - 4	*E*

Gentianaceae

Canscora diffusa (Vahl) Roemer & Schultes	AH	C	2 – 4	*E*
Erythrea roxburghii D. Don	AH	LC	12 – 5	*E*
Exacum tetragonum Roxb.	AH	LC	1 – 4	*E*
Hoppea dichotoma Heyne ex Willd.	AH	C	1 – 3	*E*

Hydrophyllaceae

Hydrolea zeylanica L.	AH	C	10 – 2	*E*

Hypericaceae

Hypericum japonicum Murr.	AH	A	1 – 12	*E*

Icacinaceae

Natsiatum herpeticum Arnott	SC	A	4 – 5	*A*

Lamiaceae				
Anisomeles indica (L.) O. Ktz.	AH	A	10 – 5	*E*
Colebrookia oppositifolia J.E. Smith	S	A	2 – 4	*E*
Dysophylla verticillata Benth.	AH	A	9 – 4	*E*
Hyptis suaveolens (L.) Poiret	AH	A	1 – 12	*E*
Leucas indica (L.) R. Br. ex Vatke	AH	A	1 – 12	*E*
Mentha piperata Stokes	PH	LC	NR	*E*
Ocimum basilicum L.	AH	LC	11 – 5	*E*
Ocimum gratissimum Forsk.	US	R	5	*E*
Ocimum sanctum L.	US	A	12 – 4	*E*
Perilla frutescens (L.) Britton	AH	LC	12 – 3	*E*
Pogostemon andersonii (Prain) Panigrahi	AH	A	2 – 3	*E*
Rabdosia strigosa (Bentham) Hara	AH	C	10 – 3	*E*
Salvia coccinea Etlinger	AH	C	2 – 6	*E*
Teucrinum viscidum Blume	AH	LC	9 – 10	*E*
Lauraceae				
Cinnamomum tamala Nees	T	C		*A*
Cinnamomum zeylanicum Blume	T	R	NR	*A*
Litsea glutinosa (Lour.) Robinson	T	C	5 – 6	*A*
Litsea monopetala (Roxb.) Pers.	T	A	4 – 6	*A*
Lecythidaceae				
Careya arborea Roxb.	T	LC	3 – 5	*A/E*
Couroupita guianensis var. *surinanensis* Eyma	T	LC	1 – 12	*E*
Leeaceae				
Leea guinensis G. Don	S	C	9 – 10	*A/E*
Lentibulariaceae				
Utricularia bifida L.	AH	LC	12 – 2	*E*
Utricularia striatula Smith	AH	LC	7 – 11	*E*
Lineaceae				
Linum usitatissimum L.	AH	C	3 – 4	*E*
Lobeliaceae				
Lobelia alsionoides Lam.	AH	C	3 – 5	*E*
Lobelia heyneana Roem. et Schult.	AH	C	2 – 5	*E*
Loganiaceae				
Mitrasacme indica Wt.	AH	R	9 – 12	*E*
Mitrasacme pygmaea R. Br. var. *pygmaea*	AH	R	9 – 12	*E*
Loranthaceae				
Dendrophthoe falcata (L.f.) Ettingshausen	SP	R	4 – 5	*E*
Helixanthera parasitica Loureiro	SP	R	NR	*E*
Macrosolen cochinchinensis (Lour.) van Tieghem	SP	R	5	*E*
Viscum album L.	SP	LC	NR	*A/E*

Lythraceae				
Ammania buccifera L.	AH	A	7 – 9	*E*
Lagerstroemia indica L.	S	A	1 – 12	*E*
Lagerstroemia parviflora Roxb.	T	C	5	*E*
Lagerstroemia reginae Roxb.	T	A	4 – 5	*E*
Lagerstroemia thorelii Gagnep.	T	A	6 – 8	*E*
Rotala cordata Koehne	AH	LC	10 – 11	*E*
Rotala rotundifolia (Buch.-Ham.) Koehne	AH	A	1 – 3	*E*
Magnoliaceae				
Magnolia grandiflora L.	T	LC	5 – 6	*E*
Michelia champaca L.	T	C	6 – 10	*E*
Malpighiaceae				
Hiptage madhabolata Gaertn.	L	LC	4	*E*
Malvaceae				
Abutilon indicum (L.) Sweet	AH	LC	9 – 1	*E*
Gossypium hirsutum L.	S	LC	5 – 10	*E*
Hibiscus mutabilis L.	S	C	5 – 9	*E*
Hibiscus cannabinus L.	AH	C	8 – 10	*E*
Hibiscus rosa-sinensis L.	S	A	1 – 12	*E*
Malva verticillata L.	AH	A	12 – 2	*E*
Sida acuta Burm.f.	AH	A	8 – 1	*E*
Sida cordata (Burm.f.) Borssum	US	C	9 – 3	*E*
Sida cordifolia L.	AH	LC	1 – 12	*E*
Sida rhombifolia L.	PH	A	9 – 5	*E*
Urena lobata L.	AH	A	9 – 4	*E*
Martyniaceae				
Martynia annua L.	AH	LC	7 – 9	*E*
Meliaceae				
Azadirachta indica A. Juss.	T	A	4 – 5	*E*
Aglaia spectabilis (Miquel) Jain & Bennet	T	LC	NR	*E*
Melia azadirach L.	T	C	4 – 5	*E*
Swietenia macrophylla King	T	LC	4 – 5	*E*
Swietenia mahagoni L.	T	C	NR	*E*
Toona ciliata Roem.	T	C	4 – 5	*E*
Menispermaceae				
Cissampelos pereira L.	GC	LC	7 – 9	*A*
Stephania japonica (Thunb.) Miers.	GC	C	6 – 10	*A*
Tinospora cordifolia (Willd.) Hook.f. & Thoms.	SC	LC	5 – 6	*A*
Mimosaceae				
Acacia auriculoformis Benth.	T	A		*A/E*
Acacia catechu (L.f.) Willd.	T	LC	8 – 9	*A/E*
Adenanthera pavonina L.	T	LC	5 – 6	*A/E*
Albizia chinensis (Osbeck) Merrill	T	C	6 – 7	*A/E*

Albizia lebbek (L.) Venth.	T	A	5 – 6	*A/E*
Albizia lucidior (Steudel) Hara	T	LC	5 – 6	*A/E*
Calliandra haematocephala Hasskarl	S	A	9 – 4	*A/E*
Leucaena leucocephala (Lamk.) de Wit	T	A	1 – 12	*A/E*
Mimosa himalayana Gamkble	S	LC	9 – 4	*A/E*
Mimosa pudica L.	AH	A	6 – 2	*A/E*
Pithecellobium dulce (Roxb.)Benth.	T	LC	4 – 5	*A/E*
Molluginaceae				
Glinus lotoides L.	AH	A	10 – 4	*A/E*
Glinus oppositifolius (L.) A.DC.	AH	A	10 – 5	*A/E*
Mollugo pentaphylla L.	AH	A	10 - 6	*A/E*
Moraceae				
Artocarpus lacucha Hamilton	T	C	12 – 1	*A*
Artocarpus heterophyllus Lamk.	T	A	1 – 12	*A*
Ficus benghalensis L.	T	VC	4 – 5	*E*
Ficus benjamina L.	T	VC	4 – 5	*E*
Ficus cunia Buch.-Ham. ex Roxb	T	C	3 – 6	*E*
Ficus elastica Roxb.	T	C	NR	*E*
Ficus racemosa L.	T	LC	NR	*E*
Ficus heterophylla L.f.	SC	R	5 – 6	*E*
Ficus hispida L.f.	T	A	1 – 12	*E*
Ficus virens Aiton	T	LC	NR	*E*
Ficus pumila L.	SC	LC	NR	*E*
Ficus rumphii Blume	T	LC	NR	*E*
Ficus religiosa L.	T	C	5 – 6	*E*
Morus australis Poiret	T	C	3 – 4	*A*
Streblus asper Lour.	T	VC	9 – 10	*A*
Moringaceae				
Moringa oleifera Lamk.	T	VC	10 – 1	*E*
Myrsinaceae				
Ardisia solanacea Roxb.	S	LC	8 – 10	*E*
Maesa indica (Roxb.) A. DC.	S	R	4 – 5	*E*
Myrtaceae				
Callistemon lanceolatus DC.	T	LC	10 – 4	*E*
Eucalyptus globulosus St.-Lag.	T	C	4 – 5	*E*
Psidium guajava L.	T	VC	1 – 12	*E*
Syzygium cumini (L.) Skeels	T	C	4	*E*
Syzygium jambos (L.) Alston	T	R	11 – 12 4 – 5	*E*
Syzygium operculinum (Roxb.) Niedenzu	T	R	2 – 3	*E*
Nyctaginaceae				
Boerhavia diffusa L.	Sf	A	1 – 12	*E*
Bougainvillea glabra Choisy	S	LC	1 – 12	*E*
Bougainvillea spectabilis Willd.	S	A	10 – 5	*E*
Mirabilis jalapa L.	PH	A	4 – 11	*E*

Nyctanthaceae				
Nyctanthes arbor-tristis L.	S	A	9 – 3	*E*
Nymphaeaceae				
Nelumbo nucifera Gaertner	PH	R	6 – 11	*E*
Nymphea stellata F. Muell	PH	LC	7 – 2	*E*
Oleaceae				
Jasminum pubescens (Retz) Willd.	SC	LC	12 – 4	*E*
Jasminum sambac (L.) Aiton	UC	C	4 – 11	*E*
Onagraceae				
Ludwigia octavalvis (Jacq.) Raven	AH	A	9 – 4	*E*
Ludwigia perennis L.	AH	A	1 – 12	*E*
Ludwigia prostrata Roxb.	AH	R	8 – 2	*E*
Papilionaceae [Fabaceae]				
Abrus praecatorius L.	SC	R	3 – 4	*E*
Abrus pulchellus Thwaites	SC	LC	3 – 4	*E*
Aeschynomene asper L.	AH	LC	9 – 10	*E*
Aeschynomene indica L.	AH	LC	9 – 2	*E*
Alysicarpus vaginalis (L.) DC.	AH	A	9 – 5	*E*
Atylosia scarabaeoides (L.) Benth.	AC	LC	8 – 12	*E*
Butea monosperma (Lamk.) Taub.	T	LC	1 – 4	*O*
Cajanus cajan (L.) Huth	AH	A	6 – 12	*E*
Cicer arietinum L.	AH	C	12 – 1	*E*
Clitorea ternatea L.	AC	C	6 – 12	*E*
Crotalaria albida Heyne ex Roth	AH	LC	6 – 10	*E*
Crotalaria calycina Schrank	AH	LC	9 – 1	*E*
Crotalaria mucronata Desv.	AH	A	1 – 12	*E*
Crotalaria prostrata (Rottl.) Roxb.	AH	C	10 – 2	*E*
Crotalaria cytisoides DC.	AH	R	12 – 2	*E*
Crotalaria retusa L.	AH	C	9 – 3	*E*
Dalbergia latifolia Roxb.	L	LC	NR	*E*
Dalbergia sissoo Roxb.	T	A	3 – 5	*E*
Desmodium gangeticum (L.) DC.	Sf	C	9 – 2	*E*
Desmodium heterophyllum (Willd.) DC.	AH	LC	8 – 4	*E*
Desmodium laxiflorum var. *variagatum* L.	Sf	LC	8 – 5	*E*
Desmodium triflorum (L.) DC.	AH	A	9 – 4	*E*
Lablab purpureus (L.) Sweet	AC	C	10 – 3	*E*
Erythrina stricta Roxb.	T	LC	2 – 3	*O*
Erythrina variegata L.	T	LC	3 – 4	*O*
Flemingia chapper Buch.-Ham.	Sf	LC	10 -2	*E*
Gliricidia sepium (Jacquin) Walpers	T	LC	5 – 6	*E*
Indigofera astragalina DC.	AH	R	8 – 10	*E*
Indigofera linnaei Ali	PH	R	10 – 6	*E*
Lathyrus aphaca L.	AH	R	1 – 4	*E*
Lathyrus sativus L.	AH	C	1 – 3	*E*
Melilotus alba Desr.	AH	C	10 – 2	*E*
Melilotus indica (L.) Allioni	AH	C	10 – 2	*E*

Mucuna pruriens L.	AC	R	2 – 3	*E*
Pachyrhizus erosus (L.) Urban	GC	R	8 – 9	*E*
Pisum sativum L.	AC	C	12 – 3	*E*
Pongamia pinnata (L.) Pierre	T	LC	6 – 7	*E*
Priotropis crotalarioides (DC.) Wight & Arnott	AH	LC	12 – 2	*E*
Pueraria phaseoloides (DC.) Bentham	Sf	C	10 – 3	*E*
Sesbania grandiflora (L.) Poiret	T	C	6 – 10	*E*
Sesbania sesban (L.) Merr.	S	LC	8 – 10	*E*
Smithia sensitiva Aiton	AH	C	10 – 4	*E*
Tephrosia candida (Roxb.) DC.	S	LC	10 – 12	*E*
Tephrosia purpurea (L.) Pers.	AH	LC	7 – 3	*E*
Vicia hirsita (L.) S.F. Gray	AC	C	1 – 4	*E*
Vicia sativa L.	AC	C	1 – 4	*E*
Zornia gibbosa Span.	AH	A	11 – 4	*E*
Passifloraceae				
Passiflora foetida L.	AC	VC	10 – 4	*E*
Passiflora grandiflora Salisb.	SC	LC	1 – 12	*E*
Pedaliaceae				
Sesamum indicum L.	AH	C	9 – 2	*E*
Peperomiaceae				
Peperomia pellucida (L.) H.B.K.	AH	A	1 – 12	*A*
Piperaceae				
Piper betle L.	SC	R	NR	*A*
Piper nigrum L.	SC	LC	12 – 2	*A*
Piper longum L.	HC	C	10 – 12	*A*
Polemoniaceae				
Phlox drummondii Hook.	AH	A	1 – 5	*E*
Polygalaceae				
Polygala chinensis A. Bennett	AH	VC	8 – 10	*E*
Polygala linarifolia Willd.	AH	R	8 – 11	*E*
Salomonia ciliata (L.) DC.	RP	C	7 – 10	*E*
Polygonaceae				
Antigonon leptopus Hook. et Arn.	SC	LC	9 – 4	*A/E*
Muehlenbeckia axillaris (Hook.f.) Endl.	S	LC	12 – 2	*A*
Persicaria barbata (L.) Hara	AH	C	8 – 1	*A/E*
Persicaria hydropiper (L.) Spach	SC	VC	7 – 2	*A/E*
Persicaria strigosa (R. Brown) Nakai	PH	C	10 – 5	*A/E*
Persicaria orientalis (L.) Spach	AH	C	11 – 5	*A/E*
Persicaria chinensis (L.) H. Gross	AH	C	10 – 6	*A/E*
Polygonum plebeium R.Br	AH	VC	2 – 5	*A/E*
Rumex dentatus L.	AH	A	1 – 5	*A*
Rumex trisetifer Stokes	AH	A	1 – 5	*A*

Portulacaceae				
Portulaca oleracea L.	AH	A	1 – 12	*E*
Portulaca quadrifida L.	AH	LC	10 – 6	*E*
Primulaceae				
Anagalis arvensis L.	AH	C	2 – 6	*E*
Proteaceae				
Grevillea robusta A. Cunn. ex R. Br.	T	C	4 – 5	*O*
Punicaceae				
Punica granatum L.	S	VC	4 – 7	*E*
Ranunculaceae				
Delphinium ajacis L.	AH	C	1 – 4	*E*
Naravelia zeylanica (L.) DC.	SC	R	NR	*E*
Nigella sativa L.	AH	LC	1 – 3	*E*
Ranunculus sceleratus L.	AH	VC	9 – 11	*E*
Rhamnaceae				
Zizyphus mauritiana Lamk.	T	VC	9 – 10	*E*
Zizyphus oenoplia (L.) Mill.	S	R	9 – 11	*E*
Rosaceae				
Duchesnea indica (Andrews) Focke.	AH	R	1 – 3	*E*
Rosa hybrida Hortorum	S	A	1 – 12	*E*
Rosa indica L.	SC	C	11 – 5	*E*
Rubiaceae				
Adina cordifolia (Roxb.) Hook.f. ex Brand.	T	LC	5 – 8	*E*
Anthocephalus chinensis (Lam.) Rich. ex Walp.	T	A	5 – 9	*E*
Borreria alata (Aubl.) DC.	AH	A	8 – 10	*E*
Borreria ocymoides (Burm.f.) DC.	AH	A	7 – 10	*E*
Borreria pusilla (Wallich) DC.	AH	LC	8 – 10	*E*
Coffea bengalensis Roxb.	S	A	2 – 5	*E*
Dentella repens (L.) J. et G. Forst.	AH	A	8 – 11	*E*
Gardenia augusta (L.) Merrill	S	C	11 – 3	*E*
Hamelia patens Jacq.	S	VC	1 – 12	*E*
Hedyotis corymbosa (L.) Lamk.	AH	A	1 – 12	*E*
Hedyotis diffusa Willd.	AH	A	6 – 9	*E*
Hedyotis racemosa Lamarck	AH	R	10 – 12	*E*
Hedyotis scandens Roxb.	Sf	LC	9 – 12	*E*
Ixora coccinea L.	S	A	1 – 12	*E*
Ixora javanica (Blume) DC.	S	C	1 – 12	*E*
Ixora parviflora Vahl	S	C	1 – 12	*E*
Kohautia gacilis (Wallich) DC.	PH	R	10 – 3	*E*
Meyna spinosa Link	S	LC	4 – 6	*E*
Mirtacarpus verticillatus (Schumm. *et* Thonn.) Vatke	AH	A	1 – 12	*E*
Morinda citrifolia L.	T	LC	3 – 4	*E*

Mussaenda philippica A. Rich.	S	A	10 – 6	*E*
Mussaenda roxburghii Hook.f.	S	R	6 – 8	*E*
Paederia foetida L.	SC	C	8 – 10	*E*
Pentas lanceolata (Forsk.) K. Schum.	S	LC	10 – 6	*E*
Randia dumetorum (Link) DC.	S	LC	5 – 7	*E*
Rutaceae				
Aegle marmelos (L.) Correa	T	LC	4 – 5	*E*
Citrus limon (L.) Burm.f.	S	C	4 – 5	*E*
Citrus maxima (Burm.) Merr.	T	VC	3 – 4	*E*
Clausena excavata Burman	S	LC	4 – 5	*E*
Clausena dentata (Willd.) Roemer	S	LC	3 – 4	*E*
Glycosmis pentaphylla (Retzius) DC.	S	C	3 – 8	*E*
Murraya koenigii (L.) Burm.f.	S	A	4 – 6	*E*
Murraya paniculata (L.) Jack.	S	A	4 – 6	*E*
Sapindaceae				
Allophyllus chartaceus (Kurz) Radlkofer	S	R	4 – 5	*A/E*
Cardiospermum helicacabum L.	AC	R	1 – 12	*E*
Dodonea viscosa (L.) Jack.	S	LC	1 – 3	*E*
Lichi chinensis Sonner.	T	VC	1 – 3	*E*
Sapotaceae				
Bassia latifolia Roxb.	T	R	4 – 5	*E*
Manilkara achras (Mill.) Fosberg	T	LC	1 – 12	*E*
Mimusops elengi L.	T	C	1 – 12	*E*
Scrophulariaceae				
Antirrhinum majus L.	AH	VC	12 – 4	*E*
Centrathera humifusca Wall. ex Benth.	RP	VC	7 – 9	*E*
Limnophylla polyantha Hook.f.	AH	VC	10 – 1	*E*
Limnophylla repens (Bentham) Bentham	AH	A	10 – 1	*E*
Limnophylla sessiliflora (Vahl) Blume	AH	C	10 – 1	*E*
Lindenbergia indica (L.) Vatke	AH	VC	1 – 12	*E*
Lindernia ciliata (Colsm,) Pennell	AH	A	6 – 3	*E*
Lindernia crustacea (L.) F. Muell.	AH	A	1 – 12	*E*
Lindernia viscosa (Hornemann) Bolgingh	AH	A	7 – 10	*E*
Lindernia multiflora (Roxb.) Mukherjee	AH	A	6 – 10	*E*
Lindernia parviflora (Roxb.) Haines	AH	A	7 – 1	*E*
Macardonia dianthera (Mill.) Small	AH	C	8 – 10	*E*
Mazus pumilus (Burm.f.) Steenis	AH	A	1 – 12	*E*
Russelia juncea Zucc.	US	C	10 – 4	*E*
Scoparia dulcis L.	Sf	A	1 – 12	*E*
Striga asiatica (L.) Kuntze	RP	LC	1 – 3	*E*
Torenia asiatica L.	RP	C	6 – 8	*E*
Sphenocleaceae				
Sphenoclea zeylanica Gaertn.	AH	C	7 – 9	*A*

Simaroubaceae				
Ailanthus excelsa Roxb.	T	VC	10 – 4	*A/E*
Ailanthus integrifolia Lamarck	T	C	10 – 2	*A/E*
Solanaceae				
Browalia americana L.	AH	LC	9 – 11	*E*
Brunfelsia pauciflora (Chamisso & Schlecht.) Benth.	S	C	10 – 5	*E*
Capsicum annuum L.	AH	A	1 – 12	*E*
Cestrum nocturnum L.	S	A	5 – 7	*E*
Datura metel L.	AH	A	1 – 12	*E*
Datura suaveolens Humb.	S	LC	1 – 12	*E*
Lycopersicum esculentum Mill.	AH	A	11 – 6	*E*
Petunia hybrida Vilmorin	AH	A	1 – 5	*E*
Physalis minima L.	AH	VC	6 – 10	*E*
Physalis peruviana L.	AH	R	6 – 10	*E*
Solanum anguivi Lamarck	S	LC	1 – 12	*E*
Solanum viarum Dunal	AH	A	1 – 12	*E*
Solanum melongena L.	AH	A	1 – 12	*E*
Solanum nigrum L.	AH	A	1 – 12	*E*
Solanum torvum Swartz	S	VC	8 – 11	*E*
Solanum tuberosum L.	GH	C	2 – 5	*E*
Solanum villosum Miller	AH	C	1 – 12	*E*
Sterculiaceae				
Abroma augusta (L.) L.f.	S	LC	7 – 11	*E*
Firmiana colorata (Roxb.) R. Brown	T	LC	3 – 4	*E*
Melochia corchorifolia L.	AH	A	5 – 9	*E*
Pentapetes phoenicea L.	AH	LC	8 – 9	*E*
Pterygota alata (Roxb.) R. Brown	T	LC	12 – 1	*E*
Pterospermum acerifolium (L.) Willd.	T	LC	4 – 6	*E*
Sterculia villosa Smith	T	C	1 – 3	*E*
Theobroma cacao L.	T	LC	1 – 12	*E*
Waltheria indica L.	AH	LC	9	*E*
Theaceae				
Camellia japonica var. *rusticana* (Honda) T.L. Ming	S	LC	12 – 2	*E*
Camellia sinensis (L.) O. Kuntze var. *sinensis*	S	A	9 – 11	*E*
Camellia sinensis var. *asssamica* (Masters) Kitamura	S	A	9 – 11	*E*
Tiliaceae				
Corchorus aestuans L.	AH	LC	7 – 10	*E*
Corchorus capsularis L.	AH	A	7 – 8	*E*
Grewia asiatica L.	T	C	5 – 6	*E*
Grewia optiva Burret	T	LC	9 – 11	*E*
Triumfetta pilosa Roth	AH	LC	8 – 10	*E*
Triumfetta rhomboidea Jacq.	AH	VC	8 – 10	*E*

Ulmaceae				
Trema orientalis (L.) Blume	T	A	10 – 2	*A*
Urticaceae				
Boehmeria platyphylla D. Don	S	LC	7 – 1	*A*
Elatostema reptans Hook.f.	AH	LC	6 – 12	*A*
Elatostema rupestre (D. Don) Weddell	AH	R	7 – 12	*A*
Laportea interrupta (L.) Chow	AH	VC	8 – 10	*A*
Pilea microphylla (L.) Lieb.	AH	A	7 – 11	*A*
Pouzolzia hirta (Blume) Hasskarl	PH	LC	10 – 12	*A*
Pouzolzia zeylanica (L.) Bennett	AH	A	1 – 12	*A*
Verbenaceae				
Callicarpa arborea Roxb.	T	C	8 – 10	*E*
Clerodendrum chinense (Osbeck) Mabberley	Sf	LC	12 – 2	*E*
Clerodendrum indicum (L.) Kintze	S	A	1 – 3	*E*
Clerodendrum innerme (L.) Gaertn.	S	LC	9 – 10	*E*
Clerodendrum japonicum (Thunberg) Sweet	Sf	LC	6 – 8	*E*
Clerodendrum thomsonae Balfour f.	SC	LC	1 – 12	*E*
Clerodendrum viscosum Vent.	Sf	A	1 – 4	*E*
Duranta repens L.	S	A	5 – 6	*E*
Gmelina arborea Roxb.	T	A	4 – 5	*E*
Holmskioldia sangunea Retzius	SC	LC	12 – 2	*E*
Lantana camara L.	S	A	1 – 12	*E*
Phyla nudiflora (L.) Greene	AH	LC	1 – 5	*E*
Premna mucronata Roxb.	T	C	5 – 6	*E*
Stachytarpheta indica (L.) Vahl	Sf	LC	2 – 4	*E*
Tectona grandis L.f.	T	A	9 – 10	*E*
Vitex negundo L.	S	LC	5 – 7	*E*
Vitaceae				
Ampelocissus sikkimensis (Lawson) Planchon	SC	A	6 – 8	*A/E*
Cayratia trifolia (L.) Domin.	SC	A	5 – 8	*A/E*
Cissus quadrangularis L.	SC	R	NR	*A/E*
Tetrastigma bracteolatum (Wallich) Planchon	SC	LC	7 – 9	*A/E*
Tetrastigma serrulatum (Roxb.) Planchon	SC	LC	7 – 9	*A/E*
Tetrastigma leucostaphylum *(Dennstedt) Mabberley*	SC	LC	NR	*A/E*

MAGNOLIOPHYTA	Habit	Abundance	Flowering Period	*Mode of Pollination*
Liliopsida				
Acoraceae				
Acorus calamus L.	GH	LC	6 – 7	*A*
Agavaceae				
Agave sisalana Perrine	S	LC	11 – 2	*E*
Amaryllidaceae				
Crinum asiaticum L.	GH	LC	5 – 6	*E*

Hippaestrum spp.	GH	C	5 – 7	*E*
Polianthes tuberosa L.	GH	C	1 – 12	*E*
Zephyranthes rosea Lindl.	GH	VC	5 – 8	*E*
Araceae				
Alocasia macrorrhiza (L.) G. Don	GH	A	NR	*E*
Amorphophallus campanulatus (Roxb.) Bl. ex Decne	GH	A	5 – 6	*E, M*
Caladium bicolor Vent.	GH	A	5 – 7	*E*
Colocasia esculenta (L.) Schott	GH	A	6 – 7	*E, M*
Colocasia fallax Schott	GH	A	6 – 7	*E, M*
Pistia strateotes L.	HA	LC	7 – 10	*E*
Pothos scandens L.	E	C	8 – 10	*A/E*
Scindapsus officinale (Roxb.) Schott	E	LC	NR	*A/E*
Typhonium trilobatum (L.) Schott	GH	A	6 – 8	*E, M*
Arecaceae				
Areca catechu L.	T	A	1 – 12	*A*
Areca sp	T	C	1 – 12	*A*
Borassus flabellifer L.	T	LC	5 – 6	*A*
Calamus rotang L.	L	LC	NR	*A*
Caryota urens L.	T	LC	2 – 3	*A*
Cocos nucifera L.	T	A	1 – 12	*A*
Phoenix sylvestris L.	T	C	4 – 5	*A*
Roystonia regia (H.B.K.) O.F. Cook	T	C	5 – 7	*A*
Bromeliaceae				
Ananus sativus Schult.f.	PH	A	1 – 12	*E*
Burmanniaceae				
Burmannia coelestis D. Don	AH	R	12 – 2	*E*
Cannaceae				
Canna edulis Ker Gawler	GH	C	11 – 3	*E*
Canna indica L.	GH	C	1 – 12	*E*
Commelinaceae				
Amischophacelus axillaris (L.) Rao et Kamm.	AH	LC	10 – 11	*E*
Amischotolype hookeri (Hassk.) Hara	AH	LC	9 – 11	*E*
Aneilema hamiltonianum Wall. ex C.B.Cl.	AH	VC	8 – 10	*E*
Commelina benghalensis L.	AH	VC	7 – 11	*E*
Commelina difusa Burm.f	PH	A	1 – 12	*E*
Commelina paludosa Blume				
Commelina suffruticosa Blume	PH	C	8 – 10	*E*
Cyanotis tuberosa (Roxb.) J.A. et J.H . Schult.	PH	LC	8 – 10	*E*
Cyanotis vaga J.A. et J.H. Schult.	AH	VC	7 – 10	*E*
Floscopa scandens Laurerio	AH	LC	8 – 9	*E*
Murdannia nudiflora (L.) Brenan	AH	A	7 – 10	*E*
Murdannia vaginata (L.) Brueck.	AH	LC	7 – 9	*E*

Costaceae				
Costus speciosus (J. Koenig) Smith	GH	VC	8 – 9	*E*
Cyperaceae				
Bulbostylis barbata (Rottb.) Kunth	AH	VC	6 – 11	*A*
Carex indica L.	AH	LC	8 – 10	*A*
Carex wallichiana Spr.	PH	R	8 – 10	*A*
Cyperus rotundus L.	GH	A	5 – 11	*A*
Cyperus compressus L.	AH	A	7 – 10	*A*
Cyperus laxus Lam.	AH	LC	8 – 10	*A*
Cyperus iria L.	AH	A	7 – 10	*A*
Cyperus pseudo-kyllingoides Kukenthal	PH	VC	7 – 10	*A*
Diplacrum caricinum R. Br.	PH	LC	8 – 9	*A*
Elaeocharis atropurpurea Retz	AH	C	7 – 11	*A*
Elaeocharis congeota D. Don	AH	A	7 – 11	*A*
Fimbristylis bisumbellata (Fork.) Bub.	AH	C	6 – 10	*A*
Kyllinga brevifolia Rottb.	PH	A	8 – 12	*A*
Pseudomariscus cyperoides (Roxb.) Bennet et Ricz.	AH	VC	7 – 10	*A*
Scirpus articulatus L.	AH	LC	7 – 11	*A*
Schoenoplectus grossus (L.f.) Palla	AH	LC	7 – 10	*A*
Scleria biflora Roxb.	AH	C	7 – 10	*A*
Dioscoreaceae				
Dioscorea alata L.	GH	C	7 – 8	*A*
Dioscorea bulbifera L.	GH	C	7 – 8	*A*
Dioscorea pentaphylla L.	GH	LC	7 – 9	*A*
Dioscorea prazeri Prain et Burkill	GH	LC	7 – 8	*A*
Eriocaulaceae				
Eriocaulon quinquangulare L.	AH	A	8 – 11	*A*
Eriocaulon xeranthemum Mart.	AH	A	8 – 11	*A*
Haemodoraceae				
Sansevieria trifasciata Prain	GH	VC	7	*E*
Hydrocharitaceae				
Blyxa roxburghii Rich.	AH	A	8 – 10	*E*
Ottelia alismoides L.	AH	A	9 – 01	*E*
Vallisneria spiralis Hook.	AH	A	9 – 11	*W*
Hypoxidaceae				
Curculigo orchioides Gaertn	PH	VC	9 – 3	*E*
Molineria capitulata (Lour.) Herb.	PH	LC	6 – 12	*E*
Iridaceae				
Belacmanda chinensis (L.) DC.	PH	C	9 – 11	*E*
Juncaceae				
Juncus bufonius L.	AH	R	9 – 10	*A*

Lemnaceae				
Spirodela polyrhiza (L.) Schleid.	AH	VC	5	*W*
Liliaceae				
Alium cepa L.	GH	VC	12 – 3	*E*
Hemerocallis fulva L.	GH	VC	5 – 7	*E*
Marantaceae				
Maranta aurandanacea L.	GH	VC	6 – 7	*E*
Musaceae				
Heliconia rostrata Ruiz et Pav.	GH	C	5 – 7	*E, O*
Musa balbisiana Colla	GH	VC	1 – 12	*C*
Musa coccinea Andr.	GH	R	5 – 10	*C*
Ravenala madagascariensis J.F. Gmel.	T	R	NR	*O, C*
Najadaceae				
Najas kurziana Rendle	AH	LC	9 – 10	*W*
Najas graminea Del.	AH	LC	9 – 10	*W*
Orchidaceae				
Aerides multiflora Roxb.	E	A	3 – 6	*E*
Bulbophyllum triste Reichb.f.	E	A	4 – 6	*E*
Cymbidium aloefolium L.	E	C	4 – 7	*E*
Dendrobium amoenum Wall. ex Lindl.	E	C	5 – 6	*E*
Phaius nanus Hook.f.	PH	LC	2	*E*
Rhynchostylis retusa Bl.	E	A	5 – 7	*E*
Cloeisostoma appendiculatum (Lindl.) Benth. et Hook.f. ex Jackson	E	R	4 – 7	*E*
Papilionanthe teres (Roxb.) Schltr.	E	A	1 – 3	*E*
Zeuxine membranacea Lindl.	PH	R	11 – 12	*E*
Pandanaceae				
Pandanus nepalensis St. John	T	VC	10	*A*
Poaceae				
Alloteropsis cimicina L.	AH	VC	8 – 10	*A*
Axonopus compressus (Sw.) Pal.-Beav.	PH	A	5 – 11	*A*
Brachiaria reptans (L.) Garden. et Hubb.	AH	C	5 – 10	*A*
Chloris barbata sensu Sw.	AH	VC	7 – 9	*A*
Chrysopogon aciculatus (Retz.) Trin.	PH	A	4 – 11	*A*
Coix lachrymal-jobi L.	AH	C	3 – 12	*A*
Cymbopogon pendulus Wats.	PH	C	9 – 1	*A*
Cynodon dactylon (L.) Pers.	PH	A	3 – 9	*A*
Dactyloctenium aegypticum (L.) Willd.	AH	VC	6 – 10	*A*
Digitaria sanguinalis (L.) Scop.	AH	A	7 – 9	*A*
Echinochloa crus-galli (L.) P. Beauv.	AH	A	5 – 10	*A*
Eleusine indica L.	PH	A	5 – 12	*A*
Eragrostis gangetica (Roxb.) Steud.	AH	A	5 – 1	*A*
Eragrostis nigra Nees ex Steud.	AH	LC	5 – 10	*A*

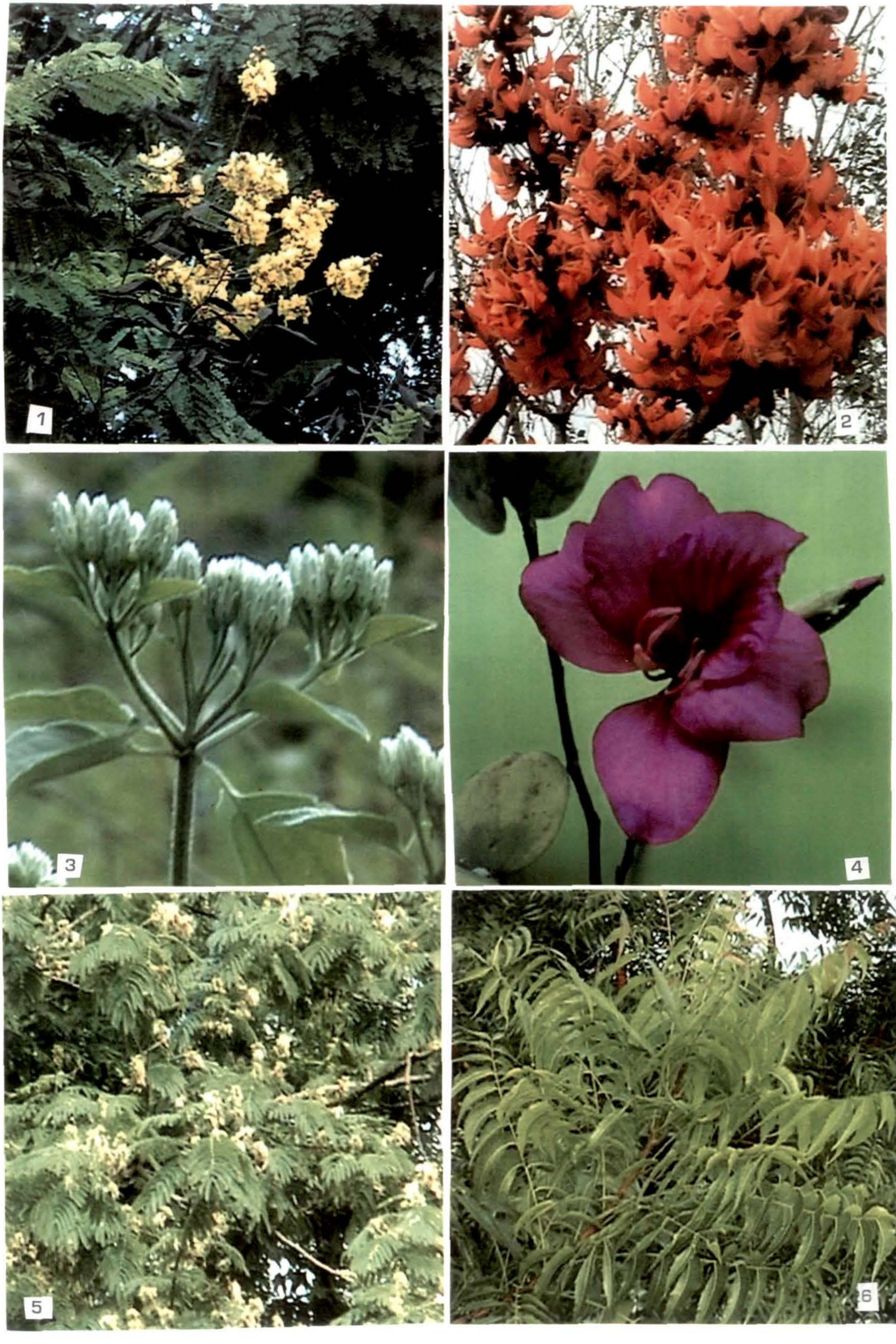
Eragrostis tenella L.	AH	A	4 – 10	*A*
Imperata cylindrica (L.) Raeus	PH	A	4 – 11	*A*
Isachne albens Trin	AH	R	7 – 2	*A*
Ischaemum indicum (Houtt.) Merr.	AH	LC	10 – 12	*A*
Oplismenus compositus L.	AH	A	8 – 12	*A*
Oplismenus burmanii P. Beauv.	AH	A	2 – 10	*A*
Oryza rufipogon Griff.	AH	VC	9 – 1	*A*
Paspalidium flavidum (Retz.) A. Camus	AH	VC	4 – 9	*A*
Paspalum conjugatum Berg.	PH	VC	8 – 12	*A*
Paspalum scrobiculatum L.	PH	VC	4 – 10	*A*
Pennisetum pedicellatum Trin.	AH	C	12 – 2	*A*
Pogonatherum paniceum (Lam.) Hack.	AH	C	2 – 7	*A*
Saccharum narenga (Nees ex Steud.)Hack.	PH	LC	10 – 12	*A*
Saccharum spontaneum L.	PH	A	9 – 1	*A*
Setaria glauca (L.) P. Beauv.	AH	A	3 – 12	*A*
Setaria palmifolia (J. Koenig)Staff.	AH	A	6 – 2	*A*
Sporobolus indicus L. var. *fertilis* Jovet et Guedes	PH	A	3 – 12	*A*
Thamnocalamus aristatus E.G. Camus	S	C	NR	*A*
Thysanolena maxima O. Ktze	US	C	12 – 8	*A*
Vetiveria zizanoides L.	Sf	LC	8 – 10	*A*
Pontederiaceae				
Eichhornia crassipes Solms	AH	VC	10 – 2	*E*
Monochoria hastata (L.) Solms	AH	C	7 – 10	*E*
Monochoria vaginalis (Burm.f.) K.B. Presl	AH	C	7 – 10 0	*E*
Smilacaceae				
Smilax zeylanica L.	GC	LC	12	*A/E*
Zingiberaceae				
Curcuma aromatica Salisb.	GH	VC	4 – 7	*E*
Curcuma longa L.	GH	VC	4 – 7	*E*
Globba racemosa Smith	GH	C	5 – 8	*E*
Hedychium coronerium L. Konig	GH	VC	8 – 10	*E*
Zingiber officinale Roscoe	GH	C	NR	*E*
Zingiber sp.	GH	R	NR	*E*

Photograph 1.

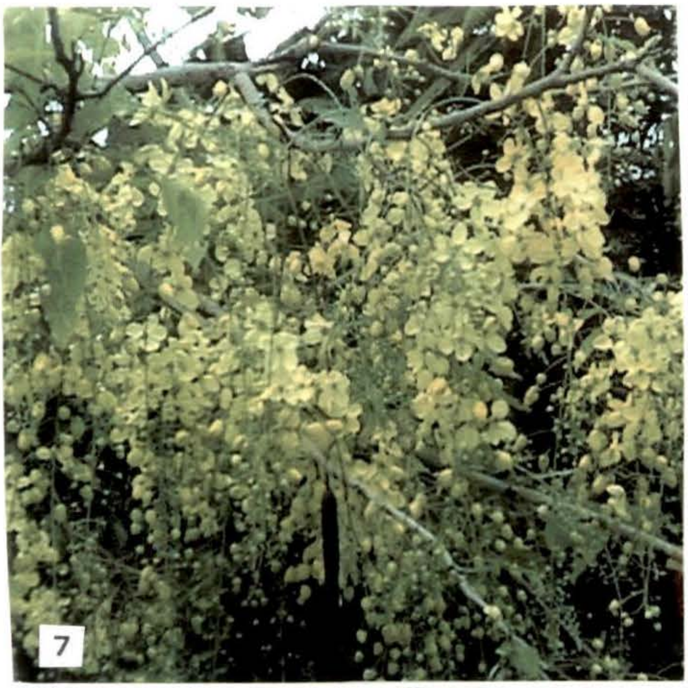
Photographs of some common plants of Jalpaiguri district

1. *Peltophorum pterocarpum*
2. *Butea monosperma*
3. *Chromolena odorata*
4. *Bauhinia purpurea*
5 *Albizia chinensis*
6. *Azadirachta indica*
7. *Cassia fistula*
8. *Spathodea campanulata*
9. *Trichosanthes lepiniate*
10. *Mimosa pudica*
11. *Acmella calva*
12. *Heliotropium indicum*
13. *Dillenia pentagyna*
14. *Nyctanthes arbor-tristis*
15. *Thea sinensis*
16. *Melastoma malabathricum*
17. *Clerodendrum viscosum*
18. *Triumfeta rhomboidea*
19. *Bidens pilosa*
20. *Costus speciosus*
21. *Corchorus aestuens*
22. *Peperomia pellucida*
23. *Kyllinga monocephala*
24. *Cyanotis axillaris*
25. *Cleome rutidosperma*
26. *Argyreia roxburghii*
27. *Mirtacarpus verticillatus*
28. *Barleria cristata*
29. *Rumex maritimus*
30. *Leucas indica*

Photograph 1: Some common plants of Jalpaiguri

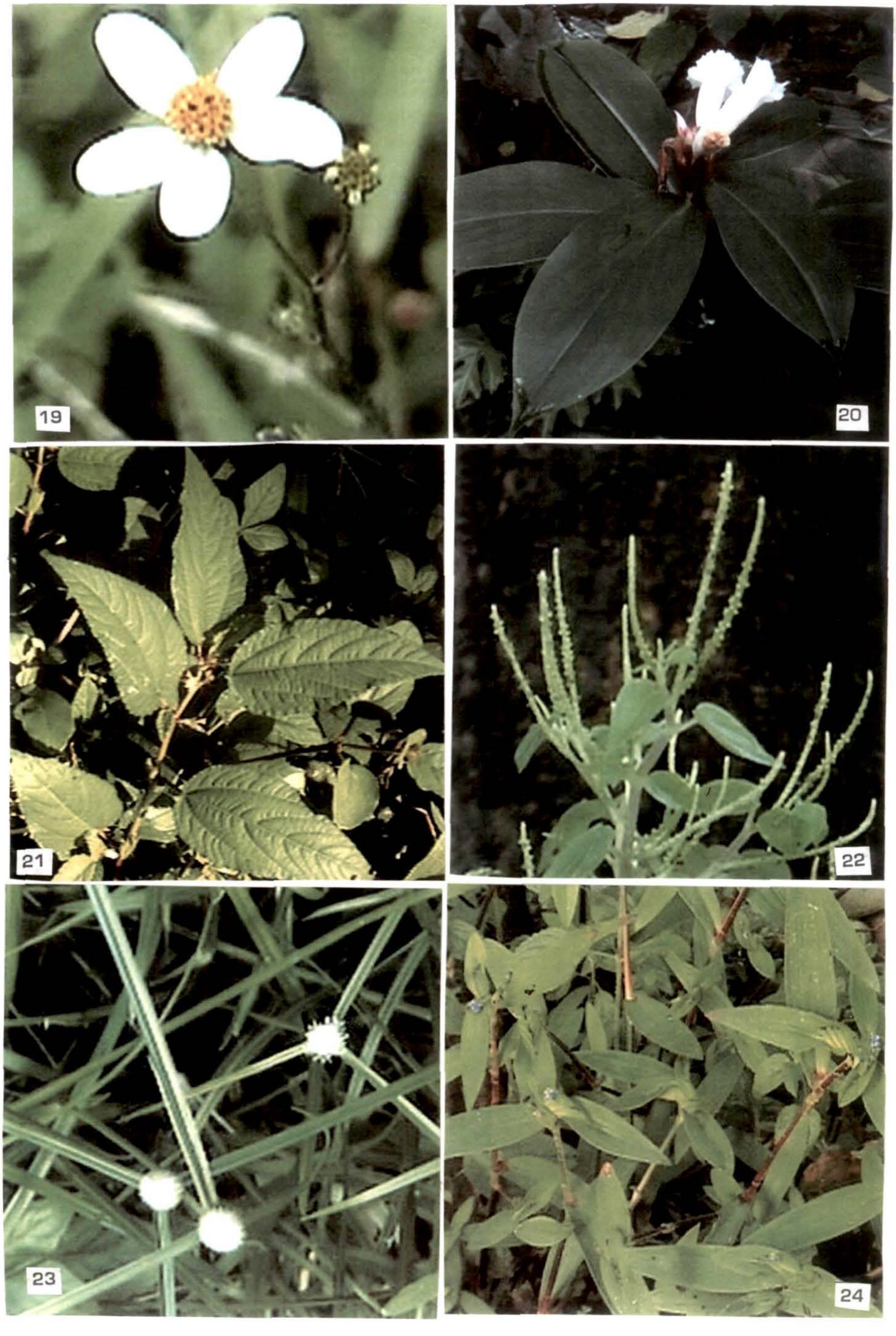


Photograph 1(Contd.): Some common plants of Jalpaiguri

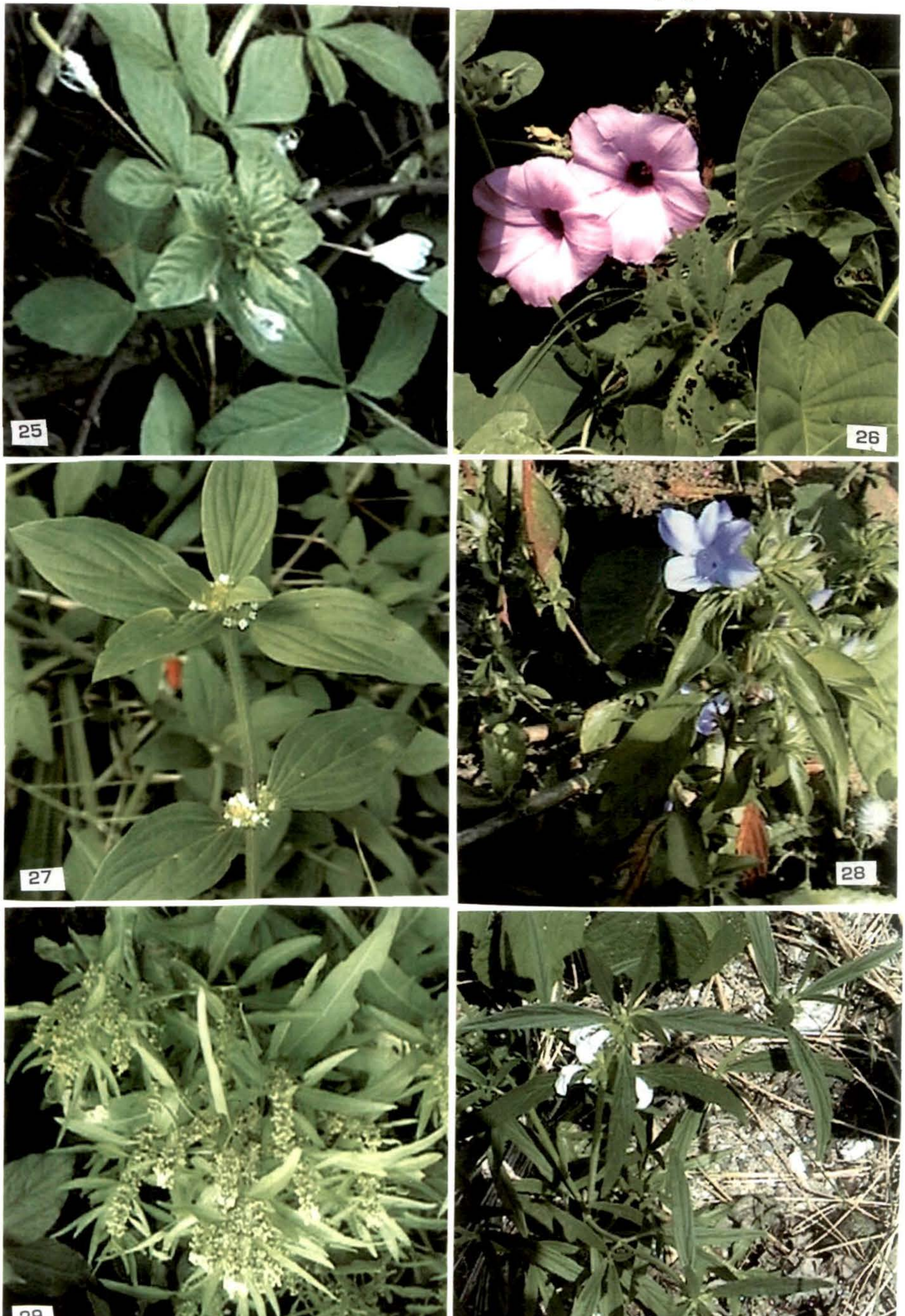


Photograph 1(Contd.): Some common plants of Jalpaiguri

Photograph 1(Contd.): Some common plants of Jalpaiguri



Photograph 1(Contd.): Some common plants of Jalpaiguri



Analysis of the flora

Constituted over a very rich basic flora, the present angiospermic flora of the Jalpaiguri town area is quite rich. It is to be accepted that the basic flora has suffered extensive change. However, table 3 is presenting the numerical distribution of angiospermic taxa in the flora.

Table 3 : Numerical distribution of angiospermic taxa in the flora of Jalpaiguri township area.

Taxa	Dicots	Monocots	Total
Families	105	29	134
Genera	385	106	491
Species	574	135	709

The record of the occurrence of 709 species within the limit of a busy township like Jalpaiguri may be considered as very rich. Taxonomic distribution (Table 3) of all plants in 105 dicotyledonous and 29 monocotyledonous families and under 491 genera (385 dicots & 106 monocots) also express the wide range diversity in the flora (Table 3).

Out of the recorded families, Papilionaceae (i.e. Fabaceae) is best represented with 47 species and is followed by Asteraceae (41 species), Poaceae and Euphorbiaceae (30 species each), Rubiaceae (25 species), Caesalpiniaceae (18 species), Scrophulariaceae, Cyperaceae and Solanaceae (17 species each) etc (Table 2 & 5). Instead of treating Papilionaceae separately, if Leguminosae (comprising of Papilionaceae, Caesalpiniaceae and Mimosaceae) is taken as a single family, then the 76 species occurring in Jalpaiguri counting 43 genera. On the other hand, there are 36 dicotyledonous and 12 monocotyledonous families which are represented in the flora with single species (Table 2). However, apart from the ten dominant families, other well represented families include Acanthaceae, Amaranthaceae, Apocynaceae, Convolvulaceae, Cucurbitaceae, Lamiacae, Moraceae etc (Table 2). Migration or extension of human civilization always cause the introduction of exotic elements in the flora (Das 1995, 2002). Many of these introduced plants get naturalized and behave like natural elements of a flora. The present flora under discussion is not an exception.

There are at least 103 dicotyledons and 19 monocotyledons species of exotic nature found in Jalpaiguri township area. These exotics are elements from widely distributed areas including tropical America, Australia, China, Japan, Europe etc. and were introduced for different reasons like food, ornamentals, fibre, medicine, halucinogenic agent, etc. However, common weeds like *Galinsoga parviflora,* *Alternanthera paronichioides, Mikania micrantha,* etc. are probably migratory weeds or were introduced unknowingly. The habit also are diversified, from small short living annuals to giant trees (Table 4). Many of these exotics are now restricted to cultivation only, whereas a good population have been naturalized.

Habit and mode of pollination of a plant is very important from the aerobiological point of view.

A. **Habit :** Recorded 709 specifies of angiospermic plants of Jalpaiguri town area has been analyzed for groups and were basically recognized for 16 habit groups (Table 2). Numerical distribution of the recorded plants has been shown in Table 4.

Table 4 : Numerical distribution of habit groups in the angiospermic flora of Jalpaiguri town area :

Habit groups	Dicots	Monocots	Total
Annual Herbs (AH)	232	53	285
Perennial Herbs (PH)	17	25	42
Hydrophytic Annuals (HA)	00	01	01
Hydrophytic Perennials (HP)	03	00	03
Geophytic Herbs (GH)	01	32	33
Suuffrutesecent Plants (Sf)	15	01	16
Undershrubs (US)	08	01	09
Shrubs (S)	85	02	87
Lianes (L)	09	01	10
Shrubby Climbers (SC)	32	00	32
Annual Climbers (AC)	24	00	24
Geophytic Climbers (GC)	10	01	11
Trees (T)	126	09	135
Epiphytes (E)	02	09	11
Root Parasites (RP)	04	00	04
Stem Parasites (SP)	06	00	06
Total :	**574**	**135**	**709**

It shows a clear dominance of annual herbs (285 spp.) in the flora. Climatically, the area supports a forested vegetation and in a forested vegetation the number of annual species reduce drastically. So, this is a clear indication of a disturbed habitat. On the other hand, the number of tree species is also quite high i.e. 135. Remnants of the forested vegetation, peoples' love for trees, plantation programs etc., are the reasons for the presence of such a good number of tree species in the area. Record of lesser number of PH, GH, Sf, E, etc. are due to the disturbances in the habitats.

B. Pollination : Two aspects of pollination are important : (1) aerobiologically compilation of a flowering calendar and (2) record the mode of pollination.

1. Flowering Calendar : A comprehensive flowering calendar of angiospermic plants of Jalpaiguri town has been prepared (Table 7) from direct observation for four years (1995 – 2001). The calendar has been presented in the Table 2 along with parameters like habit, abundance, flowering period and mode of pollination. The lowest number of flowering has been recorded in the month of June. There are two peaks in flowering. The October peak (348 spp.) which actually initiates in the month of September, coming down slowly and reached the lowest point in March and then rising again to reach a smaller peak (308 spp.) in May. From this peak it declines sharply and remains almost parallel upto August and then starts rising quite sharply to attain the October peak (Table 7).

The emerged picture finds a parallel with the local climatic condition. Monsoon starts here in mid June (Table 1) after a long dry and hot spell when seeds of Therophytic plants start germinating, and at the same time majority of other plants opts for a vegetative growth leading to the decline of the number of species. Monsoon continue upto the middle of September (Table 1), when the daily average temperature also start reducing. Then, the plants attaining vegetative growth moves into the flowering phase.

As a results a large proportion of plants remain in flowering phase in October. With the reduction of ambient temperature and the increase of dryness, most of the monsoonic therophytes slowly gets withered (releasing matured fruits). But, at the same time, during winter, numerous temperate vegetation gets emerged. These are short living and completes their life cycle by February – March. Again, during March – April with increase of the temperature, day length and generally with a few showers the plants gets stimulated to grow and flower, which include a large number of trees creating a May-peak in the flowering calendar of Jalpaiguri town (Table 2).

2. Mode of Pollination :

Seven types of pollination occur in the nature, out of which entomophilous plants occupy the highest position (477 species) which is followed by anemophilous plants (157 spp.). Lesser number of plants have been enumerated from amphiphilous (52 spp.), ornithophilous (12.spp.), hydrophilous (5 spp.), melachophilous (4 spp.) and cleistogamous (only 2 spp.) types (Table 6).

The trees are represented both by entomophilous and anemophilous species. However, a large number of anemophilous species along with some entomophilous species like *Bombax ceiba, Cassia fistula, C. siamea, Eucalyptus globulosus, Callistemon lanceolatus, Tamarindus indica, Carica papaya, Terminalia arjuna,* *Azadirachta indica, Zizyphus mauritiana* etc. which have the potentiality to produce large amount of pollen, thereby, making them a part of the airspora.

Annual and perrenial herbs are the largest representatives in the flora with a varied ecological distribution (Table 4). Most of the herbaceous species by virtue of high pollen productivity have made them a major representative type in the aerobiological composition.

Grass family, i.e. Poaceae is numerically the third largest family and is represented by 30 species under 24 genera (Table 5). The species being anemophilous with an extended flowering period and abundant pollen production, their share in the atmospheric pollen content is relatively large and noteworthy.

Table 5 : Ten dominant angiospermic families in the flora of Jalpaiguri township area.

Sl. No.	Families	Genera	Species
01.	Fabaceae (Papilionaceae)	29	47
02.	Asteraceae	37	41
03.	Poaceae	24	30
04.	Euphorbiaceae	17	30
05.	Rubiaceae	17	25
06.	Caesalpiniaceae	6	18
07.	Scrophulariaceae	11	17
08.	Cyperaceae	11	17
09.	Solanaceae	9	17
10.	Verbenaceae	11	16

Table 6 : Mode of Pollination of the investigation plants

Types of Pollination	Taxa		Total
	Dicot	Monocot	
Anemophilous	89	68	157
Entomophilous	425	52	477
Amphiphilous	49	3	52
Ornithophilous	10	2	12
Melachophilous	0	4	4
Cleistogamous	0	2	2
Hydrophilous	1	4	5
Total	**574**	**135**	**709**

Table 7 : Numerical distribution of the flowering calendar of the investigated plants of Jalpaiguri Town.

Types of Pollination	Taxa	Jan.	Feb.	March	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Anemophilous	Dicot	40	42	41	46	49	40	39	36	39	43	38	43
	Monocot	8	9	9	15	26	31	46	52	51	48	27	18
Entomophilous	Dicot	198	198	186	194	182	143	139	154	181	208	185	186
	Monocot	12	12	10	11	21	23	25	19	21	19	15	13
Amphiphilous	Dicot	29	29	24	24	19	12	8	7	15	23	24	28
	Monocot	-	-	-	-	-	-	-	1	1	1	1	1
Ornithophilous	Dicot	1	2	4	7	6	1	1	1	1	-	-	-
	Monocot	-	-	-	-	1	1	1	-	-	-	-	-
Melachophilous	Dicot	-	-	-	-	-	-	-	-	-	-	-	-
	Monocot	-	-	-	-	1	5	4	1	-	-	-	-
Cleistogamous	Dicot	-	-	-	-	-	-	-	-	-	-	-	-
	Monocot	1	1	1	1	2	2	2	2	2	2	1	1
Hydrophilous	Dicot	-	-	-	-	-	-	-	-	1	1	1	1
	Monocot	-	-	-	-	1	-	-	-	3	3	1	-
Total :		**289**	**293**	**275**	**298**	**308**	**258**	**265**	**273**	**315**	**348**	**293**	**291**

POLLEN MORPHOLOGY

SYSTEMATIC DESCRIPTION OF DOMINANT POLLEN TYPES OF JALPAIGURI TOWN

The terminology and main morphological concepts of the pollen grains are based on Wodehouse (1935), Erdtman (1952), Erdtman (1969), Chanda (1963, 1965) and Faegri and Iversen (1975).

Pollen grain diagnoses of 108 dominant plant species originating from dicotyledons and monocotyledons have been accounted below. The alphabetic arrangement of all the species have been done for the sake of convenience irrespective of their systematic position. Some of the pollen photographs has been provided in Plates I, II and III.

ACANTHACEAE :

Justicia diffusa :

3-colporate, prolate, PA × ED ±22.5 × 16.0 µm, L/B of colpi ± 13.5 × 1.5 µm, ora lalongate. Exine 13.5 x 1.5 µm, ora lalongate. Exine ± 4.0 µm thick, sexine ± 2.2 µm thick, reticulate, heterobrochate, reticulation finer in the polar region and coarser in the equatorial zone.

Nelsonia canescens :

3-colporate, prolate-spheroidal, PA×ED ± 34.4 × 32.0 µm, L/B of colpi ± 22.0 × 1.5 µm, ora lolongate with alternating pseudocolpi. Exine 3.0 µm thick, sexine ± 1.5 µm thick, reticulate.

Rungia pectinata :

3-colporate, prolate, PA×ED ± 31.0 × 20.0 µm, L/B of colpi ± 26.0/2.0 µm, ora lalongate, Exine 3.0 µm thick, reticulate :

AMARANTHACEAE :

Achyranthes aspera :

Pantoporate, spheroidal, diameter of grain ± 18 µm, No. of pores ± 26, interporal distance ± 2.5 µm, L/B of Pores ± 3.0 x 2.5 µm. Exine ± 2.5 µm thick, punctitegillate with supratectal processes.

Achyranthes bidentatus :

Pantoporate with about 28-30 pores, spheroidal with average diam. ± 26.0 µm, interporal distance ± 6.5 µm. Exine 1.5 µm thick, sexine 1.0 mµ thick, punctitegillate to microreticulate beset with supratectal processes.

Amaranthus spinosus :

Pantoparate, spheroidal, diameter of grain ± 18.5 μm, No. of pores ± 22, interporal distance ± 4.0 μm. Exine ± 2.5 μm thick, sexine ± 1.5μm thick, punctitegillate with supratectal processes.

Deeringia amaranthoides :

Pantoporate with about 14 prores, spheroidal, average diam ± 18.3 μm, pores circular, diam of pore 1.5 μm, interporal distance, ± 3.5 μm. Exine 1.4 μm thick, tectate, sexine 0.7 μm thick, punctitegillate with fine supratectal processes.

ANACARDIACEAE :

Mangifera indica :

3-colporate, subprolate, PA×ED ± 27.0 × 22.5 μm, L/B of colpi ± 19.5 × 1.5 μm, ora lolongate. Exine ± 1.5 μm thick, sexine ± 8.0 μm thick, striato-reticulate.

ANNONACEAE :

Annona reticulata :

Grains in tetragonal tetrad, heteropolar, monosulcoidate, oblate, longest and broadest axies of the tetrad ± 65.0 × 56.0 μm, rarely solitary, solitary grains elliptical in polar view; PA×ED ± 27.0 × 44.0 μm, length of sulcus ±31.5 μm. Exine ± 2.5 μm thick, tectate, sexine as thick as nexine, punctitegillate.

Polyalthia longifolia. :

Inaperturate (often in tetrad), spheroidal, diameter of grains ± 38.5 μm, apolar. Exine ± 2.0 μm thick, tectate, sexine ± 1.5 μm thick, beset with blunt echinate process.

APIACEAE :

Coriandrum sativum :

3-colporate, perprolate, PA×ED ± 24.2 × 13.8 μm, L x B of colpi ± 28.0 × 1.4 μm. Ora circular. Exine ± 3.3 μm thick, sexine ± 2.2 μm thick, finely reticulate.

Seseli indicum :

3-colporate, perprolate, PA×ED ± 24.5 × 10.6 μm, L/B of colpi ± 17.8 × 0.3 μm. Ora circular. Exine ± 2.1 μm thick, sexine ± 1.4 μm thick, reticulate.

APOCYNACEAE :

Alstonia scholaris :

3-colporate, spheroidal, diameter of grains ± 37.0 μm, colpi short broad; ora lolongate. Exine ± 1.4 μm thick, sexine slightly thicker than nexine, psilate.

Holarrhena pubescens. :

3-porate (occasionally 4-5 porate), spheroidal, diameter of grains ± 32.0 μm, pores circular, diameter of pores ± 4.0 μm. Exine ± 1.5 μm thick, sexine as thick as nexine with obscure pattern.

Nerium indicum :

4-5 porate, spheroidal, diameter of grains ± 39.5 μm, pores circular, diameter of pores ± 4.5 μm. Exine ± 1.8 μm thick, sexine as thick as nexine, finely reticulate.

Plumeria rubra :

3-colporate, prolate-spheroidal, PA×ED ± 21.0 × 20.5 μm, L/B of colpi ± 20.0 × 2.0 μm, ora lalongate. Exine ± 2.8 μm thick, sexine ± 2.0 μm thick with obscure pattern.

Thevetia peruviana :

3-colporate, subprolate, PA×ED ± 24.0 × 20.5 μm, L/B of colpi ± 16.0 × 3.5μm, ora circular. Exine ± 2.0 μm thick, sexine as thick as nexine with obscure pattern.

Ichnocarpus frutescens :

3-colporate, oblate-spheroidal, PA×ED ± 42.0 × 45.0 μm, L/B of colpi ± 39.0/2.2 μm, ora lolongate. Exine 3.5 μm thick, sexine 2.0 μm thick, reticulate.

ARECACEAE :

Areca catechu :

1-sulcate, oblate, boat shaped, PA×ED×EB ± 28.0 5 μm × 40.0 μm × 35.0 μm. L/B of sulcus ± 34.5 × 3.5 μm. Exine ± 2.5 μm thick; sexine 1.5 μm thick, reticulate.

Borassus flabellifer :

1-sulcate, oblate, PA×ED×EB ± 37.7×63.0 × 29.7 μm, L/B of sulcus ± 20.8 × 6.2 μm. Exine ± 3.6 μm thick, sexine ± 2.6 μm thick, verrucate

Cocos nucifera :

1-sulcate, oblate, PA×ED×EB ± 25.0 × 41.6 × 33.2 μm., L/B of sulcus ± 29.1×1.5 μm. Exine ± 2.28 μm thick, sexine slightly thicker than nexine, reticulate.

ASCLEPIADACEAE :

Calotropis gigantea :

Polyad in the form of pollinia, length of the translator arm ± 140.0 μm, L/B of pollinium ± 1080.0 x 430.0 μm.

ASTERACEAE :

Ageratum conyzoides :

3-colporate, subprolate, PA×ED ± 22.5 × 18.0 μm, L/B of colpi ± 17.5 × 2.0μm, ora circular. Exine ± 2.8 μm thick, sexine ± 2.0 μm thick, echinate, L/B of spines ± 2.1 x 1.7 μm

Blumea lacera :

3-colporate, prolate-spheroidal, PA×ED ± 28.0 × 26.0 μm, L/B of colpi ± 16.0 × 3.5 μm, ora circular. Exine ± 5.0 μm thick, sexine ± 3.5 μm thick echinate, L/B of spines ± 3.0 × 2.5 μm.

Artemisia vulgaris :

3-colporate, oblate-spheroidal, PA×ED±21.0 × 22.5 μm. L/B of colpi ± 16.5 × 2.5μm. Ora lalongate. Exine ±3.0μm thick, gradually thinner towards aperture, sexine ±2.0 μm thick, spinulose.

Eclipta prostrata :

3-colporate, spheroidal, diameter of grain ± 24.0 μm, ora lalongate. Exine ±2.5 μm thick, echinate, L/B of spines ± 2.5 × 2.0 μm.

Vernonia cinerea :

3-colporate, prolate-spheroidal, PA×ED ± 34.0 × 32.0 μm, L/B of colpi ± 12.0 × 3.5 μm, ora lalongate. Exine ± 3.0 μm thick, sexine ± 2.2 μm thick, echinate, L/B of spines ± 3.0 × 2.0 μm.

Xanthium strumarium :

3-colporate, prolate-spheroidal, PA×ED ± 25.0 x 24.0 μm, L/B of colpi ± 17.5 × 2.0 μm, ora lalongate. Exine ± 5.5 μm thick, sexine ± 5.5 μm thick, sexine ± 4.2 μm thick, spinulose.

BIGNONIACEAE :

Tabebuia argentea :

3-colpate, prolate, PA×ED ± 44.0 × 32.5 μm, L/B of colpi ± 40.0 × 2.5 μm. Exine ± 2.0 μm thick, sexine ± 1.5 μm thick, reticulate.

BOMBACACEAE :

Bombax ceiba :

3-colporate, oblate, PA×ED ± 34.5 × 62.5 μm, L/B of colpi ± 32.0 × 6.0 μm. Exine ± 2.0 μm thick, sexine ± 1.5 μm thick, reticulate, heterobrochate, reticulation finer in the equatorial region except apertural area, coarser in the polar region and apertural zone and intectate.

BORAGINACEAE :

Heliotropium indicum :

3-colporate, prolate, PA×ED ± 45.0 × 30.0 μm; L/B of colpi ± 15.0 × 2.0 μm; ora lalongat. Exine ± 1.5 μm thick, sexine ± 0.8 μm thick, reticulate.

Cyanoglossum lanceolatum :

3-colporate, prolate, dumb-bell-shaped, PA ± 8.5 μm, ED ± 5.0 μm at the broadest region and 3.0 μm at the constricted part. Ora lalongate. Exine ± 1.25 μm thick with obscure pattern. Sexine and nexine can not be differentiated.

CANNABINACEAE :

Cannabis sativa :

3-porate, sub-oblate, PA×ED ± 22.7 × 28.0 μm. Diam of pore ± 2.1 μm. Exine ± 2.1 μm thick, sexine ± 1.68 μm thick, scabrate.

CAPPARIDACEAE :

Capparis zeylanica :

3-colporate, subprolate, PA×ED ± 28.0 × 22.0 μm, L/B of colpi ± 20.0 × 1.5 μm, ora lalongate. Exine ± 1.8 μm thick, sexine ± 1.0 μm thick, reticulate.

Crataeva nurvala(:)

3-colporate, prolate, PA×ED ± 30.0μm × 20.0 μm, L/B of colpi ± 15.0μm × 3.0μm. Ora lalongate. Exine 2.5 μm thick, sexine 1.5 μm thick, reticulate.

CARICACEAE :

Carica papaya :

3-colporate, spheroidal, diameter of grains ± 25.5 μm, colpi and ora are very difficult to measure. Exine ± 2.0 μm thick with obscure pattern, sexine and nexine are not clearly differentiated.

CASUARINACEAE :

Casuarina equisetifolia :

3-pororate, suboblate, PA×ED ± 26.5 × 33.0 µm, pores circular, aspidote, ora circular, vestibulum ± 4.5 µm. Exine ± 2.0 µm thick, sexine as thick as nexine.

CHENOPODIACEAE :

Chenopodium album :

Pantoporate, spheroidal, diameter of grains ± 2.8 µm, No. of pores ± 60. Exine ± 2.0 µm thick, sexine ± 1.2 µm thick, scabrate.

Chenopodium ambrosoides :

Pantoporate with 70-75 pores, spheroidal, average diam. ± 25.0 µm, diam. of pores 2.0 µm. Exine 2.5µm thick, sexine 2.0 µm thick, punctitegillate with fine supratectal processes.

COCHLOSPERMACEAE :

Cochlospermum religiosum :

3-colporate, prolate, PA×ED ± 24.0 × 16.0 µm, L/B of colpi ± 18.0 × 40 µm. Ora lalongate. Exine ± 1.5 µm thick, sexine ± 1.0 µm thick, punctitegillate.

COMBRETACEAE :

Terminalia arjuna :

3-colporate, PA×ED ± 21.0 × 18.0 µm, L/B of colpi ± 18.0 × 4.0 µm, ora lalongate. Exine ± 1.5 µm thick with obscure pattern.

CONVOLVULACEAE :

Ipomoea carnea :

Pantoporate, spheroidal, diameter of grain ± 70.0 µm, No. of pores ± 50, diameter of pores ± 6.0 µm, annulus and operculum present. Exine ± 15.0 µm thick, sexine ± 14.0 µm thick, two types of processes are found, long spines with swollen base and constricted blunt tip, small spines present densely surrounding the large spines, finely reticulate.

CYPERACEAE :

Cyperus rotundus :

Inaperturate with 3-4 aperturoid areas, pear shaped, PA×ED ± 30.0 × 22.5 µm, grain subspheroidal in polar view, one aperturoid area at the broader end and rest in lateral position. Exine ± 1.2 μm thick, sexine ± 0.6 μm thick, beset with very fine processes.

Killinga brevifolia :

Inaperturate with 3-4 faintly delimited apertural areas, prolate-spheroidal, PA×ED ± 20.0 × 18.0 μm. Exine ± 1.2 μm thick, sexine ± 0.7 μm thick with obscure pattern.

EHRETIACEAE :

Ehretia serrata :

3-colporate, prolate – spheroidal, PA×ED ± 22.0μm × 18.5μm. L/B of colpi ±20.0 μm × 3.0 μm. Ora lalongate. Exine 2.5μm thick, Sexine finely reticulate, reticulation coarser towards aperture.

EUPHORBIACEAE :

Croton bonplandianum :

Inaperturate, spheroidal, diameter of grain ± 35.0 μm, Exine ± 2.8 μm thick, sexine ± 2.0 μm, bacula club-shaped showing distinct crotonoid pattern.

Euphorbia hirta :

3-colporate, prolate, PA×ED ± 28.0 × 17.0 μm, L/B of colpi ± 20.0 × 2.0 μm, ora lalongate. Exine ± 2.0 μm thick, sexine same as nexine, reticulate.

Drypetes roxburghii :

3-colporate, prolate-spheroidal, PA×ED ± 30.0 × 28.5 μm, L/B of colpi ± 29.0 × 1.5 μm, ora lalongate, Exine ± 2.0 μm thick, with obscure pattern.

Trewia polycarpa :

3-colporate, oblate-spheroidal, PA×ED ± 27.0 × 28.5 μm, L/B of colpi ± 7.0 × 1.0 μm, ora lalongate. Exine ± 1.2 μm thick, sexine as thick as nexine with obscure pattern.

FABACEAE (including Papilionaceae, Caesalpiniaceae & Mimosaceae):

Acacia auriculoformis :

Polyads, 16 celled, more or less spheroidal, individual cells of polyad subglobose in periphery and square in center, 12.0 × 9.0 μm, aperture not discernible. Exine ± 1.0 μm thick, granulate, sexine and nexine not distinguishable.

Albizia lebbek :

Polyads, 16 celled, spheroidal, diameter of polyad ± 73.0 μm, monads loosely fitted, aperture not distinguished. Exine ± 2.5 μm thick, sexine thicker than nexine, faintly granulate.

Bauhinia variegata :

3-colporate, prolate spheroidal, PA×ED ± 51.0 × 50 μm, L/B of colpi ± 40.0× 5.5 μm. Exine ± 3.5 μm thick, sexine, ± 2.5 μm thick, finely granulate.

Butea monosperma :

3-colporate, oblate-spheroidal, PA×ED ± 41.0 × 46.0 μm, L/B of colpi ± 20.5 × 2.0 μm, ora lalongate. Exine ± 2.0 μm thick, sexine as thick as nexine with obscure pattern.

Caesalpinia pulcherrima :

3-colporate, spheroidal, diameter of grain ± 49.0 μm, L/B of colpi ± 40.0 × 7.0 μm. Exine ± 6.0 μm thick, sexine as thick as nexine, reticulate, heterobrochate.

Cassia fistula :

3-colporate, prolate, PA×ED ± 34.5 × 22.5 μm, L/B of colpi ± 22.5 × 2.0 μm, ora lalongate, Exine ± 1.5 μm thick, sexine ± 1.0 μm thick, finely reticulate.

C. siamea :

3-colporate, subprolate, PA×ED ± 45.0 × 35.0 μm, L/B of colpi ± 40.0 × 2.0 μm thick, ora round to lolongate. Exine ± 3.0 μm thick, finely reticulate.

C. sophera :

3-colporate, subprolate, PA×ED ± 53.0 × 40.0 μm, L/B of colpi ± 40.0 × 2.0 μm, margo present, ora lolongate. Exine ± 2.5 μm thick, Sexine ± 1.5 μm thick, scabrate.

Dalbergia sissoo :

3-colporate, prolate, PA×ED ± 27.0 × 21.0 μm. L/B of colpi ± 21.5 × 2.5μm. Ora lalongate. Exine 3.0 μm thick. Sexine with obscure pattern.

Erythrina variegata :

3-porate, suboblate PA×ED ± 24.0 × 37.0 μm, pores circular. Exine ± 2.5 μm thick, sexine as thick as nexine, reticulate, heterobrochate.

Pongamia pinnata :

3-colporate, oblate-spheroidal, PA×ED ± 30.0 × 31.5 μm, L/B of colpi ± 20.0 × 3.0 μm, ora circular. Exine ± 2.5 μm thick, sexine ± 1.5 μm thick, reticulate.

Peltophorum pterocarpum :

3-colpate, prolate spheroidal, PA×ED ± 58.3 × 51.3 μm, L/B of Colpi ± 43.8 × 6.4 μm. Exine ± 5.3 μm thick, sexine ± 4.6 μm thick, duplibaculate, reticulate, heterobrochate.

Pithecellobium dulcis :

Polyads, 16-celled, more or less spheroidal, individual cells of polyad mostly globose, about 20.0μm in diam. Aperture not discernible. Exine. ± 1.5μm thick, psilate.

Sesbania grandiflora :

3-colporate, prolate, PA×ED ± 48.0 × 32.0 μm, L/B of colpi ± 40.0 × 4.0 μm, ora lolongate to spheroidal. Exine ± 4.0 μm thick, sexine ± 1.5 μm thick, reticulate, heterobrochate.

Tamarindus indica :

3-colporate, oblate-spheroidal, PA×ED ± 30.0 × 35.0 μm; L/B of colpi ± 28.5 × 3.0 μm, ora lalongate. Exine ± 3.0 μm thick, sexine ± 2.0 μm thick, striato-reticulate.

LAMIACEAE :

Anisomeles indica :

3-colpate, prolate, PA×ED ± 42.0 × 32.0 μm, L/B of colpi ± 35.0 × 2.0 μm. Exine ± 1.8 μm thick, sexine ± 1.0 μm thick psilate.

Ocimum sanctum

6-colpate, suboblate, PA×ED ± 30.0 × 38.0 μm, L/B of colpi ± 17.0 × 9.0 μm. Exine ± 4.0 μm thick, reticulate, simplibaculate, heterobrochate, bacula dimophic, larger knob headed bacula united at apex form the muri of larger lumina, smaller bacula occupying the central part of luminal floor.

LYTHRACEAE :

Lagerstroemia thorelii :

3-colporate, prolate-spheroidal, PA×ED ± 35.0 × 31.5 μm, L/B of colpi ± 29.0 × 2.0μm, ora circular. Exine ± 1.5 μm thick, punctitegillate.

MALVACEAE :

Hibiscus rosa-sinensis :

Pantoporate, spheroidal, diameter of grain ± 140.0 μm, No. of pores ± 32 in each side. Exine ± 12.0 μm thick, sexine ± 11.0 μm thick, echinate, large spines and very small spinules present.

Malva verticillata :

Pantoporate with about 35 pores, spheroidal, average diam ± 90.0 μm, diam of pore ± 5.0 μm. Exine. ± 10.0 μm thick, sexine 8.0 μm thick crassisexinous, echinate, length of spines 15.0 μm, breadth at the base 10.0 μm.

Sida rhombifolia :

Pantoporate with about 20 pores, spheroidal, average diam ± 75.0 μm, pores circular, diam of pores 3.5 μm. Exine. ± 4.0 μm thick, sexine ± 3.0 μm thick, echinate, length of spine 6.0 μm, breadth at the base 3.5 μm.

MARTYNIACEAE :

Martynia annua :

Polycolpate, spheroidal, diameter of grain ± 85.0 μm, colpi arranged in the form of penyagon, L/B of colpi ± 14.0 × 1.0 μm. Exine ± 3.0 μm thick, sexine ± 2.0 μm thick, sexine as thick as nexine with obscure pattern.

MELIACEAE :

Azadirachta indica :

4-colporate, prolate-spheroidal, PA×ED ± 40.0 × 38.0μm. L/B of Colpi ± 35.0 × 3.5 μm, ora circular. Exine ± 3.5 μm thick. Sexine 1.5 μm thick, obscure pattern.

Swietenia mahagoni :

4-colporate, subprolate, PA×ED ± 28.0 × 23.0 μm, L/B of colpi ± 22.0 × 1.5 μm, ora circular. Exine ± 1.5 μm thick, sexine ± 1.0 μm thick, punctitegillate.

MORACEAE :

Ficus hispida :

3-porate, oblate-spheroidal, PA×ED ± 25.0 x 27.0 μm, circular pores. Exine ± 2.5 μm thick, sexine ± 1.5 μm thick, reticulate.

MORINGACEAE :

Moringa oleifera :

3-colporate, subprolate, PA×ED ± 42.0 × 33.0 μm, L/B of colpi ± 26.0 × 3.0 μm, ora lalongate. Exine ± 3.0 μm thick, sexine 2.0 μm thick with obscure pattern.

MYRTACEAE :

Eucalyptus globulosus :

3-colporate, oblate, PA×ED ± 16.3 × 24.0 μm, parasyncolpate, L/B of colpi ± 16.0 × 1.0 μm, ora circular. Exine ± 1.0 μm thick, sexine as thick as nexine with obscure pattern.

Psidium guajava :

3-colporate, oblate, traingular in polar view, PA×ED ± 18.0 × 26.5 µm, L/B of colpi ± 5.0 × 3.5 µm, ora lalongate, Exine ± 1.5 µm thick, sexine ± 1.0 µm thick, punctitegillate.

NYCTAGINACEAE :

Mirabilis jalapa :

Pantoporate, spheroidal, diameter of grain ± 120.0 µm, No. of pores ± 68, annulus and extra annular ring present. Exine ± 4.0 µm thick, sexine ± 3.0 µm thick, echinate, reticulate.

POACEAE :

Cynodon dactylon :

1-porate (ulcerate), spheroidal, diameter of grain ± 22.0 µm, pores circular, diameter of pore ± 2.0 µm, annulus present ± 1.2 µm thick. Exine ± 1.2 µm thick, psilate, sexine and nexine not clearly differentiable.

Digitaria sanguinalis :

1-porate, spheroidal, diameter of grain ± 30.0 µm, diameter of pore ± 2.5 µm, annulus ± 2.0 µm thick. Exine ± 2.0 µm thick, psilate.

Imperata cylindrica :

1-porate, spheroidal, diameter of grain ± 30 µm, annulus present. Exine ± 1.5 µm thick, psilate.

Oryza sativa :

1-porate, spheroidal, diameter of grain ± 56.0 µm, diameter of pore ± 3.5 µm. Exine ± 2.5 µm thick, scabrate.

Saccharum spontaneum :

1-porate, spheroidal, diameter of grain ± 42.0 µm, diameter of pore ± 2.8 µm. Exine ± 2.5 µm thick, sexine with scabrate processes.

POLYGONACEAE :

Persicaria hydropiper :

Pantoporate, spheroidal, diameter grain ± 50.0 µm, No. of pores ± 10, apertures are surrounded by larger duplibaculate becula. Exine ± 7.0 µm thick, sexine ± 6.0 µm thick, intectate, heterobrochate, larger one with globose and always duplibaculate, smaller bacula rod shaped.

Rumex dentatus :

3-colpate, prolate-spheroidal, PA×ED ± 28. 0 × 26.0 μm, L/B of colpi ± 24.0 × 3.5 μm, Exine ± 20 μm thick, sexine as thick as nexine.

PORTULACACEAE :

Portulaca oleracea :

Polycolpate, spheroidal, diameter of grain ± 78.0 μm. No. of colpi ± 15, colpi arranged in the form of pentagon. Exine ± 9.0 μm thick, sexine ± 1.5 μm thick, reticulate, spinules are present on the muri.

RHAMNACEAE :

Zizyphus mauritiana :

3-colporate, suboblate, PA×ED ± 24.0 × 30.0 μm, L/B of colpi ± 20.0 × 2.5μm, ora lalongate. Exine ± 2.0 μm thick, sexine ± 1.2 μm thick with obscure pattern.

RUBIACEAE :

Anthocephalus chinensis :

3-colporate. oblate, PA×ED ± 10.0 × 13.5 μm, L/B of colpi ± 8.0 × 1.5 μm, ora circular. Exine ± 1.0 μm thick, sexine ± 1.2 μm thick, punctitegillate.

Ixora coccinea :

3-colporate, prolate, PA×ED ± 23.0 × 17.0 μm, L/B of colpi ± 20.0 × 3.5 μm, ora lolongate. Exine ± 2.0 μm thick, sexine ± 1.5 μm thick, finely reticulate.

RUTACEAE :

Aegle marmelos :

4-colporate, prolate-spheroidal, PA×ED ± 15.0 × 10.0 μm, L/B of colpi ± 12.0 × 1.5 μm, ora lalongate. Exine ± 1.5 μm thick, sexine ± 1.0 μm thick, reticulate.

Glycosmis pentaphylla :

3-colporate, prolate, PA×ED ± 25.0 × 17.5 μm, L/B of colpi ± 17.7 × 2.5 μm, ora lalongate. Exine ± 2.0 μm thick, sexine as thick as nexine, finely reticulate.

SCROPHULARIACEAE :

Lindernia crustacea :

3-colporate, prolate-spheroidal, PA×ED ± 25.0 × 23.5 μm, L/B of colpi ± 16.0 × 2.35 μm, ora not distinct. Exine ± 3.0 μm thick, sexine ± 1.5 μm thick, finely reticulate.

Scoparia dulcis :

3-colporate, prolate, PA×ED ± 18.0 × 11.0 μm, L/B of colpi ± 13.0 × 1.0 μm. Exine ± 1.2 μm thick, sexine ± 0.7 μm thick, psilate.

SOLANACEAE :

Cestrum nocturnum :

3-colporate, subprolate, PA×ED ± 30.0 × 3.5 μm, ora lalongate. Exine ± 1.8 μm thick, sexine ± 1.0 μm thick, psilate.

Datura metel :

3-colporate, oblate-spheroidal, PA×ED ± 47.0 × 48.0 μm, L/B of colpi ± 36.0 × 2.5 μm, ora lalongate. Exine ± 4.0 μm thick, sexine ± 3.0 μm thick, semitectate, striato-reticulate.

Solanum nigrum :

3-colporate, prolate-spheroidal, PA×ED ± 25.0 × 22.0 μm, L/B of colpi ± 20.0 × 3.5 μm, ora lalongate. Exine ± 1.8 μm thick, sexine ± 1.0 μm thick, psilate.

Solanum viarum :

3-colporate, prolate-spheroidal, PA×ED ± 23.5 × 21.0 μm, L/B of colpi ± 16.0/2.0 μm, ora circular. Exine ± 4.0 μm thick, sexine ± 3.0 μm thick, tectate, scabrate.

Solanum torvum :

3-colporate, prolate – spheroidal, PA×ED ± 27.1 × 26.2 μm, L/B of colpi ± 15.5 × 3.5 μm, ora lalongate, Exine ± 0.7 μm thick, sexine and nexine not clearly differentiated, punctitegillate.

STERCULIACEAE :

Pterospermum acerifolium :

3-6 porate, spheroidal, average diam. ± 60.0μm. Pores circular. Exine ± 2.5μm thick, sexine ± 1.5 thick, echinate, spines 3.5μm × 1.5μm..

THEACEAE :

Camellia sinensis :

3-colporate, sub-prolate, PA×ED ± 40.0 × 31.5 μm, L/B of colpi ± 31.5 × 2.5 μm. Ora lolongate. Exine ± 2.5 μm thick, sexine ± 2.0 μm thick, finely reticulate.

TILIACEAE :

Corchorus capsularis :

3-colporate, prolate, PA×ED ± 30.5μm × 25.5μm, L/B of colpi ± 25.5 μm × 2.5 μm. Ora transversally parallel. Exine ± 2.5 μm thick, sexine ± 1.25 μm thick, psilate.

ULMACEAE :

Trema orientalis :

2-3 porate, spheroidal, diam of grain ± 21.3 μm, pore circular. Exine ± 1.04 μm thick, granulate.

URTICACEAE :

Pouzolzia zeylanica :

5-7 porate, spheroidal, diam of grain ± 16.8 μm, pores circular. Exine ± 1.8 μm thick, sexine ± 1.0 μm. thick, psilate.

VERBENACEAE :

Callicarpa arborea :

3-colpate, prolate-spheroidal, PA × ED ± 35.0 × 32.0 μm, L/B of colpi ± 30.0/3.0 μm. Exine ± 2.5 μm thick, intectate, sexine 1.5 μm thick, much thicker at polar regions, reticulate.

Clerodendrum viscosum :

3-colpate, subprolate, PA×ED ± 80.0 × 65.0 μm, L/B of colpi ± 51.0 × 1.0 μm. Exine ± 2.5 μm thick, sexine ± 2.0 μm thick, echinate.

Lantana camara :

3- colporate (often 4, colporate), prolate-spheroidal, PA×ED ± 41.0 × 38.0 μm. L/B of colpi ± 26.0 × 3.6 μm. Ora lalongate. Exine ± 2.0 μm thick, sexine ± 1.2 μm thick, punctitegillate.

Phyla nudiflora :

3- colporate, oblate-spheroidal, PA×ED ± 31.0 × 31.5 μm, L/B of colpi ± 20.0 × 2.6 μm, ora lalongate. Exine ± 3.0 μm thick, sexine ± 2.5 μm thick punctitegillate.

Tectona grandis :

3-colpate, prolate, PA×ED ± 40.0 × 27.5 μm, L/B of colpi ± 32.0 × 2.0 μm, margo present. Exine ± 2.5 μm thick, sexine ± 1.5 μm thick, punctitegillate, supratectal processes perceptible in LO analysis.

Plate- I
Legends of Pollen grains

1. *Zizyphus mauritiana (x 1000)*
2. *Cassia siamea (x 1000)*
3. *Azadirachta indica (x 1000)*
4. *Ocimum sanctum (x 1000)*
5. *Rungia pectinata (x 750)*
6. *Eucalyptus globulosus (x 1000)*
7. *Albizia lebbek (x 750)*
8. *Corchorus capsularis (x 1000)*
9. *Sida rhombifolia (x 500)*
10. *Pterospermum acerifolium (x 1000)*
11. *Justicia diffusa (x 750)*
12. *Anisomeles indica (x 500)*

Plate- II
Legends of Pollen grains

1. *Ageratum conyzoides (x 750)*
2. *Chenopodium album (x 750)*
3. *Casuarina equisetifolia (750)*
4. *Psidium guajava (x 1000)*
5. *Lantana camara (x 750): polar view*
6. *Lantana camara (x 750): equatorial view*
7. *Bombax ceiba (x 500)*

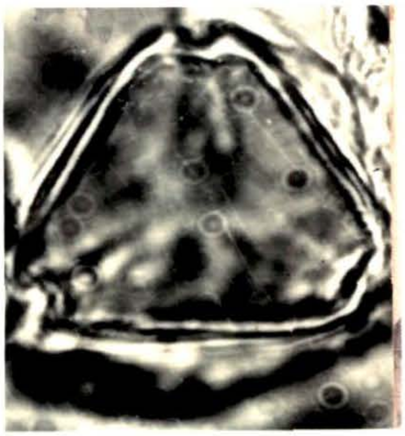
8-9. *Vernonia cinerea (x 750)*

10. *Ipomoea carnea (x 750)*
11. *Psidium guajava (x 1000)*
12. *Mirabilis jalapa (x 750)*

Plate- III
Scanning Electron Microscopic view of Pollen grains

1. *Ageratum conyzoides*
2. *Bombax ceiba*
3. *Coriandrum sativum*
4. *Nelsonia campestris*
5. *Acacia Auriculoformis*
6. *Chenopodium album*

Plate I



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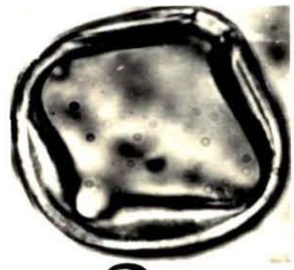

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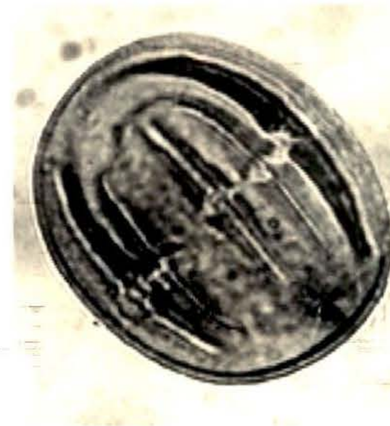

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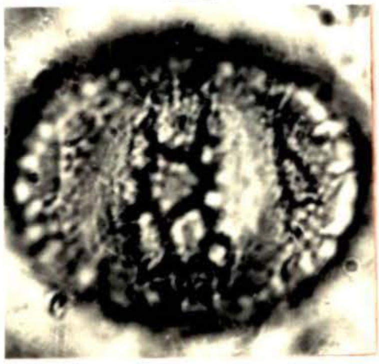

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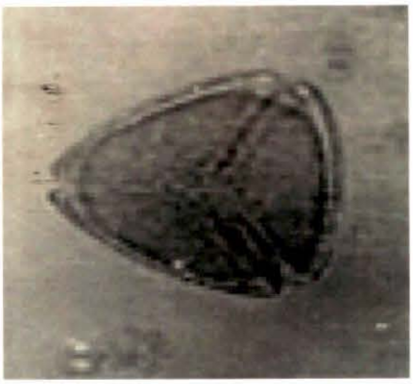

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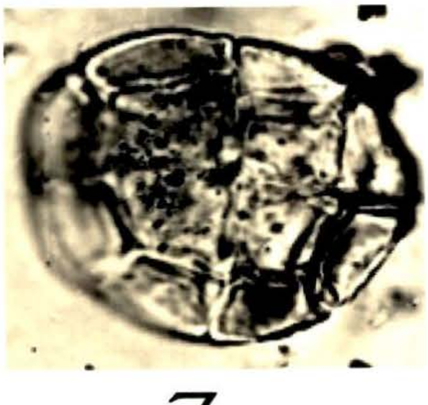

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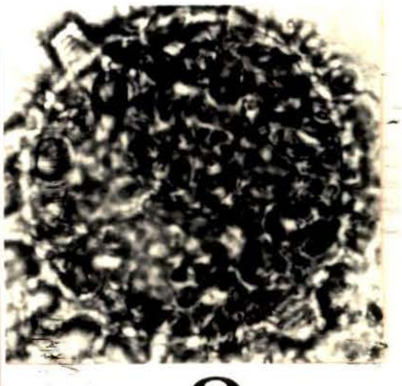

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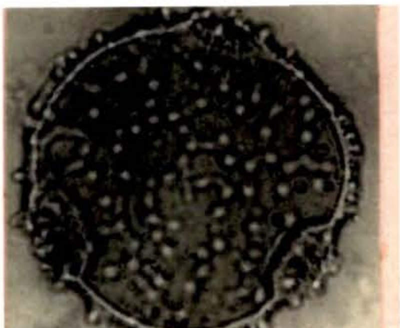

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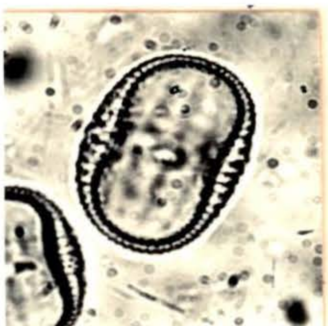

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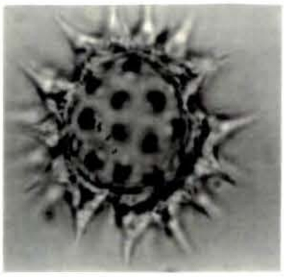
Plate-II



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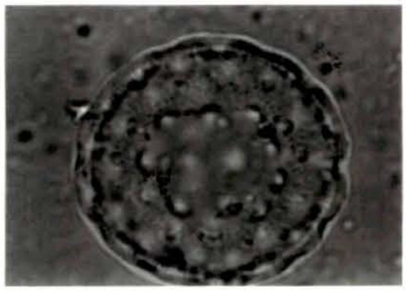

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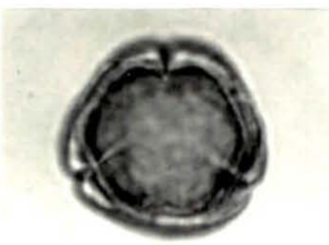

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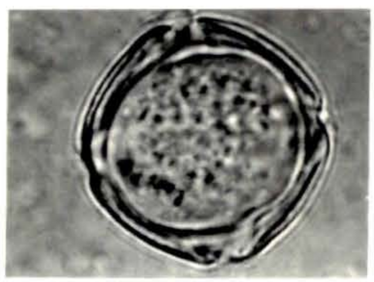

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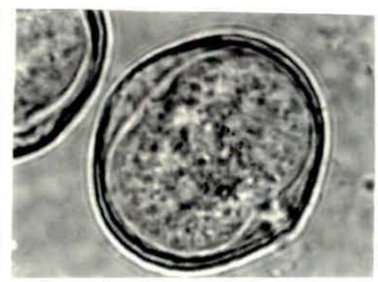

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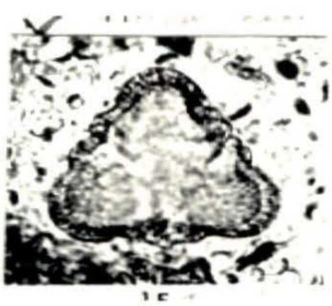

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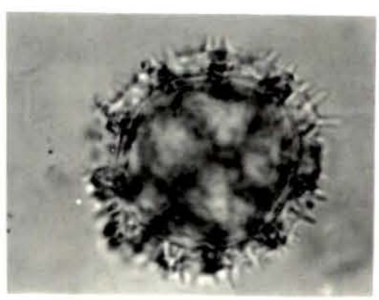

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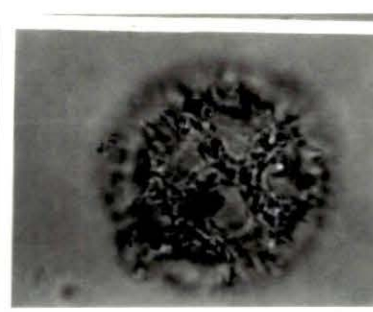

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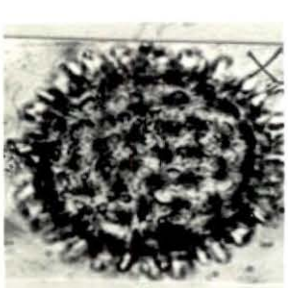

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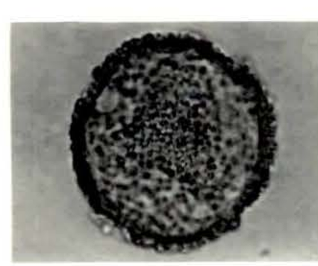

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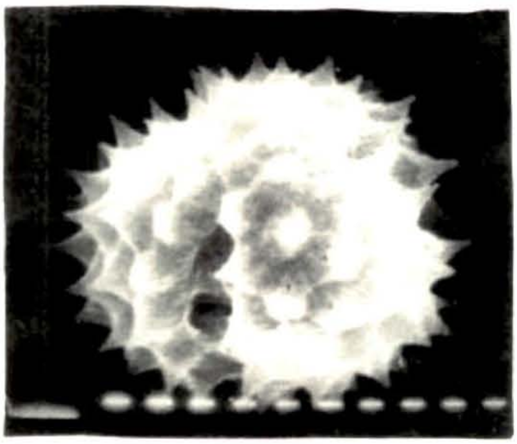
Plate III



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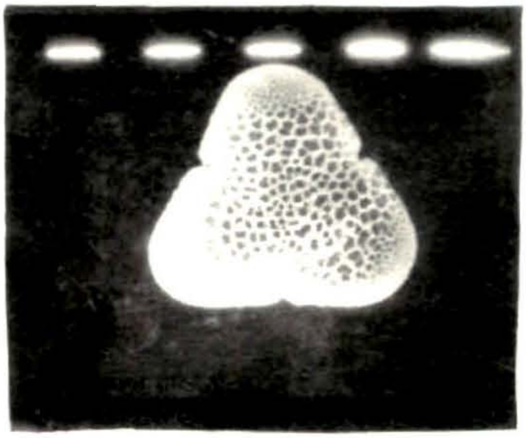

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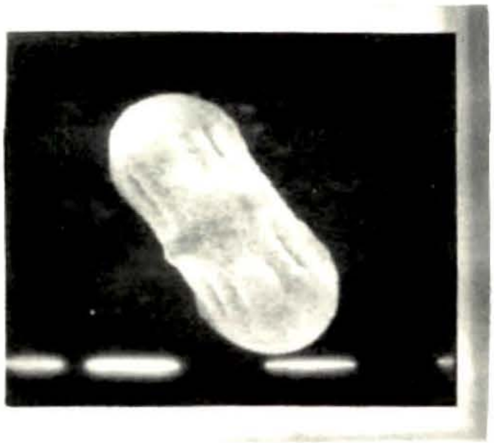

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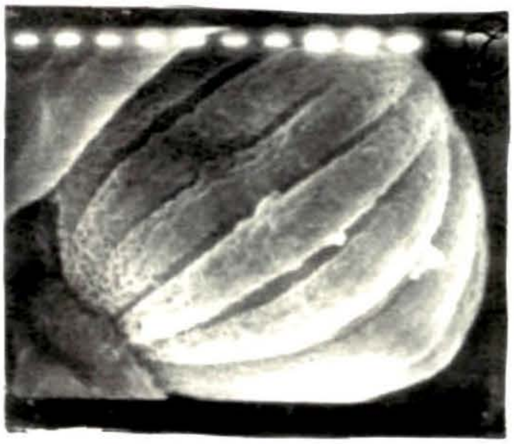

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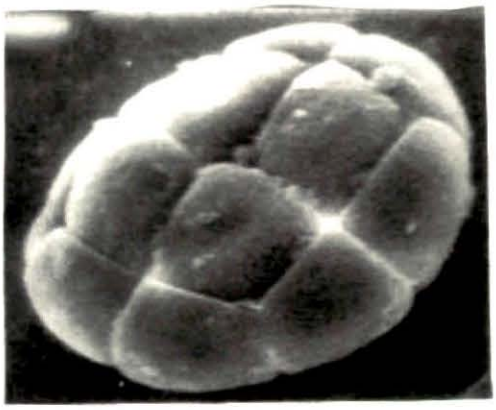

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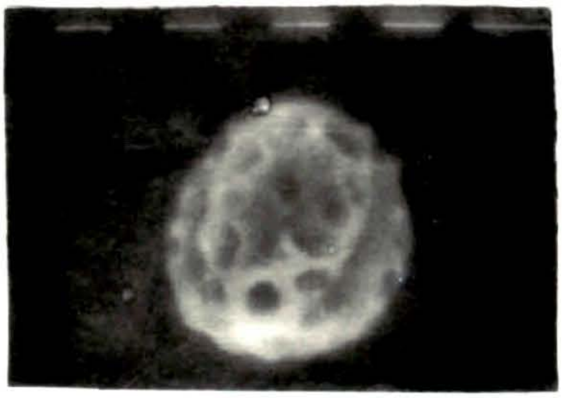


6

POLLEN KEY

MASTERY KEY

A. Grains Single				
B. Aperture absent (or indistinct)		...	Inaperturate	(1)
BB. Aperture present				
C. Apertures simple				
D. With 1 sulci	...	...	1-Sulcate	(2)
DD. With pores	Porate			
1-pore	...	...	1-Porate	(3)
2-5-pore	...	...	2-5-Porate	(4)
Pores many	...	...	Pantoporate	(5)
DDD. With colpi	Colpate			
3-colpi	...	...	3-Colpate	(6)
6-colpi	...	...	6-Colpate	(7)
Colpi many	...	...	Polycolpate	(8),
CC. Apertures compound				
D. Ora in pore	Pororate			
3-pore	...		3-Pororate	(9)
DD. Ora in colpi	Colporate			
3-colpi	...	...	3-Colporate	(10)
4-5-colpi	...	...	4-5 Colporate	(11)
AA. Grains united in group				
B. Union of 4-grains	...	...	Tetrad	(12)
BB. Union of more than 4-grains	...	...	Polyad	(13)

(1) Inaperturate

Aperture absent		
	Echinate (often tetrad)	*Polyalthia longifolia*
	Pegged (with crotonoid pattern)	*Croton bonplandianum*
With indistinct 3-4 aperturoid areas		
	Subspheroidal	*Kyllinga brevifolia*
	Pear shaped	*Cyperus rotundus*

(2) 1-Sulcate

PA. x ED. x EB.	Exceeding 37.7 × 63.0 × 29.7 μm, Sexine verrucate,	*Borassus flabellifer*
PA. x ED. x EB.	25.0 × 41.6 × 39.2 μm, Sexine reiculate, L/B Sulci 29.1/1.5μm.	*Cocos nucifera*
PA×ED×EB	28.0 × 40.0 × 35.0μm, Sexine reticulate, L/B Sulci 34.5/3.5μm.	*Areca catechu*

(3) - 1 porate

Grains less than 50.0 µm in diameter	*Cynodon dactylon* *Digitaria sanguinalis*, *Imperata cylindrica*, *Saccharum spontaneum* (wild grasses)
Grains more than 50.0 µm in diameter	*Oryza sativa*, (cultivated grass)

(4) - 2 – 5- porate

2-3 porate		
	Spheroidal to subspheroidal	
	Sexine granulate, 2-3 porate	*Trema orientalis*
	Sexine reticulate, 3 porate	*Ficus hispida*
	Sexine obscure, 3 porate (rarely 4-5 porate)	*Holarrhena pubescens*
	Sexine reticulate, heterobrochate (3 porate)	*Erythrina variegata*
	Sub-oblate, Sexine scabrate (3-porate)	*Cannabis sativa*
4-5 porate		
	Sexine finely reticulate, pores circular	*Nerium indicum*
5-7 porate		
	Spheroidal.	
	Sexine psilate,	*Pouzolzia zeylanica*
	Sexine echinate	*Pterospermum acerifolium*

(5) Pantoporate

Grains less than 35.0 µm in diam.		
	Pores less than 30	
	Pores ±28-30, interporal distance ± 6.5 µm	*Achyranthes bidentatus*
	Pores ±22, interporal distance ± 4.0 µm.	*Amaranthus spinosus*
	Pores ±26, interporal distance ± 2.5 µm.	*Achyranthes aspera*,
	Pores ±14, interporal distance ± 3.5 µm.	*Deeringia amaranthoides*
	Pores ±60, sexine scabrate	*Chenopodium album*
	Pores 70-75, punctitegillate with supratectal processes	*Chnopodium ambrosioides*

Grains more than 35.0 µm, less than 100.0 µm	
Pores $\pm$ 50	*Ipomoea carnea*
Pores $\pm$ 35	*Malva verticillata*
Pores $\pm$ 20	*Sida rhombifolia*
Pores $\pm$ 10	*Persicaria hydropiper*
Grains more than 100.0 µm in diameter	
Annulus and extra annular ring present, echinate, reticulate, (No. of pores 68)	*Mirabilis jalapa*
Annulus and extra annular ring absent, echinate with spines and spinules (No. of pores 32)	*Hibiscus rosa-sinensis*

(6) 3-Colpate

Grains prolate-spheroidal	
PA 28.0 µm, Sexine as thick as nexine	*Rumex dentatus*
PA 35.0 µm, Sexine thicker at polar region	*Callicarpa arborea*
PA 58.3 µm, Sexine thicker than nexine	*Peltophorum pterocarpum*
Grains sub-prolate to prolate	
PA less than 50.0 µm	
Punctitegillae	*Tectona grandis*
Reticulate	*Anisomeles indica*
Finely reticulate	*Tabebuia argentea*
PA more than 50 µm	
Echinate	*Clerodendrum viscosum*

(7) 6 - Colpate

Simplibaculate, bacula dimorphic, reticulate, heterobrochate	*Ocimum sanctum*

(8) Polycolpate

Colpi in the form of pentagon	
Reticulate, spinules present on muri	*Portulaca oleracea*
Reticulate, spinules absent on muri	*Martynia annua*

(9) 3 - pororate

Grains suboblate, aspidote	*Casuarina equisetifolia.*

(10) 3-colporate

Grains oblate	
Obscure pattern (with parasyncolpate)	*Eucalyptus globulosus*
Punctitegillate	
Ora lalongate (Triangular in polar view)	*Psidium guajava*
Ora circular	*Anthocephalus chinensis*

Reticulate, heterobrochate (Triangular in polar view)	*Bombax ceiba*
Grains sub-oblate	
Obscure pattern, ora lalongate	*Zizyphus mauritiana*
Grains oblate-spheroidal	
Reticulate	
Ora circular	
PA×ED ± 30;0 × 31.5 µm	*Pongamia pinnata*
Ora lolongate,	
PA×ED 42.0 × 45.0µm	*Ichnocarpus frutescens*
Striato-reticulate	
Ora lalongate	
PA×ED ±30.0 × 33.0µm	*Tamarindus indica*
PA×ED ±47.0 × 48.0µm	*Datura metel*
Punctitegillate	
Ora lalongate	*Phyla nudiflora*
Obscure pattern	
Ora lalongate	
PA×ED ±27.0 × 28.5µm	*Trewia polycarpa*
PA×ED ±41.0 × 46.0µm	*Butea monosperma*
Spinulose,	
PA×ED ±21.0 × 22.5µm	*Artemisia vulgaris*
Grains prolate – Spheroidal	
Punctitegillate	
Ora circular	*Lagerstroemia thorelii*
Ora lalongate	
PA×ED ±41.0 × 38.0µm	*Lantana camara*
PA×ED ±27.1 × 26.2µm	*Solanum torvum*
Finely reticulate	
Ora not distinct	*Lindernia crustacea*
Ora lalongate	*Ehretia serrata*
Reticulate,	
Ora lolongate (with alternating pseudo colpi)	*Nelsonia canescens*
Psilate	
Ora lalongate	*Solanum nigrum*
Obscure pattern	
Ora lalongate	
PA×ED ±21.0 × 20.5µm	*Plumeria rubra*
PA×ED ±30.0 × 28.5µm	*Drypetes roxburghii*

Scabrate	*Solanum viarum*
Echinate	
Ora-circular,	
PA×ED ±28.0 × 26.0 μm	*Blumea lacera*
Ora lalongate	
PA×ED ±34.0 × 30.0μm	*Vernonia cinerea*
Spinulose	
Ora lalongate	*Xanthium strumarium*
Finely granulate	*Bauhinia variegata*
Grains sub-prolate	
Psilate	
Ora lalongate	
PA×ED ±39.0 × 32.0μm	*Cestrum nocturnum*
Obscure pattern	
Ora lalongate	
PA×ED ±21.0 × 18.0μm	*Terminalia arjuna*
PA×ED ±42.0 × 33.0μm	*Moringa oleifera*
Ora circular	*Thevetia peruviana*
Reticulate	
Ora lalongate	
PA×ED ±28.0 × 22.0μm	*Capparis zeylanica*
Finely reticulate	
Ora lolongate	
PA×ED ±40.0 × 31.5μm	*Camellia sinensis*
Ora lalongate	
PA×ED ±45.0 × 35.0μm	*Cassia siamea*
Striato-reticulate	
Ora lolongate	*Mangifera indica*
Scabrate	*Cassia sophera*
Echinate	
Ora circular	*Ageratum conyzoides*
Grains prolate	
Reticulate	
Ora lolongate	*Sesbania grandiflora*
Ora lalongate	
PA×ED ±45.0 × 30.0μm	*Heliotropium indicum*
PA×ED ±31.0 × 20.0μm	*Rungia pectinata*
PA×ED ± 30.0 × 20.0μm	*Crataeva nurvala*
PA×ED ±28.0 × 17.0μm	*Euphorbia hitra*
PA×ED ±22.5 × 16.0μm (hetero brochate)	*Justicia diffusa*

Finely reticulate
Ora lolongate — *Ixora coccinea*
Ora lalongate
PA×ED ±35.0 × 22.5μm — *Cassia fistula*
PA×ED ±25.0 × 17.5μm — *Glycosmis pentaphylla*

Obscure pattern
Ora lalongate
PA×ED ±8.5 × 5.0μm (dumb-bell shaped) — *Cynoglossum lanceolatum*
PA×ED ±27.0 × 21.0μm — *Dalbergia sissoo*

Psilate
Ora not distinct — *Scoparia dulcis*
Ora transverselly parallel — *Chorchorus capsularis*

Punctitegillate
Ora lalongate — *Cochlospermum religiosum*

Grains spheroidal
Reticulate — *Caesalpinia pulcherrima*

Psilate
Ora lalongate — *Alstonia scholaris*

Echinate
Ora lolongate — *Eclipta prostrata*

Obscure pattern
Ora lalongate — *Carica papaya*

Grains perprolate
Finely reticulate
PA×ED ±24.2 × 13.8μm — *Coriandrum sativum*

Reticulate
PA×ED ±24.5 × 10.6μm — *Seseli indicum*

(11) 4-5 colporate

Grains 4-colporate
Ora circular
Obscure pattern — *Azadirachta indica*
Punctitegillate — *Swietenia mahagoni*
Ora lalongage
reticulate — *Aegle marmelos*

(12) Tetrad

Tetragonal tetrad, grains
Monosulcoidate — *Annona reticulata*

(13) Polyad

Grains in group of 16, round shaped	
Granulate	*Acacia auriculoformis*
Faintly granulate	
Monads lossely fitted	*Albizia lebbek*
Psilate	*Pithecellobium dulci*
Grains in form of Pollinia	*Calotropis gigantea:*

POLLEN MORPHOLOGICAL STUDY

Results :

Pollen morphological studies of 108 common plant species of Jalpaiguri town were curried out to identify the airborne pollen grains. The terminology, definitions, and other morphological concepts are based on Erdtman (1952,1969), Faegri and Iversen (1975) and Chanda (1963,1965,1966). This study showed a great variety of characteristics which cover almost all the aperturul types, e.g. inapurturate, 1-Sulcate, 1-Porate, 2-5 Porate, Pantoporate, 3-Colpate, 6-Colpate, Polycolpate, 3-Pororate, 3-Colporate, 4-5 Colporate and Polyad. In the present investigation, the identification of airborne pollen grains was done by comparing the pollen types with the reference slides and also consulting the published literatures of Erdtman (1952), Lewis *et. al.* (1984), Gupta *et. al* (1985), Banik *et. al* (1986), Majumder *et. al* (1988).

POLLEN DIAGNOSES

Sl. No.	Pollen Types	Name of the plant species
1.	Inaperturate	*Polyalthia longifolia, Croton bonplandianum, Cyperus rotundus, Kyllinga brevifolia.*
2.	1-Sulcate	*Borassus flabellifer, Cocos nucifera, Areca catechu.*
3.	1-Porate	*Cynodon dactylon, Digitaria sanguinalis, Imperata cylindrica, Saccharum spontaneum* (wild grass), *Oryza sativa,* (cultivated grass).
4.	2-5 Porate	*Trema orientalis, Cannabis sativa, Ficus hispida, Holarrhena pubescens, Erythrina variegata, Kleinhovia hospita.*
	4-5 Porate	*Nerium indicum.*
	5-7 Porate	*Pouzolzia zeylanica, Pterospermum acerifolium.*
5.	Pantoporate	*Amaranthus spinosus, Achyranthes aspera, Chenopodium album, Ipomoea carnea, Persicaria hydropiper, Mirabilis jalapa, Hibiscus rosa-sinensis.*
6.	3-Colpate	*Rumex dentatus, Callicarpa arborea, Tectona grandis, Anisomeles indica, Clerodendrum viscosum, Tabebuia argentea.*
7.	6 Colpate	*Ocimum sanctum.*
8.	Polycolpate	*Portulaca oleracea, Martynia annuna*

Contd. ...

Sl. No.	Pollen Types	Name of the plant species
9.	3 Pororate	*Casuarina equisetifolia.*
10.	3 Colporate	*Eucalyptus globulosus, Psidium guajava, Bombax ceiba, Zizyphus mauritiana, Pongamia pinnata, Datura metel, Tamarindus indica, Trewia polycarpa, Butea monosperma, Lagerstroemia thorelii, Lantana camara, Lindernia crustacea, Solanum nigrum, Blumea lacera, Vernonia cinerea, Xanthium strumarium, Bauhinia variegata, Cestrum nocturnum, Dalbergia sissoo, Terminalia arjuna, Moringa oleifera, Cassia siamea, Mangifera indica, Cassia sophera, Ageratum conyzoides, Heliotropium indicum, Euphorbia hirta, Cassia fistula, Glycosmis pentaphylla, Scoparia dulcis, Cochlospermum religiosum, Caesalpinia pulcherrima, Alstonia scholaris, Eclipta prostata, Carica papaya.*
11.	4-5 Colporate	*Azadirachta indica, Swietania mahagoni, Aegle marmelos.*
12.	Tetrad	*Annona reticulata.*
13.	Polyad	*Acacia auriculoformis, Albizzia lebbek, Samania saman.*

Discussions :

In the present investigation pollen diagnoses were made from the pollen morphological studies of 108 plant species. There are many plant families unrelated taxonomically but possess similar type of pollen grains, thus rendering difficulty in identification. This problem is particularly encountered in 3-Colporate pollen grains being the most dominating type. Same difficulty was observed with stenopalynous family like Poaceae. In case of echinate pollen grains of Malvaceae, Convolvulaceae or Pantoporate grains of Amaranthaceae, Chenopodiaceae, the identification of pollen grains upto generic or specific level was very difficult due to morphological similarity of pollen grains. Presence of a large number of 3-Colporate grains is significant, because such grains are considered to be relatively advanced in comparison to other apertural conditions. From this point of view it may be suggested that the flora which have been studied by and large is advanced palynologically irrespective of their individual taxonomical positions. Plant species belonging to Poaceae is widely distributed and second most dominating family in Jalpaiguri town contribute a large number of pollen grains to the atmosphere. The pollen grains of this family have been grouped under two categories, i.e. wild and cultivated types by having size differences. The grains larger than 50μm have been considered to be originated from cultivated varieties (Firbas, 1937; Hafsten, 1956). But the distinction is found to be arbitrary because this size criteria is not applicable in tropical countries like India and Ethiopia (Guinet, 1966; Bonnefille, 1969; Vishnu Mittre, 1973).

In the present investigation a pollen key has been prepared based on the proposition of Faegri and Iversen (1975) which is found to be helpful in identifying the airborne pollen grains obtained from two years aeropalynological survey of the investigated area.

AEROPALYNOLOGY OF JALPAIGURI TOWN

Phenology of airborne pollen grains

Phenology of each of the identified pollen grain (Table 8) is described below. Photography of some of the airborne pollen grains has been given in Plate IV and V :

(1) *Acacia auriculoformis*

The pollen of this species showed an extended period from March to October. The highest record was in May 1995-96 and in June 1996-97. Contribution to the two years aeropalynoflora was 98 (1.68) and 129 (2.18%) respectively (Table 8).

(2) *Acer* sp.

This pollen type was recorded from January to March with low percentage contribution of 0.24 in 1995-96 and 0.52 in 1996-97 (Table 8). This is migratory pollen, perhaps coming from Eastern Himalaya.

(3) *Albizia* sp.

This pollen type was recorded from January to July. The highest number occurred in May for both the years with a percentage contribution in between 1.85 – 2.09.

(4) *Alnus nepalensis*

This pollen type was recorded from October to March. The highest record was in October in 1995-96 and November in 1996-97. Contribution to the two years aeropalynoflora was 96 (1.64%) in 1995-96 and 101 (1.70%) in 1996-97. This is also a migratory pollen of Eastern Himalaya.

(5) *Areca catechu*

The pollen grains of *Areca catechu* occurred round the year and in 1995-96 with a total of 59 (1.01%) grains and in 1996-97 contributing 48 (0.81%) grains to the airspora..Maximum concentration was recorded in March 1995-96 and September 1996-97.

(6) *Artemisia* sp.

The pollen of this species recorded from October to April with a low percentage contribution of 0.82 in 1995-96 and 0.62% in 1996-97.

(7) Asteraceae

The Pollen of this family occurred round the year. It contributed 6.56% with a total of 383 pollen in 1995-96 and 7.25% with a total of 429 grains in 1996-97 with a peak period in between November to January for both the years.

(8) ***Azadirachta indica***

The pollen grain of this tree occurred from March to July for both the years, contributing a total of 64 and 41 grains respectively. The highest number of grains occurred with percentage contribution of 1.09 and 0.69 in the two years respectively.

(9) ***Betula alnoides***

Birch pollen appeared from first week of April from first week of March and continued until the end of July. It contributed 2.50% with a total of 146 grains in 1995-96 and 2.75% with a total of 163 grains in 1996-97.

(10) ***Bombax ceiba***

This pollen type was first encountered in the first week of March with maximum incidence in April (51 grains) in 1995-96 and 62 grains in March, 1996-97. Percentage concentration was 1.97 and 2.84 respectively.

(11) ***Callistemon lanceolatus***

The first bottle brush pollen grain was recorded on 2nd week of September extended upto February. In 1996-97 pollen grain was recorded up to May. Percentage contribution being 3.87% and 4.36% in 1995-96 and 1996-97 respectively.

(12) ***Cannabis sativa***

The pollen grains were recorded from March to September in 1995-96 and from March to November in 1996-97, showing highest frequency in May 1995-96 and March 1996-1997. Percentage contribution being 6.32 and 3.36 in 1995-96 and 1996-97 respectively.

(13) ***Carica papaya***

This pollen type was recorded from March to May with low percentage contribution of 0.30 for both the years.

(14) ***Cryptomeria japonica***

The Eastern Himalayan *Cryptomerica* pollen was first recorded in first week of February, subsequent occurrence extended until April in 1995-96 and May in 1996-97. It's percentage contribution was 0.34% in 1995-96 and 0.49% in 1996-97 with a total 20 and 29 grains respectively.

(15) ***Cassia* sp.**

In 1995-96, 4.45% pollen grains were distributed throughout the year varying in number in different months, the highest number was 52 in April and total pollen count was 260. In 1996-97 total count was 306 with a percentage contribution of 5.17. In the second year the grains recorded in all months with maximum incidence in September (52).

(16) *Casuarina equisetifolia*

It was first reported on first week of March though infrequent in the beginning but gradually increased in concentration with a peak of May. Frequency decreased from first week of June. It contributed 1.41% with a total of 83 and 1.03% with a total of 61 grains in 1995-96 and 1996-97 respectively.

(17) **Cheno-Amaranthaceae**

Pollen grains of goose foot family was recorded almost throughout the survey period with relatively high consistency from December to May. Percentage contribution was 4.23 (1995-96) and 4.73 (1996-97). The grains of these two families are clubbed together as morphological difference is little.

(18) *Cocos nucifera*

This pollen type was recorded in March and extended upto June. Maximum contribution was recorded in the month of May. In 1995-96 the percentage contribution was 2.55 and in the second year it was 2.53.

(19) **Cyperaceae**

The pollen grains of this family were first noted in October. Peak concentration was in October in both the year. For the remaining months occurrence was sporadic and no pollen grain was recorded in April (1995-96) and June (1996-97). Percentage contribution was 4.71 with a total 275 in the first year and 3.31 with a total 196 grains in the second year.

(20) *Eucalyptus globulosus*

Pollen grains of *Eucalyptus* were first trapped on October and extended upto March. In 1995-96, 131 grains were recorded with a concentration of 2.24%. In 1996-97, a total of 134, contributing 2.26% to the total aeropalynoflora, remained distributed in the same months.

(21) **Euphorbiaceae**

Pollen grain belonging in this family were first recorded in March and extended upto August. Total contribution to the aeropalynoflora in 1995-96 was 48 (0.82%) and 60 (1.01%) in 1996-97.

(22) *Ilex* **sp.**

The occurrence of migratory Eastern Himalayan *Ilex* was sporadic for the entire period from February to May. A total of 36 (0.61%) and 31 (0.52%) grains were recorded during the two years survey period.

(23) *Litsea glutinosa*

The pollen grain was encountered in April to June with a very low concentration.A total of 18 grains in 1995-96 and 16 grains in 1996-97 were recorded. In the first year the percentage was 0.30% and in the second year it was 0.27%.

(24) *Mangifera indica*

This pollen type was recorded in March and extended upto May; with a low percentage contribution 0.54 in 1995-96 and 0.42 in 1996-97. Peak concentration was in April.

(25) *Pinus* sp.

The pine pollen was first recorded in 2nd week of January and in 1995-96 it was frequent until May with abundance in March. In 1996-97 it was extended upto June. The total grains reported were 144 in 1995-96 and 151 in 1996-97 with percentage contribution of 2.46 and 2.55 respectively. This is migratory pollen perhaps coming from Eastern Himalaya.

(26) *Peltophorum pterocarpum*

This pollen type was first observed in September and then continued until March, with maximum values in December. It contributed a total of 129 (2.21%) and 98 (1.65%) to the total aeropalynoflora of 1995-96 and 1996-97 respectively.

(27) Polygonaceae

Pollen grains of this weed family appeared from March to July and October in 1995-96 while it was from March to June and October in 1996-97. Total pollen count was 96 (1.64%) in the first year and 86 (1.45%) in the second year. In both the years maximum number of pollen grains were recorded in April, the number being 31 and 26 respectively.

(28) *Psidium guajava*

The occurrence of *Psidium guajava* pollen grains were sporadic with two peaks and appeared from April to May and August to September. In 1995-96, 54 (0.92%) grains and in 1996-97, 49 grains contributed 0.82% to the total aeropalynoflora. In both the year maximum values recorded in May.

(29) Poaceae

Grass pollen grains were first noted on September and in high concentration and recorded in all the months of the survey period. From December to March it was with low percentage. It occurred frequently from April to October. In the first year total pollen count was 1069 (18.32%) and in the second year 1095 (18.51%).

(30) Rutaceae

In 1995-96, 1.37% grains of this family remained distributed from November to March showing maximum incidence of 20 grains in December, and the total pollen catch was 80. In 1996-97 the grains remained distributed from October to March contributing 1.18% with a total count of 70 grains, with maximum values in December (18 grains).

(31) *Quercus* sp.

The occurrence of high altitude Oak pollen grains was noted from October. The values recorded were maximum in November. A total 162 (2.77%) and 156 (2.63%) grains were noted in aeropalynoflora of 1995-96 and 1996-97 respectively.

(32) Scrophulariaceae

Pollen grain of this family occurred sporadically from February to June, in very low concentration. Total pollen contribution was 19 (0.32%) and 12 (0.20%) in 1995-96 and 1996-97 respectively.

(33) Solanaceae

Pollen types included within the family remained distributed throughout the year except in January in 1995-96, with wide fluctuation in number for different months. The highest was in April 48 grains in the first year, 57 grains in the second year. The total pollen count were 259 (4.44%) and 386 (6.52%) in 1995-96 and 1996-97 respectively.

(34) *Syzygium* sp.

The occurrence of *Syzygium* pollen grains were sporadic and appeared from April to July and September to October. The total number of pollen grains recorded were 82 (1.40%) in the first year and 67 (1.12%) in the second year.

(35) *Terminalia* sp.

This pollen type was first encountered sporadically in the first week of April, with maximum concentration in June and July. Total pollen count was 152 (2.60%) and 1.50 (2.53%) in 1995-96 and 1996-97 respectively.

(36) *Trema orientalis*

The occurrence of *Trema orientalis* pollen grains appeared from March to June, with a maximum concentration in May. The total number of pollen grains recorded were 137 (2.34%) in 1995-96 and 132 (2.23%) in 1996-97.

(37) Verbenaceae

The pollen grains of this family occurred sporadically with a moderate percentage. Total contribution was 144 (2.46%) in the first year and 139 (2.35%) in the second year.

(38) *Xanthium strumarium*

This pollen type was first recorded in October and extended up February, with maximum values in December. Total pollen count was 67% (1.14%) in 1995-96 and 50 (0.84%) in 1996-97.

(39) *Zizyphus* sp.

This pollen type was present from September to December with a low concentration. The total pollen count were 77 (1.32%) and 68 (1.14%) in 1995-96 and 1996-97 respectively.

(40) *Indeterminate type*

The unidentified pollen grains were present round the year with low concentrations. A total of 119 grains (2.04%) in 1995-96 and 171 (2.89%) in 1996-97 were recorded.

Plate- IV
Legends of airborne pollen

1. *Acacia auriculoformis* (x 500)
2. *Azadirachta indica* (x 750)
3. *Cocos nucifera* (x 500)
4. *Bombax ceiba* (x 500)
5. *Scrophulariaceae* (x 500)
6. *Quercus sp.* (x 500)
7. Cheno-Amaranthaceae (x 750)
8. Cyperaceae (x 750)
9. *Cassia sp.*(x 750)
10. Euphorbiaceae *(Croton type)*(x 500)
11. *Eucalyptus sp.*(x 800)
12. Asteraceae (x 750)
13. *Cassia sp.* (x 750)
14. Polygonaceae (x 500)
15. Poaceae (x 500)
16. *Zizyphus sp.*(x 1000)
17. *Mangifera indica* (x 500)
18. *Trema orientalis* (x 1000)
19. *Casuarina equisetifolia* (x 1000)
20. Rutaceae (x 500)

Plate- V
Legends of airborne pollen

1. *Artemisia sp.*(x 1000)
2. Indeterminate (x 500)

3-4. Polygonaceae (x 500)
5-6. Carica papaya (x 1000)

7. Solanaceae (x 500)
8. *Psidiun guajava* (x 1000)
9. *Albizia sp.* (x 750)
10. *Terminalia sp.* (x 1000)
11. *Acer sp.* (x 500)
12. Polygonaceae (x 500)
13. *Pinus sp.* (x 500)
14. *Peltophorum sp.*(x 500)

Plate-IV

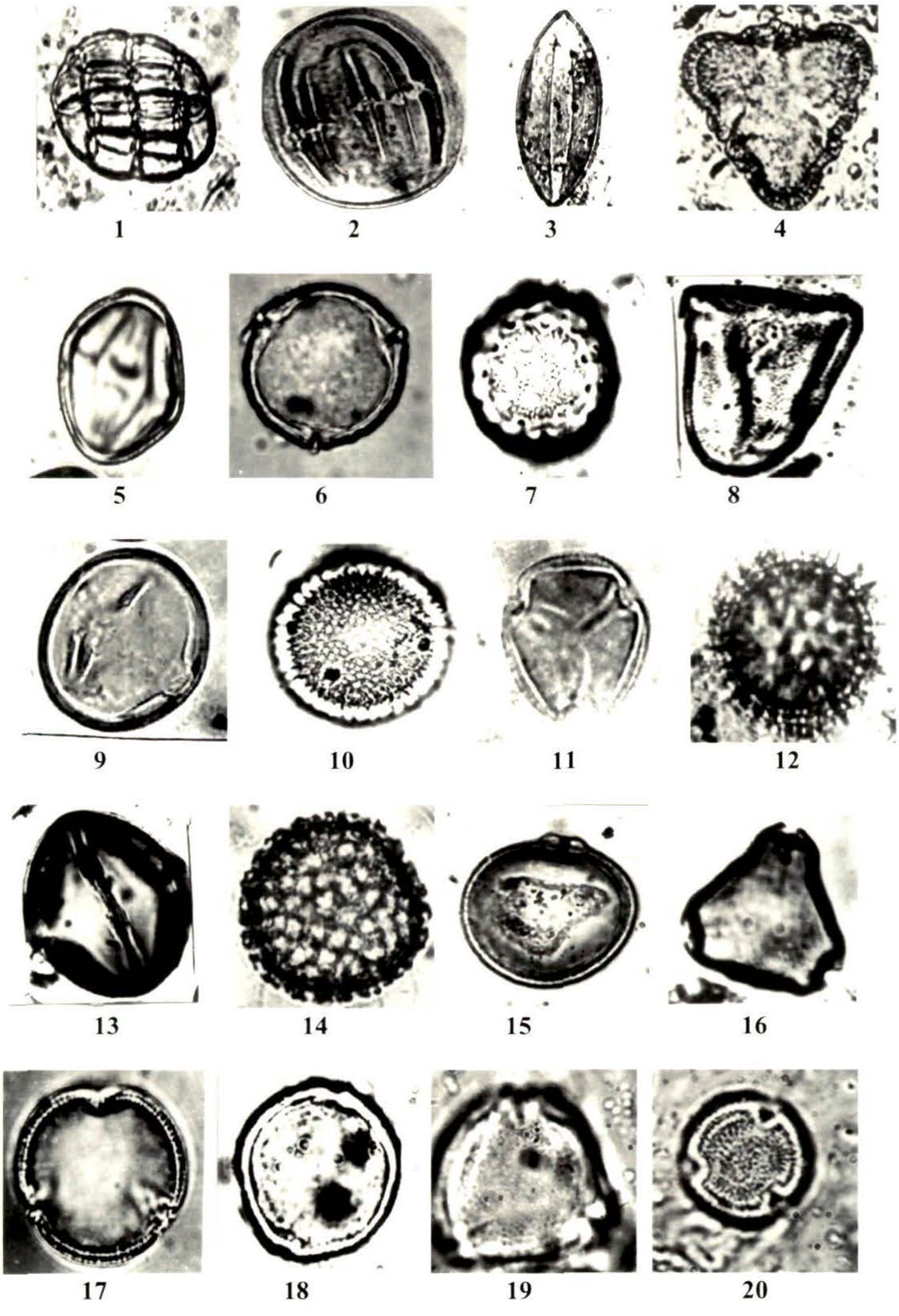
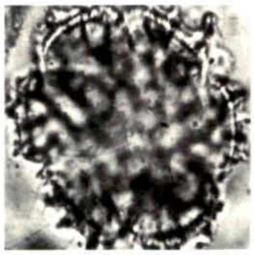


Plate- V


1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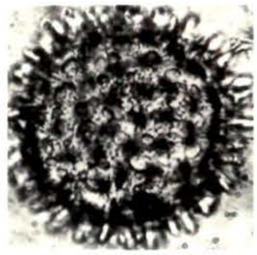
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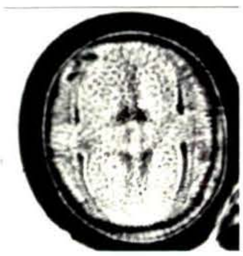
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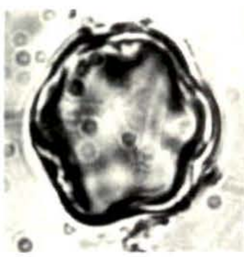
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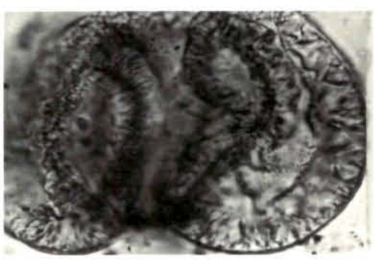
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TABLE 8 : POLLEN CALENDAR OF JALPAIGURI TOWN FOR THE YEAR 1995-1996 AND 1996-1997 BY USING GRAVITATIONAL SAMPLER

SL. NO	POLLEN TYPES	YEAR	TOTAL NUMBER PER 10 SQ.CM. TRAP SURFACE FROM 1ST OCTOBER 1995 TO 31ST SEPTEMBER 1997												TOTAL	%
			OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.		
1.	*Acacia auriculoformis*	1995-96	6	-	-	-	-	7	6	25	21	16	12	5	98	1.68
		1996-97	10	-	-	-	-	9	9	28	35	19	8	11	129	2.18
2.	*Acer* sp.	1995-96	-	-	-	6	4	4	-	-	-	-	-	-	14	0.24
		1996-97	-	-	-	11	12	8	-	-	-	-	-	-	31	0.52
3.	*Albizia* sp.	1995-96	-	-	-	11	25	21	14	27	10	-	-	-	108	1.85
		1996-97	-	-	-	17	28	16	22	30	7	4	-	-	124	2.09
4.	*Alnus* sp.	1995-96	35	30	12	6	10	3	-	-	-	-	-	-	96	1.64
		1996-97	28	32	17	12	5	7	-	-	-	-	-	-	101	1.70
5.	*Areca catechu*	1995-96	2	4	4	3	4	12	4	4	4	4	10	4	59	1.01
		1996-97	2	3	5	4	2	7	6	2	3	4	8	2	48	0.81
6.	*Artemisia* sp.	1995-96	6	4	4	6	8	14	6	-	-	-	-	-	48	0.82
		1996-97	8	6	3	3	4	8	5	-	-	-	-	-	37	0.62
7.	Asteraceae	1995-96	24	52	78	63	35	28	30	35	12	5	14	7	383	6.56
		1996-97	21	70	105	74	41	31	22	28	8	4	5	20	429	7.25
8.	*Azadirachta indica*	1995-96	-	-	-	-	-	7	6	21	18	12	-	-	64	1.09
		1996-97	-	-	-	-	-	5	4	12	15	5	-	-	41	0.69
9.	*Betula* sp.	1995-96	-	-	-	-	-	28	54	37	27	-	-	-	146	2.50
		1996-97	-	-	-	-	-	22	34	52	35	20	-	-	163	2.75
10.	*Bombax ceiba*	1995-96	-	-	-	-	-	30	51	24	10	-	-	-	115	1.97
		1996-97	-	-	-	-	-	62	55	42	9	-	-	-	168	2.84
11.	*Callistemon lanceolatus*	1995-96	35	72	47	30	18	-	-	-	-	-	-	24	226	3.87
		1996-97	41	32	54	37	35	16	3	9	-	-	-	31	258	4.36

Contd. ...

SL. NO	POLLEN TYPES	YEAR	TOTAL NUMBER PER 10 SQ.CM. TRAP SURFACE FROM 1ST OCTOBER 1995 TO 31ST SEPTEMBER 1997												TOTAL	%
			OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.		
12.	*Cannabis sativa*	1995-96	8	3	-	-	-	74	85	95	48	23	18	15	369	6.32
		1996-97	-	-	-	-	-	63	42	27	21	16	24	6	199	3.36
13.	*Carica papaya*	1995-96	-	-	-	-	-	4	9	5	-	-	-	-	18	0.30
		1996-97	-	-	-	-	-	3	12	3	-	-	-	-	18	0.30
14.	*Cassia* sp.	1995-96	41	14	6	12	14	24	52	18	21	9	14	35	260	4.45
		1996-97	38	25	11	17	21	26	38	35	16	5	22	52	306	5.17
15.	*Casuarina equisetiflia*	1995-96	-	-	-	-	-	12	25	28	18	-	-	-	83	1.41
		1996-97	-	-	-	-	-	9	24	16	7	5	-	-	61	1.03
16.	Cheno–Amaran-thaceae	1995-96	8	9	24	31	28	41	21	29	17	28	7	4	247	4.23
		1996-97	12	7	38	26	31	54	37	35	21	16	-	3	280	4.73
17.	*Cocos nucifera*	1995-96	-	-	-	-	-	21	45	67	16	-	-	-	149	2.55
		1996-97	-	-	-	-	-	16	54	74	6	-	-	-	150	2.53
18.	*Cryptomeria joponica*	1995-96	-	-	-	-	11	7	2	-	-	-	-	-	20	0.34
		1996-97	-	-	-	-	9	12	6	2	-	-	-	-	29	0.49
19.	Cyperaceae	1995-96	76	32	8	25	35	6	-	7	4	21	26	35	275	4.71
		1996-97	52	17	11	14	21	15	9	11	-	16	11	19	196	3.31
20.	*Eucalyptus globulosus*	1995-96	32	28	21	12	30	8	-	-	-	-	-	-	131	2.24
		1996-97	37	30	16	22	18	11	-	-	-	-	-	-	134	2.26
21.	Euphorbiaceae	1995-96	-	-	-	-	-	12	16	8	2	6	4	-	48	0.82
		1996-97	-	-	-	-	-	18	23	5	-	11	3	-	60	1.01
22.	*Ilex* sp.	1995-96	-	-	-	-	13	10	4	9	-	-	-	-	36	0.61
		1996-97	-	-	-	-	7	6	11	7	-	-	-	-	31	0.52
23.	*Litea glutinosa*	1995-96	-	-	-	-	-	-	12	6	-	-	-	-	18	0.30
		1996-97	-	-	-	-	-	-	9	4	3	-	-	-	16	0.27
		1996-97	4	17	32	24	9	-	-	-	-	-	-	12	98	1.65

Contd. …

SL. NO	POLLEN TYPES	YEAR	TOTAL NUMBER PER 10 SQ.CM. TRAP SURFACE FROM 1ST OCTOBER 1995 TO 31ST SEPTEMBER 1997												TOTAL	%
			OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.		
24.	*Mangifera indica*	1995-96	-	-	-	-	-	7	21	4	-	-	-	-	32	0.54
		1996-97	-	-	-	-	-	6	11	8	-	-	-	-	25	0.42
25.	*Peltophorum pterocarpum*	1995-96	11	21	30	22	16	4	-	-	-	-	-	25	129	2.21
26.	*Pinus* sp.	1995-96	-	-	-	25	20	62	21	16	-	-	-	-	144	2.46
		1996-97	-	-	-	18	24	48	30	27	4	-	-	-	151	2.55
27.	Poaceae	1995-96	135	85	35	12	28	33	78	112	187	102	65	197	1069	18.32
		1996-97	104	96	94	9	17	48	95	157	169	110	48	148	1095	18.51
28.	Polygonaceae	1995-96	6	-	-	-	-	21	31	21	11	6	-	-	96	1.64
		1996-97	5	-	-	-	-	25	26	12	18	-	-	-	86	1.45
29.	*Psidium guajava*	1995-96	-	-	-	-	-	-	9	18	-	-	16	11	54	0.92
		1996-97	-	-	-	-	-	-	12	24	-	-	5	8	49	0.82
30.	Rutaceae	1995-96	-	10	20	16	18	16	-	-	-	-	-	-	80	1.37
		1996-97	4	14	18	9	14	11	-	-	-	-	-	-	70	1.18
31.	*Quercus* sp.	1995-96	38	64	32	28	-	-	-	-	-	-	-	-	162	2.77
		1996-97	27	58	46	17	8	-	-	-	-	-	-	-	156	2.63
32.	*Scrophulariaceae*	1995-96	-	-	-	-	3	4	3	7	2	-	-	-	19	0.32
		1996-97	-	-	-	-	1	6	2	-	3	-	-	-	12	0.20
33.	Solanaceae	1995-96	35	14	4	-	31	42	48	28	31	10	7	9	259	4.44
		1996-97	27	18	7	28	54	57	38	51	37	28	16	25	386	6.52
34.	*Syzygium* sp.	1995-96	11	-	-	-	-	-	11	14	21	4	-	21	82	1.40
		1996-97	8	-	-	-	-	-	6	21	14	-	-	18	67	1.12
35.	*Terminalia* sp.	1995-96	-	-	-	-	-	-	27	16	54	48	7	-	152	2.60
		1996-97	-	-	-	-	-	-	9	12	67	51	11	-	150	2.53
36.	*Trema orientalis*	1995-96	-	-	-	-	-	21	51	58	7	-	-	-	137	2.34
		1996-97	-	-	-	-	-	18	47	52	15	-	-	-	132	2.23

Contd. ...

SL. NO	POLLEN TYPES	YEAR	TOTAL NUMBER PER 10 SQ.CM. TRAP SURFACE FROM 1ST OCTOBER 1995 TO 31ST SEPTEMBER 1997												TOTAL	%
			OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.		
37.	Verbenaceae	1995-96	-	9	3	-	7	30	47	21	18	5	4	-	144	2.46
		1996-97	-	7	-	-	4	28	37	32	22	9	-	-	139	2.35
38.	*Xanthium strumarium*	1995-96	9	11	24	16	7	-	-	-	-	-	-	-	67	1.14
		1996-97	7	8	21	11	3	-	-	-	-	-	-	-	50	0.84
39.	*Zizyphus* sp.	1995-96	21	35	9	-	-	-	-	-	-	-	-	12	77	1.32
		1996-97	24	31	6	-	-	-	-	-	-	-	-	7	68	1.14
40.	INDETERMINATE	1995-96	2	7	21	28	17	13	19	6	4	2	-	-	119	2.04
		1996-97	1	11	19	34	13	37	22	18	7	4	2	3	171	2.89
	GRAND TOTAL	**1995-96**	**541**	**504**	**382**	**352**	**382**	**626**	**808**	**766**	**563**	**301**	**204**	**404**	**5833**	
		PERCENTAGE	**9.27**	**8.64**	**6.54**	**6.03**	**6.54**	**10.73**	**13.85**	**13.13**	**9.65**	**5.16**	**3.49**	**6.92**		
		1996-97	**460**	**482**	**503**	**387**	**381**	**708**	**760**	**836**	**542**	**327**	**163**	**365**	**5914**	
		PERCENTAGE	**7.77**	**8.15**	**8.50**	**6.54**	**6.44**	**11.97**	**12.85**	**14.13**	**9.16**	**5.52**	**2.76**	**6.17**		

Results :

Seasonal Variation

Five more or less well defined seasons, i.e., Autumn, winter, spring, summer and rainy season, were demarcated in Jalpaiguri District. The total number of pollen grains recorded in different months denote a relatively significant variance (Table 8 & 9). The changes in frequency of palynomorphs were probably related to the length of flowering period, pollen productivity and their extent of dispersal. The frequency of shrub and tree pollen grains dominated over the other groups (Table 10). The flowering period of majority of the trees began from the later part of winter and extended until early monsoon period. (Table 8)

By Gravitational Sampler :

More or less well defined seasonal variations were recorded. Total monthly catches were correlated with different seasons (Table 11). In 1995-96 highest frequency of pollen grains were recorded during winter amounting to 1620 with a percentage contribution of 27.78. This was followed by highest number in spring season, with a total contribution of 24.58% A total catch of 1329 (22.78%) was recorded in summer, preceeded by rainy season with 909 grains (15.58%). Autumn recorded lowest count, i.e. 541 grains (9.28%) in 1995-96.

During 1996-97 more or less same trend as 1995-96 was observed. Winter season recorded the highest number of grains amounting to 1753 with a percentage contribution of 29.64%, in the total aeropalynoflora. This was followed by spring, with a total of 1468 grains (24.82%) and summer with 1378 grains (23.30%), rainy season recorded 855 grains (14.46%) and autumn recorded lowest count with 460 grains (7.78%).

By Rotorod Sampler :

During two years' survey period 33 pollen types (including indeterminate type) were recorded from the rotorod trap. The seasonal periodicities were recorded for all the pollen types (Table 9) and the total pollen count changed throughout the year with peak period occurring in April and May.

Monthwise on an average, April and May recorded the highest incidence of total pollen, i.e. $736m^{-3}$ and $724m^{-3}$ respectively. This was followed in the degree of prevalence by March and June (528m^{-3} each) November (376m^{-3}), October (368m^{-3}), January (344m^{-3}), etc. (Table 9).

Five more or less well defined seasons, i.e. Autumn, Winter, Spring, Summer and Rainy season were demarcated in Jalpaiguri District. The total number of pollen grains recorded in different months demonstrated a relatively significant variance (Table 12). The changes in the frequency of palynomorphs were probably related to the length of flowering period, pollen productivity and their extent of dispersal. The frequency of shrubs and tree pollen dominated over the other groups (Table 9). The flowering period of majority of the trees began from the latter part of winter and extended until early monsoon period.

When the total monthly catches were correlated with different seasons (Table 12), the highest frequency of pollen grains was recorded during the winter season, amounting to 1372m^{-3} with a percentage contribution of 27.07. This was immediately followed by spring season with a total of 1264 grains m^{-3} and percentage contribution of 24.94. A total catch of 1252m^{-3} (24.71%) was recorded in summer, preceeded by rainy season with 812 grains m^{-3} (16.02%). The autumn season recorded lowest count, i.e. 368 grains m^{-3} (7.26%).

The pollen types, i.e. the constituent members, had each a peak month (Fig 3). Accordingly, the dominant types were placed in different groups in relation to their respective high values and the corresponding season : -

Group I	Autumn	Asteraceae, Solanaceae, *Cassia*, Cyperaceae, *Eucalyptus, Xanthium, Callistemon, Peltophorum, Zizyphus.*
Group II	Winter	Asteraceae, *Areca catechu,* Cheno-Amaranthaceae, *Callistemon,* Cyperaceae, Rutaceae, *Samania saman, Zizyphus* sp., *Eucalyptus, Xanthium.*
Group III	Spring	*Bombax ceiba, Cannabis sativa, Cassia, Cocos nucifera, Cusuarina equisetifolia, Samania saman,* Cheno-Amaranthaceae, Polygonaceae, Solanaceae, Verbanaceae, Euphorbiaceae, *Mangifera india, Litsea* sp.
Group IV	Summer	*Acacia, Cannabis sativa, Cocos nucifera,* Poaceae, *Terminalia, Trema, Samania saman. Azadirachta indica.*
Group V	Rainy season	*Terminalia, Trema,* Cyperaceae, *Psidium. Areca catechu.*

The total assemblage of dominant pollen types recorded in these groups demonstrates the dominance of tree pollen grains.

TABLE 9 : MONTHLY CONCENTRATIONS (NO. PER M³ AIR) OF DIFFERENT POLLEN GRAMS COLLECTED BY ROTOROD SAMPLING IN THE AIR OF JALPAIGURI TOWN FROM OCTOBER, 1996 TO SEPTEMBER 1997

Sl. No.	POLLEN TYPES	No.	OF	POLLEN	PER	M^2	AIR							TOTAL
		O	N	D	J	F	M	A	M	J	J	A	S	
1.	*Acacia auriculoformis*	16	-	-	-	-	16	24	48	56	32	32	8	232
2.	*Alnus* sp	16	32	8	16	-	8	-	-	-	-	-	-	80
3.	Apiaceae	8	16	16	-	8	16	24	-	-	-	-	-	88
4.	*Areca catechu*	8	8	4	8	32	24	16	12	8	16	24	12	172
5.	Asteraceae	32	48	48	64	32	24	24	32	8	16	16	8	352
6.	*Azadirhchta india*	-	-	-	-	-	16	8	24	24	16	-	-	88
7.	*Betula* sp					-		48	16	16	-	-	-	80
8.	*Bombax ceiba*	-	-	-	-	-	32	48	40	16	-	-	-	136
9.	*Callistemon lanceolatus*	32	32	24	24	16	-	-	-	-	-	-	-	128
10.	*Cannabis sativa*	8	-	-	-	-	64	80	72	48	32	32	16	352
11.	*Carica papaya*	-	-	-	-	-	-	8	-	-	-	-	-	8
12.	*Cassia* sp.	24	8	8	-	16	40	32	16	16	-	-	-	160
13.	*Casuarina equisetifolia*	-	-	-	-	-	-	32	32	16	-	-	-	80
14.	Cheno amaranthaceae	16	16	48	32	40	64	16	24	24	8	-	-	288
15.	*Cocos nucifera*	-	-	-	-	-	16	56	64	16	-	-	-	152
16.	Cyperaceae	48	16	-	16	32	-	8	-	-	32	32	24	208
17.	*Eucalyptus* sp.	24	24	16	32	16	-	-	-	-	-	-	-	112
18.	Euphorbiaceae	-	-	-	-	-	-	16	8	-	8	-	-	32
19.	*Mangifera indica*	-	-	-	-	-	-	32	8	-	-	-	-	40
20.	*Pinus* sp.	-	-	-	16	16	32	24	16	-	-	-	-	104
21.	Polygonaceae	-	-	-	-	-	-	24	16	-	8	-	-	8
22.	*Psidium guajava*	-	-	-	-	-	-	-	24	-	-	32	16	72
23.	Poaceae	80	64	56	32	16	56	80	96	128	96	80	88	872
24.	*Quarcus* sp	16	32	16	24	-	-	-	-	-	-	-	-	88
25.	Samania saman	-	-	-	16	32	16	16	32	-	-	-	-	112

Contd. ...

Sl. No.	POLLEN TYPES	No.	OF	POLLEN	PER	M^3			AIR					TOTAL
		O	N	D	J	F	M	A	M	J	J	A	S	
26.	Scrophulariaceae	-	-	-	-	8	16	-	8	-	-	-	-	32
27.	Solanaceae	24	16	16	24	48	48	24	48	32	24	32	16	352
28.	*Syzygium* sp.	-	-	-	-	-	-	-	24	16	-	-	-	40
29.	*Terminalia* sp.	-	-	-	-	-	-	16	24	48	24	16	-	128
30.	*Trema orientalis*	-	-	-	-	-	16	48	24	16	-	-	-	104
31.	*Xanthium strumarium*	-	16	32	8	8	-	-	-	-	-	-	-	64
32.	*Zizyphus* sp.	16	32	16	-	-	-	-	-	-	-	-	-	64
33.	Indeterminate	-	16	16	32	8	24	32	16	8	8	-	8	168
	TOTAL :	368	376	324	344	328	528	736	724	528	320	296	196	5068

Yearly variation of Airborne Pollen Grains.

The components of airborne pollen were identical in both the years, i.e. 1995-96 and 1996-97 (Table 8).

Total aeropalynoflora :

A total of 40 types of pollen grains were recorded by gravitational sampler and 33 types by Rotorod sampler in different months during the survey period. Their percentage contribution have been given in Table 8. Highest concentration was recorded in April (1995-1996) and May (!996-1997). In the first year percentage contribution was 13.85% and in the second year it was 14.13%. A total of 33 pollen types were recorded by rotorod sampler. The highest concentration ($736m^{-3}$) of pollen have been observed in April which was followed by May ($724m^{-3}$) (Table 9).

Frequency of Incidence :

The correlation of yearly frequency of the main morphotypes between 1995-1996 and 1996-1997 showed marginal variations (Fig.3) *Cannabis sativa* displayed maximum difference (369 in 1995-1996 & 199 in 1996-1997) considering the total catches followed by Solanaceae (259 in 1995-96 & 386 in 1996-1997). Further look at the calendar (Fig.3) of dominant types reflect their relative incidence in each month during both the years.

Peak Month of Incidence :

The value of peak monthly incidence of major pollen grains, and their monthly total number per 10 cm^2 of the trapping surface during the same months of 1995-1996 and 1996-1997 have been provided in Table 8. The data incidate that the peak months of incidence were not same for all types in both the years. Moreover, the total number recorded for each individual type represented no significant differences in the investigated period.

Percentage contribution of different groups and of major individual types :

The percentage contribution of different pollen types to the total aeropalynoflora showed marginal differences.

The percentage contribution of the major pollen grains to the total aeropalynoflora in the two years survey are shown in Table 8.

TABLE 10 : MONTHLY TOTAL CONTRIBUTION OF GRASSES, HERBS AND WEEDS, SHRUBS AND TREES AND INDETERMINATE INDETERMINATE TYPES DURING THE PERIOD 1995 – 1996 AND 1996 – 1997 BY GRAVITATIONAL SAMPLER.

AEROPALYNOFLORA	YEAR	TOTAL NO. PER 10 CM^2 OF TRAP SURFACE												TOTAL
		OCT.	NOV.	DEC.	JAN.	FEB.	MARCH	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	
Grasses (Poaceae)	1995-96	135	85	35	12	28	33	78	112	187	102	65	197	1069
	1996-97	104	96	94	9	17	48	95	157	169	110	48	148	1095
Herbs & Weeds	1995-96	164	125	142	141	147	242	240	230	127	99	101	70	1828
	1996-97	132	126	185	156	155	277	204	169	108	91	59	73	1735
Shrubs & Trees	1995-96	240	287	184	171	190	338	471	418	245	98	38	137	2817
	1996-97	223	249	205	188	196	346	439	492	258	122	54	141	2913
Indeterminate types	1995-96	2	7	21	28	17	13	19	6	4	2	-	-	119
	1996-97	1	11	19	34	13	37	22	18	7	4	2	3	171

TABLE 11 : SEASONAL VARIATION OF THE TOTAL AEROPALYNOFLORA TRAPPED BY GRAVITATIONAL SAMPLER AND THEIR CORRESPONDING PERCENTAGE CONTRIBUTION DURING THE PERIOD 1995-1996 AND 1996-1997

SEASON (MONTH)	1995 – 1996		1996 – 1997	
	TOTAL NO. OF POLLEN GRAINS	PERCENTAGE CONTRIBUTION	TOTAL NO. OF POLLEN GRAINS	PERCENTAGE CONTRIBUTION
AUTUMN (October)	541	9.28	460	7.78
WINTER (November to February)	1620	27.78	1753	29.64
SPRING (March to April)	1434	24.58	1468	24.82
SUMMER (May to June)	1329	22.78	1378	23.30
RAINY SEASON (July to September)	909	15.58	855	14.46
TOTAL	5833	100.00	5914	100.00

Table 12 : Seasonal Variation of the total aeropalynoflora trapped by Rotorod Sampler during 1995-1997.

Season (Month)	Total No. of Pollen grains in m^{-3} of air	Percentage Contribution
Autumn (October)	368	7.26
Winter (November – February)	1372	27.07
Spring (March – April)	1264	24.94
Summer (May – June)	1252	24.71
Rainy (July – September)	812	16.02
Total :	**5068**	**100.00**

In results of gravitational sampler Poaceae showed highest dominance (18.32 – 18.51%) followed by Asteraceae (6.56 – 7.25%), *Cannabis sativa* (3.36 – 6.32%), *Solanaceae* (4.44 – 6.52%), *Cassia* sp. (4.45 – 5.17%), Cheno-Amararanthaceae (4.23 – 4.73%) and so on.

Discussions :

The most important aspect to conduct an Aerobiological investigation is the selection of an appropriate Sampler. The sampling techniques in case of gravitational sampler mainly work on the principles of gravity and impaction. But in the case of volumetric sampler, it is suction. Currently the most commonly used sampler is a volumetric sampler, e.g. Hirst Sampler (Hirst 1952) and Burkard 7-day automatic volumetric sampler (Burkard Manufacturing Co. U.K.) and Astir personal volumetric Sampler (Astir India Co. Ltd.). This Sampler helps in recording the periodicity and volumetric composition of airborne pollen. In the present investigation Gravity Slide Sampler and Rotorod Samplers were used to study the seasonal periodicities of airborne pollen grains of the study area.

All the 40 pollen types trapped by gravity sampler were encountered during the entire survey period. Some pollen grains belonging to the family Poaceae, Asteraceae, Cyperaceae, Solanaceae, Amaranthaceae, Chenopodiaceae, Euphorbiaceae, Rutaceae, Polygonaceae, Scrophulariaceae, Verbenaceae could not be distinguished morphologically at generic or specific levels. The grass pollen grains have been included in the family Poaceae. The pantoporate type of pollen grains have been included within Cheno-Amaranthaceae. Some pollen grains were identified upto generic or species level by comparing with reference slides. The pollen grains of *Areca catechu, Azadirachta indica, Bombax ceiba, Callistemon lanceolatus, Xanthium strumarium, Cannabis sativa, Carica papaya, Casuarina equisetifolia, Cocos nucifera, Mangifera indica* etc. were identified upto specific level as their pollen grains have distinct features and respective plant species were recorded in the ecofloristic survey.

The frequency of pollen grains in the air generally depends on the distribution, density of local vegetation, rate of pollen production and pollination mechanism. Pollen grains are generally found during respective pollination periods. The meteorological factors have also a great influence on the incidence of pollen grains, particularly during the heavy monsoon rains. Moreover, the intensity of air currents and changes in weather condition affect the qualitative and quantitative count of pollen (Hirst, 1953; Gregory 1961; Sreeramulu and Seshavataram 1962).

Wind pollinated plants produce a large number of smooth walled pollen grains which are often inconspicuous, colourless and lacking nector. Such pollen grains are mostly found in the air and are potentially more allergenic than the insect pollinated or entomophilous plants. But in the present investigations a number of entomphilous grains were found, some of which have been proved to be allergenic, viz. *Bassia latifolia, Carica papaya, Azadirachta indica, Bambax ceiba, Peltophorum pterocarpum, Eucalyptus globulosus, Cassia* sp. etc.

Out of the 33 pollen types trapped by rotorod sampler Poaceae and *Areca catechu*, were found all round the year with varying frequencies but with maximums concentration during April-June. *Bombax ceiba, Syzigium, Terminalia, Cocos nucifera, Mangifera indica,Casuarina equisetifolia* have the peak period from March to May. Other pollen types like *Eucalyptus, Cassia, Azadirachta, Xanthium* sp. were found frequently in the air with moderate concentration. Cyperaceae pollen were more prevalent during the months of July to October. *Cocos* pollen counts were relatively high in April-May and were seasonal. Pollen grains of *Mangifera indica, Bombax ceiba, Psidium guajava,* were also seasonal but in low concentration. Some pollen types, e.g. *Xanthium*, showed distinct seasonality confined to 4 months of the year. From August to October, apart from Poaceae, the main pollen contributor to the aeroapalynoflora was Cyperaceae, *Trema, Acacia, Areca, Psidium, Zizyphus,* whereas during January-March pollen grains of *Albizzia,* Solanaceae, Cheno-Amaranthaceae were the dominating constituents.

Thus in both the years, April-May are the months of maximum pollen incidence and in August it was minimum. With regard to the concentration pertaining to climatic season 76.72% of the pollen catch was obtained in the dry period (November – June) while remaining 23.28% in the wet period (July – October).

The extent of variation in the monthly incidence of certain pollen types has been shown in Table 8. However, the general running up of the seasons remained nearly the same in both years except for summer and winter seasons. There was a marginal increase in the total pollen count from first (5833) to second year (5914). The incidence of all the pollen types in both the years differed to some extent (Table 11).

In the two years' survey it was found that Poaceae was the major contributor to the aeropalynoflora and rice crop probably was the major source of this pollen type.

The predominance of grass pollen in rural and cultivated areas was also reported from Britain (Hyde, 1952), from Bhimavarans of Andhra Pradesh, India (Atluri *et. al* 1988), and from a farm in West Bengal, India (Chakraborty *et. al.* 1998a). As poaceae is a strongly stenopalynous family, it is suggested that a study of grass pollen of such areas and their daily time of pollen release will help the pollen allergy patients regarding specific identification of the allergen. There are plantations of the taxa like *Eucalyptus* sp., *Acacia auriculiformis, Mangifera indica, Psidium gurajava* etc., as a result the pollen grains of these plants are found to be present. Some pollen grains were found throughout the year and some found quite frequent with one or two peak periods. From the several pollen surveys at different parts of India (Vishnu – Mittrre and Khandelwal 1973, Deshpande and Chitaley 1976, Mandal & Chanda 1981, Atluri & Subba Reddi 1982, Singh and Babu 1982, Bhat and Rajasab 1985, Chakraborty *et. al.* 1998a & b), two peak periods of total pollen were observed. The first peak during August to November was found due to the growth and flowering of several grass species in response to the monsoon rains and the February – May peak was observed due to the flowering of tree species during that time. In this survey two main peak periods were found.

Poaceae contributed much to the first peak along with Cyperaceae and it also contributed dominantly in the second peak along with *Acacia, Cassia, Cannabis, Casuarina, Mangifera,* etc. The peaks in Poaceae coincided with the flowering period of rice crop. In the two year pollen survey variation in the total pollen count as well as individual pollen types were also noted.

It was observed that the frequency of incidence of pollen is high in low relative humidity, modest temperature and minimum rainfall. Here the same condition prevailed. Pollen dispersal is facilitated by the dry weather with low relative humidity, because the pollen particles become light and dry and can be disseminated in the air with less constraint (Gupta *et.al* 1994). Wind velocity also plays a role in pollen release. Generally, wind velocity higher than 1km./hr. results in higher concentration of airborne pollen grains (Edmonds, 1979).

The occurrence of pollen grains of *Acer* sp., *Alnus* sp., *Betula* sp., *Cryptomeria japonica, Ilex* sp., *Pinus* sp. and *Quercus* sp. were interesting in the sense that these plants do not occur in the district flora, but are restricted to the hills of Eastern Himalayas and Bhutan Ranges, thus justifying their presence probably due to long distance transport.

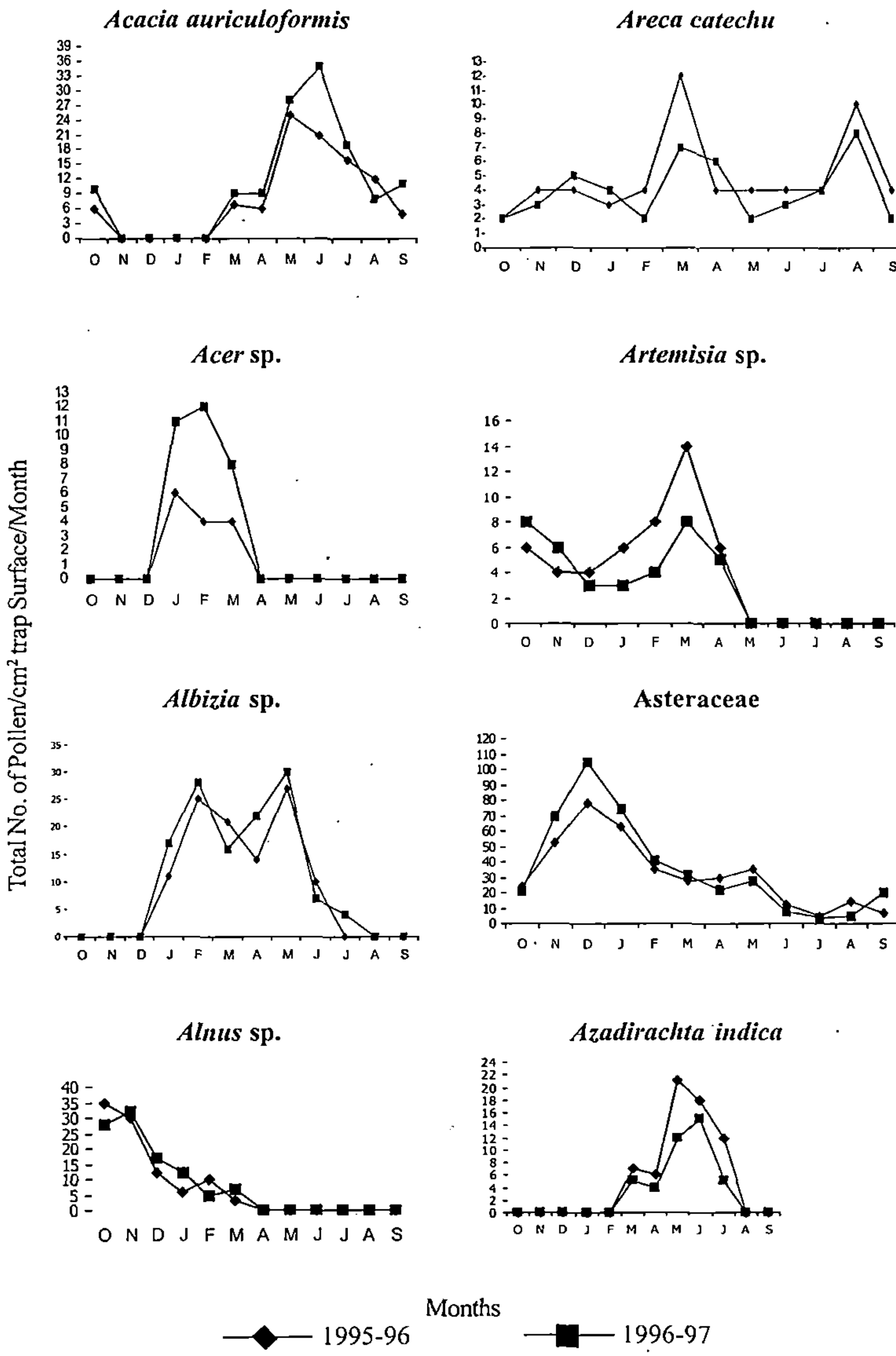
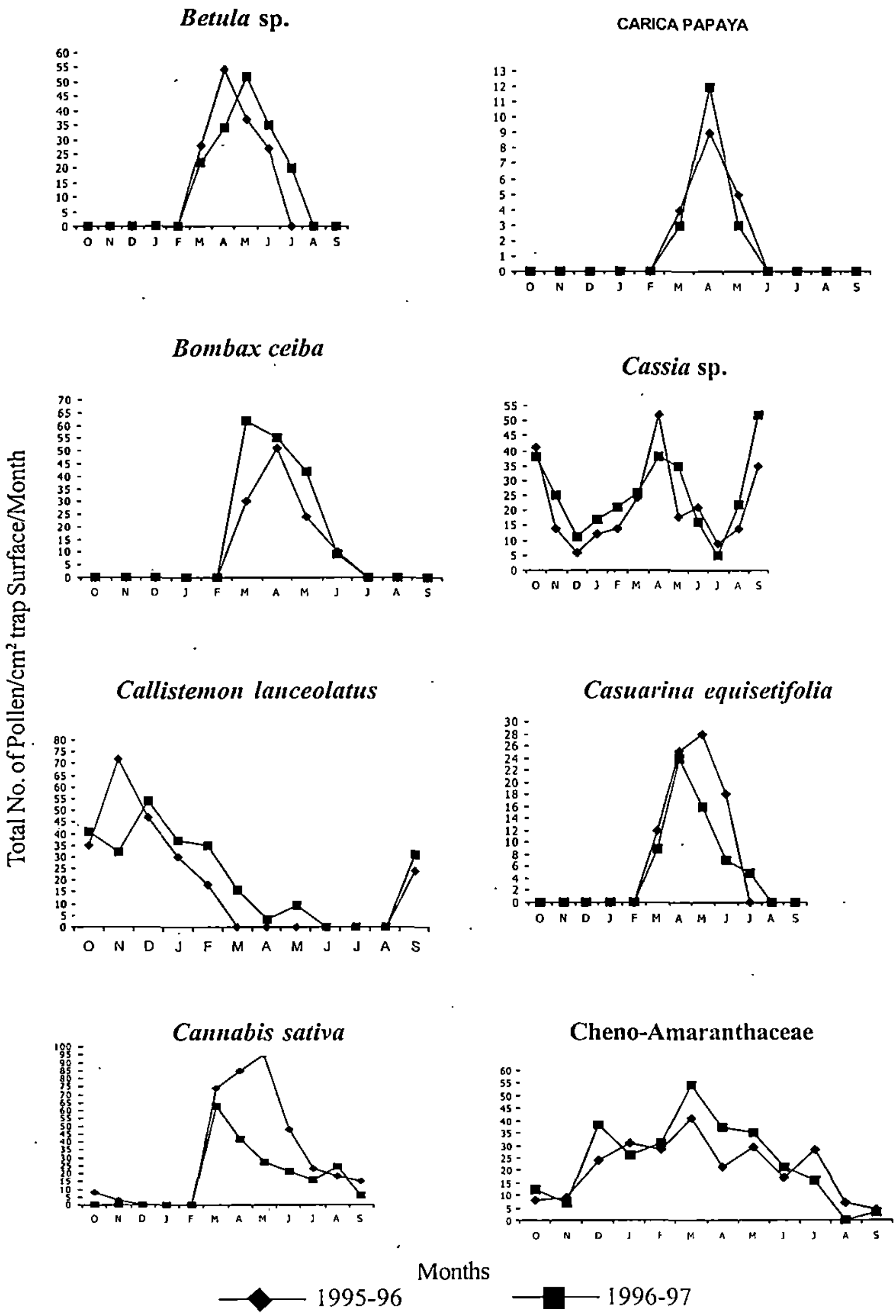
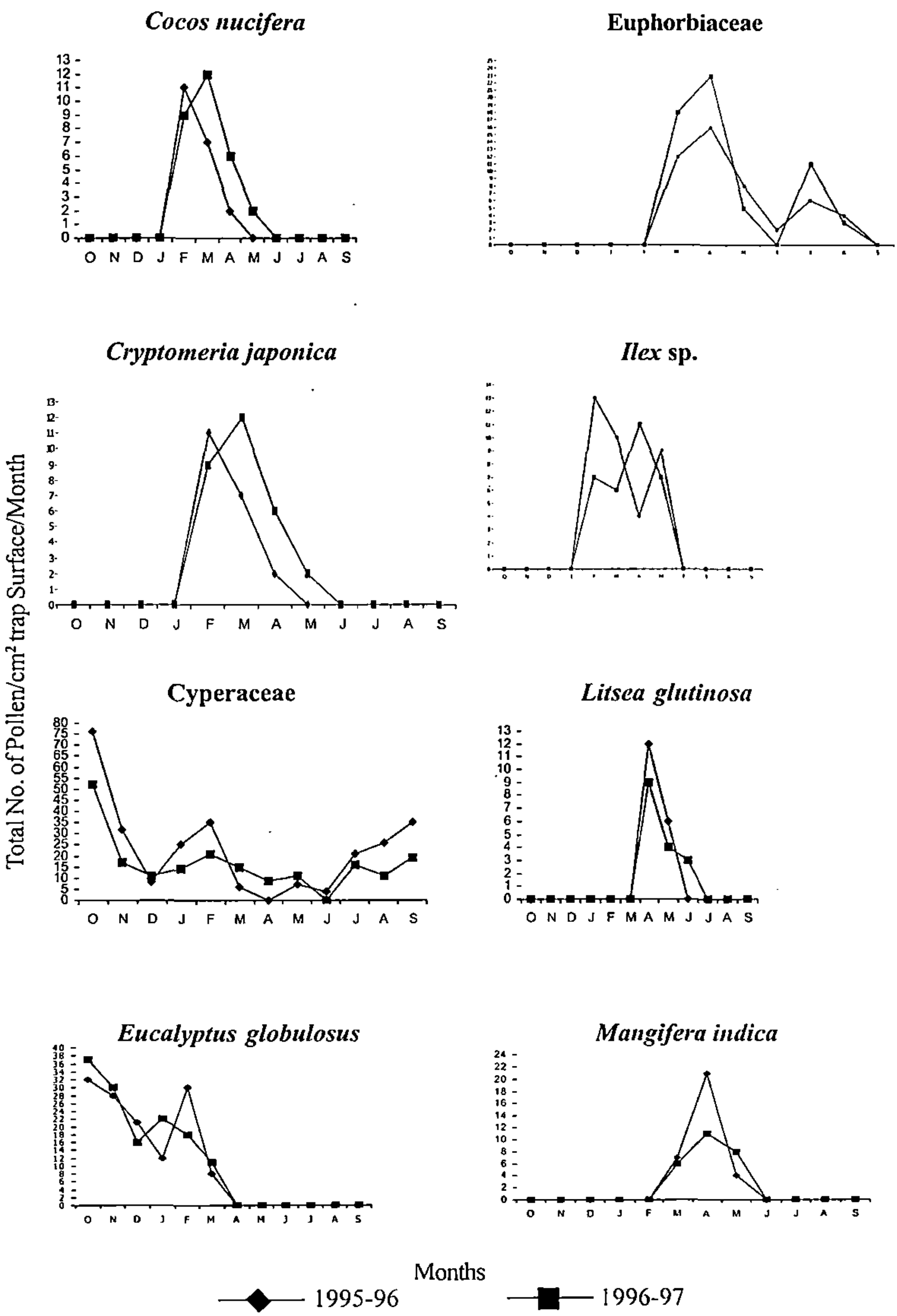
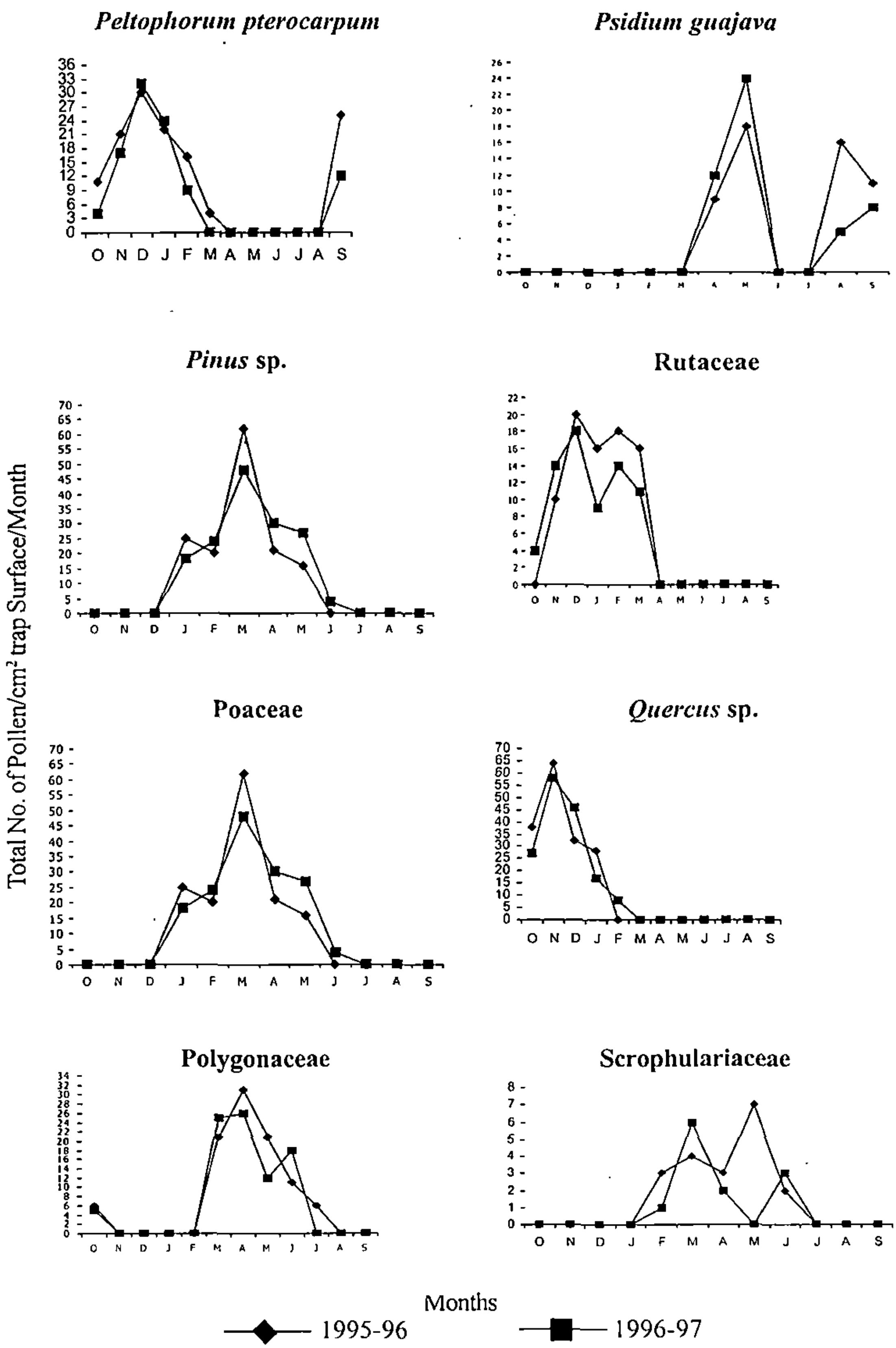


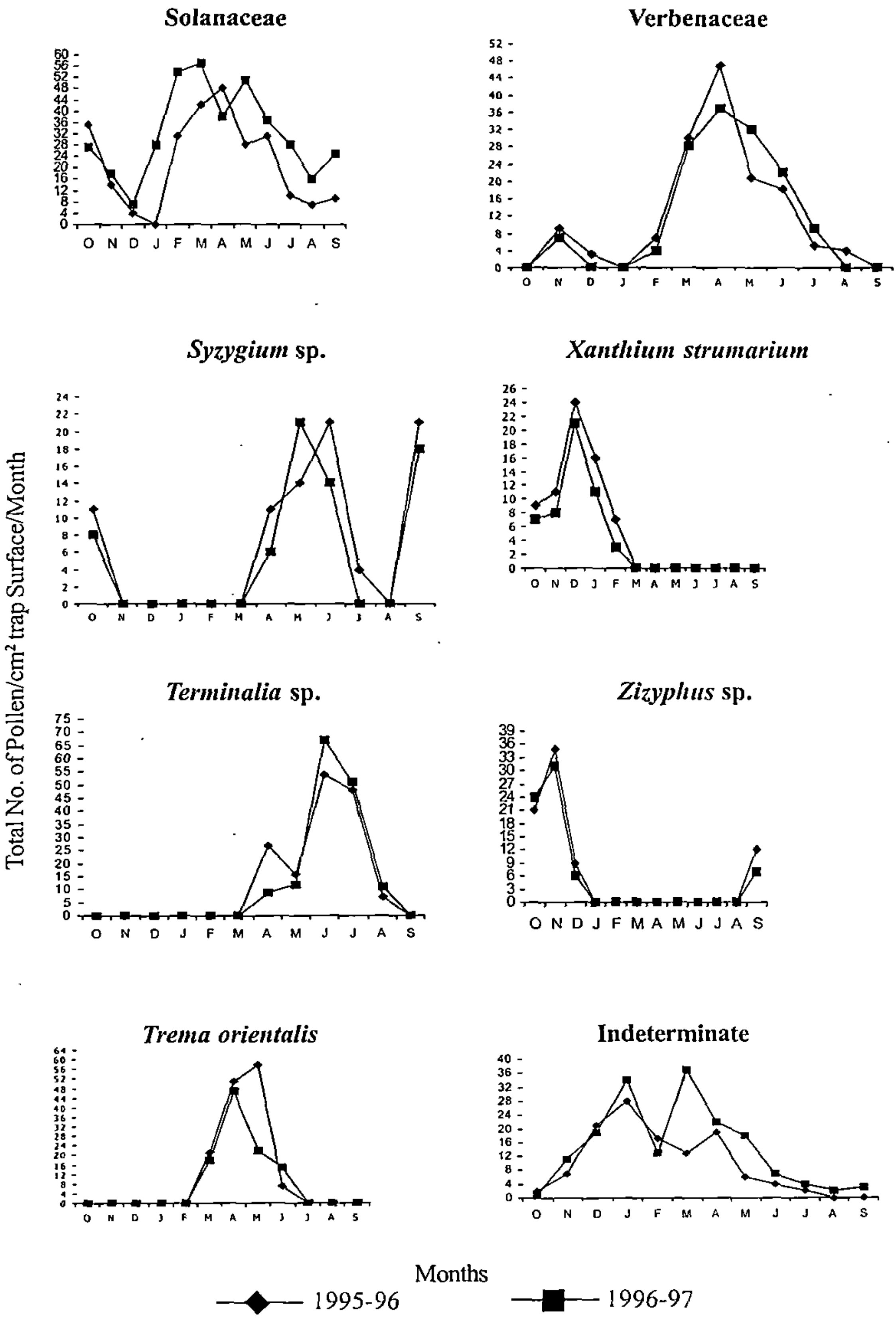
Fig. 3 : Seasonal variation of pollen types recorded in the air of Jalpaiguri by Gravitational Sampler


Betula sp.
CARICA PAPAYA
Bombax ceiba
Cassia sp.
Callistemon lanceolatus
Casuarina equisetifolia
Cannabis sativa
Cheno-Amaranthaceae
Total No. of Pollen/cm² trap Surface/Month
Months
1995-96
1996-97



Cocos nucifera
Euphorbiaceae
Cryptomeria japonica
Ilex sp.
Cyperaceae
Litsea glutinosa
Eucalyptus globulosus
Mangifera indica
O N D J F M A M J J A S
Total No. of Pollen/cm² trap Surface/Month
Months
1995-96
1996-97


Peltophorum pterocarpum
Psidium guajava
Pinus sp.
Rutaceae
Poaceae
Quercus sp.
Polygonaceae
Scrophulariaceae
Total No. of Pollen/cm² trap Surface/Month
O N D J F M A M J J A S
Months
1995-96
1996-97


Solanaceae
Verbenaceae
Syzygium sp.
Xanthium strumarium
Terminalia sp.
Zizyphus sp.
Trema orientalis
Indeterminate
O N D J F M A M J J A S
Total No. of Pollen/cm² trap Surface/Month
Months
1995-96
1996-97

CLINICAL TESTS OF SOME COMMON POLLEN GRAINS

RESULTS :

Out of 22 airborne pollen types tested for allergenicity using whole pollen extract on adult respiratory allergic patients of Jalpaiguri, West Bengal, 19 induced a positive response through skin prick test (Table 13).

The pollen extract of *Melastoma malabathrica, Camellia sinensis, Cymbopogon pendulus* did not produce any positive response (Table 13). The tests were performed on the patients with the relevant case history. The results were analysed according to Stytis *et al.* (1982).

After the clinical study the whole extracts of eight pollen types were fractionated in the range of 0–30%, 30–60% and 60–90% saturation of $(NH_4)_2SO_4$ and three fractions (designated as Fr I, Fr II, Fr III) of each pollen types was taken for skin-prick test. When skin-prick tests performed with these $(NH_4)_2SO_4$ cut fractions (Fr I, Fr II and Fr III) of the eight pollen types on respective pollen-sensitive patients, Fraction two (Fr II), i.e. 30-60% $(NH_4)_2SO_4$ cut fraction of all eight pollen types was found to be allergenicallly potent (Table 14). The higher positivity was noted in *Cocos nucifera* (85.71%) which was immediately followed in the degree of prevalence by *Cassia siamea* (82.35%), *Acacia auriculiformis* (80.00%), *Eucalyptus globulosus* (76.19%), *Borassus flabellifer* (75.00%), *Areca catechu* (75.00%), *Saccharum spontaneum* (73.33%) and *Bassia latifolia*. So it was observed that 30–60% $(NH_4)_2SO_4$ cut fraction i.e. Fr-II, elicited maximum percentage of positive response (Table 14).

DISCUSSION :

From the detailed result of skin sensitivity test (Table 13) using 22 whole pollen extracts on adult respiratory allergic patients it was observed that 19 taxa induced at least 1^+ reaction in allergic-patients. The highly potent allergic pollen showing 2^+ to 3^+ positivity were *Acacia auriculiformis, Areca catechu, Azadirachta indica, Cassia siamea, Cyperus rotundus, Cocos nucifera, Lantana camara, Borassus flabellifer* and *Saccharum spontaneum*. Among the tested pollen *Saccharum spontaneum* was the most potent allergen which showed 48.08% positive response with 43.40% + I reaction, 3.83% + II reaction and 0.85% + III reaction. The next highly potent allergen was *Azadirachta indica* showing 45.41% skin positivity with 40% +I reaction, 4.17% +II reaction, 1.25% +III reaction. The next high hypersensitivity was found in the allergenic extract of *Areca catechu* showing 40.29% positive response among 206 patients with 34.9% +I reaction and 3.88% + II response and 1.45% +III response. 35% skin positivity was produced by the antigenic extract of *Cocos nucifera* among 256 tested patients. It showed 33.59% + I response, 1.17% + II response and 0.79% +III reactions. *Borassus flebellifer* (34.34% positivity), *Cassia siamea* (30.70%) and *Eucalyptus globulosus* (30.48% positivity) were the other potent allergenic plants of the investigated area. This was followed by *Cyperus rotundus* (out of 126 patients 36 patients showed 28.57% positive response), *Bassia latifolia* (26 patients out of 114 induced 22.80% positivity), *Carica papaya* (out of 212 patients 40 possessed 18.87% positivity), *Acacia auriculiformis* (out of 85 patients 16 induced 18.82% positivity), *Peltophorum pterocarpum* (41 patients out of 242 showed 16.94% skin positivity), *Bombax ceiba* (37 patients out of 231 showed 16.01% positivity), *Oryza sativa* (20 patients out of 126 showed 15.87% positivity), *Chenopodium album* (33 patients out of 232 showed 14.22% positive response), *Lantana camara* (29 patients out of 209 induced 13.87% skin positivity). Some other pollen types also induced skin positivity showing low intensity. These include *Trema orientalis* (10 patients out of 128 induced 8.33% positivity), *Amaranthus viridis* (out of 112 patients 6 patients showed 5.36% positivity), *Justicia diffusa* (6 patients out of 184 showed 3.26% positive response).

The three pollen types namely *Melastoma malabathrica, Camellia sinensis* and *Cymbopogon pendulus* were found to be non-allergenic as they did not show any skin positivity using whole pollen extract. The result were analysed according to Stytis *et al.* (1982).

The present study was aimed to detect sensitization of individuals to common pollen of Jalpaiguri town. The most potent allergy producing plants are large trees commonly found as wild or cultivated in wide areas. *Acacia auriculiformis, Eucalyptus globulosus, Cassia siamea, Bombax ceiba, Peltophorum pterocarpum, Trema orientalis,* etc. are planted on roadside and railway stations as avenue or ornamental fruit producing trees. *Areca catechu, Azadirachta indica, Cocos nucifera, Carica papaya, Borassus flabellifer, Bassia latifolia* found in jungles and rural as well as urban surroundings which are cultivated for their commercial use. *Lantana camara* is a common hedge plant in urban areas. *Saccharum spontaneum* is a common grass growing gregariously along the river beds and wet land surroundings. *Cyperus rotundus, Chenopodium album, Justicia diffusa* are some common weeds of Jalpaiguri town. In a two year continuous aerobiological survey of Jalpaiguri town it was found that the pollen grains of those plants were commonly airborne during pollination months. This was also evidenced by the works of some previous workers (Chakraborty *et.al.* 1996, 1998a & b; Banik and Chanda, 1992; Boral and Bhattacharya, 1999, 2000; Choudhury *et.al.* 1999; Boral *et.al.* 1999, 2004) in other parts of West Bengal. The present study reveals a somewhat different picture in respect to incidence and intensities of the reaction.

Table 13 : Result of Skin-Prick-Tests using different whole Pollen extracts on adult respiratory allergic patients.

Sl. No.	Pollen allergen extract	No. of Patients tested.	No. of patients showing			% of positive response
			+1 level	+2 level	+3 level	
1.	*Acacia auriculoformis*	85	12	2	2	18.82
2.	*Amaranthus viridis*	112	6	0	0	5.36
3.	*Areca catechu*	206	72	8	3	40.29
4.	*Azadirachta indica*	240	96	10	3	45.41
5.	*Eucalyptus globulosus*	187	52	5	0	30.48
6.	*Bombax ceiba*	231	35	2	0	16.01
7.	*Cassia siamea*	195	56	3	1	30.76
8.	*Cyperus rotundus*	126	32	3	1	28.57
9.	*Cocos nucifera*	256	86	3	2	35.54
10.	*Carica papaya*	212	38	2	0	18.87
11.	*Chenopodium album*	232	31	2	0	14.22
12.	*Lantana camara*	209	26	2	1	13.87
13.	*Bassia latifolia*	114	23	3	0	22.80
14.	*Oryza sativa*	126	18	2	0	15.87
15.	*Peltophorum pterocarpum*	242	40	1	0	16.94
16.	*Borassus flabellifer*	198	64	3	1	34.34
17.	*Saccharum spontaneum*	235	102	9	2	48.08
18.	*Trema orientalis*	120	10	0	0	8.33
19.	*Justicia diffusa*	184	6	0	0	3.26
20.	*Melastoma malabathrica*	25	0	0	0	0
21.	*Camellia sinensis*	25	0	0	0	0
22.	*Cymbopogon pendulus*	25	0	0	0	0

Table 14 : Results of Skin-test using fractions of some selected Pollen antigens.

Pollen types	$(NH_4)_2SO_4$ cut fractions	Total No. of Patients tested	% of positive response
1. *Acacia auriculoformis*	Fr I (0-30%)	25	12.00
	Fr II (30-60%)	25	80.00
	Fr III (60-90%)	25	48.00
2. *Eucalyptus globulosus*	Fr I (0-30%)	21	19.04
	Fr II (30-60%)	21	76.19
	Fr III (60-90%)	21	33.33
3. *Bussia latifolia*	Fr I (0-30%)	30	16.66
	Fr II (30-60%)	30	60.00
	Fr III (60-90%)	30	36.66
4. *Cassia siamea*	Fr I (0-30%)	34	11.76
	Fr II (30-60%)	34	82.35
	Fr III (60-90%)	34	35.29
5. *Borassus flabellifer*	Fr I (0-30%)	28	14.28
	Fr II (30-60%)	28	75.00
	Fr III (60-90%)	28	28.57
6. *Cocos nucifera*	Fr I (0-30%)	21	19.04
	Fr II (30-60%)	21	85.71
	Fr III (60-90%)	21	33.33
7. *Areca catechu*	Fr I (0-30%)	24	12.5
	Fr II (30-60%)	24	75.0
	Fr III (60-90%)	24	33.33
8. *Saccharum spontaneum*	Fr I (0-30%)	15	13.33
	Fr II (30-60%)	15	73.33
	Fr III (60-90%)	15	46.66

SUMMARY

Aerobiology deals with airborne bioparticles including pollen grains and spores in terms of their sources, release, dispersal, deposition and impact on living organisms. Modern aerobiology has made significant contributions to the study of respiratory allergy. In India more than 10% of the population suffer from allergic disorders (Vishwanathan, 1964). Pollen grains are an important cause of respiratory allergy (Blackley, 1873), which are quite variable in different biozones from season to season, year to year depending on changes in ecological and climatic conditions. Allergen extracts have been in use for the diagnosis and treatment of allergy for over 75 years. So, from clinical point of view, it is important to know the details about the occurrence of pollen load in the atmosphere. Studies on airborne pollen grains have been done by many workers, though there are many associated areas which remain still unexplored. The present investigation was undertaken in an unexplored biozone of West Bengal for quantification of aeroallergen load in the atmosphere and their identification to fulfil the following objectives :

1. An ecofloristic survey of Jalpaiguri town, West Bengal, was carried out to make a list of angiospermous plants showing their habit, mode of pollination, flowering period, etc., which are essential prerequisites for aerobiological investigation.

2. Pollen morphological study of common plants of the local flora was done to identify the airborne pollen grains.

3. Airborne pollen grains of the study area were trapped by samplers and a pollen calendar was prepared to correlate the seasonal occurrence of the pollen types.

4. To determine the influence of meteorological factors on seasonal variation of pollen grains in the air.

5. To study the allergenicity of pollen grains by *in-vivo* (Skin-Prick) tests.

The entire work pertaining to the present investigation has been divided into two broad categories : (1) ecofloristic survey of the study area together with pollen morphological study of some common plants and (2) aerobiological survey in relation to pollen allergy.

In order to evaluate the aerobiological assemblage of Jalpaiguri town, a good knowledge of its ground flora and respective pollen grains were of prime importance. Accordingly, a detailed and systematic ecofloristic survey was carried out based on visual observations to make a list of plants showing their habit, habitat, mode of pollination, frequency of occurrence, flowering period and climatic condition. A preliminary survey of the flora was done earlier by Choudhury (1969), Mukherjee (1972), Das (1986). Present floristic survey have recorded a total of 709 species under 491 genera and 134 families consisting of 29 monocot and 105 dicot families. In the present survey, Fabaceae was found to be the most dominant family followed in the degree of prevalenced by Asteraceae, Poaceae, Euphorbiaceae, Rubiacae, Caesalpiniaceae, Scrophulariaceas, Cyperaceae, Solanaceae and Verbenaceae. Annual herbs (285 species) was the most dominating flora followed by trees (135 sp.), shrubs and undershrubs (96 species), climbers (67 spp.) and grasses (30 spp.). Entomophilous plants were found to be predominant (477 spp.) followed by anemophilous (157 spp.), amphiphilous (52 spp.) plants. Hydrophilous (5 spp.) and cleistogamous (2 spp.) plants were relatively poor in distribution. Seasonal distribution of the flora showed maximum flowering peak in October (348 spp.) followed by September (315 spp.) and May (308 spp). A total of five species of aquatics were distributed in ponds, canals and rivers. Among 77 species of climbers and lianes, Cucurbitaceae and Convolvulaceae were the dominant families and their contribution to the aerobiological spectrum was less significant, because of their contribution to the aerobiological spectrum was less significant, because of their entomophilous nature. Herbs (annual, perennial and geophytic) were the most dominating flora consisting of 360 species with varied ecological distribution. Grasses (Poaceae) were the third largest family represented by 30 species. The grasses being largely anemophilous with abundant pollen production were found to be one of the large contributors in airborne pollen load. Trees were represented by 135 species which grew profusely along road sides, waste places as wild, cultivated or introduced plants. The vegetation of this area, therefore, is of a humid tropical type. Taking all the factors into consideration, it can be said that the distribution of vegetation was influenced by both biotic as well as geographical factors.

Pollen morphological studies of 108 common plant species of Jalpaiguri town was carried out based primarily on apertural character. It was noted that some taxonomically divergent plant types possessed similar type of pollen grains, thus rendering difficulty in classification, particularly with reference to 3-colporate pollen grains. Similar difficulties were also encountered with stenopalynous families like Cyperaceae, Poaceae, etc., and also with echinate pollen grains of Malvaceae and

Convolvulaceae or pantoporate pollen grains of Chenopodiaceae, Amaranthaceae and Caryophyllaceae. In the present investigation a pollen key was formulates to help in the identification of airborne pollen grains.

In the second part of the study, a two-year (October, 1995 – September, 1997) aeropalynological survey of Jalpaiguri town was carried out using both by Gravity slide and Rotorod Samplers, placed on the roof of a domestic house 4m above ground level. A total of 39 pollen types were identified from Gravity slides and 32 pollen types from Rotorod Sampler represented in terms of annual mean concentration per day per cubic meter of air. In gravity slides the most abundant types originated from Poaceae (18.32 – 18.51%), followed by Asteraceae (6.56 – 7.25%), Solanaceae (4.44 – 6.52%), *Cannabis sativa* (3.36 – 6.32%), *Cassia* sp. (4.45 – 5.16%) etc. in both the years. There was an increase in the total pollen count from first (5833) to the second year (5914), probably due to less rainfall, moderate relative humidity and moderate wind speed. The incidence of all the pollen types in both the years differed slightly. It was found that the pollen grains of shrubs and trees were higher in number in both the years followed by herbs and weeds and grasses. The seasonal periodicities were studied for all the pollen types. The total pollen count changed throughout the year with maximum concentration in between November and February, probably due to moderately low temperature (12.7-27.7^{0}C), low relative humidity (50-82%) and low rainfall (5.0-14.5mm). The minimum concentration was noted during July to August due to heavy rainfall (662.3 – 968.1mm) and high relative humidity (87-88%). So the meteorological parameters like temperature, rainfall and relative humidity probably were responsible for fluctuations in pollen concentration

Using Rotorod Sampler a total of 32 pollen types were identified. April and May recorded the highest pollen count i.e. 736 and 724m^{-3} of air respectively. This was followed by March and June (528m^{-3} each), November (376m^{-3}), October (368m^{-3}) and January (344m^{-3}). Among the 32 identified pollen, Poaceae, *Areca catechu* and Solanaceae were found round the year with varying frequencies. The pollen frequencies in different months demonstrated a relatively significant variation which are probably related to the length of flowering period, pollen productivity and their extent of dispersal.

As per frequency of dominant pollen types, six different distinct pollen seasons were recognized in terms of their respective high value and the corresponding season.

The degree of allergenicity of some airborne pollen grains of Jalpaiguri town was established by skin prick test performed on a varying number of patients with relevant case histories. Out of the 22 tested pollen types 18 common airborne pollen types induced a positive response in skin prick test. The strongest hypersensitivity was produced by the pollen extract of *Saccharum spontaneum* (48.08%), followed by *Azadirachta indica* (45.41%), *Areca catechu* (40.29%), *Cocos nucifera* (35.54%), *Borassus flabellifer* (34.34%), *Eucalyptus globulosus* (30.48%), *Cassia siamea* (30.76%) etc. Some dominant airborne pollen types like *Bombax ceiba, Trema orientalis, Acacia auriculiformis, Chenopodium album* etc., produced little hypersensitivity, whereas some less abundant types like *Azadirachta indica, Eucalyptus globulosus, Cocos nucifera* etc., induced strong hypersensitivity. Pollen extracts of *Melastoma malabathrica, Camellia sinensis* and *Cymbopogon pendulus* were found to be allergenically insignificant.

It was also observed that out of the three $(NH_4)_2SO_4$ cut fractions, the fraction two was found to be allergenically most potent while performing skin-prick test among eight selected pollen types.

Results of the above investigations show that the degree of frequency of airborne pollen grains depends partly on meteorological parameters. A calendar of allergenic pollen grains will be helpful to the clinicians to correlate the patient's allergic attack with the seasonal occurrence. It was observed that *Saccharum spontaneum, Azadirachta indica, Areca catechu, Cocos nucifera, Borassus flabellifer, Cassia siamea* and *Eucalyptus globulosus* were the common airborne allergenic pollen found in air in various seasons showing high positive skin reaction. The present study is expected to be useful for the diagnosis and treatment of sensitive patients suffering from respiratory allergy.

CONCLUSIVE REMARKS

The results have been summarized below :

- From the floristic survey of Jalpaiguri town of West Bengal, India, a complete picture of the floristic composition of the investigated area, together with the pollen of the most dominant plants, essential for identification of airborne pollen grains have emerged. The survey results revealed a heterogenous composition of related and unrelated taxa. A total 709 species under 491 genera and 134 families have been enlisted. There are 29 monocot families consisting of 106 genera and 135 species and 105 dicot families having 385 genera and 574 species. This survey revealed that Fabaceae was found to be the most dominant family followed by Asteraceae, Poaceae, Euphorbiaceae and Rubiaceae. Statistically the flora was dominated by herbs (360 species). It was found that entomophilous plants were predominant consisting of 477 species. Seasonal distribution of the flora showed that highest flowering occurred during September-October.
- Pollen morphological studies of 108 common plant species of Jalpaiguri town was done, based mainly on apertural types for identification of airborne pollen grains.
- A total of 32 pollen types were identified from two years volumetric aerobiological survey by using rotorod sampler and 39 pollen types were identified by gravity slide method. High abundant types originated from Poaceae, Asteraceae, Solanaceae, *Cannabis sativa, Cassia* sp. etc.
- Seasonal periodicity was studied for all the pollen types. The highest incidence of total pollen was recorded in between November-February and minimum in between July and August. The frequency of pollen grains depended mainly on meteorological factors as a result of fluctuations of pollen concentration in different seasons.
- From the results of skin-prick test, some important allergenic pollen types viz. *Eucalyptus globulosus Saccharum, spontaneum, Azadirachta indica, Areca catechu, Cassia siamea* and *Borassus flabellifer.* were identified. It was observed that the allergenic intensity of pollen was not related to its abundance in the air.
- The fraction II i.e. 30-60% ammonium sulphate cut fraction of crude antigens of the eight selected pollen were found to be the allergenically highly potent.

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