"HAY FEVER" SYMPTOMATOLOGY IN GLASGOW: A GENERAL PRACTICE VIEW.

by

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SUMMARY

General practice appears to provide an ideal setting for the study of a common condition such as hay-fever. The study which forms the main part of this thesis was carried out during the hay-fever season of 1983 in Glasgow. The observations, comments, and discussion are those of one general practitioner, the author, who has developed a keen interest in the subject over a number of years and are based both on day-to-day contact with patients who suffer from this condition and from scientific study of the subject and its literature.

Details of the study are preceded by a historical review of hay-fever from "Rose Fever" to the discovery, in relatively recent years, of IgE. The next section deals with basic mechanisms from botany through aerobiology, pollen characteristics and chemistry to allergen exposure, the Type I allergic reaction and the symptoms thus produced. Details relating to sources of grass pollen in the Greater Glasgow area are included and much of this information is based on data obtained at the West of Scotland Agricultural College, Auchencruive, Ayr.

The thesis, which is the culmination of over four years interest in hay-fever in general practice, attempts to compare the symptom severity of eighty-two hay-fever sufferers with daily pollen counts during the hay-fever season of 1983 in Glasgow. Mean daily values for symptom severity were obtained from diary cards kept by the patients and are compared not only with the daily grass pollen count but with other elements of the total atmospheric pollen count and fungal spore counts. It has been suggested that grass pollen is indeed not the solely relevant antigen in causing hay-fever. Information was gathered about each patient's personal hay-fever symptom profile from a questionnaire incorporated into the diary cards. The study was carried out in a general practice setting and pollen counting was carried out on the roof

of the Environmental Health Department, Glasgow District Council, 23, Montrose Street, Glasgow. A representative selection of photomicrographs are presented in relation to the different types of atmospheric pollen isolated from the air over Glasgow during the hay-fever season of 1983.

The thesis concludes by making recommendations regarding the management of hay-fever in general practice and regarding the design of clinical trials of new forms of therapy for hay-fever. It also raises questions regarding incomplete correlation between patients' symptoms and information available on atmospheric pollen. Suggestions are made for further work, including, in particular, continued efforts to relate specific grass varieties in West Scotland to patients' symptom severity.

This thesis does not itself attempt to cover the wide areas of investigation and management of hay-fever in general practice but may inevitably have relevance in both of these areas. Considerable further study seems to be indicated in an attempt to improve our understanding of this common troublesome condition and thereby, hopefully, to help our patients by improved management and by more effective treatment.

<u>DECLARATION</u>

I hereby declare that the contents of this thesis represent work undertaken entirely by myself, except insofar as is detailed in the acknowledgements section.

[redacted]

<u>STUART F. WOOD.</u>

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CHAPTER 1 - INTRODUCTION

INTRODUCTION

"If consumption is too powerful for physicians, at least they should not suffer themselves to be outwitted by such little upstart disorders as hay-fever" Reverend Sydney Smith (1771-1845).

"It is to be admitted that neither of these disorders is anything but self-limiting; neither threatens life, and neither is likely to provide research material for a Nobel prize winner". McGuinness.

In the first of these quotations we are reminded that hay-fever is not seen as one of the most serious conditions that the physician is called upon to deal with. It is however a condition which causes considerable discomfort to those who suffer from it and certainly merits careful consideration by those involved in its management. McGuiness, in the second quotation, where he is referring to hay-fever and the common cold, comments on the probable significance of research related to these disorders. No study of hay-fever however can avoid touching on several specialties ranging from botany to biochemistry and from ecology to aerobiology. The literature of hay-fever is extensive although somewhat limited when related directly to general practice. The group of doctors involved in the management of hay-fever includes general practitioners, physicians with an interest in respiratory medicine, ear, nose and throat specialists and allergists. The allergy specialist, however, is relatively rare in the United Kingdom compared to North America, at present. The general practitioner seems to be in an ideal position to deal with the problem of hay-fever and referral to any of the specialists already mentioned should rarely be necessary. The general practitioner, nevertheless, may see hay-fever as a somewhat trivial and rather uninteresting condition which merits little serious consideration in comparison to many of the serious illnesses which he has to deal with on a fairly regular basis. It is hoped that this thesis may help to draw attention to hay-fever as an important and troublesome condition which warrants serious consideration and the improved management of which should make life very much more pleasant for many patients and afford considerable satisfaction to the doctor dealing with it.

The term hay-fever, although inaccurate, continues to suit everyday usage but does deserve further examination. Grass, allowed to grow to a suitable length for hay-making, is certainly a likely producer of copious antigenic pollen but other pollen grains and atmospheric spores must not be overlooked and this aspect will be dealt with in more detail later in this thesis.

Fever, or pyrexia, is not, however, a feature of this condition. A more accurate descriptive term is seasonal allergic rhinitis or rhino-conjunctivitis. This term, nevertheless, does not take account of the more general ill-effects of hay-fever and these will be considered later in this thesis also. Allergic rhinitis may be seasonal, non-seasonal or perennial.

Perennial rhinitis also includes non-allergic factors such as those which have come under the heading "vasomotor rhinitis". These trigger factors include non-antigenic dusts and fumes, changes in temperature and humidity and emotional or psychological factors. A combination of two or more of these factors may be active and a nasal mucosa made unstable by an antigenic pollen challenge may be more susceptible to smoke, perfume, or temperature change.

This thesis is concerned mainly with seasonal allergic rhinitis or "hay-fever" as the term is used in everyday language.

Prevalence

Accurate statistics regarding the prevalence of hay-fever are difficult to obtain and vary widely from study to study. This may partly be explained by the fact that only a proportion of sufferers will actually seek medical attention at all, some self-medicating with "over-the-counter" medication and some who simply put up with their symptoms.

10 per cent of the human race are said to be subject to hay-fever, asthma and eczema. A national survey in the U.S.A. in 1963 estimated that there were 12.5 million sufferers with allergic rhinitis or asthma or both, i.e. 8 per cent of the whole population. Allergic rhinitis is said to affect about one fifth of the Australian population (Bristow, 1978). A survey of American College students (Hagg and Settipane, 1969) found a prevalence rate of 20 per cent. A survey of 1,251 first-year students at Queen's University, Belfast reported a prevalence of 9.6 per cent (Harland, 1973). Roberts (1967) studied 3,833 Hampshire secondary schoolchildren and found a prevalence of 4.1 per cent. Fry (1963) reported a prevalence of 2.8 per cent in his practice population and prevalences of 4.2 per cent and 1.2 per cent respectively were reported in studies in Yorkshire and North London (Perkin, 1972; Coffman and Chalmers, 1974; Fairsheter et al, 1977). Eaton (1982) reported an apparent increase in the prevalence of hay-fever from 4.60 per cent (both sexes) in 1974 to 5.73 per cent in 1979 when he surveyed the entire population of a New Town general practice. Fagin et al (1981) claim hay-fever to be the most common of all allergic disorders affecting more than 20 million people in the U.S.A. They claim also that the prevalence of allergic rhinitis in the general population is about 10 per cent. Cuthbert (1981) recorded a prevalence of asthma and rhinitis of 17.3 per cent in a survey of 50 families in an Orkney farming community, although definite allergic causes could only be identified in 12.7 per cent.

Fry (1974) reports a cummulative incidence of hay-fever in his practice of 7 per cent over 20 years. He reports that only 2 per cent of his patients have symptoms severe enough to require some help from their doctor suggesting that between May and August 50 persons may seek treatment in a typical British general practice of 2,500 patients.

Natural History and Age-Sex Incidence

Ziering and Klein (1982) suggest that respiratory allergy develops by 2 years of age in 40 per cent of those affected and by 6 years of age in the remaining 60 per cent. Fagin et al (1981) comment that the peak incidence is in the post-adolescent teenage child. Broder et al (1974) found the prevalence to increase from less than 1 per cent in infancy to 15-16 per cent after adolescence. Fry (1974) found that most cases begin to suffer symptoms in childhood. 50 per cent will have begun at the age of 15 and 90 per cent by the age of 30. Only 1 per cent begin to suffer first symptoms after 50 years. He suggests that symptoms will recur with each year's season for 5-15 years and then stop spontaneously. Many older people do however continue to experience troublesome symptoms.

Wormald (1977) found an excess of females suffering from grass pollinosis in the child-bearing years. He found a M:F ratio of 2.1:1 in the first decade reversing in the third decade, a F:M ratio of 2.2:1 in the fourth decade and a F:M ratio of 1.9:1 in the fifth decade.

Hereditary Factors

There is no clear hereditary pattern to either the hay-fever itself or the susceptibility to it. In recent years there has been interest in its relationship to various HLA haplotypes. Gwynn and MacKintosh (1979) suggested that the HLA haplotype A1-B8 may confer a degree of protection against grass pollinosis. HLA A1-B8 is the haplotype most commonly found in North European (Caucasian) populations. They support the suggestion that allergic disease is polygenic and that there may be different genetic bases giving rise to varying degrees and types of mucosal permeability to allergens. Marsh et al (1982) suggest that the HLA haplotype HLA-Dw2 may be a genetic marker for human immune response to short ragweed pollen allergen Ra5. In their study they found that 95 per cent of ragweed allergic patients with IgE antibody to Ra5 were HLA-Dw2 positive in comparison to only 22 per cent of ragweed allergic patients with no antibody to short ragweed pollen allergen Ra5. In a separate study, Marsh and co-workers (1981) investigated the association of HLA phenotypes, A1,B8,Dw3 and A3,B7,Dw2. They are the two most common Caucasian haplotypes. They concluded that allergy is associated with HLA phenotypes contained within these two haplotypes.

Time of birth

The interesting question of whether there is any relationship between the time of birth and the development of immediate hypersensitivity to grass-pollen antigens has been studied by Kemp (1979). He found that children who reached the age of three months during a time of environmental exposure to grass pollen demonstrated a significantly increased incidence of immediate hypersensitivity reactions to three grass pollens as compared with children born at other times of the year. No significant difference was found in their reactions to the non-seasonal antigens. Smith and Springett (1979), however, found a higher proportion of asthmatics born between May and October than would be expected by comparison with the population of England and Wales but did not find any such relationship for hay-fever patients or pollen sensitive patients in general.

Relationship to Asthma

There has been interest for some time in the relationship between hay-fever and asthma in addition to their obviously sharing an atopic background. Grobler (1966) considered certain aspects of this relationship and reported that in his study all patients under 40 years of age with manifest pollinosis reacted with the nasal respiratory mucosa and the bronchial tree to pollen provocation. In subjects over 40 years of age with manifest pollinosis positive nasal and bronchial pollen provocative tests were found in 8 out of 10; 2 subjects with positive nasal reactions did not respond to the inhalation of pollen. In 11 patients (over 40 years of age) with a history of pollinosis but without manifest pollinosis anymore, a negative nasal provocative test was found in 9 subjects who did respond with bronchial obstruction to the inhalation of pollen; in the other two patients no reaction of the nasal respiratory mucosa or bronchial tree was found. In the case of the other allergens, however, the nasal complaints could not be explained with certainty to be caused by a certain allergen especially in those with negative nasal provocative tests.

CHAPTER 2 HISTORICAL REVIEW

HISTORICAL REVIEW

Although the actual term allergy dates only from 1907, when it was first used by the Austrian paediatrician Clemens von Pirquet, the first possible record of an allergic reaction may have been a fatal anaphylactic reaction to a hornet's sting suffered by Pharaoh of Menes of Memphis between 2140 BC and 3300 BC in Egypt. The first hay-fever sufferer is alleged to be Hippias, the Athenian traitor who guided the Persian invasion fleet to its landing at Marathon and commanded part of the army at the subsequent battle. The seizure he suffered while directing the disembarkation of Persian forces was described in two sentences of Herodotus which read as follows: "While he was engaged in drawing the troops up in formation he had a fit of sneezing and coughing that was more intense than usual. Since he was getting on in years, most of his teeth were loose, and he lost one of them during his violent coughing; on seeing it fall into the sand he went to a great deal of trouble to try to find it again". This incident is dated at 490 BC. Drs. Malten and Cuera, who unearthed the case, have even identified the allergen as the pollen of Helianthus annus, a common cause of hay-fever in Mediterranean countries.

In the fifteenth to sixteenth centuries mention is made of a condition known as Rose Fever. A Roman Cardinal, Oliveria Caraffa, posted guards outside his palace with orders to send away any visitor who was ill-advised enough to turn up with a bunch of roses. Valerianus mentions another Roman notable, Petrus Melinus, as a victim of rose-fever. Leonardo Botallo, who took his doctorate at the University of Pavia about 1533, is said to have been the first medical man to set down a clear description of what came to be known as "rose-fever". He had a patient who could not abide roses, since they caused his nose to itch intolerably, made him sneeze and gave him nasty headaches. Possibly even earlier still a Portuguese-Jewish physician named Juan Rodriquez gave an account of a monk, apparently not one of his own patients, for whom every summer was a time of trial. He found the scent of roses positively unpleasant, a clue which his doctors seized upon. They gave him the only possible advice, which was to shut himself up in his quarters until the roses had finished blooming. A Swiss physician, Jacob Constant de Rebecque, in 1691 gave a thirteen year history of "coryza a rosarum odore". The scent of roses caused him no trouble, evidently, except during a definite period towards the end of Spring. Just then he theorised, roses gave off tiny, "spiky" motes that scarified the tissues of the respiratory passages and thus admitted the actual "Poison" which at other times was kept out.

An English physician, Nehemiah Grew (1628-1712), who studied at Cambridge and Leyden and practised at Coventry, was the first man to see and describe grains of pollen. Jacob Constant de Rebecque had gone some logical way towards describing the mechanisms of hay-fever in postulating the involvement of tiny, "spiky" motes but the rose is of course an entomophilous or insect-pollinated plant where the heavy sticky pollen is transferred from plant to plant by bees, etc. and the pollen grains responsible for aero-allergies are from anemophilous or wind-pollinated plants.

In 1819, a London doctor, John Bostock, described his own "Periodical Affection of the Eyes and Chest". His symptoms appeared in mid-June and lasted until late July. He tried out numbers of remedies without being able to cure himself. In 1828 he reported to the Royal Medical and Chirurgical Society of London on his own and eighteen other cases of what he termed Catarrhus aestivus. The term "hay-fever" was already in use however and continued to be used despite comments that it was misleading by William Gordon, a contemporary of Bostock. Dr. Charles Harrison Blackley, writing in 1873, was inclined to believe that "hay-fever" would in the end prove to be the most appropriate term.

Dr. John Elliotson, 1831, laid the blame "upon the flower of grass, and probably upon the pollen". Philip Phoebus, Germany, mid-nineteenth century, wrote a monograph on hay-fever in an attempt to chart the geographical, ethnographical, sociological and hereditary distribution of the disease. Beard (1876) also contributed to the epidemiological research on hay-fever. It is Charles Harrison Blackley (1820-1900), however, whose name is most clearly linked with important contributions to better understanding of hay-fever. His book, "Experimental Researches on the Causes and Nature of Catarrhus Aestivus was published in 1873. A hay-fever sufferer himself, Blackley was interested in homeopathy. There were many theories at the time as to the causation of hay-fever, e.g. that it was due to the inhalation of benzoic acid, the odour of hay or other odours, that it was due to the action of ozone, the effect of dust, the influence of light and heat, and finally that it was due to the inhalation of pollen. Challenge "tests" excluded all the causative mechanisms other than pollen. He collected the pollen from well over eighty different types of plant and proceeded to carry out nasal challenges using either dry pollen, fresh pollen or extracts of pollen. He also applied pollen to his conjunctiva, to his soft palate and, by scarification, to his skin. On occasions he also inhaled pollen by mouth. He quickly observed that the pollens of grasses were the ones that caused him the most trouble. It seems likely that some of the grass pollen challenges were producing in him both "early" and "late" reactions. On many occasions he also provoked an attack of asthma.

He went on to attempt to measure the concentration of pollen in the air and developed a simple technique whereby the pollen grains from the atmosphere were deposited onto the surface of a measured area of a slide. This area was made sticky with glycerine (to which carbolic acid was added to deter insects) and the number of pollen grains present was determined microscopically. He measured the pollen count around his practice from May to August 1866 and related the peaks and falls to climatic conditions. The different air sampling systems which he developed included a method for measuring the pollen concentration at high altitude. He flew sticky slides from kites as high as 2000 feet and devised a clockwork mechanism which would reveal the slide to the air only for a predetermined time. He maintained that the disease was confined to well-educated people, particularly of Anglo-Saxon stock.

He tried many different drugs with no significant effect except local applications of Belladonna or opium. He found that avoidance of pollens was possible by spending the summer in a suitable location and mentioned small islands, narrow peninsulas, and yachts. He also experimented with personal air filtration systems. Blackley took a Doctorate of Medicine at the University of Brussels in 1874 and, on retiral, went to live in Southport.

In 1872 Morrill Wyman identified ragweed pollen as the pre-eminent cause of autumnal hay-fever in the United States. In 1903 Dunbar demonstrated that proteins are the allergenic factor and tried to treat hay-fever patients with a special serum (Pollantin) obtained by immunising horses. Alred Wolf-Eisner, 1906, pointed out that hay-fever should be seen as an allergic disease. In 1911 Noon published his classic paper in the Lancet, describing the first attempts at desensitisation of hay-fever sufferers. Prausnitz and Kustner, in 1921, demonstrated that the serum of an allergic patient contained some factor which could mediate a positive skin test. At the same time Arent de Besche, a Norwegian, showed that the blood of an allergic patient contained "anaphylactic reaction bodies". In the mid-1960s Kimishige and Teruko Ishizaka, and S.G.O. Johansson and Hans Benmich in collaboration with L. Wide identified IgE (originally labelled IgND).

Over the past ten years interest has centred on the basic science surrounding the Type I allergic reaction and the role of mast cells and basophils in the reaction.

CHAPTER 3 MECHANISMS

MECHANISMS

Hay-fever or seasonal allergic rhinitis is a Type I or immediate hypersensitivity reaction with the nose as the main target organ. The conjunctivae are also often affected and careful study of patients' symptoms, as detailed later, reveals the more widespread effects of such a reaction. For the allergic reaction to take place it is necessary for an aero-allergen (e.g. a pollen grain) to come into close contact with the body's immune system. In this section the steps involved in bringing this about are examined from the source of the pollen to the clinical features produced.

Botanical Aspects

Pollen grains house the male gametes of plants. The word pollen meant originally "fine flour" (Faegri, 1975). Pollen grains are formed in the anther, the male apparatus of the flower. The interior of the anther consists of a sporogenous tissue from which the pollen mother cells originate. The sporogenous tissue, or, later, the mass of pollen grains, is surrounded by a wall, which breaks down in some way when the pollen is ripe, and the pollen grains are liberated for transfer to the pistil (generally of another flower) where fertilisation takes place. With few exceptions, each pollen mother cell gives rise to four pollen grains (tetrad stage) that are in most plants ultimately free from one another. In some genera they do not separate, forming tetrads, or other rarer types of composite grains (dyads, polyads). The part of the pollen grain which is nearest to the centre of the tetrad is called the proximal, the line between the proximal and the distal pole of the grain is called the polar axis and the plane perpendicular to this axis through the middle of the grain is called the equatorial plane.

The plants we are mainly concerned with here are the anemophilous or wind-pollinated plants. These plants have relatively lighter pollen which can become airborne without difficulty. In general terms this group includes many grasses, trees, and weeds. The entomophilous plants are insect-pollinated and have relatively heavier, sticky pollen which is moved from plant to plant by flying insects such as bees. These latter plants include in particular the brightly coloured flowers which are of course designed to attract their insect vectors. In broad terms it is a not uncommonly held misconception that brightly coloured flowers cause hay-fever in spring and early summer when the anemophilous grasses, etc. are at their "flowering" time which is followed by pollen release. This is almost certainly what happened in the case of "Rose Fever" which has been considered in an earlier section. Only about 30 out of more than 300 families of flowering plants show adaptations for pollen dispersal in air currents (anemophily). Families in which most of the genera are wind-pollinated include grasses (Gramineae), sedges (Cyperaceae), rushes (Juncaceae), poplars (Salicaceae), dock (Chenopodiaceae), and nettles (Urticaceae). Among several families that are predominantly pollinated by animal vectors, some genera are wind-pollinated, for example, the ragweed Ambrosia in the Compositae and the ash Fraxius in the Oleaceae. The anthers of wind-pollinated species open only during favourable weather when it is warm and dry. Consequently they tend to open during daylight hours only. Some grasses show a bimodal pattern of flower opening, both in early morning or late afternoon, while others have only one daily flowering period. Massive pollen releases can be observed on a still morning in a field of grass. When the first breeze stirs the flowers, the pollen rises in small clouds forming a haze over the field. If not mown or grazed a one hectare field of rye grass will release an estimated 210 Kg of pollen in one flowering season. Pollen output of different grasses varies widely, the common agricultural grasses such as ryegrass, cocksfoot, Yorkshire fog and canary releasing between two and five million pollen grains from each flowering spike; while others such as brome and wild oat release less than one thousand grains. In Europe, North America and Australia the seasonal progression involves first tree pollens in winter and early spring. The pollens of birch, alder, hazel, oak, ash and elm lead the pollen calendar. In late spring and early summer the grass season begins followed closely by various weeds; for example, nettle, dock, sorrel, plantain, and in North America by various amarinths and ragweeds in the autumn. Circadian rhythms of pollen emission - in general, ragweed, grasses, trees and weeds, show a diurnal periodicity to pollen release and subsequent peaking in the atmosphere.

In the West of Scotland grass pollen is the main airborne allergen during the hay-fever season and this may be released from fields of cultivated grassland, from areas of uncultivated "rough-grazing" or from waste ground which is also uncultivated. Parkland and motorway verges also provide sites of grass pollen release. Regularly mown lawns, however, are unlikely to be significant sources of pollen as the grass is not normally allowed to grow tall enough to allow flowering to take place nor therefore for pollen to be released. It has generally been accepted that most grass pollen will be deposited within 50 miles of its release but this is by no means without exception. Information is available regarding cultivated grasslands and "rough-grazing" but it is difficult to know how significant wild grass growing in areas of urban and suburban wasteland may be. To the North East of Glasgow is a large farming area known as the Carse of Stirling. This has traditionally been a Timothy grass growing area and Timothy grass (phleum pratense) is considered to be an important source of allergenic pollen. It is interesting to note that the Timothy grass grown in the Carse of Stirling has been grown historically for hay production and seed production making it a source of abundant pollen. The hay was used for feeding the workhorses in the City of Glasgow. The local author, Tom Weir, describes the social and historical development of this area, also known as Flanders Moss, in his book "Tom Weir's Scotland". In a prevailing North-Easterly wind this area potentially becomes a very significant source of Timothy grass pollen for the Greater Glasgow area. Details regarding winds and other weather statistics are given in Appendix I. Rye grass is however the commonest cultivated grass in the West of Scotland. There has been a significant decrease in the farming acreage devoted to hay in Scotland from 223,000 hectares in 1971 to 176,000 hectares in 1981. This is largely the result of an increase in silage production for winter cattle feeds. This reduction in pollen sources has not been noticeably accompanied by a reduction in the seasonal prevalence of hay-fever although accurate statistics are of course not available. Bent grass and Yorkshire fog are frequent inhabitants of uncultivated grassland whereas Meadow Foxtail and Red Fescue are found commonly at roadsides.

There are, of course, marked geographical differences in relation to pollen production. Perennial ryegrass, so common in the West of Scotland, does not survive in Scandinavia where tree pollen, such as birch, causes considerable problems (Viander and Koivikko, 1978). Holopainen et al (1979) reviewed what they considered to be the most important allergens in allergic rhinitis in the Nordic countries. They divided the plants into three main groups: deciduous trees, grasses, and flowers. The allergen distribution among these three pollen groups was studied in a series of 335 patients with seasonal nasal symptoms attending the Ear, Nose and Throat Hospital, Helsinki University in the years 1968-76. It was evident that allergens were evenly distributed among trees, grasses, and flowers, each group including about 40 per cent of the patients. Symptoms in spring and early summer were usually caused by trees. Birch, alder and willow were the trees chiefly responsible for symptoms, birch pollen being by far the most important on account of the massive pollination of this tree. Allergy to tree pollens is usually associated with hypersensitivity to grass pollens. Among the grasses tested, Timothy, Alopecarus, Kentucky Blue grass and Meadow fescue elicited positive reactions most frequently.

The majority of grass-sensitive patients reacted to all four species. In some patients, positive reactions were recorded for other fairly common grasses, such as Agrostis, Agrophyrum, reed, etc but from a clinical point of view these were of minor importance. In late summer mugwort is the most common cause of seasonal rhinitis in Finland.

<u>Aerobiology</u>

A consideration of airborne allergens must include some mention of the various aspects collectively labelled as aerobiology or the microbiology of the atmosphere. It is the lower layers of the atmosphere, from ground to 10 Km, which are relevant in this respect. These layers together are known as the troposphere. The much higher stratosphere is generally considered to be free of terrestrial dust, including organic spores. The troposphere comprises five layers:

Laminar boundary layer
Local eddy layer
Turbulent boundary layer
Transitional or outer frictional turbulence layer
Convective layer.

The tropause is the boundary between troposphere and stratosphere. Wind dispersal of spores has three principal stages:

Spore liberation
Disperson
Deposition

Many air sampling techniques have been developed over a number of years and include Gravity Sedimentation Methods, Inertial Methods, and Forced Air-Flow Impactors. Details of these are shown in Table 1, although not all are appropriate for the purpose of pollen counting. Two different techniques have been employed to obtain the pollen counts in Glasgow and these will be described in detail later in the section entitled "Description of Study".

Table 1 Air Sampling Techniques

GRAVITY SEDIMENTATION METHODS

Sedimentation from still air

Sedimentation from wind

1) The "gravity slide"
2) The gravity petri dish
3) Conical funnels

Sedimentation from artificially moving air

INERTIAL METHODS

Impaction using wind movement

1) Vertical and inclined sticky microscope slides
2) Vertical cylinder
3) Aeroconiscopes (aeroscopes)

FORCED AIR-FLOW IMPACTORS

1) Sieving filters
2) Impaction filters
3) Liquid scrubbing devices
4) Impingers
5) Centrifugal samplers
6) Impactors
7) The slit sampler
8) The cascade impactor
9) The automatic volumetric spore trap (Hirst)
10) The Andersen sampler
11) Whirling arm

Climate and topography

Davies (1969) reviewed the effects of climate and topography in relation to aero-allergens at Davos, Switzerland and London. He pointed out that temperature determines when the season occurs, its length and, during a period of years the severity of a particular season. Prolonged rain washes the air free from particulate matter and by wetting the surfaces of vegetation temporarily inhibits spore dissemination. Very heavy rain washes pollen grains, and even the anthers which bear them, to the ground.

Temperature inversions prevent the ascent of spore clouds at different altitudes. These may be surface inversions such as those which occur in London in the summer or may be caused by katabatic wind - the flow of cold air off the Alpine ice down into the valleys. Spore clouds flowing over British cities are mainly of an exogenous origin from such scources as crops, woodlands, and pastures outside. In the U.S.A. ragweed eradication programmes in the cities have been shown to neither reduce the amounts of pollen trapped nor the incidence of ragweed pollinosis. Norey et al (1977) found clinical allergy to Mesquite pollen to be relatively common despite an urban location in Irvine, California, some fifty miles from the nearest native Mesquite.

Geographical differences

Bagni et al (1976) compared city spore concentrations in the European Economic Community in 1973. The sampling sites included in the study were in Bologna, Brussels, London, Munich and Strasbourg. They emphasised the importance of April and May mean air temperature on grass development and noted great differences between the pollen challenge in the five cities. The importance of local variation even within one area was reviewed by Morrow-Brown and Jackson (1978) who operated eight identical volumetric spore traps simultaneously during the summer of 1969 at various sites up to 56 Km from Derby (their base) to compare their results with those from a sampling site in the centre of Derby. Figures varied somewhat in different types of site but for most pollen and spore types total numbers and seasonal pattern at all the sampling sites were found to be similar. The same authors compared the air spora of two sites on the east coast of Britain and one on the west coast with their regular sampling site in Derby. Concentrations of airborne spores and pollen were found to be usually less at the coastal sites than in Derby. The effect of wind direction was shown to be important at coastal sites because daily counts often showed rises and falls corresponding to off and on-shore winds respectively. Counts at the west coast site were nearly always lower than those on the east. These findings, together with the prevalence of westerly winds over Britain and the different land use in the east and west, suggest that fewer airborne allergens may be encountered on the west coast.

Aeroallergens.

The composition of the air spora has been widely studied. There are said to be 1,200 species of bacteria and Actinomycetes, 40,000 species of fungi, numerous mosses, liverworts, ferns and their allies, and more than 1,000 species of pollen -producing flowering plants of which about 10 per cent are wind-pollinated. In Britain, Cladosporium and Sporobolomyces predominate, followed by the Lydine and coloured basidispores of the mushrooms and toadstools. Fewer in number, but not necessarily less in total volume, are the pollens, Alternaria, ascospores, and the large-spored plant-pathogenic fungi. Concentrations of spores of a single species, or a group of related species, often show a "diurnal" rhythm. Buisseret (1976) draws attention to fungal spores as a cause of seasonal allergic symptoms. He noted an absence of ocular symptoms in patients allergic to fungal spores which may be due to the larger size and weight of spores compared with pollen grains, making them less likely to be blown into the eyes and this may indeed be a helpful diagnostic pointer. [Note: The term spore is relevant to asexual reproduction in contrast to pollen which represents the male gametes of plants as has already been mentioned]. The family, fungi, includes yeasts in one group and moulds and filamentous fungi in another. The moulds, alternaria and cladosporium, are producers of airborne spores. [Note: A few species of alternaria and cladosporium are plant parasites or pathogens but more commonly they are saprophytic and found on decaying plants and leaf litter, including grass].

The term "October hay-fever" has been applied in the U.S.A. to symptoms caused by common mushroom spores in "fall".

Wodehouse (1945) listed the requirements of an aeroallergen as "buoyancy, abundance, and allergenic toxicity". The viability of a microbe is not required of an aeroallergen. An allergenic microbe is still active when dead, so long as it is not too far deteriorated chemically. The glycoprotein allergen in house dust remains active after the sugars are split off the molecule, but activity ceases when acid hydrolysis is carried to the splitting off of amino acids. The aeroallergens investigated are based on protein, or less often, on polysaccharides. The pollen grains of many anemophilous plants meet Wodehouse's requirements.

There have been some unusual reports of aeroallergens in hay-fever. Gillett (1978) noted his hay-fever symptoms to be worse during the rainy season in Entebbe, Uganda and that they followed a lunar periodicity with a sudden onset each new moon and gradual diminution to a cessation of symptoms by full moon. There was a close correlation of his symptoms with the number of "lake flies" (Chironomids and Chaoborids) resting on the external wall of his house. It is well known that "lake flies" emerge from Lake Victoria in dense clouds every new moon and over the succeeding ten days or so. Skin tests in Khartoum indicated a high sensitivity to similar flies.

Pollen Characteristics and Chemistry

A pollen grain is made up of three main concentric layers typically containing approximately 20 per cent protein, 37 per cent carbohydrate, 40 per cent lipid, and 3 per cent mineral. The central part is the living cell which germinates on the stigma and forms the pollen tube that penetrates the style and brings the fertilising nuclei down to the ovum. The middle layer is the intine. It is present in all pollen grains and envelops the whole of the grain in an apparently uniform sheath. Cellulose is probably a major constituent of the intine. Its other chemical constituents have been reported to be pectic substances and callose, other polysaccharides, proteins, and enzymes. Proteins may be interbedded in vesicles in the intine. They are easily leached out and may be the cause of allergic reactions in man. Antigens have also been reported from the exine. The largest concentrations of proteins are found under apertures where the intine usually appears more stratified. The onci are thickenings immediately underlying the apertures. The third, outer layer, is the exine. This forms an extraordinarily resistant wall. The exine consists of two main layers: the inner one, the intexine or endexine, and the outer one, the ectexine. Rather wide pores are a genuine feature of the endexine. The ectexine comprises small, radial, rod-like elements. Most pollen grains possess apertures and two types are observed; pores and furrows (colpi). The size range of pollen grains is from 5 µm to 200 µm.

Pollen allergens are proteins or glycoproteins and have been characterised for both ragweed and grass pollens. T.P. King and co-workers at the Rockefeller University in New York isolated and purified the allergens from ragweed pollen in 1964, naming the two most potent antigens E and K. They have proved to be acidic proteins comprising two sub-units, an alpha chain of molecular weight 21,800 and a beta alpha chain of molecular weight 15,700 giving a total molecular weight of 38,000. The two chains are readily dissociated by heat, and are linked by covalent bonds. Antigen E is present in four different forms that are all immunologically similar but differ in isolectric points. The allergens of grass pollen are equally complex and three groups of heat-stable glycoproteins are the principal allergens. The two principal groups of allergens named groups I and II by D.G. Marsh and collaborators have molecular weights of 30,000 and 10,000 respectively and each have several isoallergens differing in isolectric point. The allergens of ragweed and grass pollen are located in extracellular wall sites, i.e. the intine and exine.

Stanley and Linskens (1974) have studied many aspects of pollen biology in great detail. They confirm that pollen grain size varies over a broad spectrum from 5 µm to greater than 200 µm, as has already been described. In the majority of anemophilous (wind-pollinated) plants pollen grain size is within the limits of 17-58 µm. The greatest bulk of grass pollen lands within 3 metres of the source. Less than one per cent of all air-borne grass pollen reaches 1 Km from the source. Bioelectrical forces may also be involved in pollen sedimentation. A high percentage of pollen carry a negative electrostatic charge. While there is no evidence to support the view that electropotential gradients between pollen and receptive organs are involved in pollination the possibility does exist that long distance transport is influenced by electrical relations.

Stanley and Linskens (1974) agree that the most important allergic antigens are proteins or polypeptides although polysaccharides, glycoproteins and lipoproteins can also be effective antigens. For a substance to be an important cause of respiratory allergy such as hay-fever it must be contained in the inhaled air in relative abundance and release a chemical antigen (allergen) which fulfils certain chemical criteria.

The antigen should:

1. be foreign;
2. in general, have a molecular weight over 10,000;
3. the molecular structure should possess a certain rigidity as is usually conferred by aromatic groups, disulphide linkages or double bonds;
4. the molecular surface configuration must afford "polar groups", for attracting antibodies and conveying specificity;
5. be metabolised by the body in a specific period of time.

Proteins and certain other chemical moieties which can be elicited from pollen and mould spores fulfil most of the above requirements; their chemical structure makes them effective antigens. It is thought that entomophilous insect-pollinated pollen may also contain antigenic proteins.

The allergenic component of the pollen grain is only a very small part of it - allergens usually only comprise 0.5-1.0 per cent of the total extractable pollen proteins. In 1977 Aufosso et al first isolated and characterised an allergen from a plane tree (Platanus acerifolia) pollen - a glycoprotein with a molecular weight of 22,000.

Allergen Exposure

In an earlier section it was stated that the nose is the main target organ in hay-fever but the mode of contact with the nasal mucosa bears some further examination. Air normally passes the nose at a speed of two metres per second. The nose has three distinct functions, performed in the nasal cavities: warming, moistening and filtration of air. We are concerned in particular here with filtration. Large particles are removed by the vibrissae - the hairs at the entrance to the nostrils. Turbulent precipitation removes other particles. Air passing through the nasal passageways hits many obstructive vanes, such as the turbinates, the septum, and the pharyngeal wall. Each time air hits one of these obstructions it must change its course, and the particles suspended in the air, having far more mass and momentum than air itself, cannot change their direction of travel as rapidly as air can. They therefore continue forward striking the surfaces of the obstructions. Particles are entrapped in the mucus secreted by the mucous membrane covering the surfaces of the nose. The effect of the ciliated epithelium is to mobilise the mucus towards the pharynx where it is either expectorated or swallowed. Almost no particles larger than four to six µm in diameter are allowed to enter the lungs in the inspired air. Particles smaller than one half µm in diameter usually remain suspended even in the alveolar air and are expelled from the lungs during expiration. Particles between 0.5 µm and 4 µm precipitate or diffuse against the walls of the respiratory passages or alveoli adhering to the alveolar fluid. It is therefore particles which adhere to the nasal mucous membrane which are of importance in hay-fever. Non-specific irritation of the nasal passageways may stimulate the sneeze reflex. Afferent impulses pass in the fifth nerve to the medulla where the reflex is integrated. An air block occurs mainly at the soft palate and uvula. Pressure is built up in the lungs and pharynx behind the uvula which is suddenly depressed, and large amounts of air pass rapidly through the nose, thus helping to clear the nasal passages of foreign matter. Sneezing can also be triggered by afferent impulses from the eyes, e.g. bright light. Particles between 1 µm and 10 µm in diameter are most likely to be trapped in the nose and included among those, grass pollen grains are most commonly implicated as causes of nasal allergy. Mygind (1979) points out that physical work, by increasing air-flow over the nasal mucosa, will increase nasal deposition of pollen and promote rhinitis. Pollen grains are normally in contact with the nasal airway mucosa for 10-30 minutes due to the mucociliary clearance system.

The Immune Reaction

A commonly accepted modern view of the Type I immune reaction involved in that the antigenic polypeptides of the pollen grain wall react with the F_{ab} fragments of the IgE molecules which are attached to the membrane of mast cells in the nasal mucous membrane. Adjacent IgE molecules are thus "bridged" at their F_{ab} fragments. When a critical number of IgE molecules are cross-linked by allergen binding to their F_{ab} fragments changes occur in the cell membrane to allow calcium to pass into the cells from the extracellular space. An increase in intracellular calcium causes granules within the mast cell to swell and then move towards the cell surface by a process requiring energy consumption. Fusion of the perigranular and plasma membranes enables the pre-formed mediators, which are packaged within the granules, to escape. These mediators include histamine, heparin, chemotactic factors which stimulate the selective migration of eosinophils and neutrophils and also a variety of tissue damaging enzymes. Entry of calcium into the cells stimulates the breakdown of some of the membrane phospholipids by enzymes which are called phospholipases. Their activity releases an unsaturated fatty acid, arachidonic acid, in parallel with the release of the granule mediators. Mast cells and basophils have the capacity to transform this arachidonic acid to other potent mediators. Metabolism via the cyclo-oxygenase pathway produces prostaglandins, and in particular, prostaglandin D2, whereas lipoxygenase metabolism of arachidonic acid gives the leukotrienes and potent chemotactic lipids. Mediators are released within 1-2 minutes of antigen challenge and some, like histamine and prostaglandin D2, cause vascular engorgement and nasal obstruction. Others, like bradykinin, cause irritation of afferent nerves producing nasopharyngeal itching and sneezing or the leukotrienes C, D, and E, which compose a substance previously recognised as slow reacting substance of anaphylaxis (SRS-A), cause oedema of the mucous membrane. The preformed and newly generated chemotactic factors stimulate neutrophils, basophils and eosinophils to migrate to the inflamed mucous membrane and thereby aggravate and prolong the inflammatory reaction. This mechanism probably accounts for the more chronic nasal symptoms more commonly seen in perennial rhinitis but may also be responsible for the continued irritability and instability of the nasal mucous membrane throughout the hay-fever season. The role of thymopoietin and of cyclic AMP in this process is also under investigation (Sattaur, 1982). There is considerable interest in the role of IgG in rhinitis and IgG_4 has been found to be increased (Parish, 1981). There are similarities between IgG S-TS and IgG_4 and researchers have postulated that they may in fact both be the same sub-class of IgG. IgG_2 has not been implicated in rhinitis.

Mygind has extensively studied this aspect of the subject and has made several important discoveries related to it. When the allergenic substances have penetrated through the epithelium they may be ingested by macrophages which present the processed allergens for the immunocompetent cells, the lymphocytes. Only a small number of B-lymphocytes will, upon stimulation with a particular allergen, be transformed into plasma cells which are capable of forming 2,000 IgE molecules per second. Stimulation of B-lymphocytes and the consequent formation of IgE antibody is under the control of T-lymphocytes which both partly facilitate the process (helper cells) and partly inhibit it (suppressor cells). IgE has a special affinity for the surface of mast cells and basophil leucocytes. Mygind (1982) points out that blockage of sympathetic innervation leads to nasal blockage. During the pollen season basophil leucocytes migrate through the surface epithelium to the airway lumen but mast cells migrate only into the epithelium. The closer the mediator cell is to the epithelial surface, the more important role it plays in allergic rhinitis. Biochemical mediators released from mast cells and basophil leucocytes are either preformed within granules or generated from precursor molecules. Preformed mediators include histamine and the eosinophil chemotactic peptides (ECF-A). Membrane derived mediators consist of arachidonic acid metabolites - the enzyme lipoxygenase produces leukotrienes (including SRS-A) and 5-HETE from arachidonic acid, and cyclo-oxygenase generates prostaglandins, prostacyclins, and thromboxanes. A late reaction, reproducible and defined in time, has not been convincingly demonstrated in the nose. Histamine is an important mediator of nasal allergy but nasal hyper-reactivity is probably induced by other mediators, possibly the arachidonic acid metabolites. Histamine release from epithelial mediator cells may therefore promote allergen penetration into the lamina propria, where there is a much higher number of mediator cells than in the epithelium and airway lumen. Experiments suggest that a direct histamine effect on nasal blood vessels is important for any persistent nasal blockage in allergic rhinitis. Ordinary H_1 antagonist antihistamines have little effect on blockage in allergic rhinitis. Itching, sneezing, and discharge are mainly reflex mediated. Inhibition of these is mainly an effect on sensory nerves in the nose.

Mygind (1982) has suggested the following hypothetical pathogenesis of allergic rhinitis: allergen exposure of the sensitised nasal mucosa increases the number of epithelial mediator cells - basophil leucocytes on the surface and mast cells between the epithelial cells. Thus both cell types, one derived from the circulation, and the other derived from the mucous membrane, appear to be of significance for the mediation of allergic symptoms in the nose. Histamine, released from these cells, increases epithelial permeability and promotes allergen penetration and contact with the larger number of submucosal mast cells. Histamine also increases vascular permeability and dilates blood vessels mainly via a direct effect on vascular H_1 and H_2 receptors. Itching, sneezing and to a high degree, hypersecretion are caused by histamine effect on nervous H_1 receptors, hypersecretion being mediated via a parasympathetic reflex in the trigeminal and vidian nerves. Allergen exposure results also in increased mucosal reactivity, which is delayed in time and is probably not induced by histamine but more likely by the membrane-derived metabolites of arachidonic acid.

Konno and Togawa (1979) have reviewed the role of the vidian nerve (the nerve of the pterygoid canal) in nasal allergy. They found that localised nasal stimulation led to hyperrhinorrhoea in both sides of the nasal cavity before vidian neurectomy. Unilateral vidian neurectomy blocked hyperrhinorrhoea only in that cavity in which the nerve was sectioned. Hyperrhinorrhoea from the contralateral side with an intact vidian nerve was blocked with sensory anaesthesia of the opposite side of the nasal cavity where the stimulation was applied. Nasal hypersecretion in allergic rhinitis was assumed to be mostly due to stimulation of sensory receptors by a chemical mediator and reflex stimulation of the nasal glands. Vidian neurectomy, however, did not have any apparent influence on the swelling of the nasal mucosa caused by localised stimulation of allergen and histamine.

In agreement with Mygind, Hastie, Heroy and Levy (1979) suggested that both basophils and mast cells may play a role in the pathogenesis of allergic rhinitis. They concluded that when nasal symptoms develop in allergic subjects on antigenic exposure basophils migrate into the secretions and mast cells migrate into the epithelium. It is suggested that this may partly explain Connell's "nasal priming" effect, i.e. some cells migrating into epithelium and secretions as the season develops.

Platts-Mills (1979) studied the local production of IgG, IgA and IgE antibodies in grass pollen hay-fever and showed that antibody response to pollen antigens is truly local. Most patients with grass pollen hay-fever were found to have IgG, IgA and IgE binding activity to group I protein of Rye grass pollen (BA) in both their serum and nasal secretions. IgG and IgA in nasal secretions had a higher proportion of pollen specific antibody than the IgG and IgA in serum showing that most of the IgG (BA) and IgA (BA) in nasal secretions must have been produced locally. In contrast, IgG antibody to diphtheria toxin was found to represent a lower proportion of nasal IgG than serum IgG. These findings for IgG anti-toxin supported the view that the pollen specific IgG (BA) must have been produced locally. Results also suggested that IgE in nasal secretions was also produced locally. Saliva samples were found to have little or no pollen-specific IgG, IgA, or IgE BA. The major antibody response to injections of grass pollen extract was increased serum IgG BA which was not matched in nasal secretions. The possibility is raised that serum IgG BA and IgE BA are produced predominantly in local lymph nodes whereas the BA found in nasal secretions was derived from plasma cells in the nasal mucosa.

Zeiss et al (1978) quantified IgE antibody specific for ragweed Antigen E (AgE) on the basophil surface in patients with ragweed pollinosis. They found a limited number of IgE receptors on the basophil surface as contrasted with the concentration of IgE in the plasma.

Clinical Features

Sneezing, runny nose (watery nasal discharge or rhinorrhoea), blocked nose and itchy eyes are well known as the major effects of the pollen provoked Type I immune reaction already considered. A wide range of more minor symptoms also appears to be associated with hay-fever and this aspect will be considered further along with the major symptoms in the "Results" section of this thesis.

Sore throat, cough, and wheezing are of particular interest as these symptoms may be assumed to be associated with respiratory infection and therefore treated inappropriately. This is more likely to occur where the major hay-fever symptoms are less prominent in a particular case. Although symptoms, of course, predominate, physical signs may be noted in hay-fever, and, in particular in childhood sufferers (Jones, 1978; Ziering and Klein, 1982). The "allergic salute" describes the characteristic rubbing of the nose with the back of the hand and this may in turn produce a "transverse bar" - a persisting skin crease across the lower part of the nose. Puffy eyelids are common and the associated extra skin folds in the lower eyelids are known as "Dennie's lines". "Allergic shiners" is a term used to describe the swelling and blue discolouration of the lower eyelids.

Correlation of Symptoms with Pollen Counts

Viander and Koivikko (1978) studied the seasonal symptoms of hyposensitised and untreated hay-fever patients in relation to birch pollen counts and examined the correlations with nasal sesntivity, prick tests and RAST (radio-allergosorbent test). In the early part of the season, when birch pollen counts were low, the onset of symptoms was significantly associated with high sensitivity of the patients. In the late season many patients showed symptoms irrespective of their nasal and RAST sensitivity. About 90 per cent of the total group of patients reported mild symptoms when the pollen count exceeded $80/m^3$ in the early season and 80 per cent of them still had symptoms when the count was below $30/m^3$ in the late season. There are few reports on the correlation between the clinical sensitivity of the patients and the appearance of the first seasonal symptoms. Hyde (1972) estimated that 10 per cent of hay-fever patients are likely to have symptoms when the pollen count exceeds $10/m^3$. The most sensitive patients reported symptoms even before pollen can be detected by Hirst traps (Davies, 1975). According to Frankland and Davies (Unpublished results, see Davies and Smith (1973)) all clinically sensitive patients experience symptoms of hay-fever when the grass pollen count exceeds $50/m^3$. Similar counts were obtained by Ogden and Lewis (1960) and by Fuckerieder (1976). In Viander and Koivikko's study 90 per cent of patients had symptoms when the pollen count exceeded $80/m^3$. The larger amounts of birch rather than grass pollen required to provoke symptoms in all clinically sensitive patients could be explained by the smaller size of birch pollen, resulting in a much smaller average volume in birch pollen than in grass pollen (Hyde, 1972). Thus with the same number of grass and birch pollen spores, quite different concentrations of pollen allergen per cubic metre of air will be obtained. An alternative explanation would be different allergenicity of different pollens and a different speed of release of allergens from different pollen grains in the nasal mucosa (March, 1975). A high proportion of the patients, irrespective of their clinical sensitivity continued to have symptoms late in the pollen season, when the pollen counts were low. High symptom scores in relation to pollen counts late in the ragweed season have been reported previously (Lichtenstein et al, 1966; Sack and Golan, 1942). A probable explanation for this phenomenon would be a decreased nasal threshold after the environmental exposure to pollen, "the priming of the end organ" suggested by Connell (1968). Thus the existence of symptoms at low pollen counts reflects the high nasal sensitivity of the patients only early in the pollen season, not late in the season. Lichtenstein's group at John Hopkins (Bruce et al, 1977), studying the role of ragweed pollen in autumnal asthma, found significant correlation of symptom scores with ragweed, alternaria, hormodendrum, fusarium, and helianthusporium pollen counts. Their study design was very similar to that about to be described where the emphasis is on relating patient's symptoms to elements of the total pollen count rather than on skin test or RAST results.

CHAPTER 4 DESCRIPTION OF STUDY

DESCRIPTION OF STUDY

Aims of Study

The study was designed to examine the symptomatology of patients suffering from hay-fever and to attempt to correlate their symptoms with atmospheric pollen counts in Glasgow and with the data which could be obtained regarding the shedding of pollen by the grasses found in the West of Scotland.

Methods

Information regarding individual patient's hay-fever symptoms was gathered using a diary card on which patients were asked questions related to their hay-fever in previous years and on which they were asked to record the severity of their hay-fever symptoms during the 1983 season on a day-to-day basis. They were asked to mark their symptom severity each night at bedtime. This related to the 24 hour period just ending and was recorded on a 10 cm visual analogue scale which ranged from (symptoms) "absent" to "severe". Pollen counts were carried out on the roof of the Department of Environmental Health of Glasgow District Council in the city centre and included not only grass pollen counts but also tree pollens and mould spores. Information relating to the likely times of pollen release from grasses found in different sites of the West of Scotland was obtained from the Agronomy Department of the West of Scotland Agricultural College at Auchencruive, Ayr.

The Patients

The patients included in the study were from the author's own urban general practice in the West End of Glasgow or from the practices of general practitioner colleagues who had an association with the Department of General Practice, University of Glasgow for teaching purposes. Additional patients were included from the Student Health Service of the University of Glasgow. In the case of patients not from the author's own practice, the author visited the various teaching practices and the Student

Health Service to see the patients personally. All patients were issued with a Hay-Fever Diary to record symptom severity and to gather background information. All patients in the study were undergoing continuous treatment with one of two newer generation, non-sedative anthistamines, Terfenadine or Astemizole, which, for the purpose of this study, could be considered to have comparable protective effects. It is clearly not possible to withhold medication for any length of time during the season from patients suffering from hay-fever. It is assumed that symptom scores are therefore lower than would have been obtained in untreated patients.

Symptom Scores

The main element of the Hay-Fever Diary was a 10 cm visual analogue scale on which the patients were asked to record "global" symptom severity by means of a cross marked somewhere along a 10 cm line between "No symptoms" and "Severe" (See Appendix 2). Symptoms were thus recorded daily and patients were asked to complete their diaries each night at bedtime in relation to the entire preceding 24 hour period. The earliest date on which any data is available is 19th May and the latest date is 29th August. No attempt was made to separate out the various elements of hay-fever symptomatology, e.g. sneezing, blocked nose, runny nose, itchy eyes, etc. in relation to the patient's own scoring of their symptoms. Visual analogue scales have been used widely since 1969 to rate subjective feeling (Emanuel, 1981). In the form of "the graphic rating scale" the technique was described as early as 1921. Visual analogue scales have been used to measure various subjective symptoms including pain, sedation, mental alertness, and subjective feelings and mood. The simple scale used in this study without superimposed numbers and not sub-graded with written descriptions of intermediate severity has been considered to be the most effective. Charlton et al have studied the use of self-completion diaries incorporating 10 cm visual analogue scales in the assessment of symptom severity in hay-fever. They considered whether the verbal instructions of the doctor/observer made any difference to the way the diaries were completed and found no advantage in giving these verbal instructions over leaving the patients to complete their symptom diaries from the written instructions alone. Nicholson (1978), however, highlights the imperfections of visual analogue scales as a means of assessment when compared with relatively more objective means of assessment, e.g. psychomotor testing in the laboratory. Maxwell (1978) studied the sensitivity and accuracy of the visual analogue scale in a "classroom experiment" involving the assessment of ordinally related volumes of sound. He found that five out of forty-nine results were erroneously significant. He concluded that his results were to some extent reassuring but that there was also some cause for concern. He cautioned against the use of complex statistical methods in the analysis of results obtained using visual analogue scales.

Pollen Counts

Introduction

Gregory (1952) first used the term "air spora" and Davies (1962) described it as an ever changing mixture of plant particles of diverse shape and size and pointed out that sampling techniques should trap them all with a known efficiency. Early experiments involved a horizontally exposed sticky slide, the somewhat inaccurately termed "gravity slide" which was cheap but rather inefficient and biased in favour of the larger particles. The Cascade Impactor was one of the first volumetric methods of air sampling. The Hirst Automatic Volumetric Spore Trap was based on the second of four progressively finer jets which constituted the Cascade Impactor. In the Hirst Trap air is drawn at 10 litres per minute through a 14 x 2 mm orifice which is directed into the wind by a vane. The particles in the airstream are impacted onto a sticky surface microscope slide which is moved 2 mm an hour behind the inner edge of the orifice. The coating on the slide is usually petroleum jelly. On a slide exposed for 24 hours the trapped particles occur in a trace measuring 14 x 48 mm. After suitably mounting for microscopic examination in glycerine jelly, which was used for counting in Glasgow, or lactophenol solvar, the trace may be scanned longitudinally to obtain a daily mean or scanned at 4 mm intervals to trace 2 hourly changes in concentrations.

The standard Hirst Automatic Volumetric Spore Trap was one of the two methods used to obtain the pollen counts recorded in this study.

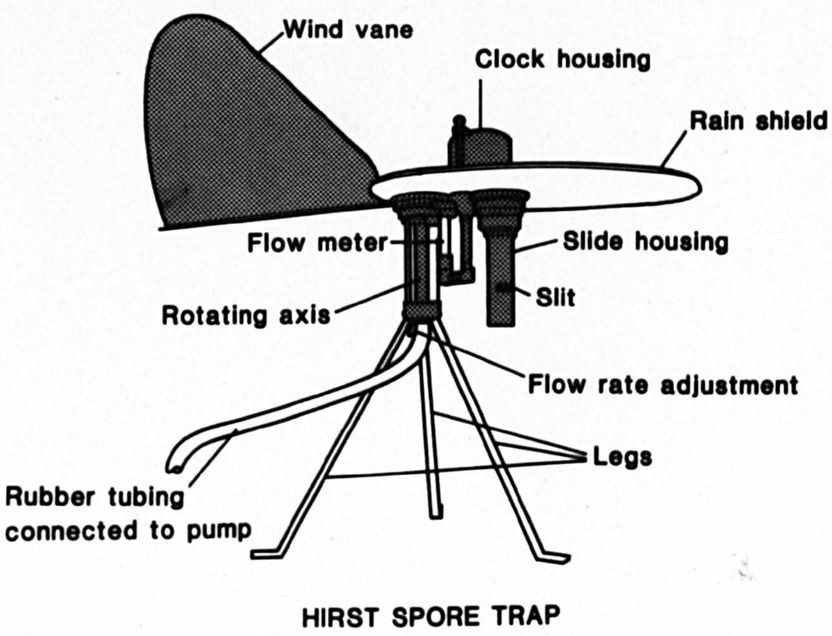


Plate 1 Diagram of Hirst Spore Trap

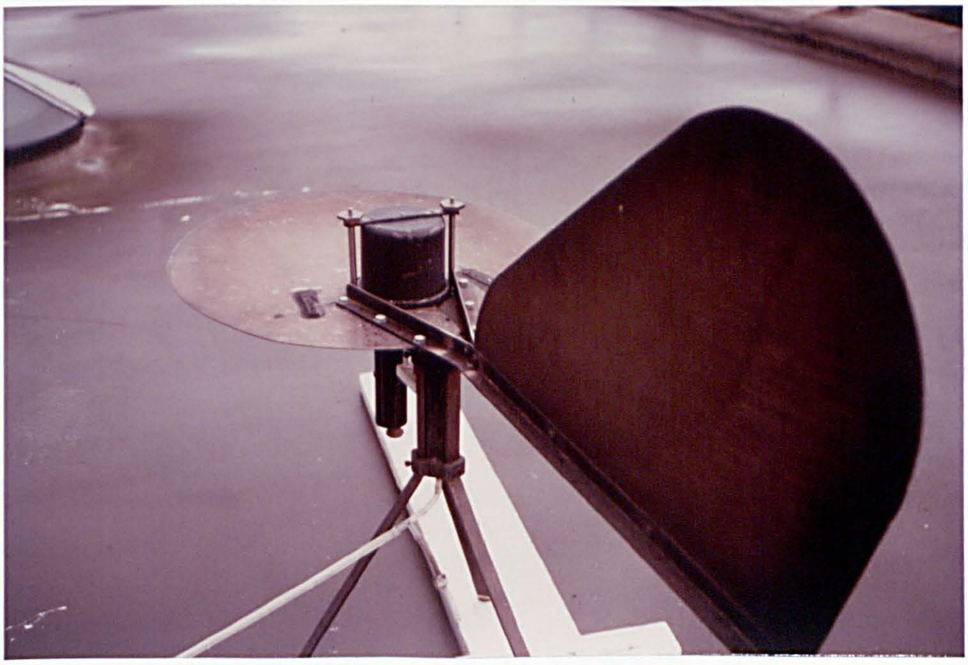


Plate 2 Hirst Spore Trap used in this study, on roof of Environmental Health Department.

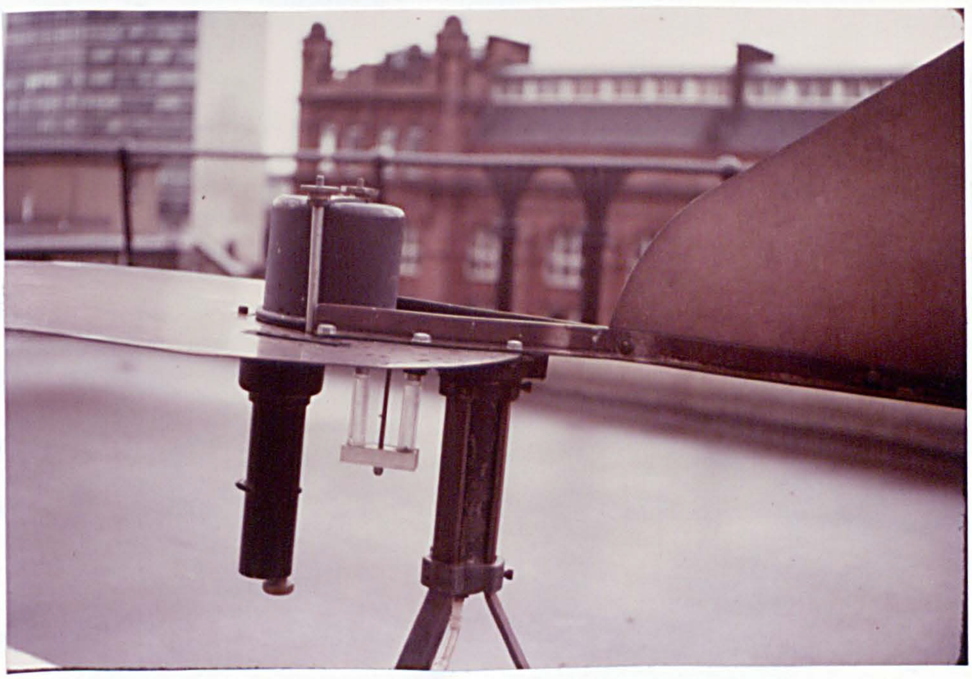


Plate 3 Further view of Hirst Spore Trap.

The counts thus obtained relate, of course, only to the immediate vicinity of the sampling and there may be quite marked variations within the larger area such as the Greater Glasgow area in this case. Spot sampling may help to reduce this error and techniques have been developed to attempt this. The Gregory portable spore trap is a simple version of the Hirst trap in which the sticky slide is stationary and through which air is drawn by means of a hand operated pump. The rotorod sampler of Perkins consists of a pair of thin brass rods of square cross section which are whirled at a constant speed by a battery operated motor. The leading edge of each rod carries a strip of "Sellotape" smeared with glycerine jelly and after exposure the strip is removed, cut into four pieces and mounted in glycerine jelly beneath a cover glass on a slide.

An attempt has been made to produce a personal pollen counting device (Leuschner and Boehm, 1979) but has so far met with little success. Apparently a further attempt has involved the use of a tiny pump to create suction but this device is not as yet available.

Morrow Brown (1978) described his own simplified version of the Hirst Trap in Derby and reports that it is comparable to the Hirst Trap for larger particles (down to 10 μm diameter) and considerably better for small particles (down to 1.0-2.0 μm). In the Morrow Brown trap the slide moves horizontally and the air jet passes vertically downwards. A further development of this horizontal trap allows for readings to be taken for three days on separate slides without overlap. Such an instrument has been used by the Environmental Health Department of Rotherham Borough Council and, based on this, the Air Pollution Division of the Environmental Health Department of Glasgow District Council built the horizontal spore trap illustrated in Plates 4-6. In contrast to the Morrow Brown trap this modified Rotherham trap has the same characteristics, i.e. orifice size, air flow, slide movement speed, as the Hirst trap.

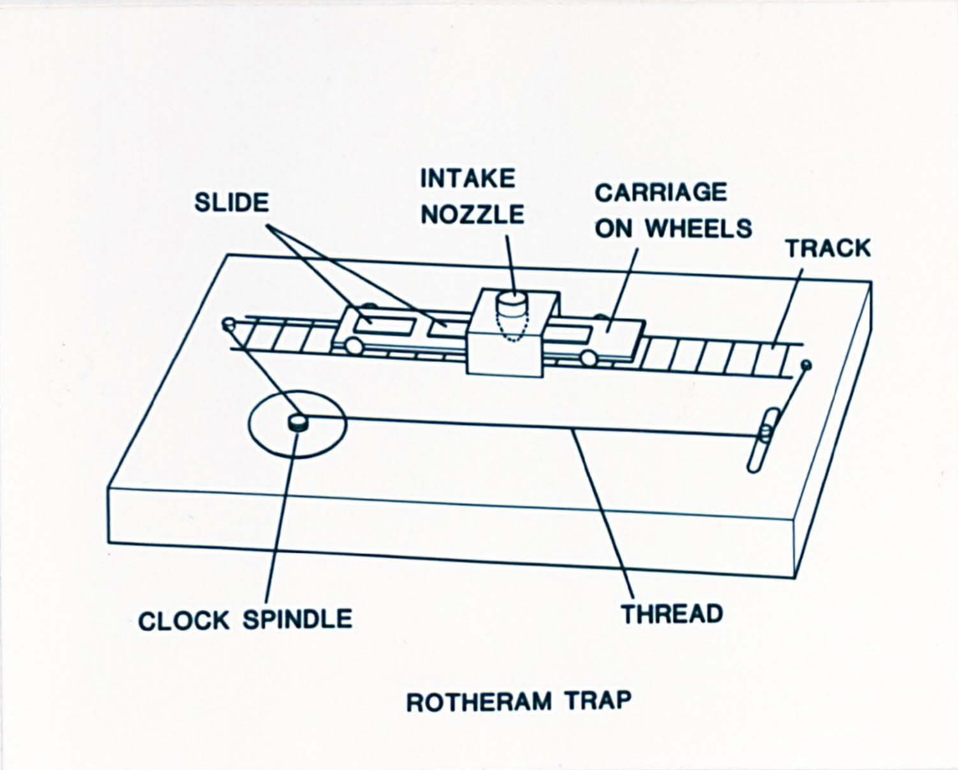


Plate 4 Diagram of Rotherham Trap.

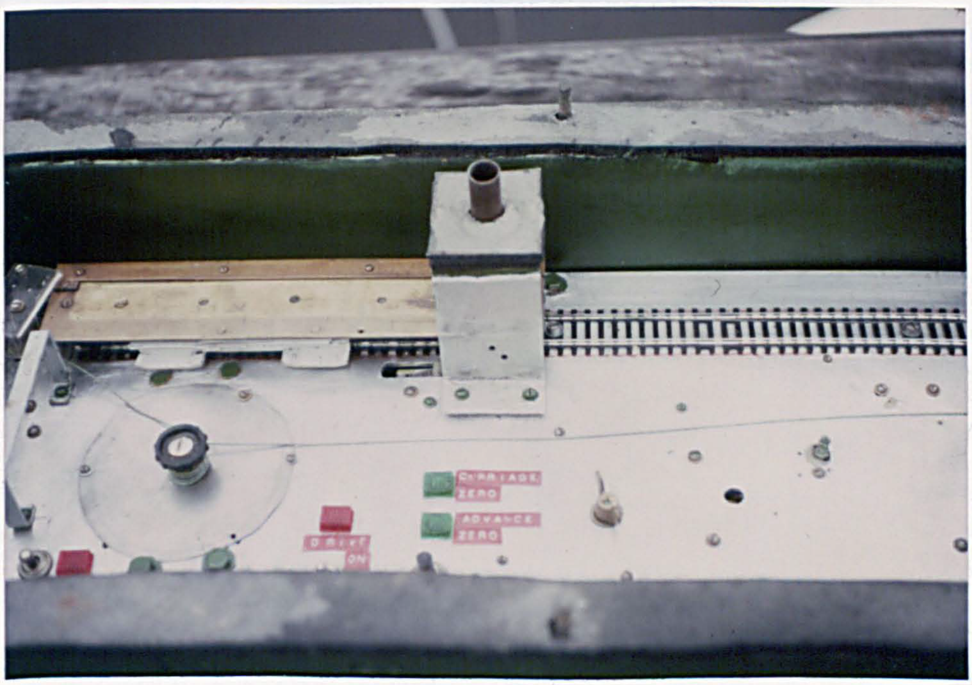


Plate 5 Interior of modified Rotherham Trap used in this study.

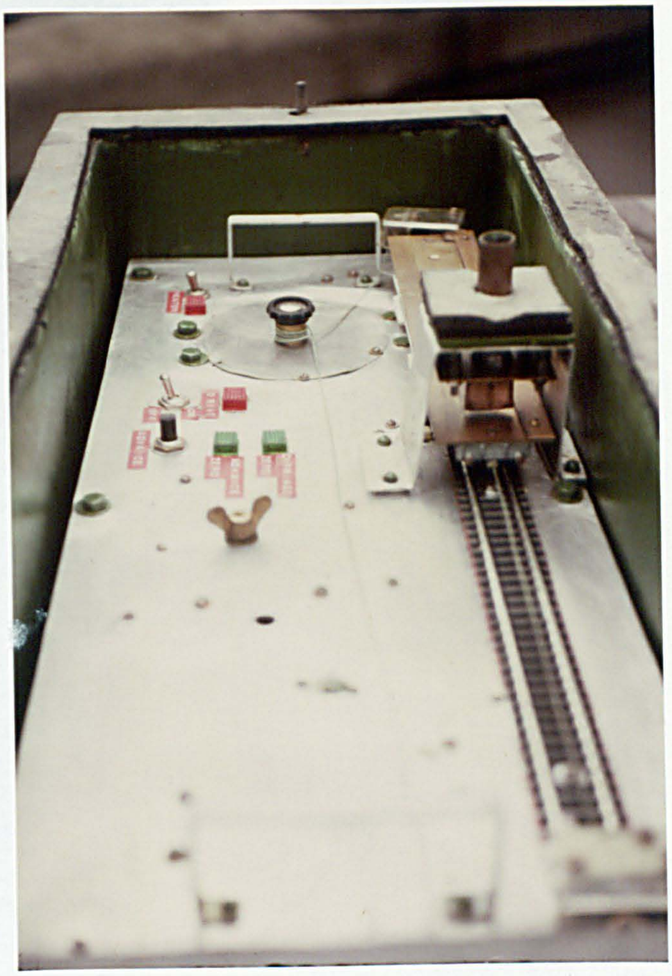


Plate 6 Further view of modified **Rotherham trap.**

Air Sampling Techniques Used in Glasgow for This Study.

For the purposes of this study the Hirst trap and the modified Rotherham trap were operated in parallel on the flat roof of the Environmental Health Department at 23, Montrose Street, Glasgow in effectively, the city centre area. Height above sea level is 40 metres and above ground level is 25 metres. Latitude is 55°52'N, and longitude is 04°15'W. Suction is applied to both traps by means of an air suction pump to produce air-flow of 10 litres/min monitored by a variable-area flowmeter (Platon trap-meter) temporarily applied to the inlet nozzle in the case of the modified Rotherham trap. The Hirst trap incorporates its own flowmeter.

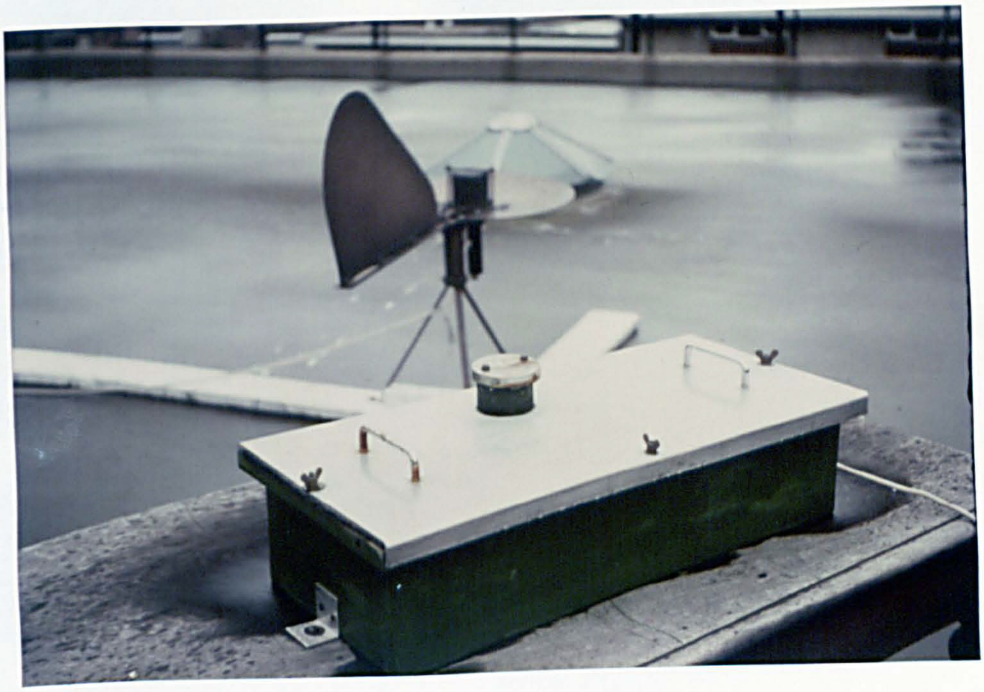


Plate 7 The Hirst Trap and the modified Rotherham Trap on the flat roof of 23, Montrose Street, Glasgow.

Slides for both traps were glass microscope slides greased by application of a film of white petroleum jelly, applied molten using a simple applicator of folded filter paper round a slide. After removal from the trap, the slide bearing the trace receives a glycerine jelly mountant kept molten in an oven at 37°C, after which a cover glass is applied. The slide is put in a refrigerator till the mountant has set. Examination for pollen counting is carried out on a microscope with a magnification of 400X, using a travelling stage. Four traverses are made, each of 0.25 cm width, using a calibrated graticule, and the counts totalled to give the number of grains per cubic metre of air. Pollen counts were carried out from 10th April, 1983 until 31st August, 1983.

Data related to sources and shedding of grass pollen.

A visit was made to the West of Scotland Agricultural College, Auchencruive, Ayr, where Dr. R.D. Harkess of the Agronomy Department was able to provide information describing the different kinds of grassland found in the West of Scotland with their estimated total areas and the variety of different grasses affecting each kind of grassland. Approximate total areas of the different grass varieties can therefore be calculated.

CHAPTER 5 RESULTS

RESULTS

Patient Data - Descriptive

Sets of data from 81 patients were included in the analysis. 45 patients (55.5%) were male and 36 patients (44.4%) were female. The mean age of the patients was 27.0 years with an age range of 17 to 25 years. (Only patients aged 12 years and over were included in the study).

Tables 2-7 summarise the information gathered about the patients' hay-fever at the beginning of the study and not related in particular to the 1983 season. The symptoms in Table 6 were recorded in a totally unstructured way by the patients. Grouping the first 5 symptoms together gives a total of 13 patients (16.1%) who described symptoms which could be considered more referable to the lower respiratory tract. 11 patients (13.6%) reported sore/itchy throat and 8 patients (9.9%) reported sore/itchy ears.

Table 2 Severity of hay-fever in previous years

Very mild	Moderate	Quite bad	Very bad	Not recorded
4 (5.0%)	23 (28.4%)	36 (44.4%)	16 (19.7%)	2 (2.5%)

Table 3 Time of year involved

Only in the summer months	All the year round but worse in summer	All the year round	Not recorded
55 (68.0%)	20 (24.7%)	4 (5.0%)	2 (2.5%)

Table 4 Frequency of symptoms

On the odd day	Continuosly	Not recorded
25 (30.9%)	49 (60.5%)	7 (8.6%)

Table 5 Pattern of Symptoms

	Never	A Little	A Lot	Very badly	Not recorded
Sneezing	1 (1.2%)	18 (22.2%)	43 (53.1%)	16 (19.8%)	3 (3.7%)
Runny Nose	4 (4.9%)	13 (16.1%)	44 (54.3%)	14 (17.3%)	6 (7.4%)
Blocked Nose	7 (8.6%)	26 (32.1%)	24 (29.6%)	19 (23.5%)	5 (6.2%)
Itchy eyes	3 (3.7%)	22 (27.2%)	29 (35.8%)	24 (29.6%)	3 (3.7%)

Table 6 Other Symptoms Recorded

Tight/sore/congested chest	2]	
Wheeze	2]	
Cough	4]	13 (16.1%)
Asthma	3]	
Difficulty breathing	2]	
Sore/itchy throat	11	(13.6%)
Sore/itchy eyes	8	(9.9%)
Hot/prickly face	1	
Light-headed	1	
Runny eyes	2	
Sore/itchy nose	3	
Headache	4	
Rash	1	
Sweating	3	
Exhaustion	1	
Itchy skin	2	
Sinusitis	1	
Lethargy/lassitude	3	
Aversion to sunlight	1	
Dizzy	1	
Nose bleed	1	

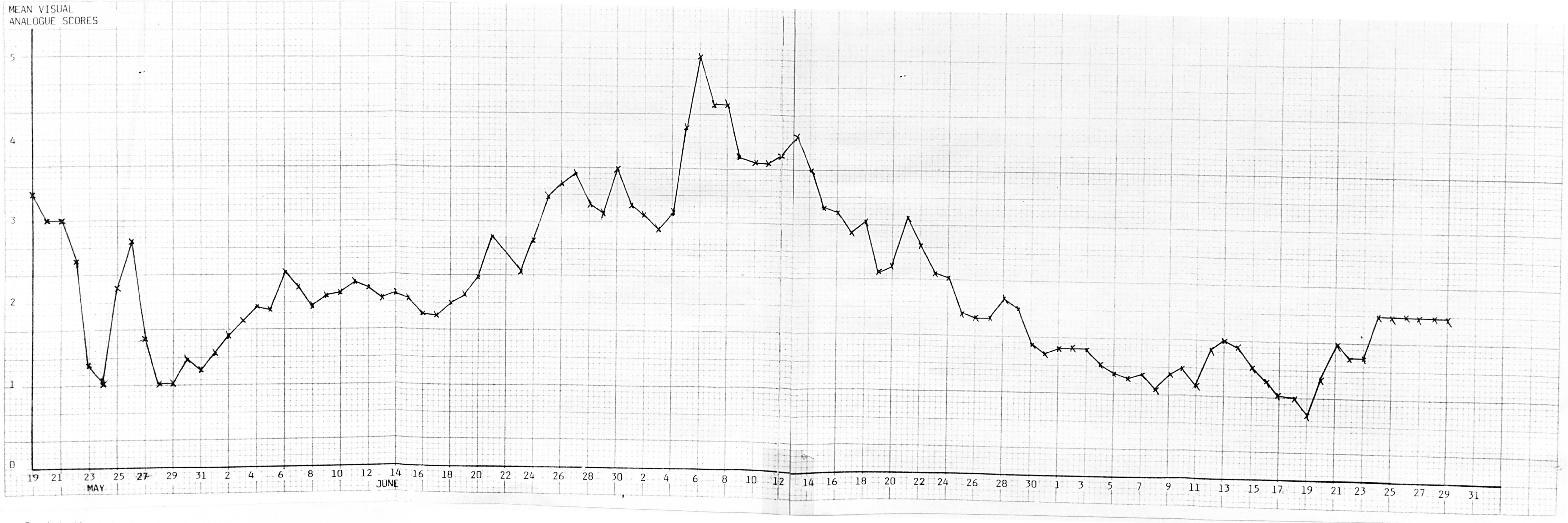
Table 7 Usual pattern of treatment

Only on days when symptoms present	Every day during the season	Not recorded
24 (29.6%)	44 (54.3%)	13 (16.1%)

Mean Visual Analogue Score

Appendix 3 shows the mean visual analogue score for 19th May to 29th August. These figures are derived by taking the mean of the daily visual analogue scores for each of the patients recording a score on their hay-fever diary on a particular day. This means that the figure for the

14th July is the mean of the visual analogue scores for the 72 patients recording a score that day, whereas early in the season, on May 24th, the mean score is obtained from the scores of only 6 patients. The number of patients recording on each particular day is shown with the mean derived from them. The data contained in Appendix III is presented in graphical form in Graph I. Although the visual analogue score is on a scale from 0 to 10, the mean score never rises above 5.06 and, interestingly, never falls below 1.0 except on August 19th.

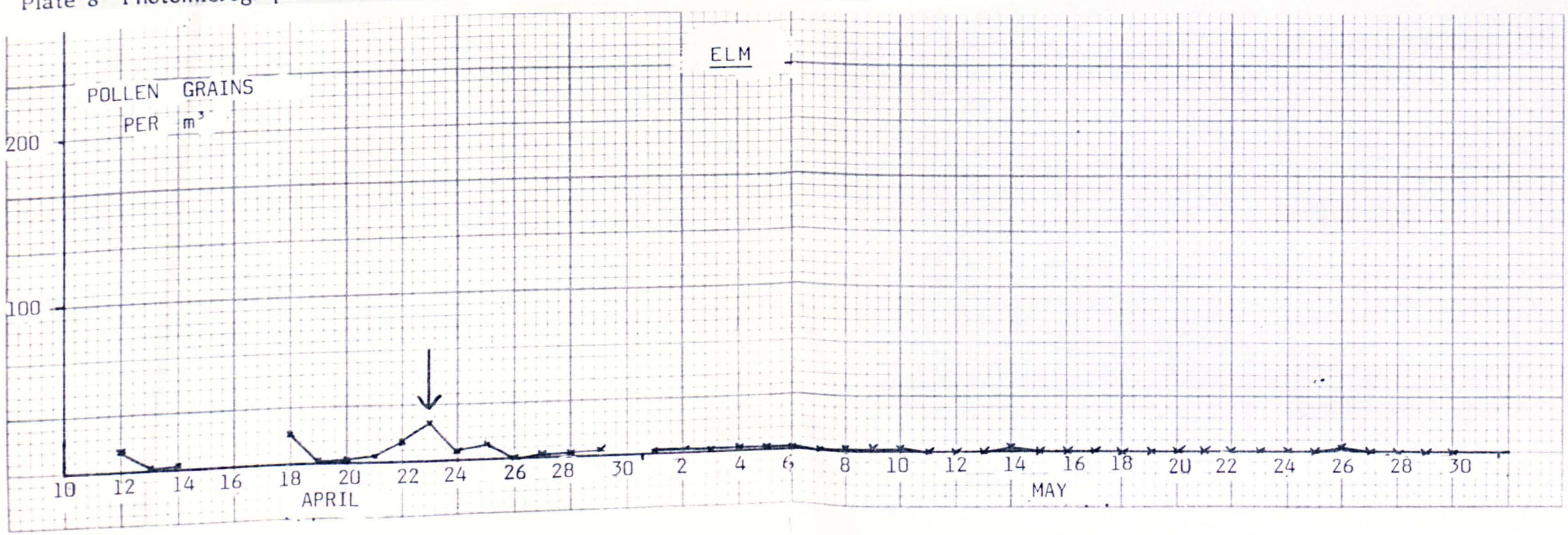


Graph I Mean visual analogue scores from May 19th to August 29th.

Pollen and Spore Counts

Appendix IV shows the daily pollen counts obtained from April 12th to August 31st, 1983. Graphs 2 to 11 show the daily pollen counts for elm, willow, ash, birch, beech, pine, grass, nettle, alternaria, and cladosporium. Plates 8 to 17 are photomicrographs of the corresponding pollen grains or mould spores taken from slides on the day during the season which is arrowed on the graphs.

Plate 8 Photomicrograph of elm pollen grain x 500



Graph 2 Daily pollen count - elm.

Pollen and Spore Counts

Appendix IV shows the daily pollen counts obtained from April 12th to August 31st, 1983. Graphs 2 to 11 show the daily pollen counts for elm, willow, ash, birch, beech, pine, grass, nettle, alternaria, and cladosporium. Plates 8 to 17 are photomicrographs of the corresponding pollen grains or mould spores taken from slides on the day during the season which is arrowed on the graphs.

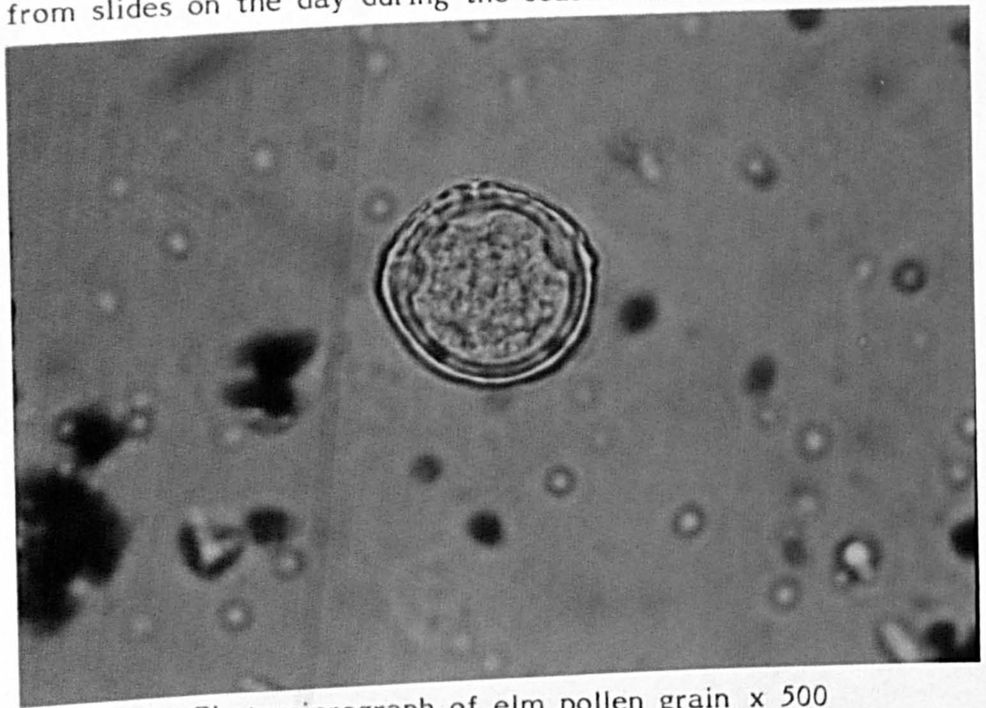
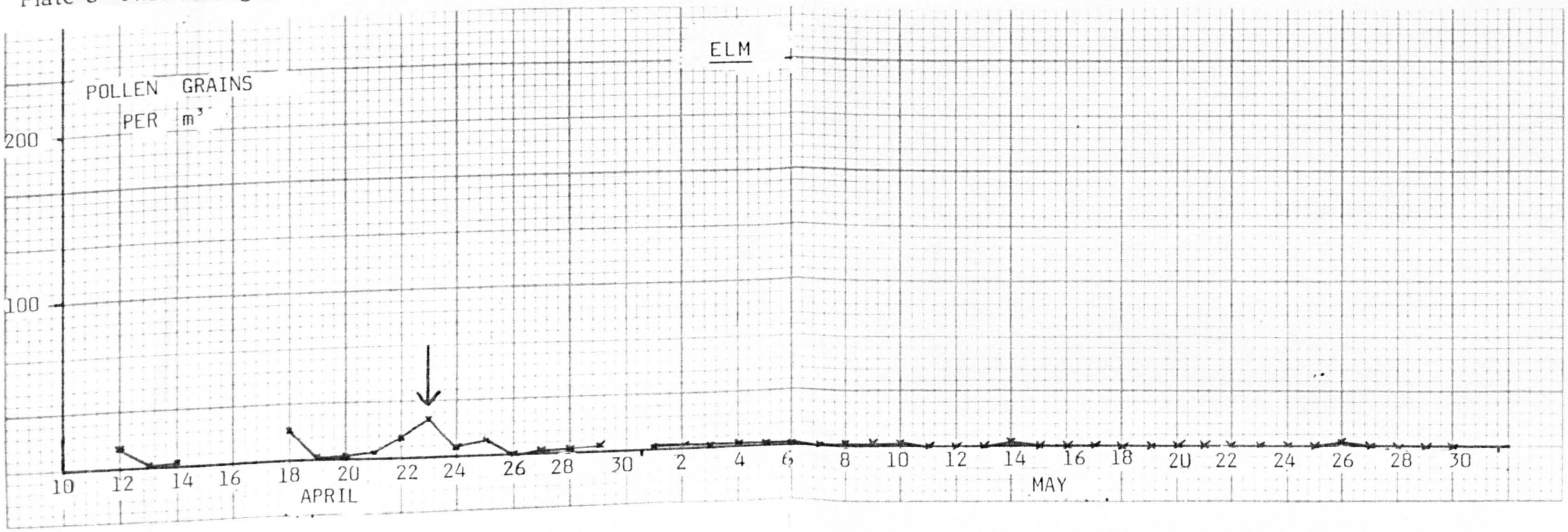
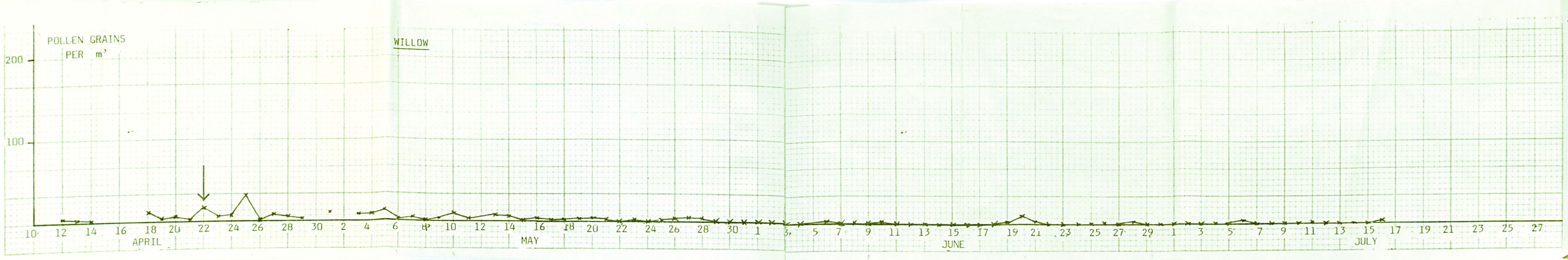


Plate 8 Photomicrograph of elm pollen grain x 500



Graph 2 Daily pollen count - elm.



Graph 3 Daily pollen count - willow

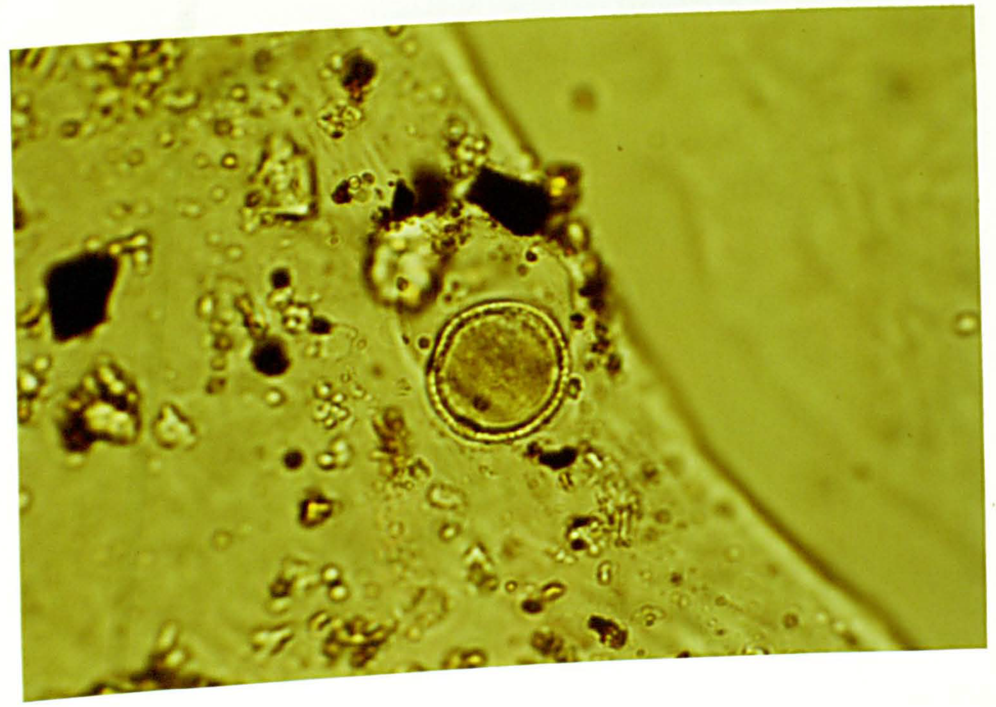
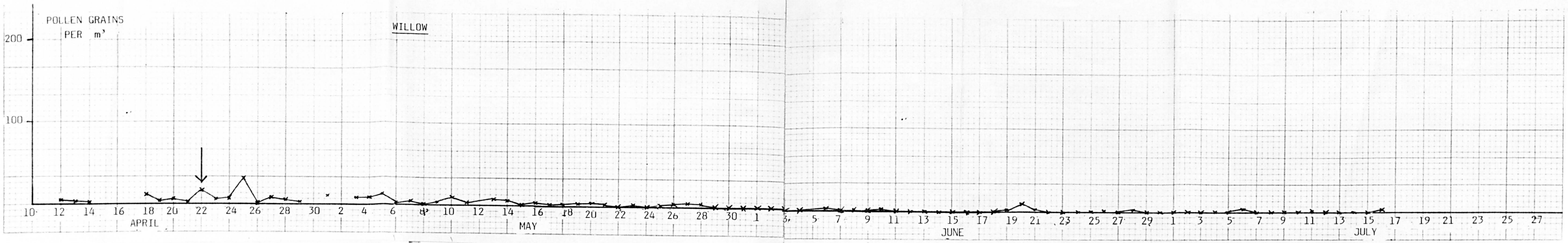


Plate 9 Photomicrograph of willow pollen grain x 500



Graph 3 Daily pollen count - willow

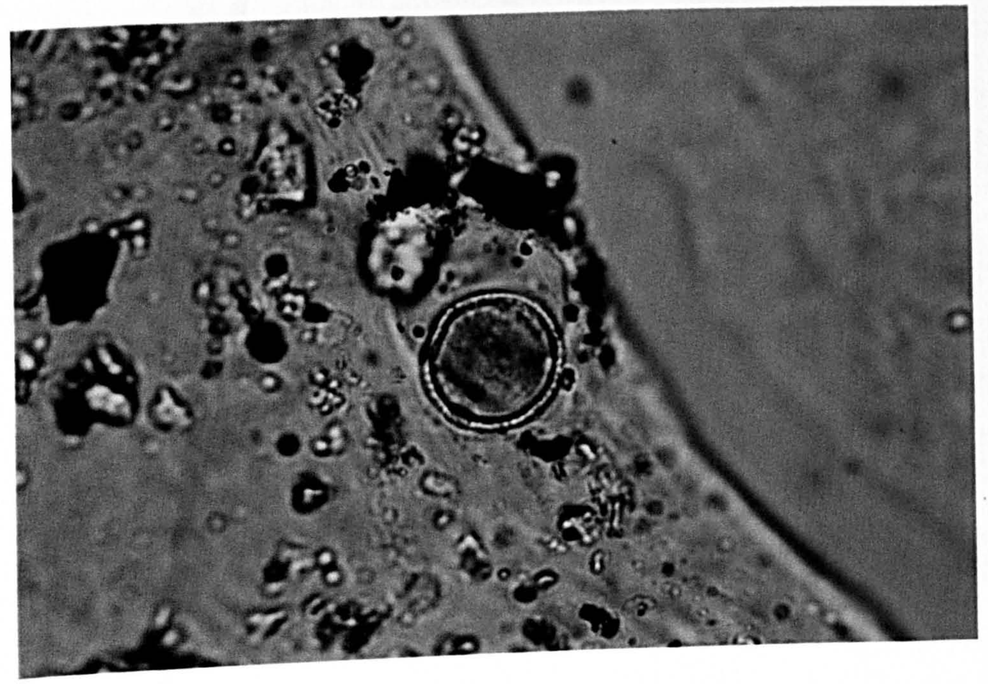
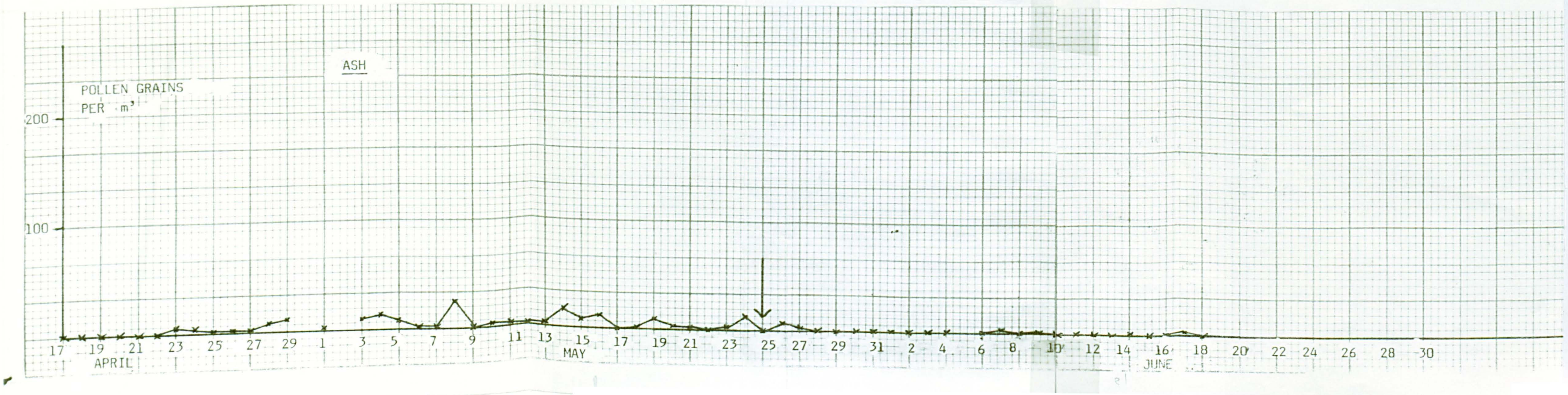


Plate 9 Photomicrograph of willow pollen grain x 500

Plate 10 Photomicrograph of ash pollen grain. x 500



Graph 4 Daily pollen count - ash.

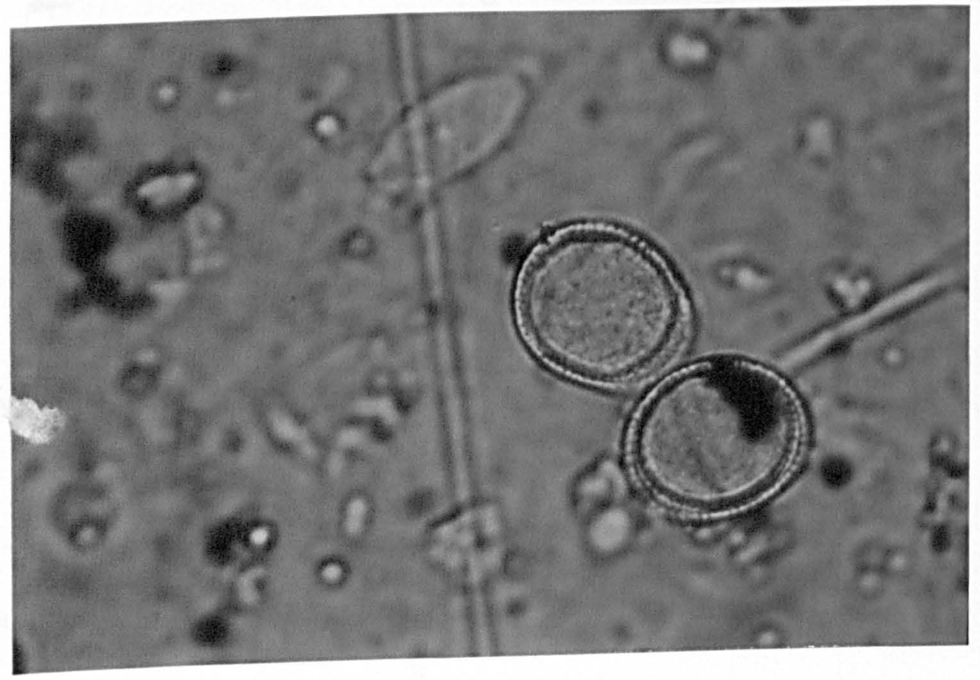
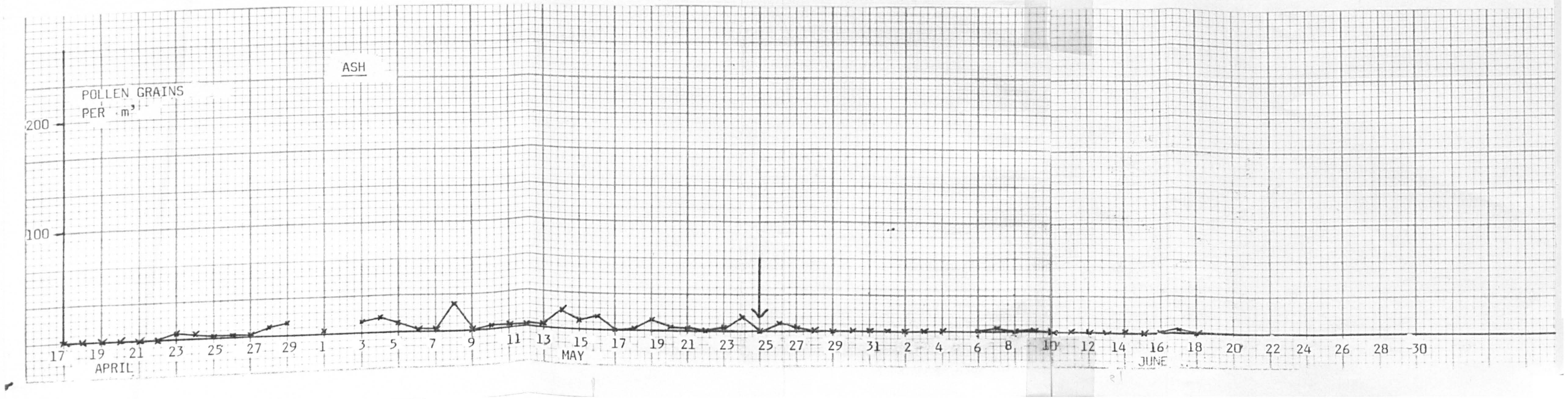
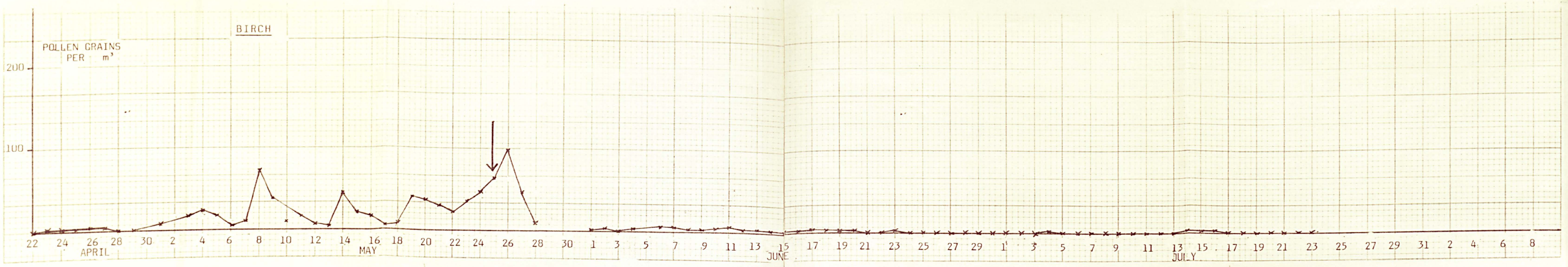


Plate 10 Photomicrograph of ash pollen grain. x 500



Graph 4 Daily pollen count - ash.



Graph 5 Daily pollen count - birch

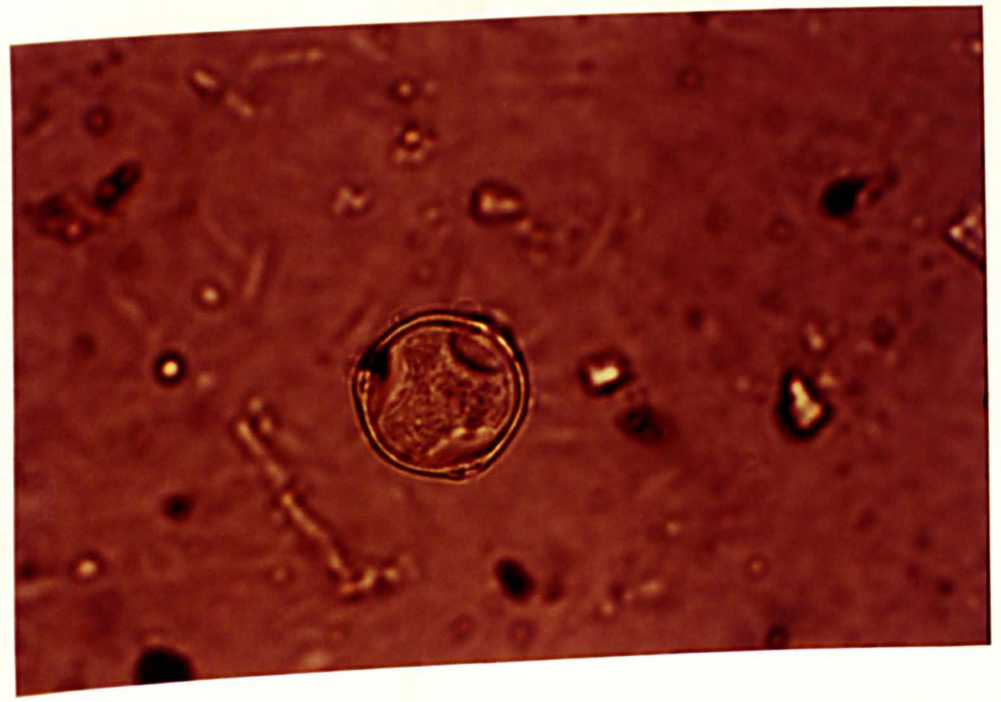
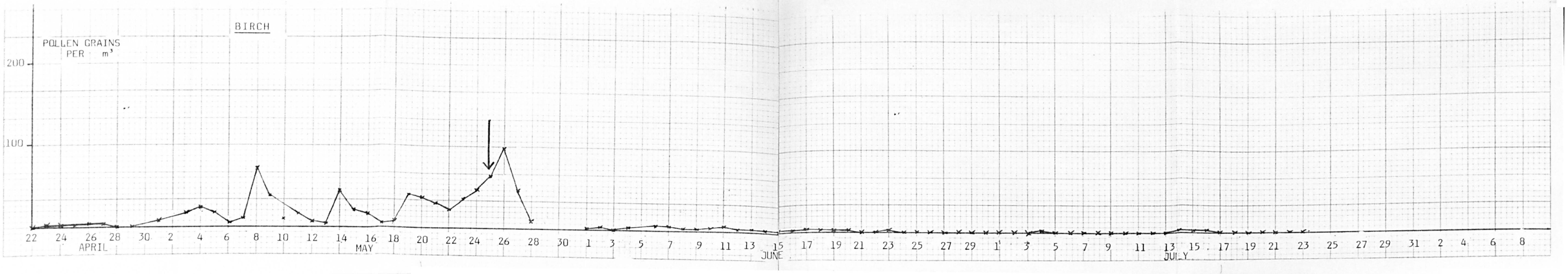


Plate II Photomicrograph of birch pollen grain x 500



Graph 5 Daily pollen count - birch

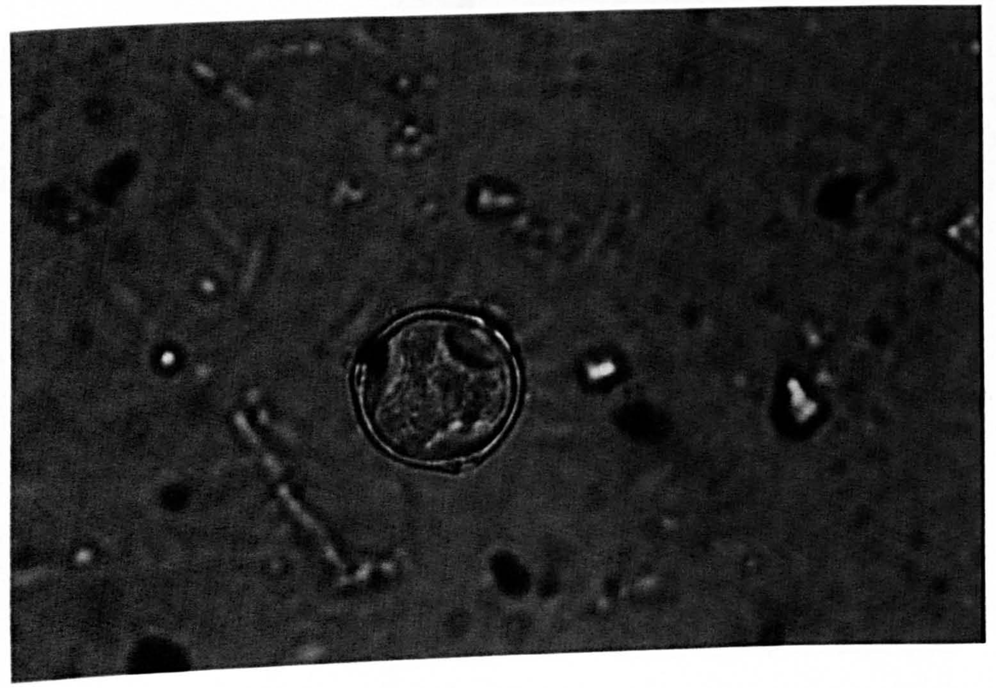
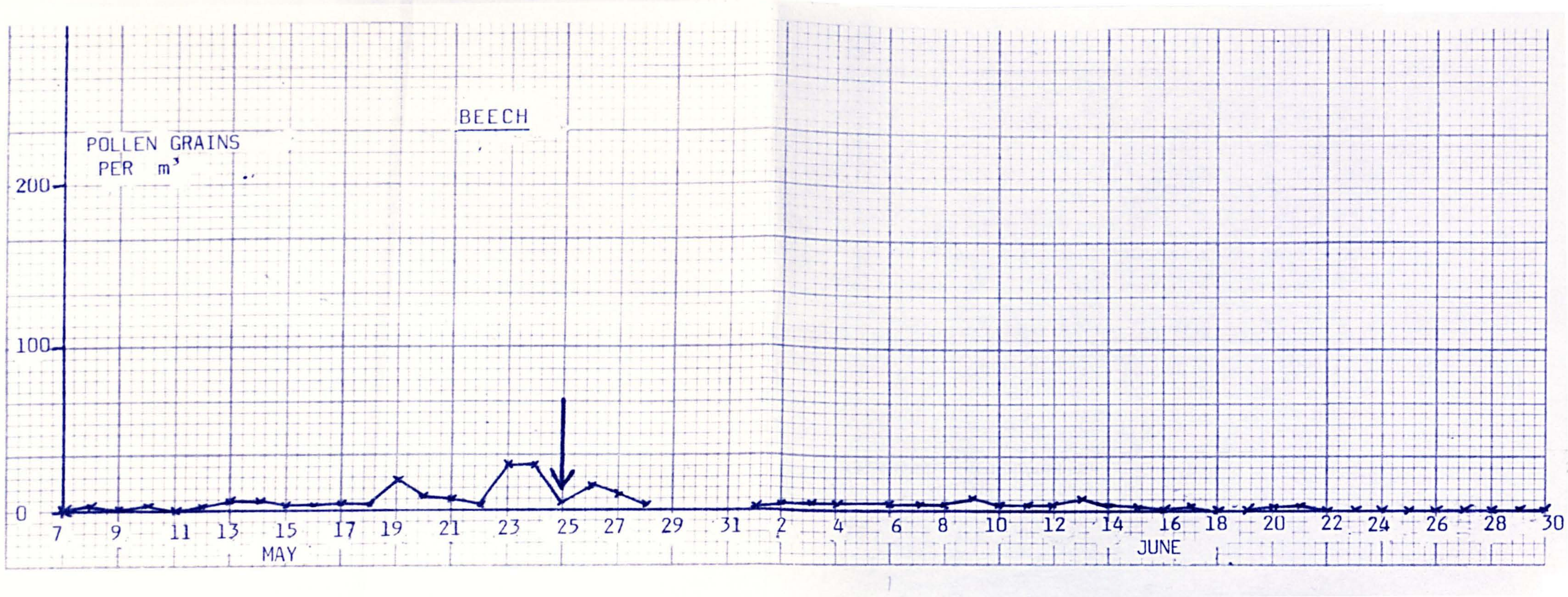


Plate II Photomicrograph of birch pollen grain x 500



Graph 6 Daily pollen count - beech

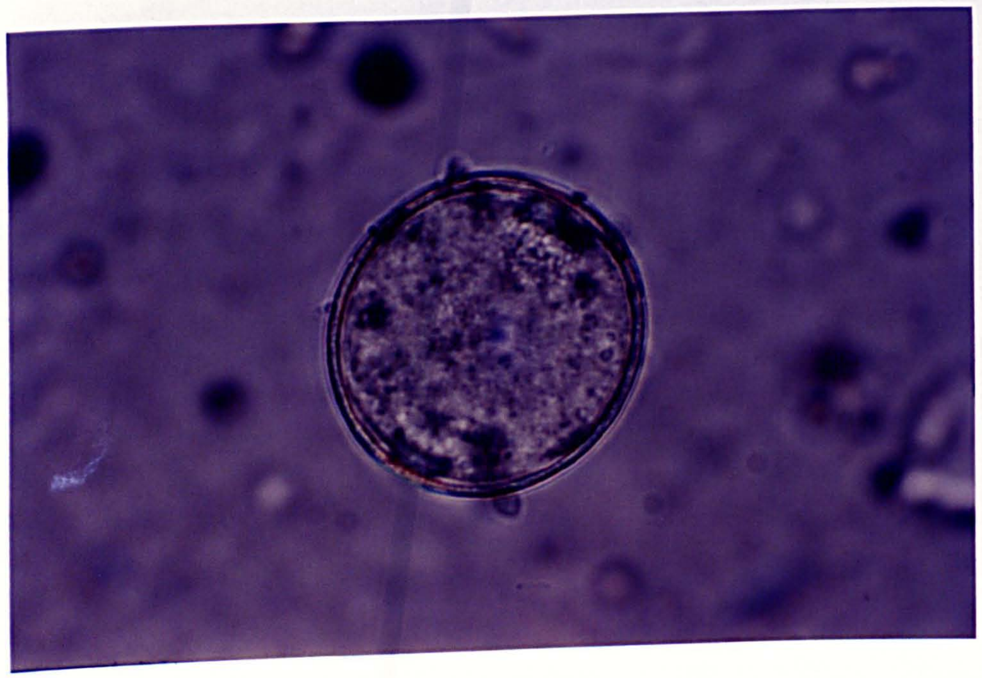
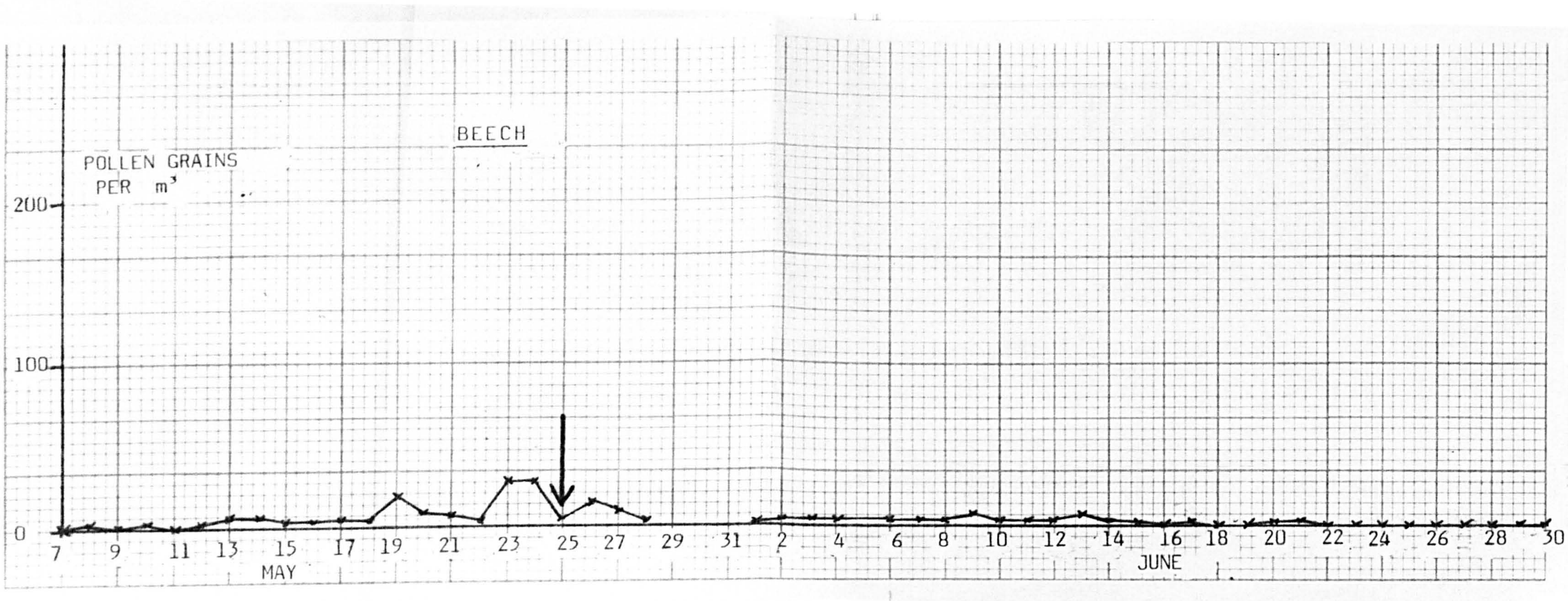


Plate 12 Photomicrograph of beech pollen grain. x 500



Graph 6 Daily pollen count - beech

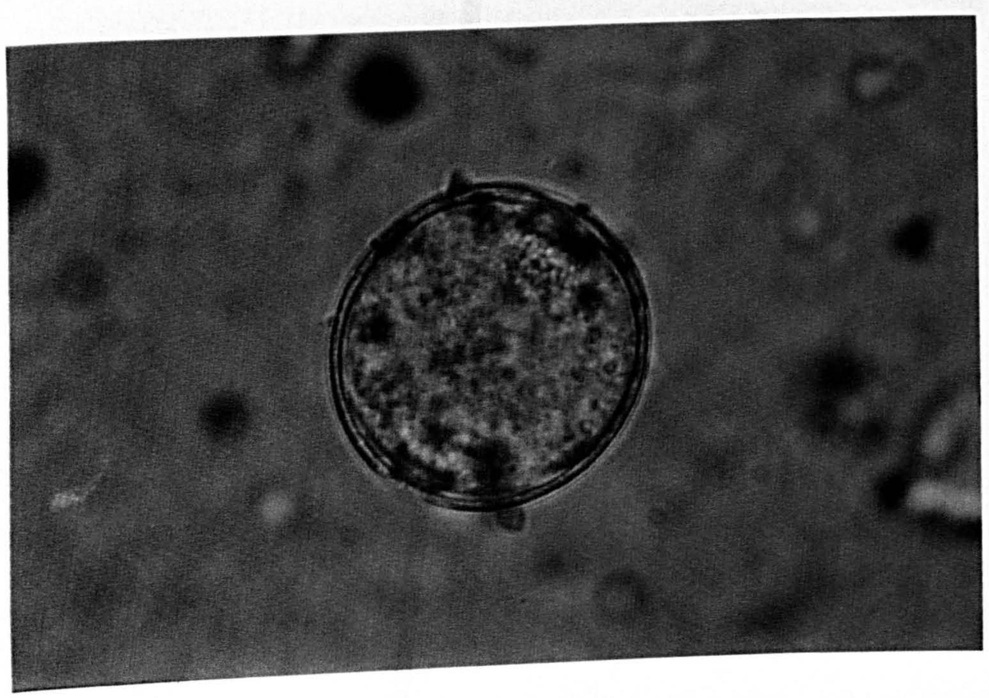


Plate 12 Photomicrograph of beech pollen grain x 500

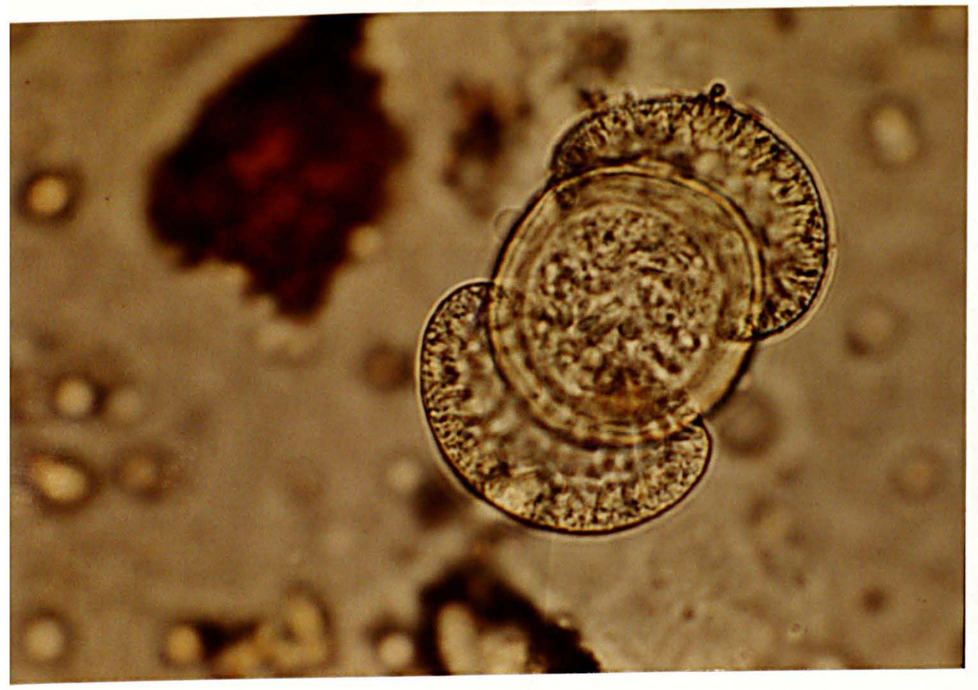
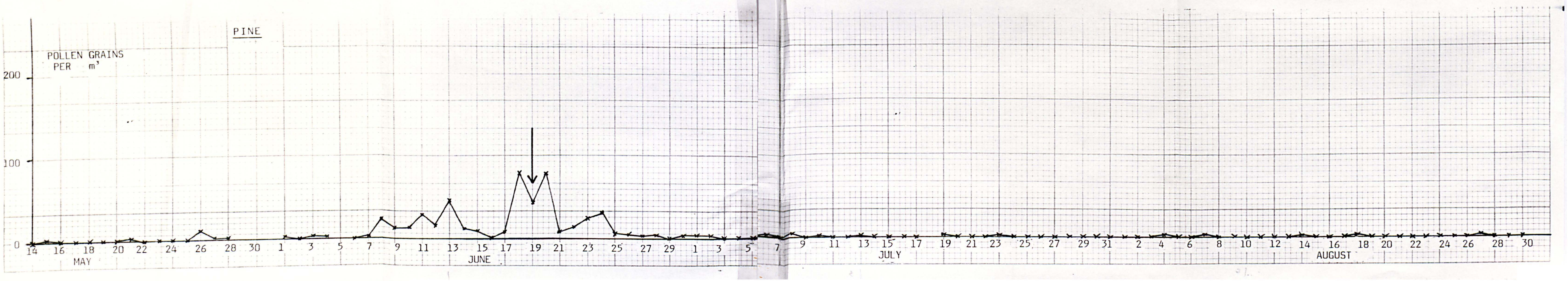


Plate 13 Photomicrograph of pine pollen grain. x 500



Graph 7 Daily pollen count - pine.

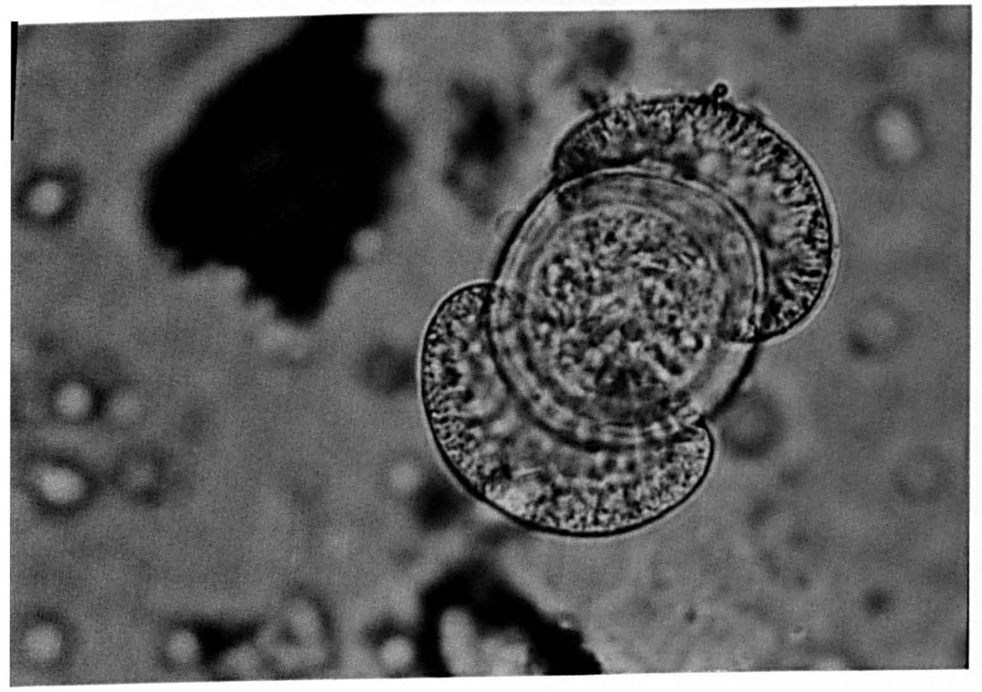
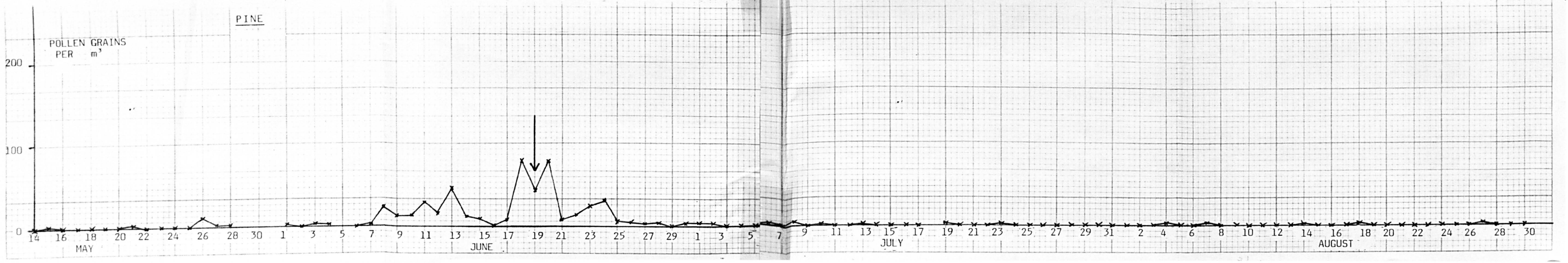
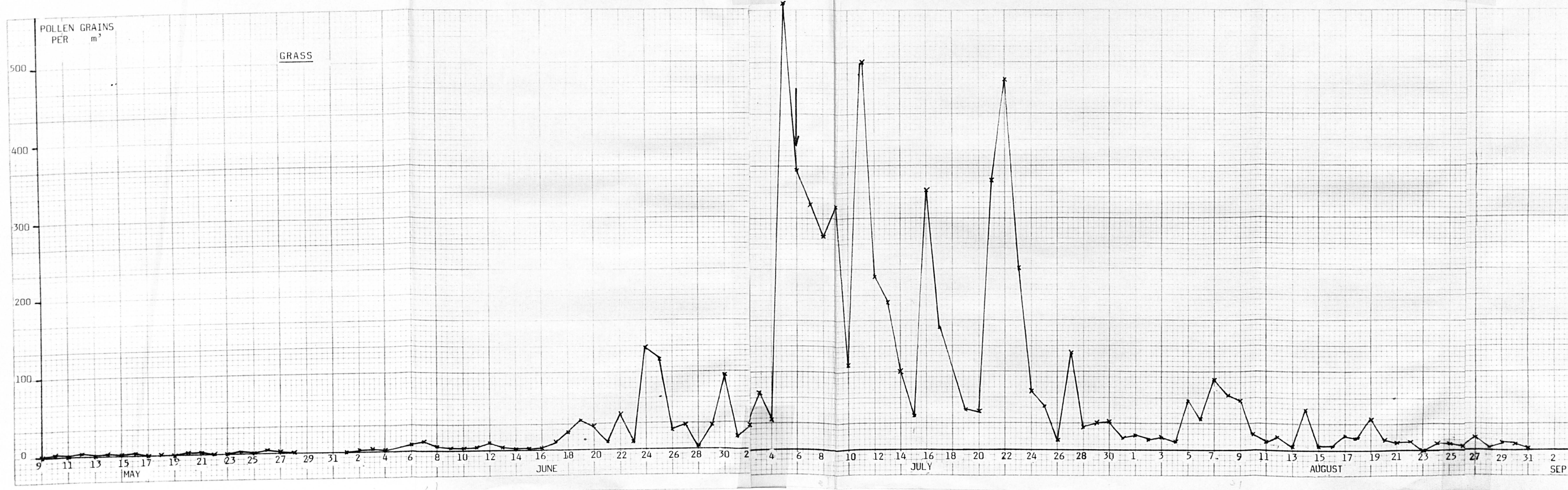


Plate 13 Photomicrograph of pine pollen grain. x 500



Graph 7 Daily pollen count - pine.



Graph 8 Daily pollen count - grass

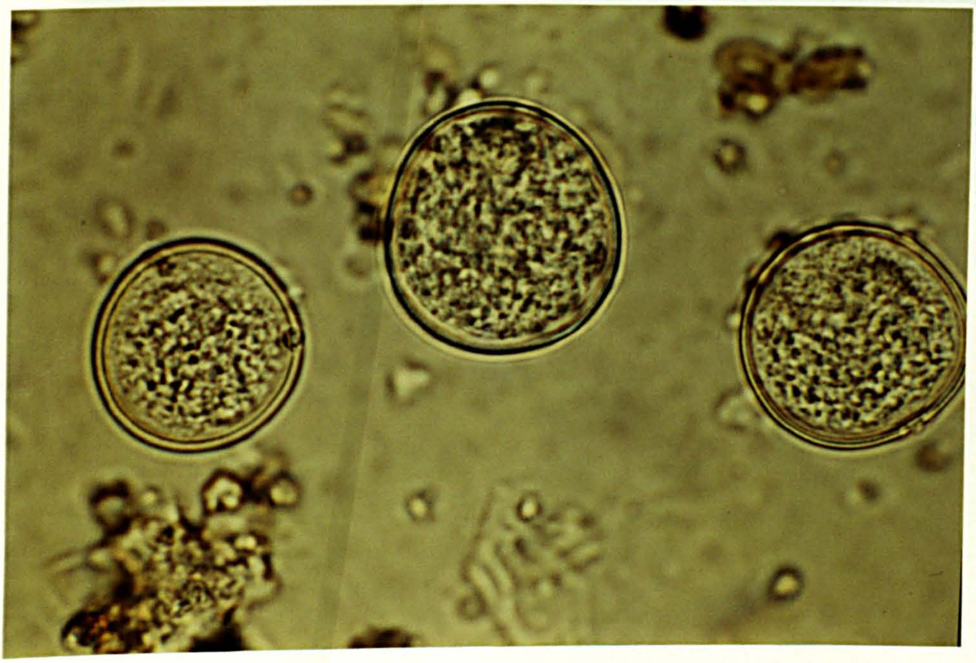


Plate 14 Photomicrograph of grass pollen grain. x 500

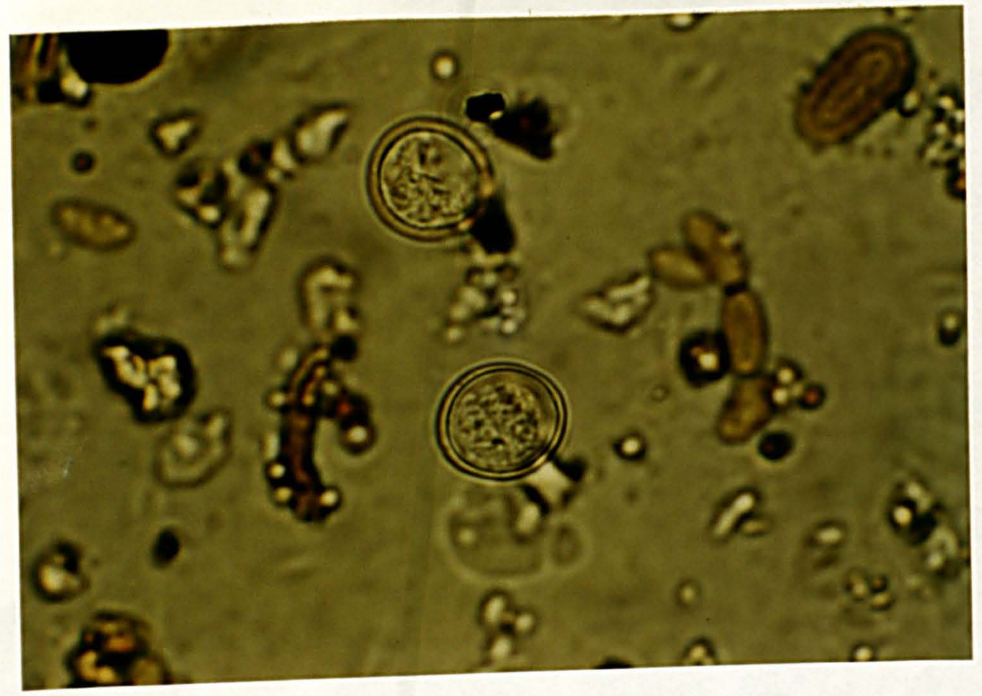
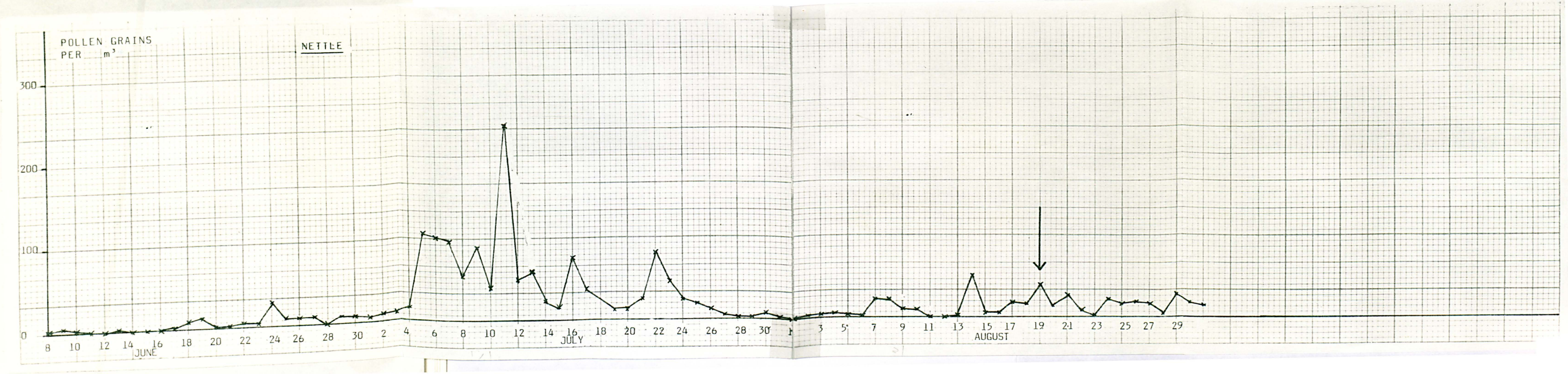


Plate 15 Photomicrograph of nettle pollen grain. x 500



Graph 9 Daily pollen count - nettle.

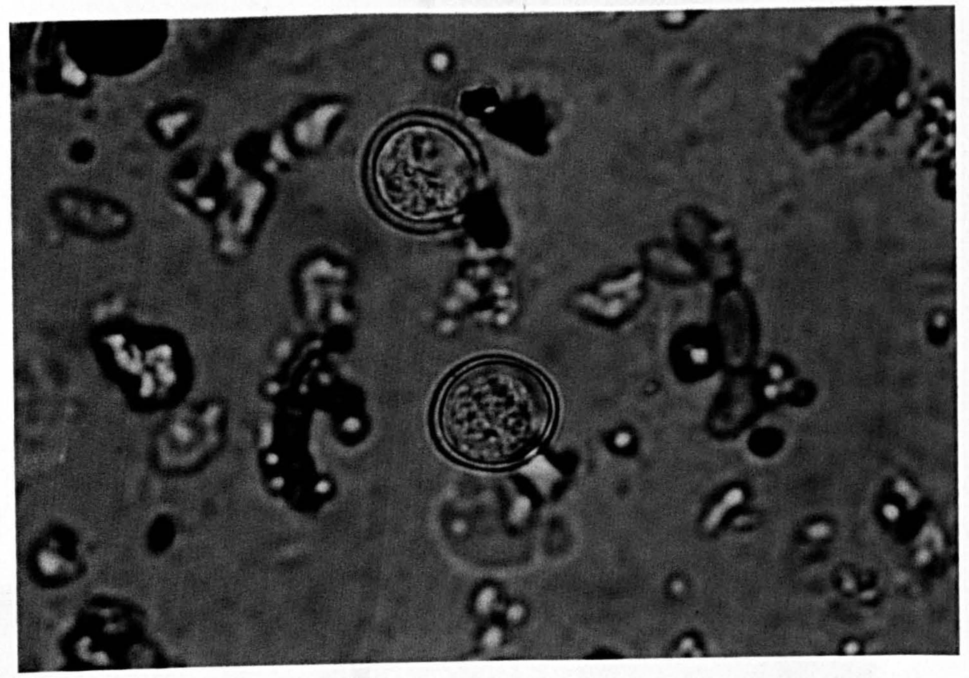
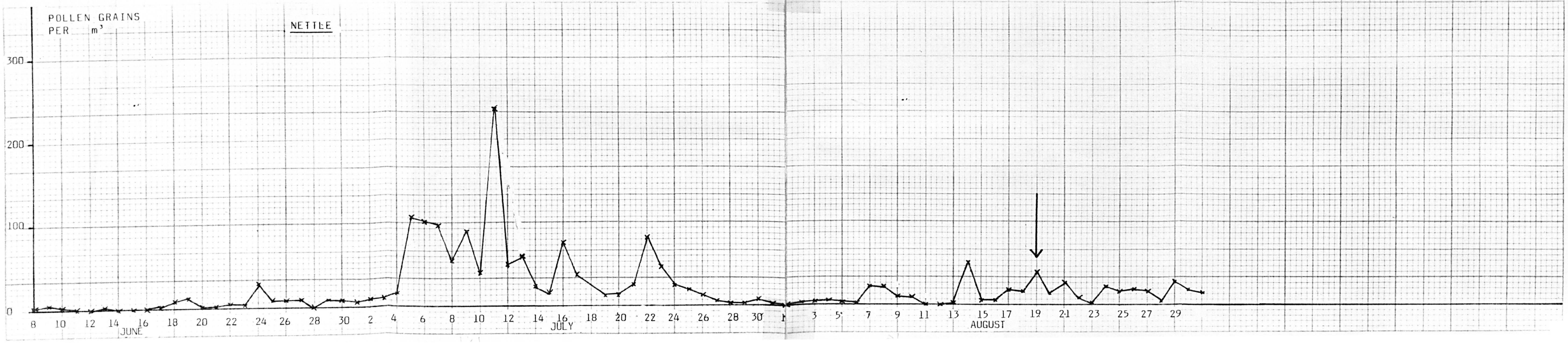
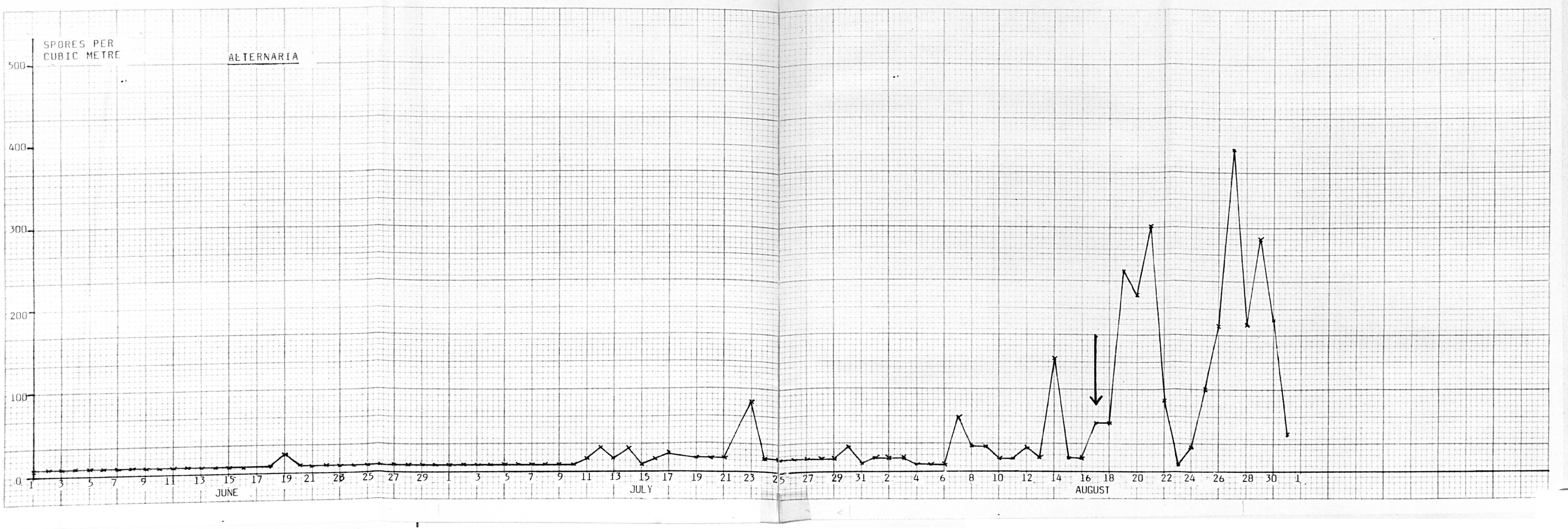


Plate 15 Photomicrograph of nettle pollen grain. x 500



Graph 9 Daily pollen count - nettle.

Plate 16 Photomicrograph of alternaria mould spore (with grass pollen grain) x 500



Graph 10 Daily pollen count - alternaria.

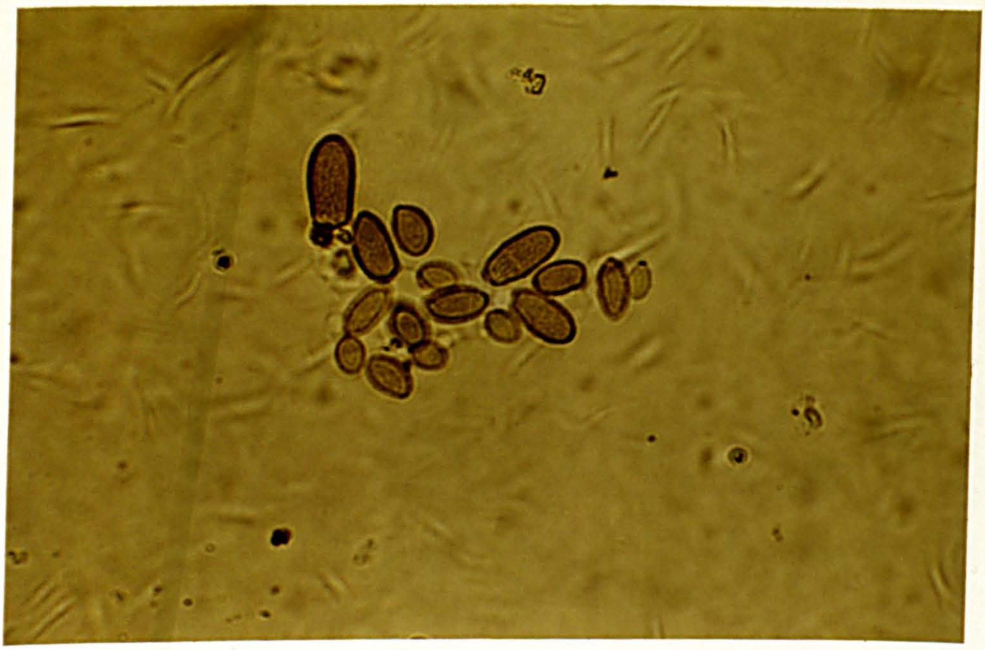
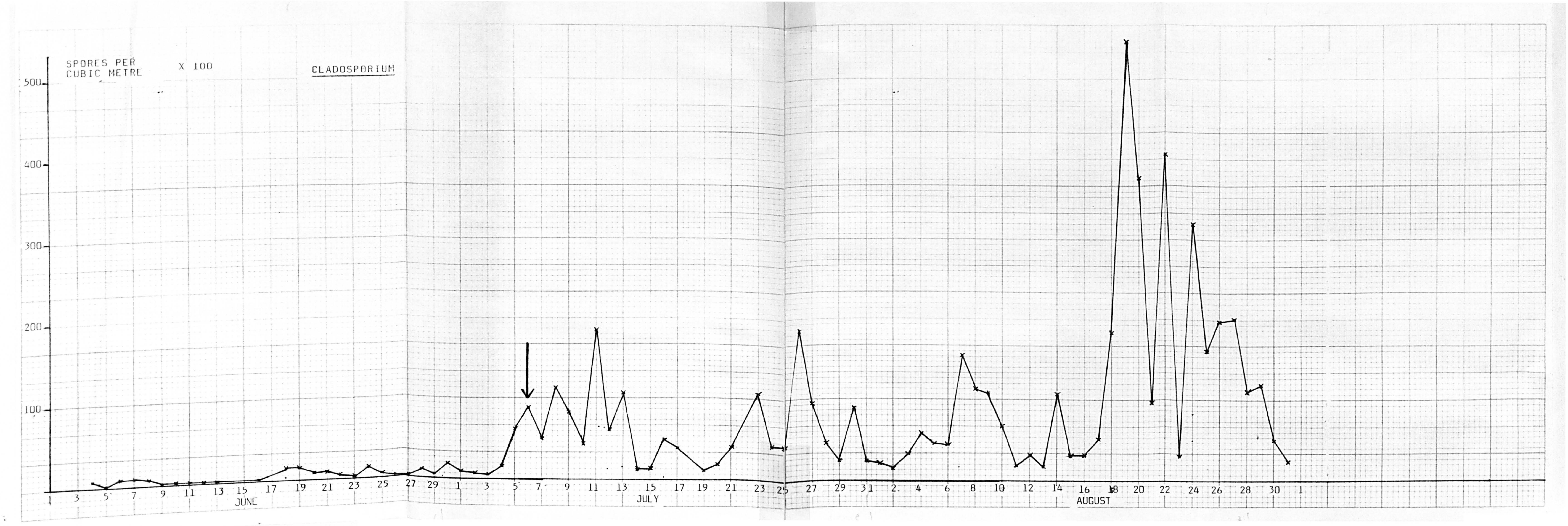


Plate 17 Photomicrograph of cladosporium mould spore x 500



Graph II Daily pollen count - cladosporium.

Plates 18 and 19 are slides from the trap on 19th August and 25th May respectively. Plate 18 shows a nettle pollen grain (centre of field) and an alternaria mould spore (below right of centre). Plate 19 shows two ash pollen grains (left of field) and one birch pollen grain (right of field).

Plate 18 Photomicrograph of slide from trap on 19th August showing a nettle pollen grain (centre of field) and an alternaria mould spore (below right of centre). x 500

Plate 19 Photomicrograph of slide from trap on 25th May showing two ash pollen grains to the left of the field and one birch pollen grain to the right of the field. x 500

The figures shown relate to counts performed on slides from the modified Rotherham trap except where otherwise identified as having been taken alternatively from the Hirst trap.

Figure 1 shows in histogram form the progression of the pollen season in 1983 from elm and willow in early April to nettle in late August. The figures used are weekly mean pollen counts rather than daily pollen counts.

Figure 2 shows, again in histogram form, the weekly mean grass pollen count for 1983 compared with 1973. Figure 3 shows the same information for 1974, 1975 and 1977.

Figure 4 shows the weekly mean pollen counts for pine, birch, and nettle presented in similar form and comparing 1983 with 1973 and 1974.

Figure 5 shows the daily grass pollen count for 1983 presented in histogram form.

Figures 6 and 7 show the weekly mean spore counts for Alternaria and Cladosporium respectively for 1983 compared with 1973 and 1974.

The information presented in Figures 1-4 confirms 1983 to have relatively high counts for the pollens included and thus likely to be a troublesome year for hay-fever sufferers. The grass pollen season in particular was longer in duration in 1983 than in the other years for which data is presented and the peak counts tend to be higher. Figure 7 demonstrates the relatively much higher counts for Cladosporium spores for 1983 compared with 1973 and 1974.

Figure 1 : Weekly mean pollen counts for 1983 in histogram form

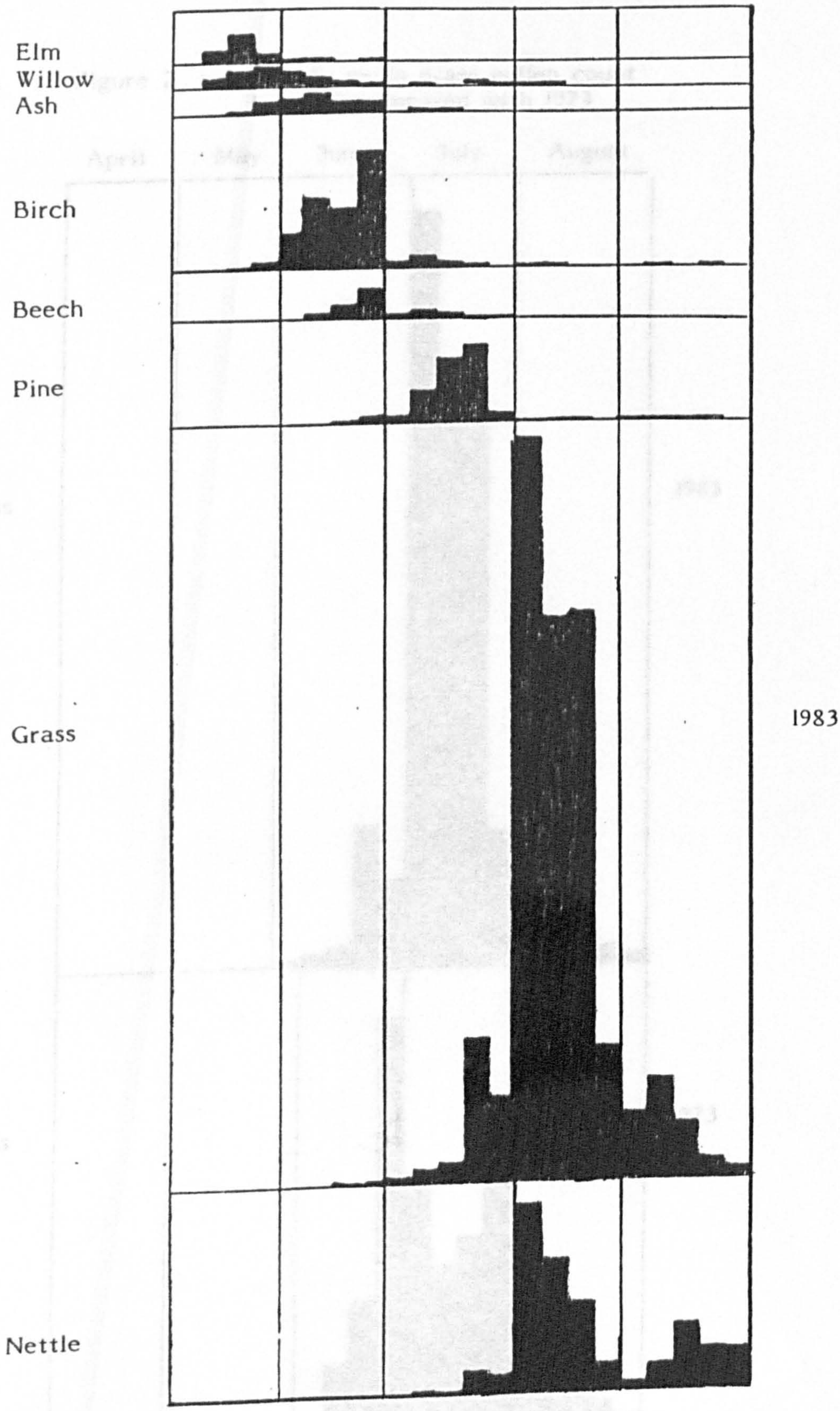


Figure 2 : Weekly mean grass pollen count for 1983 compared with 1973

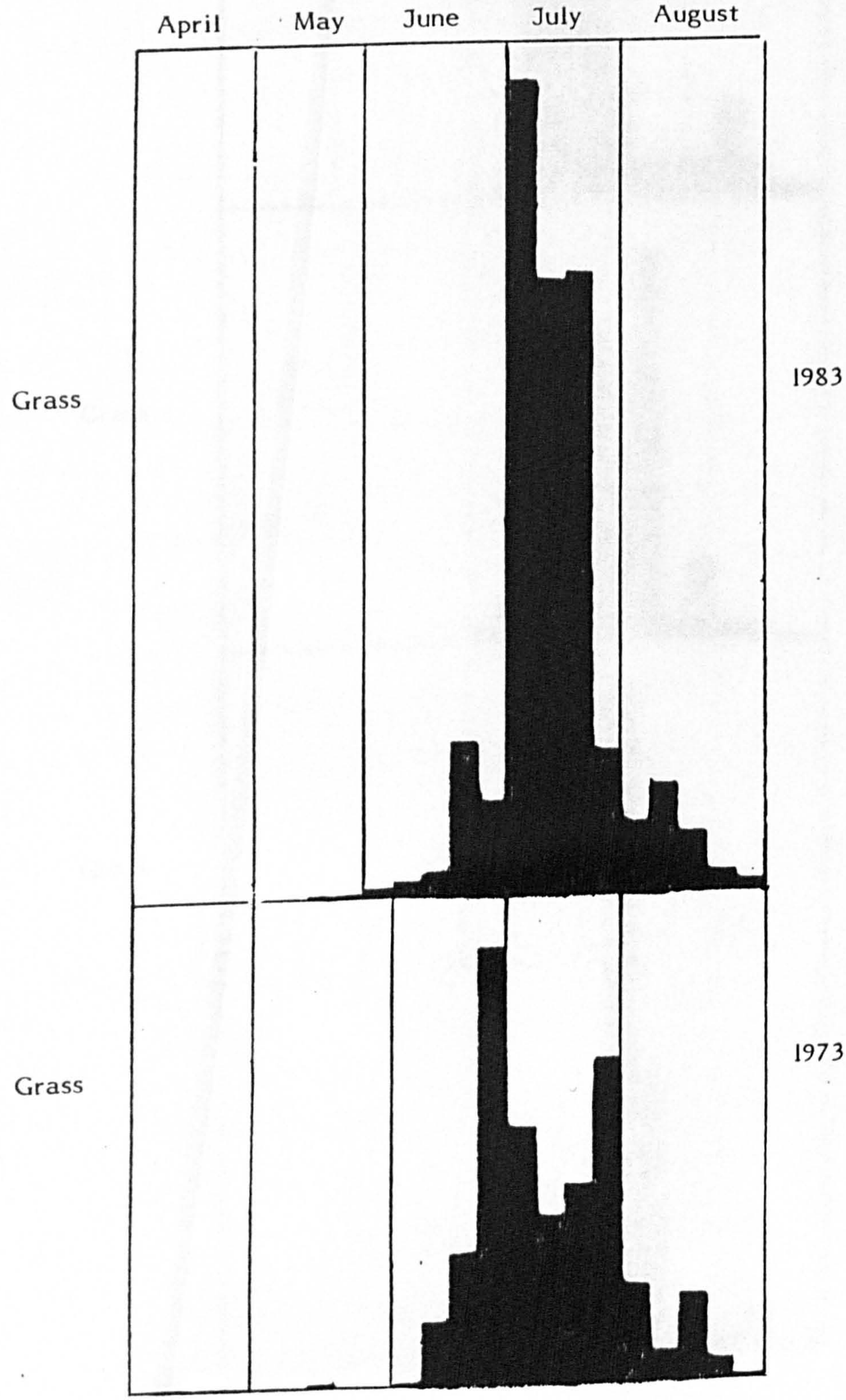


Figure 3 : Weekly mean grass pollen counts for 1974, 1975, 1977

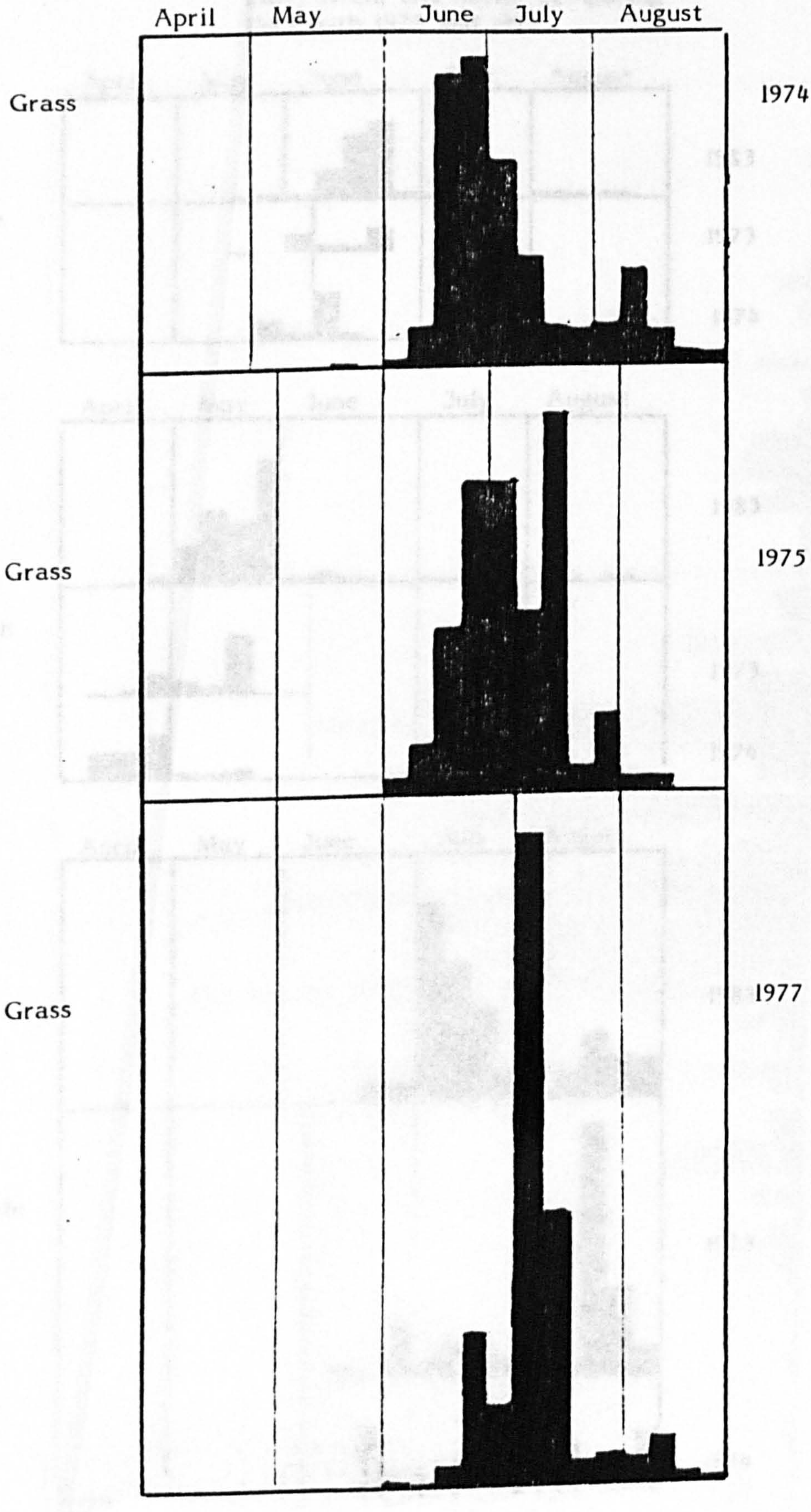


Figure 4 : Weekly mean pollen counts for pine, birch, and nettle comparing 1983 with 1973 and 1974

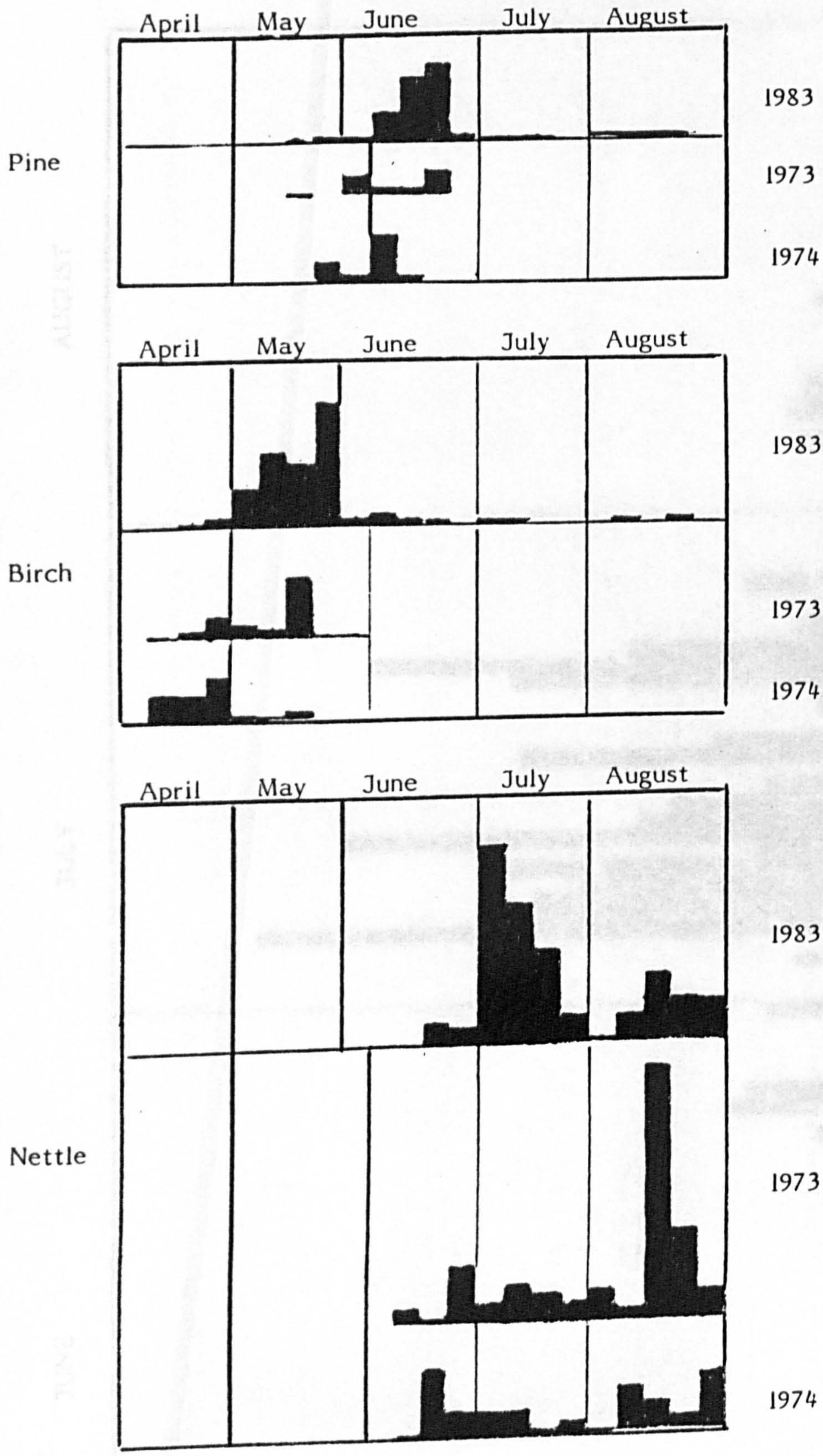


Figure 5 : Daily grass pollen count for 1983 in histogram form

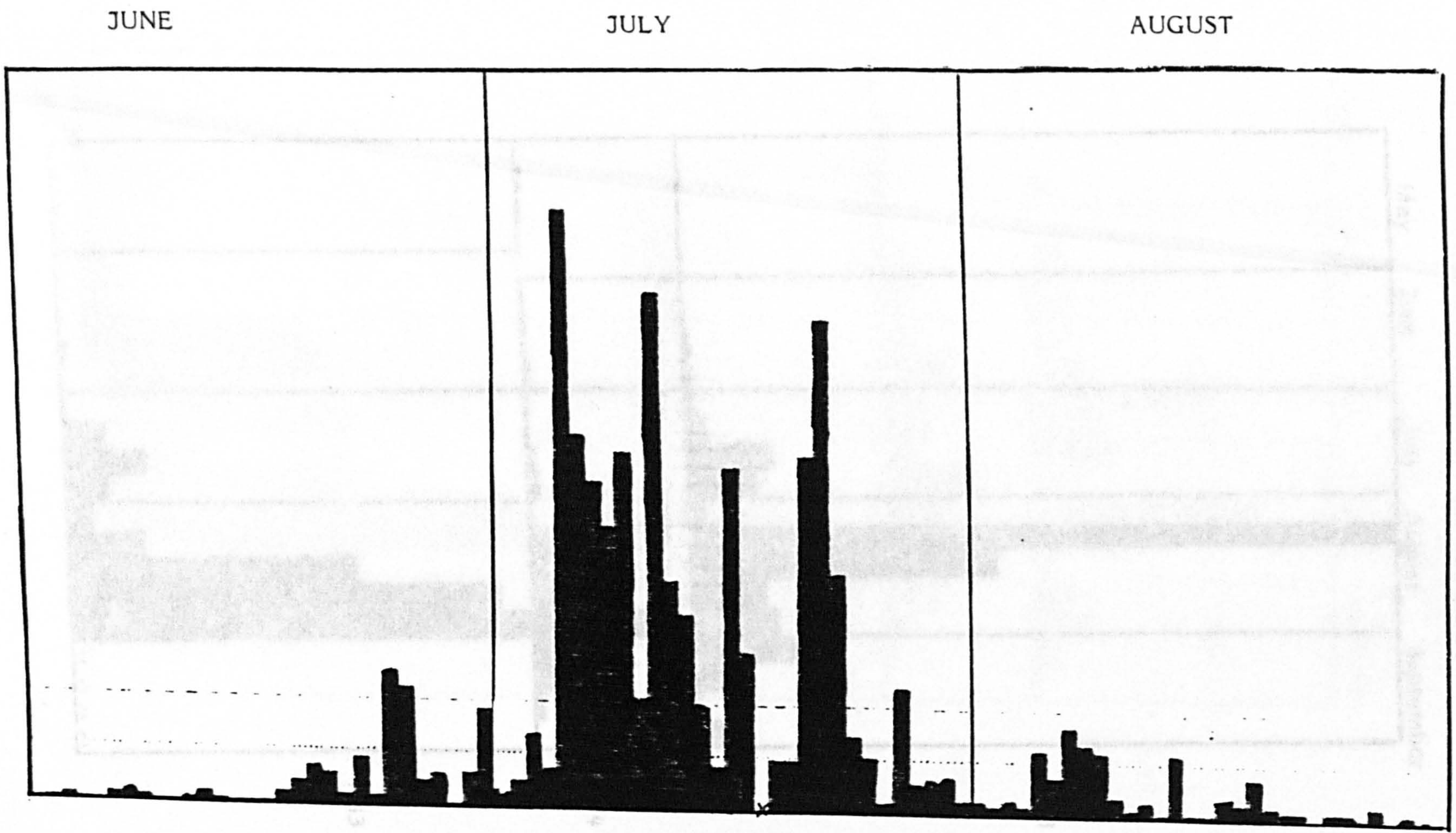


Figure 6 : Weekly mean Alternaria spore counts for 1983 compared with 1973 and 1974

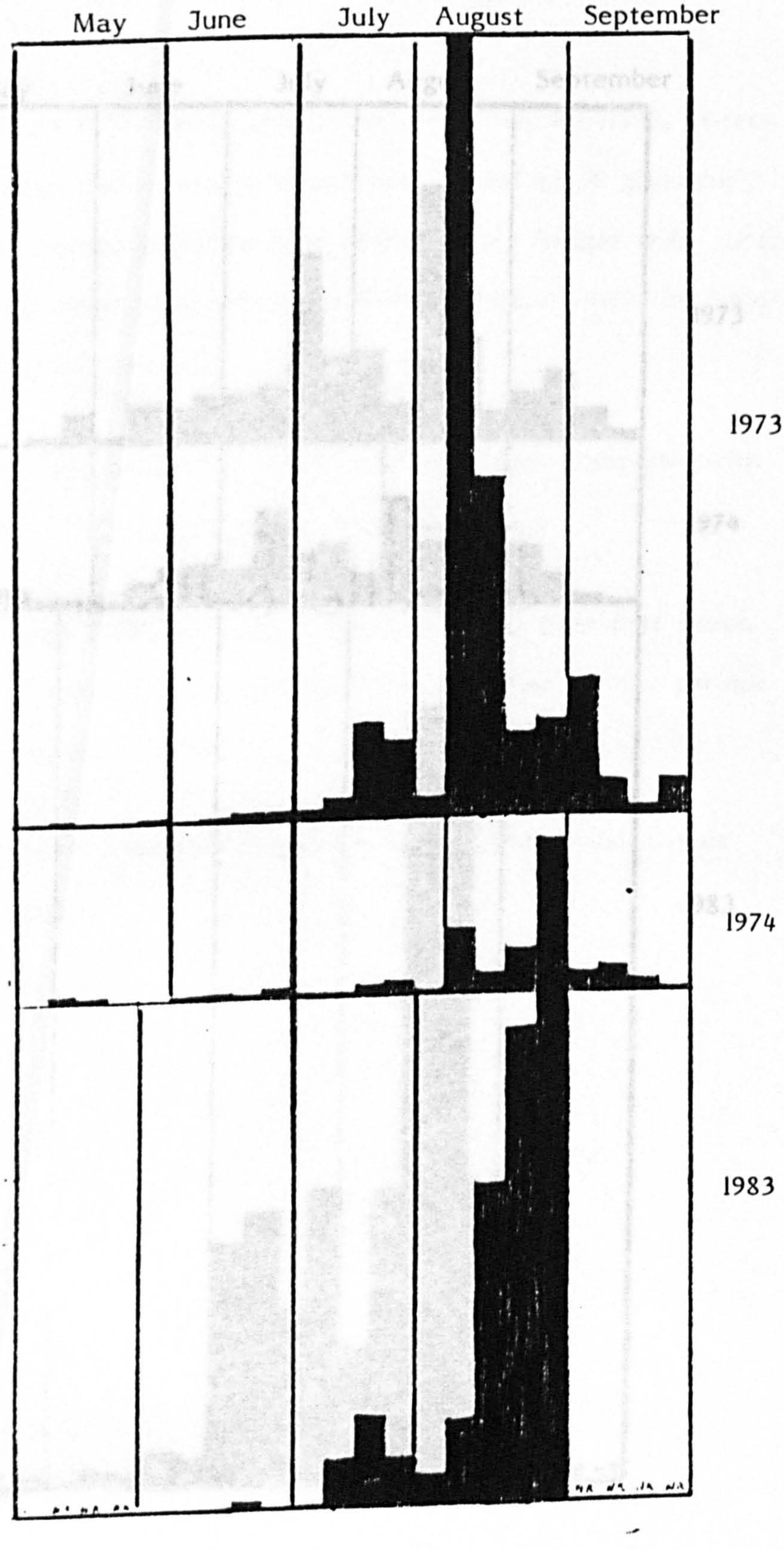
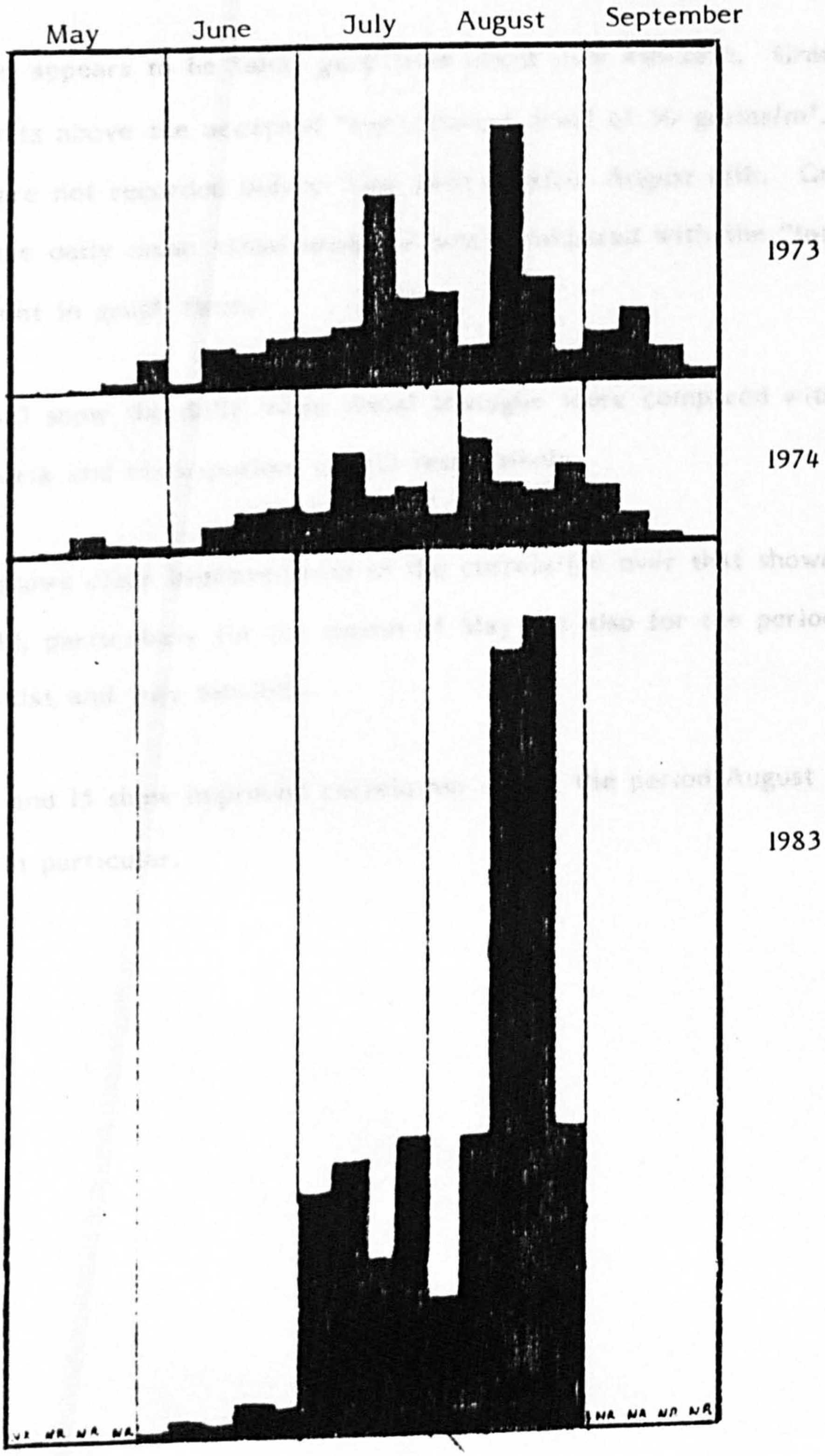


Figure 7 : Weekly mean Cladosporium spore counts for 1983 compared with 1973 and 1974



Comparions of Pollen Counts with Patient Symptom Scores

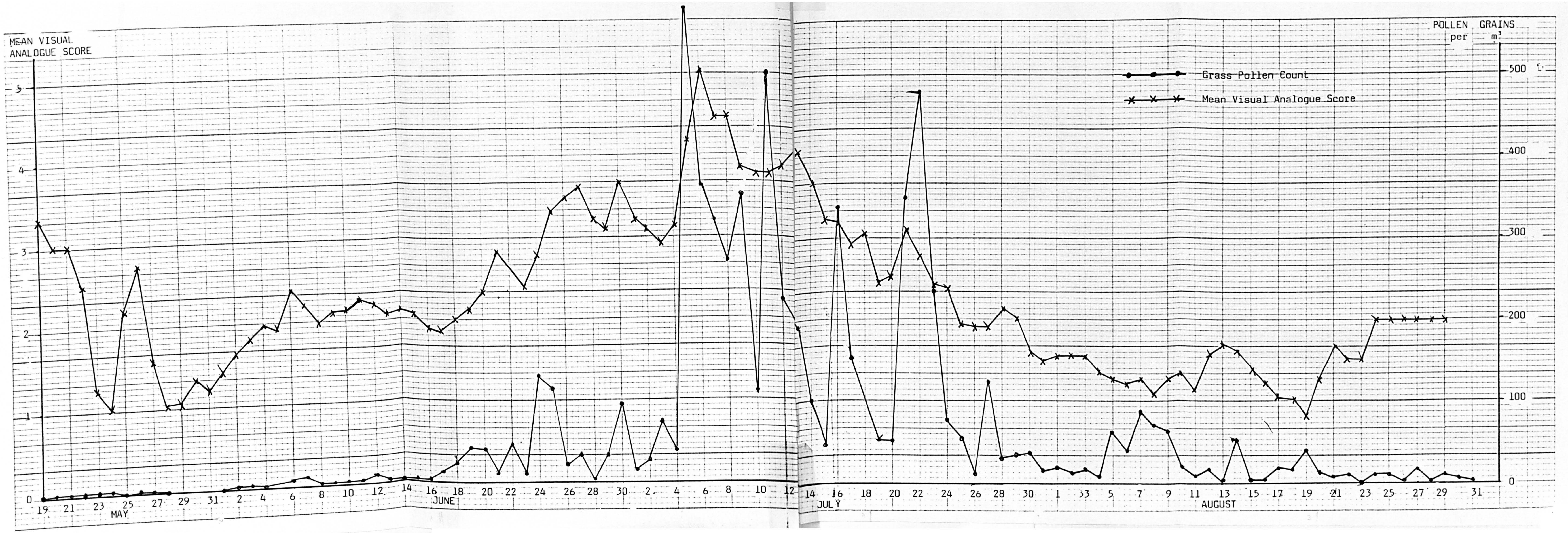
Graph 12 shows the daily mean visual analogue score compared with the grass pollen count.

Correlation appears to be fairly good from about July 4th-28th. Grass pollen counts above the accepted "significance" level of 50 grains/m^3, however, are not recorded before June 24th or after August 14th. Graph 13 shows the daily mean visual analogue score compared with the "total pollen" count in graph form.

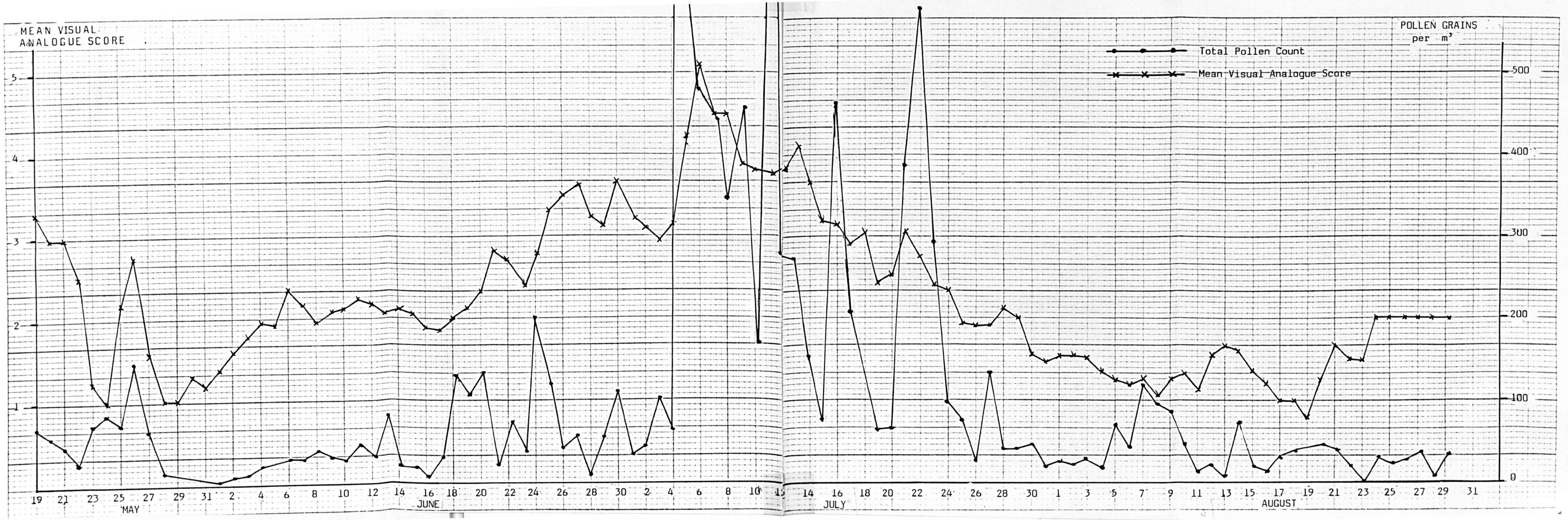
Graphs 14-15 show the daily mean visual analogue score compared with the alternaria and cladosporium counts respectively.

Graph 13 shows clear improvements in the correlation over that shown in Graph 12, particularly for the month of May but also for the periods June 17th-21st and July 6th-10th.

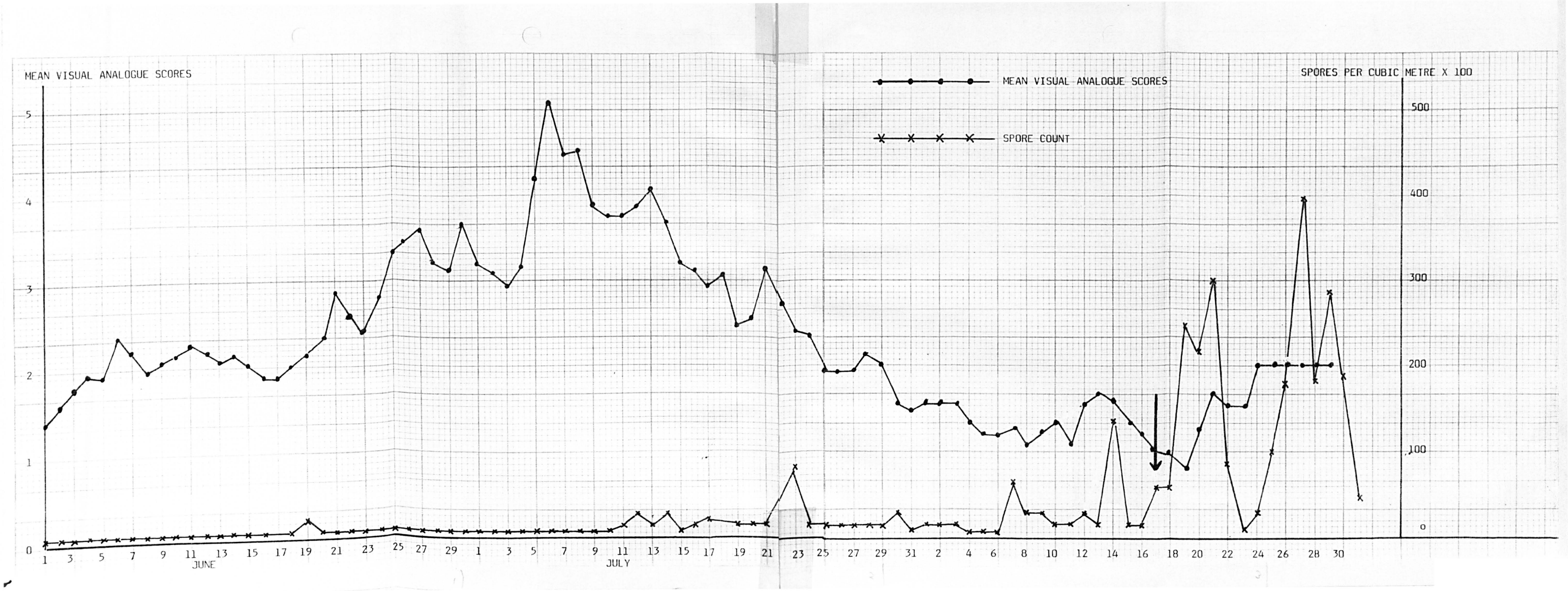
Graphs 14 and 15 show improved correlation during the period August 18th-29th in particular.



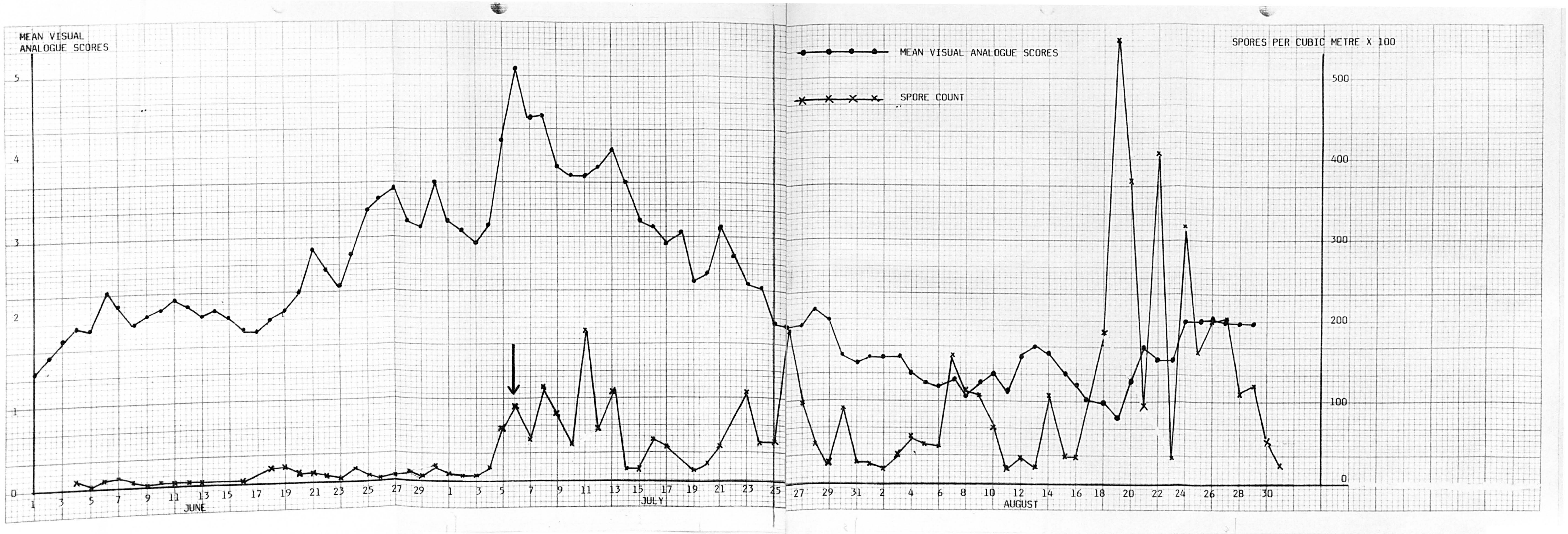
Graph 12 Daily mean visual analogue score compared with the grass pollen count.



Graph 13 Daily mean visual analogue score compared with the total pollen count.



Graph 14 Daily mean visual analogue score compared with the alternaria spore count.



Graph 15 Daily mean visual analogue score compared with the cladosporium spore count.

Information derived from Agronomy Department,
West of Scotland Agricultural College.

Table 8 Areas of grassland in Central and Strathclyde Regions of Scotland (Thousands of hectares) 1982

Rough grazings	870
Grass over 5/7 years old	188
Grass under 5/7 years old	80
Cereals (barley)	40
Roadsides, amenity and garden grass	50 (rough estimate)

The relatively smaller figure for grass under 5/7 years old represents a trend towards longer term grassland as reseeding costs rise. There is a slow continuing input into improving rough grazings. A portion of the Cereals is now Winter barley (possibly 12%). Of the cereals, which are basically grasses, barley produces most "free" pollen and Winter barley (sown September/October) produces more pollen than the traditional Spring barley (sown February/March).

Flowering of the various grasses and associated pollen release is estimated to occur about 20-26 days following the "50% ear emergence date" given in the "Classification of Grass Varieties" of the West of Scotland Agricultural College. This information is confirmed by the grass breeder of a local seed company who suggests that the interval is 3-3½ weeks. ("The 50% ear emergence date" is that date by which ears have appeared on 50% of the plants). Approximate dates are also available for pollen release from the different grass varieties and this can therefore be compared with the pollen counts available and with the patients' symptom scores.

Table 9 Areas of grassland mown for hay and silage in Central and Strathclyde Regions of Scotland (Thousands of hectares)

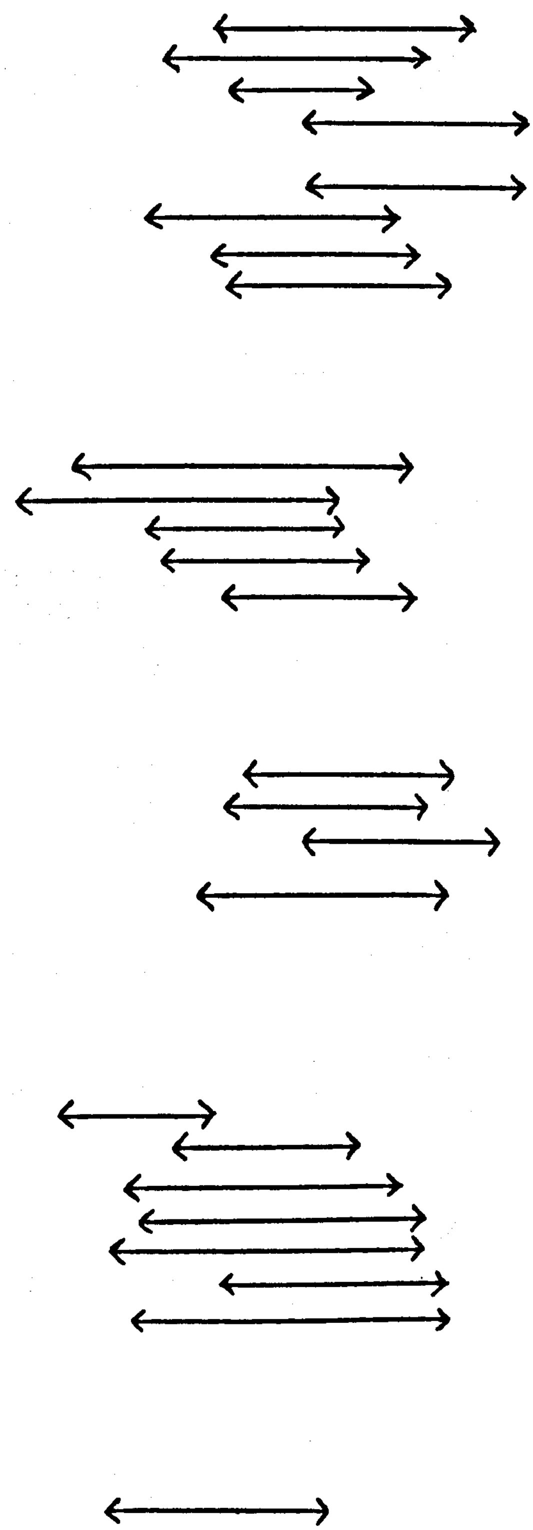
	1976	1981	1982
Hay	57	47	41
Silage	32	44	47

The swing from hay to silage has been fairly slow in Central and Strathclyde Regions probably due to the type of farming in the Argyll area (hill sheep) and the traditional cash crop Timothy hay production in the Carse of Stirling. Grass mown early to make silage will not, of course, be a potential source of pollen compared with grass allowed to flower and mown late to make hay.

Table 10 gives an approximate guide to the shedding of pollen by grasses in West Scotland (Central and Strathclyde Regions).

Table 10 An approximate guide to the shedding of pollen by grasses in West Scotland (Central and Strathclyde)

	Botanical content estimates (%)	May 15-31	June 1-15	June 16-30	July 1-15	July 16-31	Aug 1-15
Rough grazings (870,000 ha)							
Agrostis spps (Bent)	15						
Festuca spps (Fescue)	15						
Nardus (Mat-grass)	10						
Molinia (Purple moor grass)	30						
Rushes	10						
Sedge & woodrush	10						
Deschampsia (Hair grass)	5						
Holcus (Yorkshire fog)	5						
Permanent grass (5 years +) (188,000 ha)							
Agrostis spps (Bent)	50						
Poa spps (Meadow grass)	10						
Festuca spps (Fescue)	5						
Lolium (Rye)	30						
Holcus (Yorkshire fog)	5						
Rotational grass (>5 years) (80,000 ha)							
Lolium multiflorum (Rye)	5						
Lolium perenne (Rye)	70						
Phleum (Timothy)	10						
Dactylis (Cocksfoot),] Agrostis (Bent),] Poa (Meadow grass)]	15						
Roadsides/amenity/gardens (50,000? ha)							
Alopercurus (Foxtail)	5						
Dactylis (Cocksfoot)	5						
Poa (Meadow grass)	25						
Festuca (Fescue)	20						
Agrostis (Bent)	30						
Holcus (Yorkshire fog)	10						
Arrhenatherum)Oat grass)	5						
Cereals (40,000 ha)							
Barley							



CHAPTER 6 DISCUSSION, CONCLUSIONS and SUGGESTIONS FOR FURTHER WORK

DISCUSSION

Descriptive data obtained from diary card questionnaire

Certain aspects of the information obtained here are less surprising than others. The finding that 72.8 per cent of the patients describe the severity of their hay-fever in previous years as either "moderate" or "quite bad" is as one might have expected. It is however, rather interesting to note that 60.5 per cent usually experience symptoms continuously during the season in comparison with 30.9 per cent who experience symptoms on the "odd day" only. 67.9 per cent of patients experience symptoms only in the summer months whereas 29.6 per cent experience symptoms all the year round with 24.7 per cent reporting seasonal exacerbation during the summer. It is rather more surprising to find that 54.3 per cent of patients take treatment every day during the season whereas 29.6 per cent take treatment only on days when symptoms present. The more continuous rather than sporadic nature of the condition is highlighted as is the patients' apparent preference for continuous medication. The patients' reports of "other symptoms" experienced highlight the range of complaints which are either directly related to the hay-fever or are attributed to it by the patients. 16.1 per cent of patients recorded symptoms referable to the lower respiratory tract. 13.6 per cent of patients reported throat symptoms and 9.9 per cent had ear symptoms. The doctor could conceivably be misled into diagnosing a "local" problem relevant to these particular areas and overlook the underlying more general allergic aetiology. A high index of suspicion, particularly during the hay-fever season, should help avoid such incomplete or mis-diagnosis.

Mean Visual Analogue Scores

The most meaningful information from this data relates to the middle section of the graph where a larger number of patients are recording their daily visual analogue score. The mean score during the early and late sections of the graph are derived from a reduced number of patients and one must be careful to avoid drawing too general conclusions from these sections. It is unfortunate that the first symptom score data is not available until May 19th whereas Elm pollen, for example, has been trapped as early as April 12th. A more desirable arrangement might be to have all patients in the group recording their symptom scores from April 1st, for example, and continuously through into September. This design would certainly have to be considered for future studies. It is of course difficult to obtain patients' full co-operation over a considerably longer period of recording symptom scores particularly where their interest and involvement was possibly not stimulated by experiencing hay-fever symptoms themselves during lengthy periods of this extended "season". The mean symptom score fluctuates much less so than the pollen count throughout the period of the study but never rises above 5.0 (scale 0-10) and falls below 1.0 only on August 19th as has been commented on in an earlier section. The choice of "bed-time" as the time for recording the visual analogue symptom score is based largely on convenience as a time when most patients would remember and have time to mark their diary cards. It is possible that there may be a tendency for a patient's assessment of the severity of his or her hay-fever symptoms to be affected particularly by conditions during the late afternoon and evening in particular rather than the entire preceding 24 hours as intended. Recording symptom scores more than once in 24 hours might help to overcome this but again raises the problem of jeopardising patient compliance by asking the patient to do too much too often. A similar problem exists if one had asked the patients to record separate symptom scores for different aspects of their hay-fever, i.e. sneezing, runny nose, blocked nose and itchy eyes. The purpose of this study was to compare hay-fever symptom severity, in general terms, with information gathered on airborne allergens.

Pollen counts

The wide range of airborne pollen grains and fungal spores suspended in the atmosphere over Glasgow is highlighted. The role of grass pollen as a causative agent in hay-fever is well established but the role of the tree pollens, nettle pollen and Alternaria and Cladosporium spores is less clear. The hay-fever season of 1983 produced relatively high counts for some or all of these elements of the total atmospheric pollen and spore counts in comparison with some previous years about which information is available. The graphs of daily pollen counts reveal marked day-to-day fluctuations which tend to make prediction of pollen counts unreliable and impractical. In general terms, therefore, hay-fever patients, and their doctors, are unlikely to have much warning of possibly quite high pollen counts and the attendant symptoms which they produce. The tree pollens tend to be fairly early in the season with elm, willow, and ash fairly clearly preceding the grass pollen season. Birch and pine pollens were present at the start of the grass pollen season making it difficult to separate out their respective possible causative roles. Nettle pollen is present throughout much of the grass pollen season. Cladosporium spores are present with grass pollen but their peak levels are after the end of the grass pollen season. Alternaria spores have a similar pattern to that described for Cladosporium but are less in evidence until the second half of August when they peak with Cladosporium.

Correlation of mean visual analogue scores with pollen counts.

Graph 12 shows the daily mean visual analogue score compared with the grass pollen count. Correlation is good from June 23rd to July 27th approximately and grass pollen counts again rise above the significance value of 50 grains per cubic metre from 5th to 9th August. There is no correlation between 19th May and 16th June and from 16th to 29th August. Graph 13 compares the daily mean visual analogue score with the total pollen count, i.e. including tree and nettle pollens, etc. but excluding fungal spores. This clearly improves overall correlation but particularly in the period 19th May to 16th June. This improvement in correlation is largely the result of the inclusion of Birch pollen which is prevalent from 8th to 27th May approximately, and Beech pollen, prevalent from 8th June to 24th June and of Nettle pollen, prevalent from 5th July to 24th July particularly but detected again from 7th to 29th August approximately, although to a lesser extent. In the description pollens other than grass have not been assumed to be any more or less antigenic, or troublesome, grain for grain, than grass. It seems generally uncertain whether this is indeed the case or whether Birch, for example, causes more problems with hay-fever symptoms than would the equivalent count for grass pollen (Viander and Koivikko, 1970). The relative importance, if any at all, of fungal spores such as Alternaria and Cladosporium is even less clear. Graphs 14 and 15 show the daily mean visual analogue score compared with spore counts of Alternaria and Cladosporium respectively. These counts numerically are much higher than daily pollen counts alone and, to facilitate graphical illustration, the Cladosporium counts have been reduced by a factor of 100. This improves correlation from July 26th to August 29th and is particularly striking from August 24th to August 29th. The importance of these two fungal spores as causative agents in hay-fever has been discussed by Buisseret (1976) but little consideration is generally made of them when relating hay-fever symptoms to airborne pollen. As can be seen from Plates 16 and 18 Alternaria spores are relatively large when compared with grass or nettle respectively and could therefore easily be trapped by the "nasal filter". Cladosporium spores, however, are considerably smaller but do tend to "clump" and this "clumping" could conceivably lead to them being filtered out in the nose rather than passing directly to the lower respiratory tract.

It is interesting to note that the daily mean visual analogue score rises steadily from late May to a peak at the end of the first week of July despite relatively poor correlation with pollen and spore counts during the period 29th May to 16th June in particular. This does not appear to be in agreement with the "nasal priming" theory of Connel who suggested that early in the season a considerably higher count of airborne pollen is required to cause symptoms than later in the season when the nasal mucosa is unstable and sensitive even to non-antigenic irritants. From 4th July to 29th August particularly, considerable day-to-day fluctuations in the pollen and spore count are not reflected in the mean visual analogue score suggesting that hay-fever should really be considered as a condition which is active throughout the season albeit with day-to-day fluctuations but still troublesome when the daily pollen and spore count is relatively low. This suggests that continuous therapy directed against hay-fever is likely to be more successful than sporadic, symptomatic medication particularly when prediction of especially high pollen and spore counts seems to have considerable practical difficulties associated with it. Studies designed to compare different forms of therapy should preferably not be cross-over studies in view of the day-to-day variations in symptoms scores and the relatively short period of time which the season covers.

Correlation of grass pollen count with data on grass flowering periods.

Light microscopic examination of grass pollen grains as used in this study does not permit the identification of different grass varieties. Timothy grass (Phleum) has been considered to be an important source of allergenic pollen in the causation of hay-fever. As shown in Table 10, Timothy grass begins to shed its pollen in West Scotland between July 1st and 15th and pollen release is completed between August 1st and 15th. This is therefore broadly consistent with the recorded grass pollen counts showing "significant" counts from June 24th until August 14th approximately.

Timothy grass in West Scotland however constitutes only 8,000 hectares in area, entirely as rotational grass, compared with a total of 116,400 hectares of Rye grass (lolium) which is made up of 60,000 hectares of rotational grass and almost as much again of permanent grass.

The broad margins described for pollen release times in West Scotland and the variability of climatic conditions make it very difficult to draw clear associations between the grass pollen counts obtained and the pollen shedding of different grass varieties. Electron microscopic examination of trapped pollen grains should make it possible to identify different grass types from their exine characteristics (Nilsson, et al, 1977).

GENERAL CONCLUSIONS

Where a diagnosis of hay-fever might be appropriate it would seem sensible for the general practitioner to have a high index of suspicion where symptoms are "atypical". An awareness of the local pollen and spore "calendar" may help the general practitioner in diagnosis and management of hay-fever. Consideration of the "total pollen" count and spore counts may be of more help to the general practitioner than the grass pollen count alone although this latter count is the one generally considered at present. For patients experiencing symptoms early in the season, birch, beech and pine may be relevant whereas Alternaria and Cladosporium spores may be more relevant for those having symptoms late in the season. Nettle pollen may add to the problems experienced by patients during the period of significant grass pollen counts. Continuous or maintenance therapy may have advantages over sporadic therapy and studies to compare different forms of therapy should preferably be of parallel rather than cross-over design.

Hay-fever may therefore merit more consideration from the general practitioner and this might lead not only to improved management of the hay-fever patient but to increased interest for the doctor dealing with the condition.

FURTHER WORK SUGGESTED BY THE STUDY AND ITS RESULTS AND CONCLUSIONS

The information currently available on the prevalence of hay-fever in the community seems to merit further examination and it would be useful to learn what proportion of patients affected simply put up with their symptoms or buy "over-the-counter" remedies from the pharmacist.

Longer recording periods for symptom scores and for pollen and spore counts would improve the data already available in respect of the correlation of symptoms with aerobiological activity throughout the entire calendar year. Inclusion of skin prick tests, RAST (radio-allergo sorbent test) results, and even nasal challenge tests would be an interesting addition to further studies although nasal challenge tests in particular do not naturally fall within the province of the general practitioner.

Electron microscopy of grass pollen grains collected in the trap might help in identifying which grass varieties seem to predominate at times of patients' peak symptom scores bearing in mind the wide range of grasses known to be growing in West Scotland.

"Light, dust, contradiction, an absurd remark, the sight of a dissenter - anything sets me sneezing; and if I begin sneezing at twelve, I don't leave off till two o'clock, and am heard distinctly in Taunton, when the wind sets that way - a distance of six miles. Turn your mind to this little curse".

Sidney Smith
(letter, June 1835)
Anglican minister and wit.

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APPENDIX I WEATHER DATA

GLASGOW WEATHER CENTRE

DATA SHEET No. 36 - MAY, 1983

GLASGOW STATISTICS

Date	Air Temperature Min °C	Air Temperature Max °C	00-24 Rainfall (mm)	Sunshine (hours)	Hours with Wind Gusts ≥39 mph	Hours with Wind Gusts ≥55 mph	Max Gusts
1	04	10	Nil	0.2	-	-	32
2	06	10	Trace	Nil	-	-	29
3	05	13	Nil	1.0	-	-	18
4	06	15	Nil	7.4	-	-	24
5	06	12	12.3	Nil	-	-	23
6	09	13	24.7	0.5	-	-	20
7	09	14	1.5	0.9	-	-	11
8	08	13	0.1	0.8	-	-	15
9	06	11	8.5	4.9	1	-	39
10	03	10	3.8	1.5	6	-	45
11	06	11	2.7	3.3	-	-	33
12	07	13	1.8	2.8	-	-	29
13	07	11	13.0	1.7	-	-	36
14	07	13	0.5	5.6	-	-	30
15	08	15	0.8	3.7	-	-	26
16	08	15	Nil	9.3	-	-	36
17	07	11	2.9	0.1	-	-	31
18	08	13	0.1	0.6	-	-	24
19	06	14	Trace	7.4	-	-	16
20	06	16	7.3	5.4	-	-	26
21	07	14	1.2	3.3	-	-	18
22	05	13	1.1	5.9	-	-	23
23	- 0	16	Nil	11.9	-	-	15
24	04	15	1.3	0.1	-	-	20
25	08	16	Nil	5.3	-	-	29
26	06	18	Nil	11.2	-	-	23
27	01	11	0.6	0.1	-	-	22
28	07	10	0.7	Nil	-	-	21
29	09	11	Trace	Nil	-	-	17
30	07	15	Trace	1.6	-	-	21
31	08	15	2.6	1.9	-	-	22
Mean/ Total	6.3	13.1	87.5	98.4	7	-	
1941/70 Average	6.2	15.1	68	184.5	24.2	1.5	

NOTES: 1) Some daily values are rounded off to the nearest unit, but means, totals and averages are precise.

2) This information is extracted from records of observations made at Glasgow (Abbotsinch) Airport.

GLASGOW WEATHER CENTRE

DATA SHEET No. 36 - MAY, 1983

Date

1 Dry and rather cloudy throughout. Wind, Northeast to Easterly light till 7 a.m., becoming moderate and near fresh at times in afternoon.

2 Remaining dull with light and mostly intermittent rain from midday onwards. Wind, Northeasterly moderate backing to light Northwesterly after 6 p.m.

3 Dry, apart from a few spots of rain between 8 a.m. and 10 a.m., and only a few brief sunny intervals. Wind, light Northwesterly becoming Westerly till 7 p.m. then veering Easterly.

4 Dry throughout though cloudy start cleared to give good sunny spells late morning and afternoon. Wind, Northeast or Easterly mainly light, moderate 6 p.m. to 10 p.m.

5 Cloudy at first with periods of rain from 11 a.m., slight at first but moderate most of the evening. Wind, Easterly moderate.

6 Continuous, and often heavy rain till 11 a.m. followed by frequent light showers. Wind East or Northeasterly light or moderate early becoming light after midday.

7 Periods of rain and drizzle till midday, then showers heavy locally becoming dry after 8 p.m. Wind, light Northeast or Easterly at first becoming between Northwest and Southwesterly during the afternoon but Northeasterly again late evening.

8 Dry and cloudy apart from light rain and drizzle 10 a.m. to 1 p.m., followed by mainly light showers during the afternoon. Wind, light Easterly or calm till 1 p.m. becoming between Southwest and Northwesterly.

9 Cloudy with period of rain from before 5 a.m. till 9 a.m. The rest of the day was very showery, some moderate and of hail but sunny intervals as well. Wind, light and variable becoming from 7 a.m. Southwest to Westerly moderate occasionally fresh but light again after 9 p.m.

10 Showers throughout, some prolonged and moderate at times, and only a few sunny spells. Wind, Southeasterly light increased from 8 a.m. to moderate and fresh for a time in the early afternoon.

11 Light showers early and dry but cloudy till midday. Further showers remainder of the day. Wind, East to Southeasterly, mainly moderate.

12 Showers continued till after midday with thunderstorms developing during the afternoon and further showers in the evening. Wind, East to Southeast moderate.

13 Showers merged to periods of rain, sometimes moderate. Wind, East to Southeasterly moderate becoming light veering Southwesterly and increasing to moderate again after midday.

14 Showers throughout with sunny periods especially in the afternoon. Wind, South to Southwesterly moderate.

15 Cloudy with showers gradually dying out during the afternoon and sunny spells developing. Dry and clear from 6 p.m. Wind, light South or Southeasterly gradually backing during the afternoon to East or Northeasterly, occasionally moderate.

16 Dry, and after a fine start, rather cloudy till late morning but good long sunny spells the rest of the day. Cloudy late evening. Wind, Easterly light becoming moderate around 6 a.m. and fresh for a time in the late afternoon and early evening.

17 A dull day and after a period of general rain 5 a.m. to 10 a.m. further light rain or showers the remainder of the day. Wind, East to Northeast moderate becoming light by late evening.

18 Dry at first, light rain or showers from 10 a.m. till late afternoon becoming dry during the evening. Wind, Easterly light or moderate.

19 Apart from some overnight drizzle, dry and cloudy till midday then long sunny spells till evening. Thunder for a time but remaining dry in most areas. Wind, light Easterly becoming Northwest to Westerly around midday.

20 Dry with clear spells at first and sunny intervals during the morning. Light shower around 2 p.m. cleared for a time but thunder followed by moderate rain from 5 p.m. - 10 p.m. Wind mainly light Easterly but variable in thunderstorms.

21 Cloudy night with intermittent rain or showers from 7 a.m. till midday. Some brief sunny spells followed, but further light showers late afternoon and early evening. Wind, light Easterly till 3 p.m. becoming Westerly or Northwesterly.

22 Apart from a light shower around 4 p.m. mainly dry and cloudy till midday. Sunny intervals and showers afternoon and evening cleared to give a fine late evening. Wind, Westerly light but moderate 8 a.m. - 7 p.m.

23 Long clear spells followed by a dry and sunny day. Wind, light Southwest or Westerly.

24 Rather cloudy though dry at first but light rain or showers from 10 a.m. onwards for the remainder of the day. Wind, light variable at first, but Northeast or Easterly from 6 a.m.

25 Cloudy till after midday then sunny periods in afternoon and evening. Wind light Northeast to Easterly till 10 a.m., West or Northwesterly mainly light but moderate 6 p.m. -9 p.m.

26 Cloudy overnight but breaking to give a dry and sunny day. Wind, Northeast or Easterly early and late but Northwest or Northerly 7 a.m. till 5 p.m., but remaining light throughout.

27 Long clear spells overnight but cloud increased from dawn with a period of mainly slight rain from 12.30 p.m. till nearly 8 p.m. Wind, light and variable becoming Northwest to Northerly from 8 a.m.

28 Cloudy with spells of light rain or drizzle throughout. Wind, light between Northwest and Northeast.

29 Cloudy with spells of light rain throughout. Wind, light Northeast becoming Easterly early in day.

30 Mainly dry though cloudy throughout with only the briefest of sunny intervals. A light shower in some places around 7 p.m. Wind, Northeast to East mainly light becoming moderate by late evening.

31 Cloudy with a period ofrain from 4 a.m. finally clearing after 2 p.m. Some brief sunny intervals and dry till the end ofthe day. Wind, Northeast or Easterly mainly moderate.

GLASGOW WEATHER CENTRE

SUMMARY OF GENERAL WEATHER IN THE GLASGOW AREA

MAY 1983

		Actual	Long-term Average
Total RAINFALL (mm)		87.5	68
No. of "WET DAYS" ($\geq$1.0 mm in 24 hrs)		15	12.0
No. of days of SLEET or SNOW FALLING		0	0.1
Total hours of BRIGHT SUNSHINE		98.4	184.5
No. of days/hours with WIND GUSTS $\geq$39 mph		2 / 7	5.1 / 24.2
Mean daily MAXIMUM AIR TEMPERATURE (^{o}C)		13.1	15.1
Mean daily MINIMUM AIR TEMPERATURE (^{o}C)		6.3	6.2
No. of days of AIR FROST		1	0.7
RELATIVE HUMIDITY average	at 00 hrs (%)	79	80
	at 06 hrs (%)	82	83
	at 12 hrs (%)	70	64
	at 18 hrs (%)	69	65

RAINFALL — An above average month as a whole, despite a dry start, with the 5th till 13th particularly wet - 68.4 mm falling during this spell. The second half of month was much drier than average. Wetter than last year and only 1976 (121 mm) and 1981 (138 mm) have had higher totals in the last ten years.

TEMPERATURE — A cooler than average month mainly as a result of daytime temperature well below the seasonal average. The 20th was the first of only four days with temperatures over 60^{o}F (15.5^{o}C) during the month. Only 1975 and 1979 have been cooler since 1970.

WIND — Predominance of light or moderate easterly winds.

SUNSHINE — Second poorest total recorded in May since records began in 1881. 90 hours in 1906 is poorest and this is lowest total since 1925 when 106 hours were recorded in this area.

HUMIDITY — Cool dull days gave higher values than average while night time readings were nearer average.

Glasgow Weather Centre
1 June 1983

GLASGOW WEATHER CENTRE

DATA SHEET No. 36 - JUNE, 1983

GLASGOW STATISTICS

Date	Air Temperature Min °C	Air Temperature Max °C	00-24 Rainfall (mm)	Sunshine (hours)	Hours with Wind Gusts ≥39 mph	Hours with Wind Gusts ≥55 mph	Max Gusts
1	09	11	8.1	Nil	-	-	33
2	08	10	10.1	Nil	-	-	28
3	07	09	11.9	Nil	-	-	23
4	08	18	0.7	2.7	-	-	24
5	09	14	Trace	0.1	-	-	25
6	03	17	Nil	14.8	-	-	31
7	07	19	Trace	3.9	-	-	23
8	13	19	2.7	0.8	-	-	26
9	11	15	Trace	3.2	-	-	33
10	08	15	1.2	3.2	-	-	33
11	11	16	2.3	3.9	-	-	35
12	08	16	0.4	9.6	3	-	44
13	06	15	8.1	0.3	2	-	43
14	09	14	1.0	9.1	6	-	43
15	06	16	Trace	13.8	-	-	38
16	06	12	3.6	Nil	-	-	24
17	10	17	Trace	0.6	-	-	20
18	09	21	Nil	12.8	-	-	18
19	07	25	Nil	14.5	-	-	14
20	13	22	Trace	7.0	-	-	28
21	10	18	Nil	7.7	-	-	29
22	09	21	Trace	4.6	-	-	21
23	12	14	Trace	Nil	-	-	24
24	10	19	Nil	2.7	-	-	20
25	07	20	Trace	7.8	-	-	24
26	11	17	Trace	6.1	-	-	35
27	09	17	Nil	13.3	-	-	31
28	09	15	2.9	Nil	-	-	29
29	09	16	Trace	5.9	-	-	32
30	10	20	Nil	11.1	-	-	25
Mean/ Total	8.8	16.6	53.0	159.5	11	-	
1941/70 Average	9.3	17.9	60	181.2	17	0.7	

NOTES: 1) Some daily values are rounded off to the nearest unit, but means, totals and averages are precise.

2) This information is extracted from records of observations made at Glasgow (Abbotsinch) Airport.

GLASGOW WEATHER CENTRE

DATA SHEET No. 36 - JUNE 1983

Date

1 Dull and cloudy throughout with rain from around 1 p.m. slight during afternoon but moderate for most of the evening. Wind, moderate Northeasterly, fresh at times.

2 Moderate occasionally heavy rain overnight with further periods of rain and drizzle throughout the day. Wind, moderate Northeast to Easterly.

3 A day of mostly continuous and, at times, moderate to heavy rain. Wind, Northeast to Easterly moderate.

4 Light rain turned to drizzle till around 9 a.m., then mainly dry with sunny periods the rest of the day though light showers in places around midday and 6 p.m. Wind, light and variable becoming light Southwesterly by midday and moderate during the afternoon.

5 Some light drizzle 5 a.m. to 9 a.m. then dry and cloudy till evening, clearning to fair. Wind, Northeast to Easterly light but moderate 11 a.m. till 9 p.m.

6 Fine clear night followed by long spells of sunshine. Wind, Northeast to Easterly light till 5 a.m., then moderate but fresh late afternoon and early evening.

7 Mostly cloudy though bright with sunny periods during morning and light rain here and there in the late evening. Wind, light to moderate Easterly.

8 Cloudy with intermittent rain and drizzle during the morning but more continuous though light from 5 p.m. onwards. Wind, light Easterly till 9 a.m. then Southwesterly mostly moderate.

9 Light drizzle between 3 a.m. to 8 a.m. becoming dry though mainly cloudy. Some brief sunny intervals and an odd light shower in the afternoon. Wind, Southwest or Westerly mainly moderate though fresh for a time during the afternoon and falling light late evening.

10 Some light rain overnight cleared to give sunny intervals at first but cloud spread into area bringing rain and drizzle from 3 p.m. Wind Southwest to Westerly light increasing to moderate from 8 a.m. then fresh from late afternoon.

11 Rain and drizzle cleared around 9 a.m. to give a bright day with some sunny periods though there were a few light showers in the evening. Wind, Southwest fresh for most of the day, only becoming light after 9 p.m.

12 Clear periods followed by sunny spells though a few light showers developed after 3 p.m. Wind, light Southwesterly increased to fresh or strong from 9 a.m. till 6 p.m., falling to light again in evening.

13 Some clear intervals and an isolated shower around 4 a.m. but gradually becoming cloudy with intermittent rain from midday onwards. During the afternoon mostly light but moderate to heavy rain in the evening. Wind, Southwesterly light increased to moderate by 6 a.m. backing slowly in afternoon to Southeasterly by evening.

14 Cloudy night with showers which continued throughout the day though good sunny spells developed. Wind, Westerly fresh or strong with gale force gusts early but by evening becoming moderate then light.

15 Mostly clear overnight with a light shower around 6 a.m. Good long spells of sunshine during the day though cloudy by late evening. Wind, West or Northwesterly moderate becoming light after 8 p.m.

16 Cloudy and dry till 6 a.m. then periods of rain sometimes moderate till 8 p.m. Wind, light variable at first, Easterly from 6 a.m. veering Southwesterly after midday increasing to moderate.

17 Light rain and drizzle at first cleared by 2 a.m. to give a dry, mostly cloudy day. Wind, Southwest to Westerly light.

18 Variable cloud and most early cleared to give long sunny spells. Wind, light and variable till 10 a.m. then Southwesterly.

19 Early morning most soon cleared to give a sunny day. Wind, calm or light mainly between Southwest and Northerly.

20 Some clear intervals and sunny periods but a good deal of high cloud throughout, with a spot of two of rain around 5 p.m. Wind, Northeast to Easterly light gradually increasing during morning to moderate.

21 Low cloud for most of the night only broke around 1 p.m. to give sunny spells through high cloud. Wind, Northeast to Easterly light but moderate 7 a.m. to 7 p.m.

22 Mist and fog lifted only slowly around 10 a.m. Brief sunny intervals and light rain or showers during the early afternoon cleared to give a dry and bright evening. Wind, Northeast or Easterly light till 10 a.m. then West or Northwesterly.

23 Apart from a little drizzle during the night, dry but dull throughout. Wind, moderate Easterly.

24 Dry and rather cloudy all day, any sunshine was short lived in the early afternoon. Wind light Northeast or Easterly.

25 Some clear intervals and sunny periods morning and afternoon but clouding over later with light drizzle from 7 p.m. till 10 p.m. Wind, calm or light Southwesterly increasing to moderate from 9 a.m.

26 Cloudy with light rain or drizzle at times during the morning, clearing to give a sunny afternoon and evening. Wind, moderate Westerly increasing to moderate around 8 a.m. and to fresh occasionally in the afternoon.

27 Dry, and after a cloudy night long sunny spells during the day. Wind, West to Northwesterly light at first but mainly moderate from 7 a.m.

28 After a dry and clear start, cloud and rain at times from 4 a.m. for most of the day. Some outbreaks of moderate rain in afternoon and evening. Wind, Westerly light or moderate backing a little and increasing to moderate after midday.

29 Intermittent light rain and drizzle till 2 a.m. gradually cleared to give a dry day. After a cloudy start, sunny periods developed from midday becoming cloudy again during the evening. Wind, Westerly moderate but light in late evening.

30 Cloudy night, but by dawn sunny periods developed and later in the morning long sunny spells and a fine evening. Wind, light between Southwest and Northwesterly, moderate 4 p.m. till 8 p.m.

GLASGOW WEATHER CENTRE

SUMMARY OF GENERAL WEATHER IN THE GLASGOW AREA

JUNE 1983

		Actual	Long-term average
Total RAINFALL (mm)		53.0	60
No. of "WET DAYS" (≥1.0 mm in 24 hrs)		10	10.8
No. of days of SLEET or SNOW FALLING		0	0.0
Total hours of BRIGHT SUNSHINE		159.5	181.2
No. of days/hours with WIND GUSTS ≥39 mph		3 / 11	3.1 / 17.0
Mean daily MAXIMUM AIR TEMPERATURE (^{o}C)		16.6	17.9
Mean daily MINIMUM AIR TEMPERATURE (^{o}C)		8.8	9.3
No. of days of AIR FORST		0	0.0
RELATIVE HUMIDITY average	at 00 hrs (%)	79	80
	at 06 hrs (%)	81	83
	at 12 hrs (%)	65	64
	at 18 hrs (%)	63	65

RAINFALL — Drier than average and lowest total since 1977 despite a very wet start with 31 mm out of total 53 mm in the first four days. No measureable rain from the 17th till 27th - 11 days.

TEMPERATURE — A below average month, and a little cooler than last year but very similar to June 1980 and 1981. Only 1971 and 1972 cooler in the last 30 years. Temperatures recovered by mid-month after a very cool (cold) first three days.

WIND — Light winds from Northeast to Easterly during the first week, thereafter Southwest to Westerly predominated.

SUNSHINE — Duller than average but the best total since 1979. Poor start to the month only improved from the 18th.

HUMIDITY — Close to average values.

Glasgow Weather Centre
1 July 1983

GLASGOW WEATHER CENTRE

DATA SHEET No. 36 - JULY 1983

GLASGOW STATISTICS

Date	Air Temperature Min °C	Air Temperature Max °C	00-24 Rainfall (mm)	Sunshine (hours)	Hours with Wind Gusts ≥39 mph	Hours with Wind Gusts ≥55 mph	Max Gusts
1	07	15	9.9	Nil	-	-	36
2	10	15	0.1	6.3	2	-	41
3	11	15	0.9	Nil	-	-	38
4	11	16	0.1	Nil	-	-	21
5	14	23	0.8	1.6	-	-	24
6	10	26	Nil	13.2	-	-	17
7	15	23	Trace	1.2	-	-	20
8	12	27	Nil	11.2	-	-	15
9	14	27	Nil	8.9	-	-	16
10	13	21	Nil	6.7	-	-	23
11	14	28	Nil	10.0	-	-	15
12	14	30	Nil	10.1	-	-	17
13	14	27	Nil	8.4	-	-	17
14	13	22	Nil	8.6	-	-	28
15	14	19	0.2	1.9	-	-	31
16	05	20	Nil	10.7	-	-	24
17	11	22	Nil	8.8	-	-	20
18	12	19	Trace	10.7	-	-	26
19	09	19	Trace	4.1	-	-	17
20	11	19	Nil	1.4	-	-	15
21	10	25	Nil	15.0	-	-	24
22	08	28	Nil	12.1	-	-	18
23	14	25	Trace	3.9	-	-	22
24	14	22	1.2	1.6	-	-	21
25	15	22	6.6	1.0	-	-	17
26	15	20	Trace	0.3	-	-	17
27	12	23	Nil	7.0	-	-	24
28	12	21	0.2	0.6	-	-	29
29	14	21	Trace	6.6	-	-	38
30	10	19	0.5	1.5	-	-	23
31	13	18	0.7	6.1	-	-	24
Mean/ Total	12.0	21.8	21.2	179.5	2	-	
1941/70 Average	10.8	18.6	75	159.4	9.9	0.1	

NOTES: 1) Some daily values are rounded off to the nearest unit, but means, totals and averages are precise.

2) This information is extracted from records of observations made at Glasgow (Abbotsinch) Airport.

GLASGOW WEATHER CENTRE

DATA SHEET No.36 - JULY 1983

Date

1 Mostly dry until late morning then dull with continuous slight rain, becoming moderate at times until late evening then slight. Wind, West to Southwest mainly moderate.

2 A little rain before dawn, but a dry morning with sunny intervals. Occasional slight showers in afternoon, and slight rain from late evening. Wind, Westerly fresh or strong at times becoming moderate in evening.

3 Mainly cloudy with occasional slight rain becoming dry in evening. Wind, West to Southwest moderate or fresh, locally strong at times around dawn becoming light in evening.

4 Mainly cloudy with occasional drizzle in afternoon and evening when it became misty on high ground. Wind, Southwest light or moderate.

5 Low cloud and drizzle, dying out during the morning. Dry afternoon and evening with sunny intervals developing. Wind, calm becoming Southwest from mid-morning, mainly light but moderate in afternoon. Humid.

6 Dry, mainly sunny. Wind, light and variable becoming ENE light later in evening.

7 Mostly dry and cloudy but one or two light showers around until midday, and hazy sunshine in evening. Becoming very humid. Wind, light Northeast or Easterly.

8 Dry. Mainly sunny, but misty around dawn and thunderstorm with torrential rain in Hamilton around 6 or 7 p.m. Wind, mainly Westerly very light. Humid.

9 Dry and mainly sunny but fog and low cloud dawn till mid-morning. Wind, light ENE. Very humid.

10 Dry. Fog or low cloud from dawn, lifting during morning but cloud not breaking properly until mid-afternoon. Wind, East to Northeast light or moderate. Humid.

11 Local drizzle 5 a.m. to 8 a.m. with mist and low cloud otherwise dry, and sunny from mid-morning. Very humid. Wind, light East to Northeast.

12 Dry. Mainly sunny. Wind, light and variable, mainly Easterly until dawn and late in evening and West to Northwest in afternoon/early evening. Very humid. Wet bulb 22.8°C at 1500.

13 Dry. Cloudy from dawn till late morning, otherwise sunny. Wind, light East becoming variable then West from mid-afternoon.

14 Dry. Mainly sunny. Wind, West or Northwest light until dawn then moderate.

15 Mostly cloudy. Occasional mainly slight drizzle or showers from dawn till early evening. Wind, Westerly moderate, occasionally fresh from dawn until early evening.

16 Dry and bright with sunny intervals. Wind, light and variable until a little after dawn then Easterly moderate, becoming light later in evening.

17 Dry. Cloudy at first, mainly sunny from mid-morning. Wind, very light Easterly becoming Westerly during morning.

18 Cloudy start, odd spot of drizzle around 4 a.m., clearing by 9 a.m., to give a sunny day. Wind, Southwest to Westerly light but moderate 9 a.m. to 7 p.m., but Easterly late.

19 Cloudy at first with light rain and drizzle around 9 a.m. Reamining mostly cloudy and dry with a few sunny intervals. Wind, Northeast to East light but West or Northwesterly from 7 a.m., Northeasterly after 10 p.m.

20 Mostly cloudy though dry throughout. Wind, Northeast to Easterly light till midday becoming West or Northwesterly.

21 Clear night followed by a day of unbroken sunshine. Wind, light Southwest or Westerly.

22 Continuing clear with sunshine from dawn but becoming more cloudy during the evening. Wind, light variable becoming Easterly after 7 p.m.

23 Some clear spells overnight but becoming mostly cloudy with light showers or intermittent rain from 8 a.m. till 2 p.m. Dry afternoon but light shower around 7 p.m. Wind, Easterly mostly light.

24 Cloudy throughout with some light rain from 6 a.m. to 9 a.m. but dry thereafter. Wind, Northeast to Easterly light to moderate.

25 Period of rain then drizzle from 2 a.m. till 9 a.m. Remaining cloudy with thunderstorms and rain from 4 p.m. till 7 p.m., but dry in evening. Wind, East or Northeasterly light but variable in evening.

26 Cloudy throughout and mostly dry. An odd spot of drizzle around 9 a.m. but light rain after 10 p.m. Wind, light East or Southeasterly veering Southwest to Westerly around 11 a.m.

27 Light rain soon cleared and following a cloudy night sunny periods developed from late morning onwards. Wind, light Westerly gradually veered from late morning to Northwesterly and increased to moderate.

28 Rather cloudy throughout with light rain from time to time though it was dry after 6 p.m. Wind, Southwest to Westerly light at first but mainly moderate from 6 a.m.

29 One or two spots of rain overnight and during the morning but clearing conditions by early afternoon gave a dry sunny evening. Wind, Westerly moderate to fresh decreasing in evening to moderate or light.

30 Fine night followed by a mostly cloudy day with only a few brief sunny periods. A sport or two of light rain late afternoon and evening. Wind, Southwest to Westerly light to moderate.

31 Rain from midnight till 6 a.m. cleared to give a dry day with sunny intervals. Wind, light or moderate, Southwesterly at first veering Westerly after 6 a.m. and to Northwesterly during evening.

GLASGOW WEATHER CENTRE

SUMMARY OF GENERAL WEATHER IN THE GLASGOW AREA

JULY 1983

		Actual	Long-term average
Total RAINFALL (mm)		21.2	75
No. of "WET DAYS" (≥ 1.0 mm in 24 hrs)		6	11.7
No. of day of SLEET or SNOW FALLING		0	0
Total hours of BRIGHT SUNSHINE		179.5	159.4
No. of days/hours with WIND GUSTS ≥39 mph		1 / 2	2.4 / 9.9
Mean daily MAXIMUM AIR TEMPERATURE (°C)		21.8	18.6
Mean daily MINIMUM AIR TEMPERATURE (°C)		12.0	10.8
No. of day of AIR FROST		0	0
RELATIVE HUMIDITY average	at 00 hrs (%)	80	82
	at 06 hrs (%)	83	84
	at 12 hrs (%)	66	67
	at 18 hrs (%)	63	67

RAINFALL : Second successive dry July and only three years, 1868 - 15.0 mm, 1978 - 14.7 mm and last year - 12.6 mm, have been drier since records began. Dry spell from 6th to 23rd had just 0.2 mm on the 15th as the only measureable rain in the period.

TEMPERATURE : Only July 1955 (17.1°C) has been warmer in Glasgow. Two main warm spells - 5th to 14th and 21st to 25th. The highest ever recorded July temperature of 30.1°C on 12th during a spell of very hot days.

WIND : Winds generally light and from an Easterly or Southeasterly direction during the dry period in the month.

SUNSHINE : Although above average not nearly as good as 1982 (201 hours) mainly as a result of low cloud from the East coast keeping totals down.

HUMIDITY : Below average especially during daytime in the dry spell - 6th to 23rd.

Glasgow Weather Centre
1 August 1983

GLASGOW WEATHER CENTRE

DATA SHEET No.36 - AUGUST 1983

GLASGOW STATISTICS

Date	Air Temperature Min °C	Air Temperature Max °C	00-24 Rainfall (mm)	Sunshine (hours)	Hours with Wind Gusts ≥39 mph	Hours with Wind Gusts ≥55 mph	Max Gusts
1	06	18	Nil	11.0	-	-	29
2	05	19	0.1	9.9	-	-	24
3	08	18	3.7	0.2	-	-	35
4	12	19	Nil	4.7	-	-	24
5	10	21	Nil	9.7	-	-	21
6	08	22	Nil	1.7	-	-	20
7	10	23	Nil	2.1	-	-	20
8	12	25	Nil	10.7	-	-	17
9	11	26	Nil	10.5	-	-	20
10	09	27	Nil	12.5	-	-	20
11	10	19	Trace	1.2	-	-	25
12	11	20	Nil	11.5	-	-	32
13	09	23	Nil	13.5	-	-	24
14	09	26	Nil	11.8	-	-	31
15	15	18	0.9	0.4	-	-	$\boxed{38}$
16	11	20	1.4	11.5	-	-	18
17	03	21	7.4	4.0	-	-	22
18	16	22	0.2	0.5	-	-	24
19	14	27	Nil	9.3	-	-	22
20	10	22	0.5	3.3	-	-	26
21	16	24	Trace	3.4	-	-	18
22	12	21	0.2	1.2	-	-	14
23	14	17	12.8	Nil	-	-	11
24	11	22	Nil	6.0	-	-	15
25	15	23	Nil	1.9	-	-	17
26	12	23	Nil	0.9	-	-	23
27	15	21	Nil	9.3	-	-	25
28	10	18	Nil	4.0	-	-	15
29	10	19	Nil	1.9	-	-	28
30	14	21	Nil	7.6	-	-	26
31	11	20	0.6	4.1	-	-	23
Mean/ Total	10.9	21.4	27.8	180.2	-	-	
1941/70 Average	10.6	18.5	89	143	15.1	0.6	

NOTES: 1) Some daily values are rounded off to the nearest unit, but means, totals and averages are precise.

2) This information is extracted from records of observations at Glasgow (Abbotsinch) Airport.

GLASGOW WEATHER CENTRE

DATA SHEET No.36 - AUGUST 1983

Date

1 After a cloudy start clearing skies brought a dry day with long sunny spells. Wind, West to Northwesterly light but moderate 9 a.m. to 9 p.m.

2 Clear spells overnight, but some light showers from 8 a.m. till midday. Dry afternoon and evening with sunshine but cloud gradually increased during the evening. Wind, mostly light Westerly but moderate for a time late afternoon.

3 Dry and cloudy at first with short spell of light rain and drizzle 10 a.m. till 1 p.m. Mostly dry afternoon but further more persistent rain and drizzle from 5 p.m. till end of the day. Wind, Southwesterly light increasing from 10 a.m. to moderate or fresh.

4 Dry thought mostly cloudy at first with sunny intervals occurring late afternoon and evening. Wind, light Southwesterly gradually becoming moderate Northwesterly by afternoon but Westerly in evening.

5 Some clear periods at first and good sunny spells during the day. Wind, West or Northwesterly, mostly light.

6 Dry but generally cloudy throughout. Wind, light between Southwest and West.

7 Becoming clear for a time but rather cloudy for most of the day with just brief glimpses ofthe sun. Wind, Southwest light becoming calm but Easterly light from 9 a.m.

8 Some clear periods at first though low cloud formed for a time. By 10 a.m. sunny spells developed for the remainder of the day. Wind, light Northeast to Easterly.

9 Clear skies at first but low cloud formed around dawn broke by 10 a.m. to give long sunny spells. Wind, light Northeast or Easterly.

10 Some overnight mist soon cleared to give another dry sunny day. Wind, light Easterly at first but Southwest to Northwesterly after midday.

11 Clear at first but cloudy from 7 a.m. Dry apart from some light rain midday and 6 p.m. Wind, Southwest to Westerly light but moderate from evening.

12 Clear spells at first, but cloudy for a while early morning but sunny spells developing after 9 a.m. Wind, West to Northwesterly mostly moderate but fresh late afternoon.

13 Dry, clear periods overnight and good long sunny spells. Wind, West to Northwesterly light, moderate 9 a.m. till 6 p.m.

14 Dry, and after some short-lived mist patches sunny spells developed. Wind, light Westerly at first, Southwest moderate to fresh from 11 a.m.

15 Clear start becoming cloudy with some light rain from midday for most of the afternoon but dry again in evening. Wind, Southwesterly light increasing moderate around 5 a.m. to fresh by 10 a.m. but decreasing slowly during the evening to light.

16 Light rain at first cleared to give a dry sunny day. Wind, between Southwest and Northwesterly mainly light.

17 Clear skies at first, some mist around dawn with increasing cloud from late morning onwards and rain from 5 p.m., was moderate or heavy for most of the evening. Wind, light variable at first, Southeast or Easterly after 9 a.m.

18 Light rain and drizzle gradually cleared by 6 a.m. Cloudy with odd spot of drizzle around midday. Wind, South to Southwesterly light but moderate 10 a.m. to 4 p.m.

19 Misty overnight clearing to give a dry sunny day. Wind, calm at first becoming light Easterly from 8 a.m.

20 Clear spells and short lived fog patches early. A few sunny periods but after thunder in the early afternoon more cloudy during the evening. Wind, light Easterly increased to moderate around 7 a.m. decreasing again in the evening.

21 Dull start cleared slowly by midday. Thunder late afternoon but dry clear evening. Wind, light Easterly till 2 p.m. then west or Northwesterly.

22 Clear at first with fog patches forming 4 a.m. till 8 a.m. Remaining mostly cloudy all day with a little light rain 6 p.m. to 9 p.m. Wind, light between Southwest and Northwesterly, but Northeast by late evening.

23 Rain and drizzle on and off at first, became more continuous and thundery during the morning before drying up around 6 p.m. Clearing skies in the evening. Wind, Northeasterly light becoming variable from early morning.

24 Becoming misty and low cloud persisted till 9 a.m. Rather cloudy but sunny periods developed especially in the evening. Wind, variable at first, light Easterly or Northeasterly from 9 a.m.

25 Remaining cloudy and dry throughout. Wind, light Northeasterly or Easterly but Westerly after midday.

26 Dry throughout, some early morning mist cleared to a cloudy day. Wind, light and variable at first, and Southwesterly moderate from midday decreased late in evening.

27 Low cloud cleared around 6 a.m. to a dry day with good sunny periods though more cloudy again by evening. Wind, light Southwesterly increased to moderate during the morning, but changed to Easterly around 6 p.m.

28 Cloudy and dry throughout. Wind, light and Easterly all day.

29 Mostly cloudy though dry. Some brief sunny intervals by late afternoon. Wind, Northeast or Easterly light, increased and veered to Southwest moderate around 11 a.m.

30 Cloudy overnight clearing by 10 a.m. to give good sunny spells but cloudyagain after 7 p.m. Wind, moderate Southwesterly.

31 Clear intervals overnight but rather cloudy during the morning and afternoon though some sunny intervals did occur. Fine evening. Wind, light Easterly till 10 p.m. becoming South to Southeasterly light or moderate.

GLASGOW WEATHER CENTRE

SUMMARY OF GENERAL WEATHER IN THE GLASGOW AREA

AUGUST 1983

		Actual	Long-term average
Total RAINFALL (mm)		27.8	89
No. of "WET DAYS" (≥1.0 mm in 24 hrs)		6	13.4
No. of days of SLEET or SNOW FALLING		0	0
Total hours of BRIGHT SUNSHINE		180.2	143
No. of days/hours with WIND GUSTS ≥39 mph		0 / 0	2.7 / 15.1
Mean daily MAXIMUM AIR TEMPERATURE (°C)		21.4	18.5
Mean daily MINIMUM AIR TEMPERATURE (°C)		10.9	10.6
No. of days of AIR FROST		0	0
RELATIVE HUMIDITY average	at 00 hrs (%)	81	82
	at 06 hrs (%)	85	86
	at 12 hrs (%)	64	70
	at 18 hrs (%)	64	68

RAINFALL — A much drier than average month with almost half the total falling on one day - 23rd. Drier than 1982 (97 mm) and amongst the ten driest Augusts since records began in 1868.

SUNSHINE — Best total since 1977 (189 hours) and 1976 (219 hours); only four Augusts have ever recorded more sunshine.

WIND — With anticyclonic or ridge conditions existing winds were light throughout and mainly from a Southwesterly direction.

TEMPERATURE — Warmest since 1975 and just five Augusts had higher mean temperatures since readings began in this area.

HUMIDITY — While night humidity was near average, by day values were lower than August average.

Glasgow Weather Centre.
1 September 1983

APPENDIX II DIARY CARD

PLEASE TICK EVERY BOX WHICH IS TRUE FOR YOU e.g.

I am.... Male ☐ Female ☐

My hayfever, in previous years has usually been....

Very Mild ☐ Moderate ☐ Quite Bad ☐ Very Bad ☐

I have symptoms: On the odd day ☐ Continuously for days on end ☐

I get trouble: Only in the summer months ☐ All the year round but worse in summer ☐ All the year round ☐

I usually take treatment for it: Only on days when I get symptoms ☐ Every day during the season ☐

When I get hayfever:

	Never	A little	A lot	Very badly
I sneeze	☐	☐	☐	☐
My nose runs	☐	☐	☐	☐
My nose blocks	☐	☐	☐	☐
I get itchy eyes	☐	☐	☐	☐
I have other symptoms (please describe)	☐	☐	☐	☐

Now please complete the Hayfever Diary overleaf.

DIARY CARD

INSTRUCTIONS FOR USING THIS DIARY

EVERY night before going to bed mark the line with an, "X" e.g. moderate will be between the centre and severe, mild will be between the centre and absent.

The mark should score the severity of your 'hayfever' symptoms.

Please write in day and date e.g. Monday 14/6/83

Severe |————————————x————| Absent

.....day Date / / Treatment taken today? Yes ☐ No ☐	Severe |——————————| Absent
.....day Date / / Treatment taken today? Yes ☐ No ☐	Severe |——————————| Absent
.....day Date / / Treatment taken today? Yes ☐ No ☐	Severe |——————————| Absent
.....day Date / / Treatment taken today? Yes ☐ No ☐	Severe |——————————| Absent
.....day Date / / Treatment taken today? Yes ☐ No ☐	Severe |——————————| Absent
.....day Date / / Treatment taken today? Yes ☐ No ☐	Severe |——————————| Absent
.....day Date / / Treatment taken today? Yes ☐ No ☐	Severe |——————————| Absent

APPENDIX III MEAN VISUAL ANALOGUE SCORE FOR 19th MAY to 31st AUGUST.

DAILY MEAN VISUAL ANALOGUE SCORE

Date		Number	Mean	Standard deviation
May	19th	3	3.33	3.21
	20th	2	3.00	1.41
	21st	3	3.00	1.41
	22nd	2	2.50	2.10
	23rd	4	1.25	0.96
	24th	5	1.00	0.71
	25th	6	2.17	2.88
	26th	8	2.75	2.81
	27th	11	1.54	2.30
	28th	13	1.00	1.35
	29th	13	1.00	1.29
	30th	13	1.31	1.55
	31st	16	1.19	1.79
June	1st	26	1.38	1.70
	2nd	30	1.57	2.36
	3rd	32	1.78	2.44
	4th	34	1.94	2.65
	5th	34	1.91	2.68
	6th	36	2.36	3.08
	7th	39	2.18	2.75
	8th	45	1.93	2.43
	9th	47	2.08	2.45
	10th	49	2.10	2.65
	11th	50	2.24	2.67
	12th	50	2.18	2.36
	13th	52	2.04	2.36
	14th	54	2.11	2.46
	15th	57	2.03	2.48
	16th	58	1.88	2.49
	17th	58	1.84	2.52
	18th	58	2.00	2.50
	19th	58	2.14	2.45
	20th	57	2.30	2.52
	21st	58	2.81	3.07
	22nd	58	2.72	3.01
	23rd	58	2.38	2.57

Date		Number	Mean	Standard deviation
June (contd)	24th	59	2.76	2.83
	25th	62	3.29	3.19
	26th	63	3.48	3.20
	27th	63	3.60	3.20
	28th	63	3.22	2.96
	29th	65	3.09	3.18
	30th	65	3.66	3.18
July	1st	63	3.19	3.14
	2nd	64	3.11	3.04
	3rd	65	2.92	3.04
	4th	63	3.14	3.34
	5th	64	4.17	3.55
	6th	66	5.06	3.94
	7th	66	4.47	3.65
	8th	65	4.48	3.53
	9th	65	3.85	3.46
	10th	65	3.78	3.39
	11th	65	3.77	3.44
	12th	67	3.83	3.54
	13th	71	4.11	3.53
	14th	72	3.65	3.33
	15th	71	3.20	2.92
	16th	69	3.17	2.94
	17th	70	2.93	2.98
	18th	70	3.06	2.92
	19th	68	2.43	2.36
	20th	70	2.53	2.56
	21st	70	3.11	2.92
	22nd	69	2.78	2.93
	23rd	69	2.39	2.67
	24th	68	2.37	2.77
	25th	68	1.94	2.45
	26th	66	1.91	2.40
	27th	65	1.91	2.61
	28th	65	2.14	2.47
	29th	64	2.00	2.61
	30th	63	1.55	2.15
	31st	62	1.47	2.11

Date		Number	Mean	Standard deviation
Agust	1st	60	1.53	2.30
	2nd	58	1.55	2.29
	3rd	55	1.53	2.17
	4th	54	1.37	2.16
	5th	51	1.25	1.80
	6th	51	1.20	1.56
	7th	48	1.27	2.03
	8th	46	1.06	1.56
	9th	43	1.28	1.52
	10th	41	1.41	1.53
	11th	37	1.13	1.98
	12th	34	1.59	2.23
	13th	31	1.68	2.38
	14th	31	1.61	2.13
	15th	26	1.38	2.06
	16th	22	1.18	1.30
	17th	10	1.00	1.05
	18th	7	1.00	1.00
	19th	5	0.80	1.09
	20th	4	1.25	1.50
	21st	3	1.67	1.52
	22nd	2	1.50	0.71
	23rd	2	1.50	0.71
	24th	2	2.00	1.41
	25th	1	(2.00)	0
	26th	1	(2.00)	0
	27th	1	(2.00)	0
	28th	1	(2.00)	0
	29th	1	(2.00)	0

APPENDIX IV DAILY POLLEN COUNTS

DAILY POLLEN AND FUNGAL SPORE COUNTS PER CUBIC METRE

GLASGOW 1983

POLLEN	APRIL 10th	11th	12th	13th	14th	15th	16th
	*	*				*	*
Alnus (Alder)							
Fraxinus (Ash)							
Fagus (Beech)							
Betula (Birch)							
Rumex (Dock/Sorrel type)							
Ulmus (Elm)			10	1	2		
Gramineae (Grass)							
Corylus (Hazel)							
Aesculus (Horse Chestnut)							
Tilia (Lime)							
Urtica (Nettle)							
Quercus (Oak)							
Pinaceae (Pine type)							
Plantago (Plantain)							
Populus (Poplar)							
Compositae (Ragwort type)							
Luzula (Rush)							
Carex (Sedge)							
Salix (Willow)			5	2	1		
Taxus (Yew type)				5			
Others/Unidentified							
Total pollen			15	8	3		
FUNGAL SPORES							
Alternaria							
Alternaria ÷ 2							
Cladosporium							
Cladosporium ÷ 200							
TOTAL POLLEN + FUNGAL SPORES			15	8	3		

* Traps not in operation.

DAILY POLLEN AND FUNGAL SPORE COUNTS PER CUBIC METRE

GLASGOW 1983

POLLEN			APRIL				
	17th	18th	19th	20th	21st.	22nd	23rd
	*				H		
Alnus (Alder)							
Fraxinus (Ash)						1	
Fagus (Beech)							4
Betula (Birch)							1
Rumex (Dock/Sorrel type)		17	3	4	5	11	19
Ulmus (Elm)							
Gramineae (Grass)							
Corylus (Hazel)							
Aesculus (Horse Chestnut)							
Tilia (Lime)							
Urtica (Nettle)							
Quercus (Oak)							
Pinaceae (Pine type)		1					
Plantago (Plantain)							
Populus (Poplar)							
Compositae (Ragwort type)							
Luzula (Rush)							
Carex (Sedge)							
Salix (Willow)		10	3	5	1	15	4
Taxus (Yew type)		1	1			1	14
Others/Unidentified		1	1	1	1	2	1
Total Pollen		30	8	10	7	30	43
FUNGAL SPORES							
Alternaria							
Alternaria ÷ 2							
Cladosporium							
Cladosporium ÷ 200							
TOTAL POLLEN + FUNGAL SPORES		30	8	10	7	30	43

*Traps not in operation

H - Hirst trap.

DAILY POLLEN AND FUNGAL SPORE COUNTS PER CUBIC METRE

GLASGOW 1983

POLLEN	APRIL 24th	25th	26th	27th H	28th	29th	30th *
Alnus (Alder)							
Fraxinus (Ash)	3	1	1	1	7	8	
Fagus (Beech)							
Betula (Birch)	1	2	4	3			
Rumex (Dock/sorrel type)							
Ulmus (Elm)	5	8		1	1	3	
Gramineae (Grass)							
Corylus (Hazel)							
Aesculus (Horse Chestnut)							
Tilia (Lime)							
Urtica (Nettle)							
Quercus (Oak)							
Pinaceae (Pine type)							
Plantago (Plantain)							
Populus (Poplar)							
Compositae (Ragwort type)							
Luzula (Rush)							
Carex (Sedge)							
Salix (Willow)	6	28		7	5	2	
Taxus (Yew type)	5	3		1	5	1	
Others/Unidentifed)		1	2		3		
Total pollen	20	43	7	13	21	14	
FUNGAL SPORES							
Alternaria							
Alternaria ÷ 2							
Cladosporium							
Cladosporium ÷ 200							
TOTAL POLLEN + FUNGAL SPORES	20	43	7	13	21	14	

* Traps not in operation

H - Hirst trap.

DAILY POLLEN AND FUNGAL SPORE COUNTS PER CUBIC METRE

GLASGOW 1983

POLLEN	MAY 1st	2nd *	3rd	4th	5th	6th	7th
Alnus (Alder)							
Fraxinus (Ash)	2		8	11	7	1	1
Fagus (Beech)							
Betula (Birch)	6		16	21	16	5	8
Rumex (Dock/Sorrel type)							
Ulmus (Elm)	1		1	2	1	1	
Gramineae (Grass)							
Croylus (Hazel)							
Aesculus (Horse Chestnut)							
Tilia (Lime)							
Urtica (Nettle)							
Quercus (Oak)							
Pinaceae (Pine type)							
Plantago (Plantain)							
Populus (Poplar)						2	
Compositae (Ragwort type)							
Luzula (Rush)							
Carex (Sedge)							
Salix (Willow)	9		7	7	11	1	2
Taxus (Yew type)	1				5		
Others/Unidentified	1		3	2	4	2	
Total pollen	20		35	43	44	12	11
FUNGAL SPORES							
Alternaria							
Alternaria ÷ 2							
Cladosporium							
Cladosporium ÷ 200							
TOTAL POLLEN + FUNGAL SPORES	20		35	43	44	12	11

* Traps not in operation.

DAILY POLLEN AND FUNGAL SPORE COUNTS PER CUBIC METRE

GLASGOW 1983

POLLEN	MAY 8th	9th	10th	11th	12th	13th	14th
Alnus (Alder)		1					
Fraxinus (Ash)	22		1	3	2	3	16
Fagus (Beech)	2	1	1		1	5	5
Betula (Birch)	71	34	8	14	6	3	43
Rumex (Dock/Sorrel type)							
Ulmus (Elm)	2	2	2			3	1
Gramineae (Grass)			1		1		1
Corylus (Hazel)							
Aesculus (Horse Chestnut)							2
Tilia (Lime)							
Urtica (Nettle)							
Quercus (Oak)							1
Pinaceae (Pine type)							
Plantago (Plantain)							
Populus (Poplar)	2						
Compositae (Ragwort type)							
Luzula (Rush)	1						
Carex (Sedge)							
Salix (Willow)		2	9	2		6	4
Taxus (Yew type)							1
Others/Unidentified	1	5	1	2	2		4
Total pollen	101	45	23	21	12	20	80
FUNGAL SPORES							
Alternaria							
Alternaria ÷ 2							
Cladosporium							
Cladosporium ÷ 200							
TOTAL POLLEN + FUNGAL SPORES	101	45	23	21	12	20	80

DAILY POLLEN AND FUNGAL SPORE COUNTS PER CUBIC METRE

GLASGOW 1983

POLLEN	MAY 15th	16th	17th	18th	19th	20th	21st
Alnus (Alder)							
Fraxinus (Ash)	6	11		1	8	3	1
Fagus (Beech)	1	1	2	1	16	7	6
Betula (Birch)	19	16	4	7	42	36	28
Rumex (Dock/Sorrel type)							
Ulmus (Elm)							
Gramineae (Grass)	1	2				1	1
Corylus (Hazel)							
Aesculus (Horse Chestnut)							
Tilia (Lime)							
Urtica (Nettle)							
Quercus (Oak)							1
Pinaceae (Pine type)	1						1
Plantago (Plantain)							
Populus (Poplar)							
Compositae (Ragwort type)							
Luzula (Rush)							
Carex (Sedge)							1
Salix (Willow)		3	1	1	3	4	1
Taxus (Yew type)							
Others/Unidentified)	1	3	1	2		3	2
Total pollen	29	36	8	12	69	54	42
FUNGAL SPORES							
Alternaria							
Alternaria ÷ 2							
Cladosporium							
Cladosporium ÷ 200							
TOTAL POLLEN + FUNGAL SPORES	29	36	8	12	69	54	42

DAILY POLLEN AND FUNGAL SPORE COUNTS PER CUBIC METRE

GLASGOW 1983

POLLEN	MAY 22nd	23rd	24th	25th	26th	27th	28th
Alnus (Alder)							
Fraxinus (Ash)		4	12		6	3	
Fagus (Beech)	1	26	25	3	13	9	4
Betula (Birch)	21	34	42	60	98	42	8
Rumex (Dock/Sorrel type)							
Ulmus (Elm)					1		
Gramineae (Grass)			1		4	2	
Corylus (Hazel)							
Aesculus (Horse Chestnut)							
Tilia (Lime)							
Urtica (Nettle)							
Quercus (Oak)		1					
Pinaceae (Pine type)					10	1	1
Plantago (Plantain)							
Populus (Poplar)							
Compositae (Ragwort type)							
Luzula (Rush)					1		
Carex (Sedge)	1	1	1	1	2		
Salix (Willow)		1		1	2	3	2
Taxus (Yew type)							
Others/Unidentified	3	4	6	5	6	3	
Total pollen	26	71	87	70	143	63	15
FUNGAL SPORES							
Alternaria							
Alternaria ÷ 2							
Cladosporium							
Cladosporium ÷ 200							
TOTAL POLLEN + FUNGAL SPORES	26	71	87	70	143	63	15

DAILY POLLEN AND FUNGAL SPORE COUNTS PER CUBIC METRE

GLASGOW 1983

POLLEN	MAY			JUNE			
	29th	30th	31st	1st	2nd	3rd	4th
	*	*	*				
Alnus (Alder)							
Fraxinus (Ash)							
Fagus (Beech)				1	3	3	2
Betula (Birch)				1	2		3
Rumex (Dock/Sorrel type)							1
Ulmus (Elm)							
Gramineae (Grass)					1	4	1
Corylus (Hazel)							
Aesculus (Horse Chestnut)							
Tilia (Lime)							
Urtica (Nettle)							
Quercus (Oak)							
Pinaceae (Pine type)				2		3	1
Plantago (Plantain)							1
Populus (Poplar)							
Compositae (Ragwort type)							
Luzula (Rush)							
Carex (Sedge)							1
Salix (Willow)							
Taxus (Yew type)							
Others/Unidentified					2	2	9
Total pollen				4	8	12	19
FUNGAL SPORES							
Alternaria				7	7	7	7
Alternaria ÷ 2				3.5	3.5	3.5	3.5
Cladosporium				43	29	79	677
Cladosporium ÷ 200				0.21	0.14	0.39	3.3
TOTAL POLLEN + FUNGAL SPORES				7.71	11.64	15.89	25.8

" Traps not in operation

DAILY POLLEN AND FUNGAL SPORE COUNTS PER CUBIC METRE

GLASGOW 1983

POLLEN	JUNE 5th	6th	7th	8th	9th	10th	11th
	*	H	H				
Alnus (Alder)							
Fraxinus (Ash)			2				
Fagus (Beech)		5	4	3	6	1	1
Betula (Birch)		5	5	2	2	4	6
Rumex (Dock/Sorrel type)							1
Ulmus (Elm)							
Gramineae (Grass)		7	11	5	2	2	4
Corylus (Hazel)							
Aesculus (Horse Chestnut)							
Tilia (Lime)							
Urtica (Nettle)				1	5	1	
Quercus (Oak)							
Pinaceae (Pine type)			1	21	12	12	25
Plantago (Plantain)						1	
Populus (Poplar)							
Compositae (Ragwort type)							
Luzula (Rush)		3	1				
Carex (Sedge)		1	1			1	1
Salix (Willow)							
Taxus (Yew type)		2				1	
Others/Unidentified		7	5	7	4	5	3
Total pollen		30	30	39	31	28	41
FUNGAL SPORES							
Alternaria		7	7	7	7	7	7
Alternaria ÷ 2		3.5	3.5	3.5	3.5	3.5	3.5
Cladosporium		734	936	749	130	288	173
Cladosporium ÷ 200		3.6	4.6	3.7	0.6	1.4	0.8
TOTAL POLLEN + FUNGAL SPORES		37.1	38.1	46.2	35.1	32.9	45.3

* Traps not in operation

H - Hirst trap.

DAILY POLLEN AND FUNCAL SPORE COUNTS PER CUBIC METRE

GLASGOW 1983

POLLEN	JUNE 12th	13th	14th	15th	16th	17th	18th
Alnus (Alder)							
Fraxinus (Ash)							
Fagus (Beech)			1			1	
Betula (Birch)	3	6	2	1		2	
Rumex (Dock/sorrel type)	1	4	2	1	1	4	3
Ulmus (Elm)			1			2	6
Gramineae (Grass)							
Corylus (Hazel)	9	3	1	1	1	11	22
Aesculus (Horse Chestnut)							
Tilia (Lime)							
Urtica (Nettle)							
Quercus (Oak)		1				1	8
Pinaceae		1					
Plantago (Plantain)	14	45	10	8		7	81
Populus (Poplar)	1		1		2		3
Compositae (Ragwort type)							
Luzula (Rush)							1
Carex (Sedge)							
Salix (Willow)		2		2		1	1
Taxus (Yew type)							
Others/Unidentified	5	17	2	3	2	2	5
Total pollen	33	79	20	16	6	31	130
FUNGAL SPORES							
Alternaria	7	7	7	7	7		7
Alternaria ÷ 2	3.5	3.5	3.5	3.5	3.5		3.5
Cladosporium	173	202	72	29	144		1490
Cladosporium ÷ 200	0.8	1.0	0.3	0.1	0.7		7.4
TOTAL POLLEN + FUNGAL SPORES	37.3	83.5	23.8	19.6	10.2		140.9

DAILY POLLEN AND FUNGAL SPORE COUNTS PER CUBIC METRE

GLASGOW 1983

POLLEN	JUNE 19th	20th	21st	22nd	23rd	24th	25th
Alnus (Alder)							
Fraxinus (Ash)							
Fagus (Beech)		1	1				
Betula (Birch)	1	1			1		
Rumex (Dock/sorrel type)	3	8	1	4		6	11
Ulmus (Elm)							
Gramineae (Grass)	37	31	9	45	8	130	115
Corylus (Hazel)							
Aesculus (Horse Chestnut)							
Tilia (Lime)							
Urtica (Nettle)	10	2	1	4	2	28	7
Quercus (Oak)							
Pinaceae (Pine type)	41	79	7	13	24	30	6
Plantago (Plantain)	3	2	1	2	1	1	2
Populus (Poplar)							
Compositae (Ragwort type)		1					
Luzula (Rush)							
Carex (Sedge)	4			2			
Salix (Willow)	1	8	2				
Taxus (Yew type)							
Others/Unidentified	6	7	1	3		5	6
Total pollen	106	133	23	73	36	200	147
FUNGAL SPORES							
Alternaria	22	7	7	7	7	7	7
Alternaria ÷ 2	11	3.5	3.5	3.5	3.5	3.5	3.5
Cladosporium	1440	705	720	578	331	1318	540
Cladosporium ÷ 200	7.2	3.5	3.6	2.8	1.6	6.5	2.7
TOTAL POLLEN + FUNGAL SPORES	124.2	140	30.1	79.3	41.1	210	153.2

DAILY POLLEN AND FUNGAL SPORE COUNTS PER CUBIC METRE

GLASGOW 1983

POLLEN	JUNE 26th	27th	28th	29th	30th	JULY 1st	2nd
Alnus (Alder)							
Fraxinus (Ash)							
Fagus (Beech)						1	
Betula (Birch)							
Rumex (Dock/Sorrel type)	1	1		7	1	1	
Ulmus (Elm)							
Gramineae (Grass)	23	31	2	32	95	15	26
Corylus (Hazel)							
Aesculus (Horse Chestnut)							
Tilia (Lime)							
Urtica (Nettle)	8	8		7	6	5	7
Quercus (Oak)							
Pinaceae (Pine type)	5	1	3		3	3	3
Plantago (Plantain)		2					
Populus (Poplar)							
Compositae (Ragwort type)							
Luzula (Rush)							
Carex (Sedge)	1						
Salix (Willow)	1		1				
Taxus (Yew type)							
Others/Unidentified)	3	11	2	2	4	8	6
Total pollen	42	54	8	48	109	33	42
FUNGAL SPORES							
Alternaria	7	7	7	7	7	7	7
Alternaria ÷ 2	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Cladosporium	144	197	950	419	1771	900	785
Cladosporium ÷ 200	0.7	0.9	4.7	2.0	8.8	4.5	3.9
TOTAL POLLEN + FUNGAL SPORES	46.2	58.4	16.2	53.5	121.3	41	49.4

DAILY POLLEN AND FUNGAL SPORE COUNTS PER CUBIC METRE

GLASGOW 1983

POLLEN	3rd	4th H	5th	JULY 6th	7th	8th	9th
Alnus (Alder)							
Fraxinus (Ash)							
Fagus (Beech)							
Betula (Birch)		1					
Rumex (Dock/Sorrel type)	4	3	17	10	14	3	8
Ulmus (Elm)							
Gramineae (Grass)	72	38	578	361	318	276	347
Corylus (Hazel)							
Aesculus (Horse Chestnut)							
Tilia (Lime)							
Urtica (Nettle)	9	13	139	101	97	55	91
Quercus (Oak)							
Pinaceae (Pine type)				1		4	1
Plantago (Plantain)			2	1	4	1	
Populus (Poplar)							
Compositae (Ragwort type)							
Luzula (Rush)							
Carex (Sedge)							
Salix (Willow)				3			
Taxus (Yew type)							
Others/Unidentified	15	4	13	6	6	3	9
Total pollen	100	59	749	483	439	342	456
FUNGAL SPORES							
Alternaria	7	7	7	7	7	7	7
Alternaria ÷ 2	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Cladosporium	547	1584	6106	9070	5299	11203	8410
Cladosporium ÷ 200	2.7	7.9	30	45	26	56	42
TOTAL POLLEN + FUNGAL SPORES	106.2	70.4	782.5	531.5	468.5	401.5	501.5

H - Hirst trap.

DAILY POLLEN AND FUNGAL SPORE COUNTS PER CUBIC METRE

GLASGOW 1983

POLLEN	JULY 10th	11th	12th	13th	14th	15th	16th
Alnus (Alder)							
Fraxinus (Ash)							
Fagus (Beech)							
Betula (Brich)					2	1	1
Rumex (Dock/sorrel type)	11	26	4	12	6	2	4
Ulmus (Elm)							
Gramineae (Grass)	108	500	222	191	100	42	335
Corylus (Hazel)							
Aesculus (Horse Chestnut)							
Tilia (Lime)							
Urtica (Nettle)	39	237	48	57	22	15	74
Quercus (Oak)							
Pinaceae (Pine type)	1			2			
Plantago (Plantain)	1	2	2	2	2		
Populus (Poplar)							
Compositae (Ragwort type)							
Luzula (Rush)	3		1	1	5		2
Carex (Sedge)							
Salix (Willow)		1					3
Taxus (Yew type)							
Others/Unidentified	5	4	3	10	11	13	11
Total pollen	168	770	280	275	148	73	430
FUNGAL SPORES							
Alternaria	7	14	29	14	29	7	14
Alternaria ÷ 2	3.5	7	14	7	14	3.5	7
Cladosporium	4124	18648	6120	10628	1285	1224	5104
Cladosporium ÷ 200	20	93	30	53	6.4	6.1	25.5
TOTAL POLLEN + FUNGAL SPORES	191.5	870	324	335	168.4	82.6	462.5

DAILY POLLEN AND FUNGAL SPORE COUNTS PER CUBIC METRE

GLASGOW 1983

POLLEN	JULY 17th	18th *	19th	20th	21st	22nd	23rd
Alnus (Alder)							
Fraxinus (Ash)							
Fagus (Beech)							
Betula (Birch)							
Rumex (Dock/Sorrel type)	1		2		1	3	5
Ulmus (Elm)							
Gramineae (Grass)	155		49	48	346	477	233
Corylus (Hazel)							
Aesculus (Horse Chestnut)							
Tilia (Lime)			1	1	1		
Urtica (Nettle)	37		11	11	23	79	45
Quercus (Oak)							
Pinaceae (Pine type)			1				1
Plantago (Plantain)	2		1	1	2		2
Populus (Poplar)							
Compositae (Ragwort type)					1		
Luzula (Rush)						8	
Carex (Sedge)							
Salix (Willow)							
Taxus (Yew type)							
Others/Unidentified	13			5	7	14	9
Total pollen	208		65	65	381	581	295

FUNGAL SPORES	17th	18th	19th	20th	21st	22nd	23rd
Alternaria	22		14	14	14		86
Alternaria ÷ 2	11		7	7	7		43
Cladosporium	3874		1166	1743	3945		10642
Cladosporium ÷ 200	19		5.8	8.7	19		53
TOTAL POLLEN + FUNGAL SPORES	238		77.8	80.7	407		391

* Traps not in operation.

DAILY POLLEN AND FUNGAL SPORE COUNTS PER CUBIC METRE

GLASGOW 1983

POLLEN	JULY 24th	25th	26th	27th	28th	29th	30th
Alnus (Alder)							
Fraxinus (Ash)							
Fagus (Beech)							
Betula (Birch)							
Rumex (Dock/sorrel type)	1	1	1	1		1	
Ulmus (Elm)							
Gramineae (Grass)	74	54	11	122	30	33	35
Corylus (Hazel)							
Aesculus (Horse Chestnut)							
Tilia (Lime)			1		1		
Urtica (nettle)	23	18	12	4	2	1	6
Quercus (Oak)							
Pinaceae (Pine type)							
Plantago (Plantain)		2	1		1		
Populus (Poplar)							
Compositae (Ragwort type)							
Luzula (Rush)		1	2	4	1		
Carex (Sedge)							
Saliz (Willow)							
Taxus (Yew type)							
Others/Unidentified	1	4	1	5	5	5	2
Total pollen	99	80	29	136	40	40	43
FUNGAL SPORES							
Alternaria	14	14	14	14	14	14	29
Alternaria ÷ 2	7	7	7				
Cladosporium	4025	4133	18720	9601	4565	2376	9115
Cladosporium ÷ 200	20	20	93	48	22	11	45
TOTAL POLLEN + FUNGAL SPORES	126	107	129	191	69	58	107

DAILY POLLEN AND FUNGAL SPORE COUNTS PER CUBIC METRE

GLASGOW 1983

POLLEN	JULY 31st	AUGUST 1st	2nd	3rd	4th	5th	6th
Alnus (Alder)							
Fraxinus (Ash)							
Fagus (Beech)							
Betula (Birch)							
Rumex (Dock/Sorrel type)	2		1				1
Ulmus (Elm)							
Gramineae (Grass)	14	16	11	15	9	62	38
Corylus (Hazel)							
Aesculus (Horse Chestnut)							
Tilia (Lime)		3	1	1			
Urtica (Nettle)	1		1	2	5	2	1
Quercus (Oak)							
Pinaceae (Pine type)					1		
Plantago (Plantain)				2		1	
Populus (Poplar)							
Compositae (Ragwort type)		1	3	2	1	2	1
Luzula (Rush)				1	1		
Carex (Sedge)							
Salix (Willow)							
Taxus (Yew type)							
Others/Unidentified	1	4	2	4	1	1	2
Total pollen	18	24	19	27	18	68	43

FUNGAL SPORES							
Alternaria	7	14	14	14	7	7	7
Alternaria ÷ 2	3.5	7	7	7	3.5	3.5	3.5
Cladosporium	2254	2088	1584	3377	5558	4377	4298
Cladosporium ÷ 200	11	10	7.9	16	27	21	21
TOTAL POLLEN + FUNGAL SPORES	32.5	41	33.9	50	48.5	92.5	67.5

DAILY POLLEN AND FUNGAL SPORE COUNTS PER CUBIC METRE

GLASGOW 1983

POLLEN	AUGUST 7th	8th	9th	10th	11th	12th	13th
Alnus (Alder)							
Fraxinus (Ash)							
Fagus (Beech)							
Betula (Birch)					1		
Rumex (Dock/sorrel type)			1				
Ulmus (Elm)							
Gramineae (Grass)	88	69	62	19	8	15	4
Corylus (Hazel)							
Aesculus (Horse Chestnut)							
Tilia (Lime)		1					
Urtica (Nettle)	20	21	9	9			1
Quercus (Oak)							
Pinaceae (Pine type)	1						
Plantago (Plantain)	2	1			1		
Populus (Poplar)							
Compositae (Ragwort type)	2	1	2	4			1
Luzula (Rush)	1		1	8		1	
Carex (Sedge)							
Salix (Willow)							
Taxus (Yew type)							
Others/Unidentified)	3	2	11	2	2	1	
Total pollen	117	95	86	42	12	17	6
FUNGAL SPORES							
Alternaria	65	29	29	14	14	29	14
Alternaria ÷ 2	32	14	14	7	7	14	7
Cladosporium	15336	14530	14054	6652	1757	3168	1656
Cladosporium ÷ 200	76	72	70	33	8.7	15	8.2
TOTAL POLLEN + FUNGAL SPORES	225	181	170	82	27.7	46	21.2

DAILY POLLEN AND FUNGAL SPORE COUNTS PER CUBIC METRE

GLASGOW 1983

POLLEN	AUGUST 14th	15th	16th	17th	18th	19th	20th
Alnus (Alder)							
Fraxinus (Ash)							
Fagus (Beech)							
Betula (Birch)							
Rumex (Dock/Sorrel type)				1			
Ulmus (Elm)							
Gramineae (Grass)	49	4	4	17	14	39	12
Corylus (Hazel)							
Aesculus (Horse Chestnut)							
Tilia (Lime)		1					
Urtica (Nettle)	19	4	4	11	22	81	24
Quercus (Oak)							
Pinaceae (Pine type)	1				1		
Plantago (Plantain)		2					
Populus (Poplar)							
Compositae (Ragwort type)	1	2	2	2		4	1
Luzula (Rush)	2	4	2			6	
Carex (Sedge)							
Salix (Willow)							
Taxus (Yew type)							
Others/Unidentified	6	2	1	1	1	4	4
Total pollen	72	19	13	32	38	134	41
FUNGAL SPORES							
Alternaria	137	14	14	58	58	245	216
Alternaria ÷ 2	68	7	7	29	29	122	103
Cladosporium	10700	3082	3297	5212	18288	54670	37677
Cladosporium ÷ 200	53	15	16	26	91	273	188
TOTAL POLLEN + FUNGAL SPORES	193	41	36	87	158	529	332

DAILY POLLEN AND FUNGAL SPORE COUNTS PER CUBIC METRE

GLASGOW 1983

POLLEN	AUGUST 21st	22nd	23rd	24th	25th	26th	27th
Alnus (Alder)							
Fraxinus (Ash)							
Fagus (Beech)							
Betula (Birch)	1						
Rumex (Dock/Sorrel type)							
Ulmus (Elm)							
Gramineae (Grass)	7	8		7	7	4	13
Corylus (Hazel)							
Aesculus (Horse Chestnut)							
Tilia (Lime)							1
Urtica (Nettle)	27	8	2	19	14	17	15
Quercus (Oak)							
Pinaceae (Pine type)							1
Plantago (Plantain)				1			
Populus (Poplar)							
Compositae (Ragwort type)	2	3		2	1	1	1
Luzula (Rush)		1			2		
Carex (Sedge)							
Salix (Willow)							
Taxus (Yew type)						1	
Others/Unidentified	2	1		1		4	7
Total pollen	39	21	2	30	24	27	38

FUNGAL SPORES	21st	22nd	23rd	24th	25th	26th	27th
Alternaria	303	87	7	29	101	173	396
Alternaria ÷ 2	151	43	3.5	14	50	86	198
Cladosporium	9749	40594	2981	32082	16071	19894	20254
Cladosporium ÷ 200	48	202	14	160	80	99	101
TOTAL POLLEN + FUNGAL SPORES	238	266	19.5	204	154	212	337

DAILY POLLEN AND FUNGAL SPORE COUNTS PER CUBIC METRE

GLASGOW 1983

POLLEN	AUGUST 28th	29th	30th	31st	SEPTEMBER 1st *	2nd *	3rd *
Alnus (Alder)							
Fraxinus (Ash)							
Fagus (Beech)							
Betula (Birch)							
Rumex (Dock/Sorrel type)							
Ulmus (Elm)							
Gramineae (Grass)	1	8	6	1			
Corylus (Hazel)							
Aesculus (Horse Chestnut)							
Tilia (Lime)							
Urtica (Nettle)	5	26	16	13			
Quercus (Oak)							
Pinaceae (Pine type)							
Plantago (Plantain)			1				
Populus (Poplar)							
Compositae (Ragwort type)							
Luzula (Rush)				1			
Carex (Sedge)							
Salix (Willow)							
Taxus (Yew type)							
Others/Unidentified	1	1	3	1			
Total pollen	7	35	26	16			
FUNGAL SPORES							
Alternaria	173	288	187	43			
Alternaria ÷ 2	86	144	93	21			
Cladosporium	10994	11751	5069	2276			
Cladosporium ÷ 200	54	58	25	11			
TOTAL POLLEN + FUNGAL SPORES	147	237	144	48			

* Traps not in operation.

APPENDIX V PHOTOGRAPHIC DATA

PHOTOGRAPHIC NOTES

The photomicrographs were obtained using a Leitz Wetzlar Dialux 20EB microscope with a x50 oil immersion objective and a x10 photo eyepiece. The attached camera was a Wild with automatic exposure control and the film was Kodak Ektachrome 160ASA (3,000K).