Incidence of atmospheric pollen in the Pretoria-Witwatersrand-Vereeniging region during 1987/1988

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Summary

Atmospheric pollen and spores have been monitored continuously in the Pretoria-Witwatersrand-Vereeniging region (PWV) since 1987. Two Burkard 7-day recording traps were used in Johannesburg and Pretoria, and 11 gravity samplers were installed at various sites in the PWV. An analysis of the pollen component and pollen calendars average data for 1987 and 1988 are presented. Grass pollen was the most significant contributor in absolute and relative terms, comprising 52% of total pollen. The season peaked between October and March, but grass pollen was found throughout the year. Pollen of Northern Hemisphere trees was abundant, relative to that of indigenous trees. The flowering season for these exotics was very short and intense, possibly due to the short spring season. Seasonal taxa started flowering earlier in Pretoria than in Johannesburg. Herbaceous taxa were well represented in the atmospheric sample. The major contributor was the daisy family. The greatest proportion of pollen, 58,8%, was non-seasonal. Species in this category flower consecutively throughout the year. Of the taxa, 28,4% were spring-flowering. The allergenicity of pollen encountered in the atmospheric sample is discussed.

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The elegant aerobiological studies of Ordman[1,2] have offered the only published South African data in the field of atmospheric pollen and spores to date. It is highly likely that these have changed considerably since his surveys were undertaken. Not only are there the effects of industrialisation and changing land-use patterns, but also the results of altered gardening fashions. This article focuses on pollen of the Pretoria-Witwatersrand-Vereeniging (PWV) metropolitan area.

Pollen is recognised world-wide as one of the major causes of upper respiratory tract allergy.[1,3,4] It is broadly divided into two categories: entomophilous (insect-dispersed) and anemophilous (wind-dispersed). The former is generally larger, heavier, stickier and produced in smaller quantities than the latter. Pollen ranges in size from about 7 μm to 100 μm, with a median of around 20 μm. It is produced in vast quantities. For example, Traverse[5] calculated that 1 ha of maize (*Zea mays*) could produce about 500 litres of pollen per season. Most plants flower seasonally so that related allergies are also seasonal.

Materials and methods

From January 1987 continuous atmospheric sampling has been conducted in the PWV area. Two sampling methods were used. Simple gravity samplers were located at 11 sites distributed throughout the study area. These trapped pollen on petroleum-jelly-coated microscope slides. Two Burkard samplers were installed at 2 of these sites, 1 at the South African Council for Scientific and Industrial Research (CSIR) in Pretoria and 1 at the research station of the University of the Witwatersrand at Frankenwald in Johannesburg. The latter two localities comprise several hectares of natural vegetation surrounded by suburban gardens. Here, cultivated taxa include annuals and trees predominantly of the Northern Hemisphere. The vegetation across the range of sites is sufficiently varied to ensure that the entire spectrum of taxa commonly found in the study area was sampled.

Slides were collected weekly. The petroleum-jelly was dissolved and the residue was acetolysed following the method of

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Faegri and Iverson.[6] Pollen was stained with safranine and water mounts were read at a magnification of 400, until 250 pollen grains had been counted. During winter months such counts were not possible.

The Burkard Seven-Day Recording Volumetric Spore Trap is extensively used abroad[3,4,7,8] and permits standardised comparisons to be made internationally. This apparatus samples air as a function of time, consistently into the wind. Particles are aspirated through a narrow orifice at 10 l/minute, and impacted onto petroleum-jelly-coated tape. The tape is attached to a revolving drum which completes a revolution in 7 days, turning at 2 mm/h.

At the end of each week throughout the sampling period the strip was cut into daily sections, stained with Safranine and mounted on microscope slides. Daily, 3 longitudinal bands each 0,33 mm wide were scanned to provide a direct count of the aerospora contained in 1 m^3 of air.[4] Strips were read at a magnification of 400. All instruments were erected to sample air 2 m above ground.

Results

A pollen calendar was constructed for the PWV by combining data from all samplers for 1987 and 1988 (Fig. 1). The entire flowering period is shown for each taxon from the first occurrence of atmospheric pollen. Data from the Burkard samplers were averaged to show relative percentages of the most common taxa. The allergenicity of taxa is indicated where this is known.

Weekly data obtained over the 2-year study period from the 11 gravity samplers were averaged to show annual pollen distribution (Fig. 2). Pollen categories are traditionally used by allergists to differentiate between percentages of grasses, trees and a group termed 'weeds' for convenience.

Discussion

The dose-response concentration threshold for pollen is not well defined in published reports. The information that is available refers to Northern Hemisphere conditions and taxa. Presumably it is a highly individualistic measurement and, conceivably, prevailing atmospheric conditions may either exacerbate or alleviate symptoms.

Davies and Smith[9] considered 50 gr/m^3 to be the limit for severe discomfort in individuals sensitised to grass pollen. This cut-off point is frequently quoted.[7,10,11] In 1976 Fuckerieder[12] reported that 25 gr/m^3 would ellicit a response in 50% of grass-sensitive patients, and that 50 gr/m^3 would do the same in 100% of such patients. Viander and Koivikko[13] found

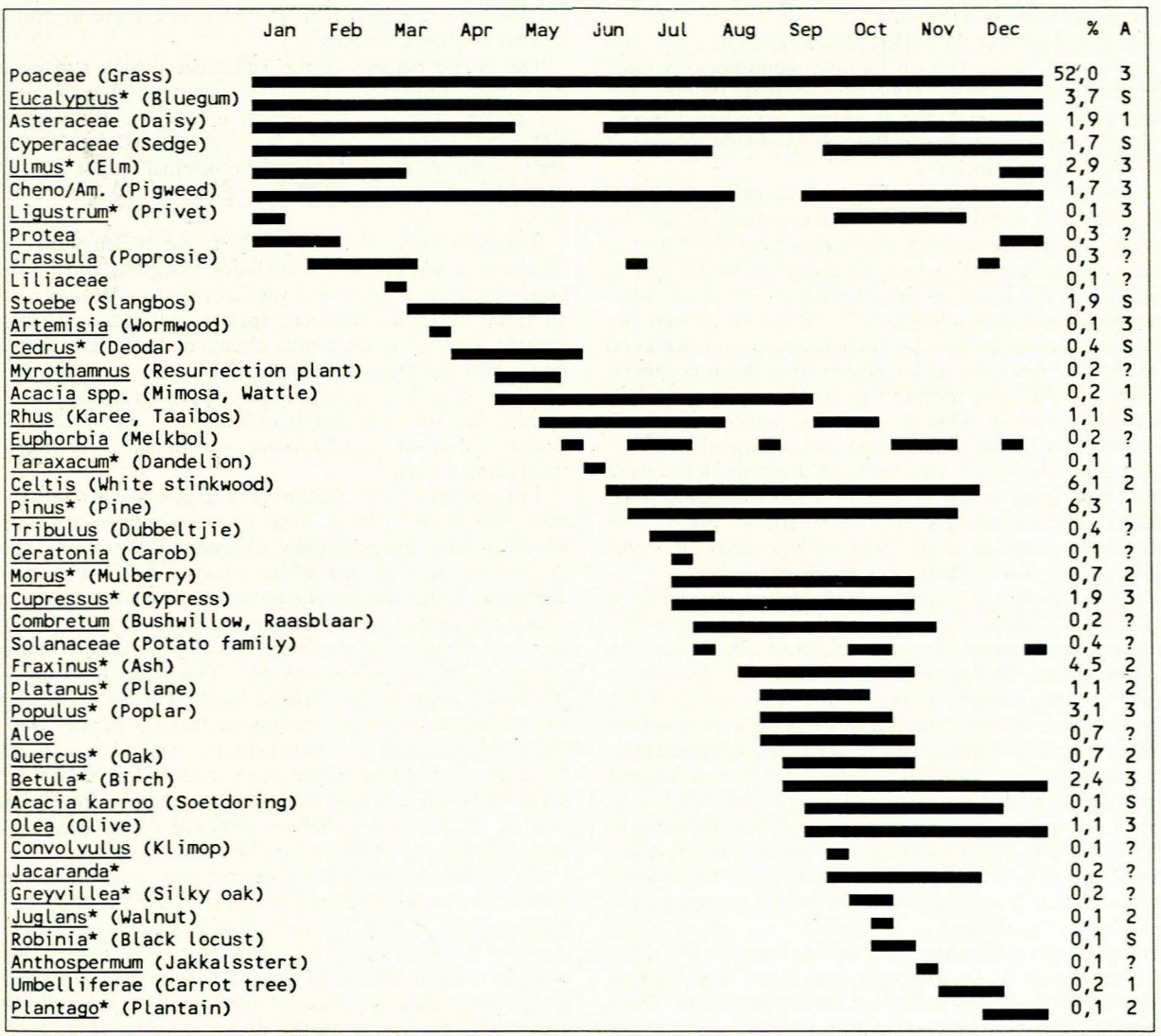

Fig. 1. Pollen calendar for PWV (1987/1988) (* = exotics; % = mean annual percentage; A = allergenicity, where 3 = major, 2 = moderate, 1 = minor, S = suspect, ? = unknown).

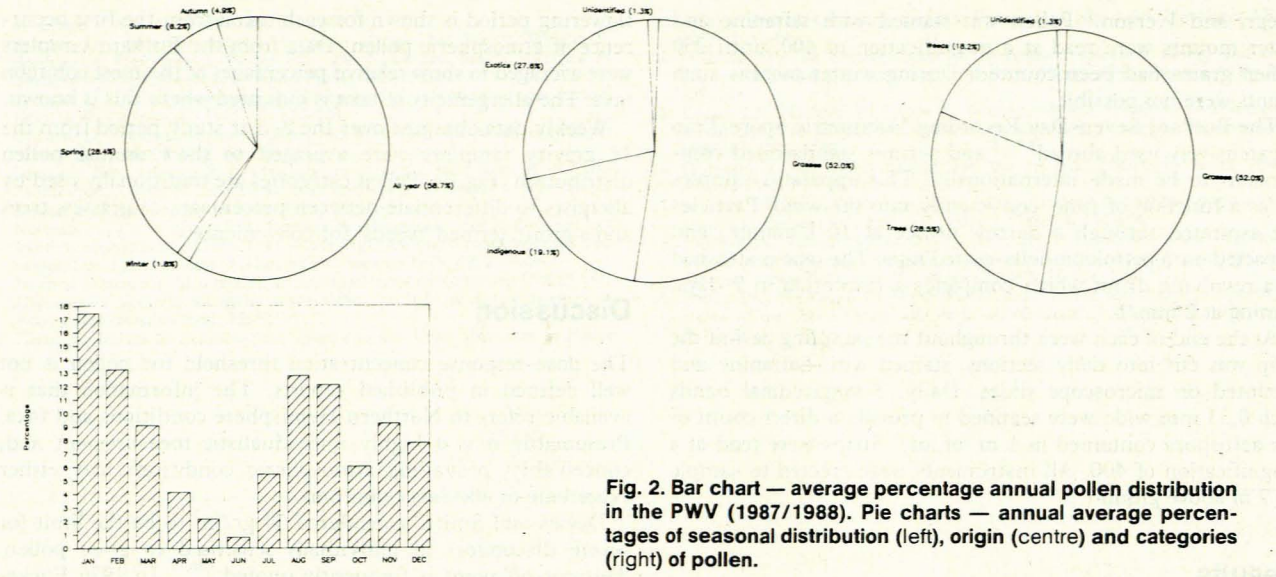

Fig. 2. Bar chart — average percentage annual pollen distribution in the PWV (1987/1988). Pie charts — annual average percentages of seasonal distribution (left), **origin** (centre) **and categories** (right) **of pollen.**

that birch-sensitive patients would react when this pollen reached 200 gr/m^3. It seems therefore that a general rule of thumb does not apply and that plants differ in the amount of pollen that will provoke a response.

The start and close of the pollen season varied by a few days from site to site, depending on localised conditions. A more regular variation was found regionally between Pretoria and Johannesburg. In general, the flowering period of seasonal taxa started somewhat earlier in Pretoria, probably because of slightly higher temperatures.

The most significant input to the pollen calendar was that of the anemophilous grasses, with a regional average of 52% for the study period. The highest daily grass count (210 gr/m^3) was measured in Johannesburg on 5 January 1988. This taxon is ubiquitously recognised as one of the most common causes of seasonal respiratory allergy.[2,4,14,15] Although grasses are seasonal, the various species flower consecutively, so that at no time in the year was grass pollen absent from the atmosphere. It is therefore probably incorrect to consider grass a strictly seasonal phenomenon. This is especially pertinent, since it appears that closely related taxa share cross-allergenicity.[14,16,17] However, published reports refer only to Northern Hemisphere species. I have been unable to find documentation concerning the status of the vast suite of South African grasses. By default, and because of likely shared allergenicity, it seems logical to assume that our grass species are all suspect.

Since grass pollen is morphologically indistinguishable at species level, it is impossible to specify which grasses contribute to an atmospheric sample. At best, inferences can be made by field observations. The greatest contribution was doubtlessly made by common thatch grass (*Hyparrhenia hirta*) which constitutes about 80% of grass in the study area. In addition, the anthers (pollen-bearing organs) are borne approximately 1,5 m above ground, well-exposed to wind. Bermuda grass (*Cynodon dactylon*) and the exotic kikuyu (*Pennisetum clandestinum*) are common on lawns and sports fields. In terms of percentage contribution these short varieties probably featured minimally and only in very localised situations. Pampas grass (*Cortaderia selloana*), planted to stabilise goldmine dumps, was also only locally significant.

The anemophilous Northern Hemisphere trees made a significant contribution to the atmospheric sample. The regional average was 23,6% of total pollen for the 2-year period. These trees are all seasonal, with the majority flowering over a very abbreviated spring season. The highest pollen count was recorded for the poplar (*Populus* spp.), with 233 gr/m^3 measured in Johannesburg on 2 September 1987. However, the regional average of only 3,13% for 1987/1988 reflects the short and intense pollinating season. The most common of the poplars is the naturalised grey poplar (*P. canescens*), found in profusion in vleis and along streams.

The poplar belongs to the Salicaceae, which also includes the willow (*Salix* spp.). This taxon was noticeably absent from the pollen calendar. The reason is that the many weeping willows (*S. babylonica*) seen along rivers throughout the country are thought all to be clones of the original female tree introduced into the country.[18] Thus no pollen of this species will be found.

Relatively large amounts of Myrtaceae pollen were found. This entomophilous family includes bluegums and flowering gums (*Eucalyptus* spp.) and various myrtles (*Melaleuca* spp.), all from Australia. Different species pollinate in successive months. Pollen was frequently clumped, attesting to its stickiness. Also Australian, entomophilous and recorded in fair numbers were the mimosas (*Acacia* spp.). Ordman[2] was of the opinion that the entomophily of bluegums, acacias (both indigenous and exotic) and *Jacaranda mimosifolia* precluded them from being a hazard.

The paucity of information on allergenicity extends to our other indigenous plants. Due to cross-antigenicity, species which do occur are potentially allergenic. For example, species of *Celtis* related to our white stinkwood (*C. africana*) are allergenic.[19] Our indigenous olive (*Olea europeae* subsp. *africana*), the exotic ash (*Fraxinus* spp.) and privet (*Ligustrum* spp.) are members of the family Oleaceae, a serious source of allergy in Mediterranean regions.[15] The karee (*Rhus* spp.) and the exotic pepper tree (*Schinus molle*) belong to the family Anacardiaceae. Ordman[2] mentioned that the pepper tree was often incriminated but never found conclusively to cause hayfever. Few pollen grains were found, but pollen of the karee was abundant. Sap from this tree causes contact dermatitis (L. E. Davidson 1989 — personal communication), so that antigens may be present in the pollen as well.

Of interest in the pollen spectrum was the considerable presence of herbaceous taxa — so-called 'weeds' (Fig. 2). The majority are, in fact, indigenous veld flowers mostly of the daisy family (Asteraceae), e.g. slangbos (*Stoebe vulgaris*), wormwood or wildeals (*Artemisia* spp.) and everlastings (*Helichrysum* spp.). The latter and several other daisies are collectively grouped as Asteraceae in the pollen calendar (Fig. 1), since their pollen is morphologically difficult to differentiate. The family also includes many garden glowers, e.g. asters, calen-

dulas, chrysanthemums, and traditional weeds, e.g. blackjack (*Bidens pilosa*), khakibos (*Tagetes minuta*), dandelion (*Taraxacum* spp.) and cosmos (*Cosmos bipinnata*).

Chenopodiaceae/Amaranthaceae occurred frequently. Included are both indigenous and exotic plants, ranging from weeds of the pigweed and goosefoot variety to garden plants such as Joseph's coat (*Amaranthus tricolor*). Representatives are to be found in flower practically throughout the year.

All other taxa in the weed category were found only incidentally and in small numbers. As a group, however, the weeds constituted 18,2% of total annual pollen output (Fig. 2). They are predominantly entomophilous and seasonal, but many species have a very long flowering season. Moreover, in the daisy family the flowering seasons of various species overlap, so that the effective season is almost continuous.

Small particle fractions

It seems that a fair amount of uncertainty surrounds entomophilous pollen and its role in allergy. Two limitations are thought to pertain. Firstly, they are generally considered not to occur in the atmosphere in appreciable numbers. Secondly, they are considered too large to pass into the smaller airways. The findings of this project do not support the first contention. With regard to the second point, recent reference in a published report highlights a factor that may be pertinent.

Solomon[20] reviewed several apparently anomolous studies where pollinosis associated with identifiable pollen types did not match incidence of atmospheric pollen. Symptoms occurred either before pollen was recorded or the allergy persisted beyond the pollen season. Similar observations have been recorded by Spieksma *et al.*[4] In explanation, Solomon[20] reported evidence of the association of pollen allergens with small particles in the aerosol range. Such allergen particles may elute from pollen grains before their dispersal. It is conceivable that proteins of entomophilous plants can similarly become airborne. If they contain antigens, the size and dispersal mode of the intact grains then become irrelevant.

Conclusion

The high percentage of Northern Hemisphere taxa combined with the large numbers of grasses, augur poorly for allergy sufferers in the region. In addition, the seasonal distribution of atmospheric pollen is unfavourable. Of the annual total averaged pollen for 2 years for the Pretoria/Johannesburg area, 58,8% can be considered as non-seasonal, being present throughout the year.

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