

REGIONAL-SPECIFIC POLLEN AND FUNGAL-SPORE ALLERGENS IN SOUTH AFRICA

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A TRIBUTE TO PAUL POTTER

Paul Potter shared work space with me when he took up his position as the first registrar appointed to the Allergy Department at the Red Cross War Memorial Children's Hospital. He was immediately intrigued by pollen sampling and centred his project around the daily pollen count and the application of the aeroallergens to the diagnosis and treatment of the allergy clinic patients. His interest in aerobiology did not wane when he moved to Groote Schuur where he played a major role in the publication of aerobiology findings. Paul included me in the design and preparation of a Cape Town Allergy Congress workshop and he arranged for congress delegates who wanted to learn how to identify aeroallergens to spend time in my laboratory. He coerced me into co-editing a textbook: Pollen and Mould Allergens in South Africa. When I left the Red Cross Hospital he arranged funding so that pollen sampling could continue under the auspices of his Allergy Diagnostic and Clinical Services Unit at the University of Cape Town Lung Institute. A long pollen data set had accumulated from the ground-breaking work of Eugene Weinberg, followed by later pollen monitoring, so with Paul's support and encouragement I am documenting a 30-year history of the Aerobiology of the Western Cape. He has invested countless hours in discussions and debates concerning this project. His energy and enthusiasm have been inspiring and have motivated me to turn a job into a lifelong career.

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ABSTRACT:

The selection of skin-prick and ImmunoCAP radioallergosorbent test (RAST) testing panels for tree, grass, weed and fungal-spore aeroallergens is an easier task when pollen and fungal-spore levels for the particular geographic area are accessible to the allergologist. In South Africa, long-term pollen and fungal-spore level information exists for the Western Cape, where several areas in the greater Cape Town Metropole have been monitored. In Gauteng, sporadic pollen-sampling studies have been carried out in the vicinity of Johannesburg and Pretoria. In KwaZulu-Natal, short-term studies have sampled airspora in Durban and Richards Bay, and a three-year pollen and fungal-spore assessment has been conducted in Secunda, Mpumalanga. These findings are examined in relation to the choice of allergen-testing panels. There are vast unsampled areas of South Africa – containing major cities – where the major pollen allergens and their levels in the atmosphere are not known and, in addition, there is great variation in climate across these areas. Climate dictates the vegetation biome as well as

the flowering times of allergenic plants. Guidelines for the selection of allergen-testing panels in clinical settings, where no pollen monitoring exists, are discussed.

HISTORICAL BACKGROUND

David Ordman, who pioneered the study of environmental aeroallergens in South Africa from 1945 to 1972, outlined many of the environmental problems relating to aeroallergens in different regions of southern Africa (South Africa, Zimbabwe and Namibia) providing a solid research base.¹⁻⁶ The discovery of the house-dust mite (HDM) provided evidence for his observation that house dust at the coast was more allergenic than dust from houses inland, as HDM prefer humid conditions.⁵ Ordman's examination of the incidence of allergic disease in population samples in urban vs rural environments in the same ethnic group were illuminating.⁵ Evidence-based studies in the second half of the 20th century confirmed his theories.^{7,8} His examination of the allergenicity and flowering times of grasses, such as *Hyperbentia hirta*, which he noted as 'the dominant grass found east of the Drakensberg escarpment' or *Themeda triandra*, found west of the Drakensberg mountains,² were expanded by Potter and Prescott.⁹ They demonstrated IgE activity reactivity in >90% of patients tested for the

African grass *Pennisetum clandestinum* (kikuyu), which was introduced from East Africa. Their work was expanded to study the indigenous grass, *Stenotaphrum secundatum* (buffalo grass), which grows in many coastal areas on the east coast of South Africa, and *Eragrostis curvula*, a pasture grass that is widespread in the country. Ordman identified allergenic trees such as *Cupressus* (cypress) and *Schinus molle* (Brazilian pepper tree), and his understanding of the influence of climate on respiratory disease established the groundwork for aerobiology and the identification of specific pollen and fungal-spore allergens in South Africa.

WESTERN CAPE POLLEN-SAMPLING STUDIES

Emeritus Professor Eugene Weinberg, who was head of the Allergy Clinic at the Red Cross War Memorial Children's Hospital for three decades, reintroduced pollen sampling to the Western Cape in 1973. He established a pollen and fungal-spore monitoring programme at the School of Child and Adolescent Health, Department of Paediatrics, University of Cape Town. This monitoring system was set up to identify the allergenic pollen and fungal spores in the ambient air, and to measure the levels and assess the seasonality of the aeroallergens triggering symptoms in his allergic patients. The range of pollens and fungal spores that the unit has been able to identify is shown in Table I. On his retirement, the pollen-sampling programme was supported by Professor Paul Potter, head of the Allergy Diagnostic and Clinical Research Unit at the University of Cape Town Lung Institute, using a volumetric spore trap. This spore trap was initially sited at the Land Survey Building in Mowbray and later at the South African Astronomical Observatory, in the suburb which bears its name.

THE RONDEBOSCH SAMPLING SITE (1973–2007)

This aeroallergen-monitoring programme was set up at the Red Cross War Memorial Children's Hospital in Rondebosch primarily for the benefit of the patients attending the Allergy Clinic at the hospital. The findings were, however, also shared with the other academic hospitals in the Western Cape.

RONDEBOSCH POLLEN LEVELS

Grass was found to be the major aeroallergen in this area, which had a short tree season (August–October). The major tree-pollen loads were found to be *Platanus* (plane) and *Quercus* (oak) with low levels of *Ulmus* (elm), *Myrtus* (eucalyptus), *Olea* (olive), *Cupressus* (cypress), *Pinus* (pine) and *Casuarina* pine. There were occasional low counts for *Acacia*, *Betula* (birch), *Populus* (poplar) and *Salix* (willow). Weed-pollen levels were rarely significant and included: *Plantago* (English plantain), *Myrica* (sweet gale), *Chenopod* (goosefoot), *Urtica* (nettle) and *Taraxacum* (dandelion). Very low levels were recorded for fern spores (*Polypodium*), *Rumex* (Polygonaceae) and *Oenothera* (evening primrose). The typical Cape fynbos was represented by low background counts of

TABLE I: POLLEN GRAINS & FUNGAL SPORES IDENTIFIED BY LIGHT MICROSCOPY

POLLEN GRAINS		FUNGAL SPORES
Cyperaceae	Ericaceae	<i>Alternaria</i>
Poaceae	Euphorbiaceae	<i>Ascospores</i>
Restionaceae	Iridaceae	<i>Aspergillus/Penicillium</i>
<i>Typhus</i>	Juncaceae	<i>Basidiospores</i>
<i>Acacia</i>	Liliaceae	<i>Bispora</i>
<i>Betula</i>	Loranthaceae	<i>Chaetomium</i>
Cupressaceae	Malvaceae	<i>Cladosporium</i>
Hippocastinaceae	Myricaceae	<i>Curvularia</i>
Moraceae	Oenotheraceae	<i>Epicoccum</i>
Myrtaceae	Oxalidaceae	<i>Nigrospora</i>
Oleaceae	<i>Plantago</i>	<i>Fusarium</i>
Pinaceae	Polygonaceae	<i>Helminthosporium</i>
Podocarpaceae	Polypodiaceae	<i>Leptosphaeria</i>
<i>Platanus</i>	Proteaceae	<i>Periconia</i>
<i>Populus</i>	Ranunculaceae	<i>Pithomyces</i>
Prosopis	Rosaceae	<i>Pleospora</i>
<i>Rhus</i>	<i>Rumex</i>	<i>Puccinia</i>
<i>Quercus</i>	Rutaceae	Rusts
Salicaceae	Solanaceae	Smuts
<i>Ulmus</i>	<i>Taraxacum</i>	<i>Spegazzinia</i>
<i>Casuarina</i>	Thymelaceae	<i>Stemphylium</i>
Amaryllidaceae	Tiliaceae	<i>Tetraploa</i>
Asteraceae	Umbelliferae	<i>Torula</i>
Boraginaceae	Urticaceae	Mildew
Bruniaceae	<i>Parietaria</i>	
Caryophyllaceae		
Chenopodiaceae		

Erica (heather), *Asteraceae* (daisy family) and occasional *Proteaceae* pollen grains.

RONDEBOSCH FUNGAL-SPORE LEVELS

Fungal-spore counts were variable and weather-dependent but significant levels were consistently recorded for *Alternaria*, *Cladosporium* and *Epicoccum*. Ascospore levels peaked following rain and Basidiospore levels rose in autumn months. The highest fungal-spore levels were recorded during the spring and autumn seasons.¹⁰

THE MOWBRAY SAMPLING SITE (2008–2009)

Similar findings to those from the Red Cross War Memorial Children's Hospital were recorded for this nearby site, the Land Survey Building (see Figure 1), which was deliberately chosen for continuity of the airspora levels.

MOWBRAY POLLEN LEVELS

In addition to the pollen allergens listed above, significant



Figure 1: The Burkard spore trap at the Land Survey Building site in Mowbray

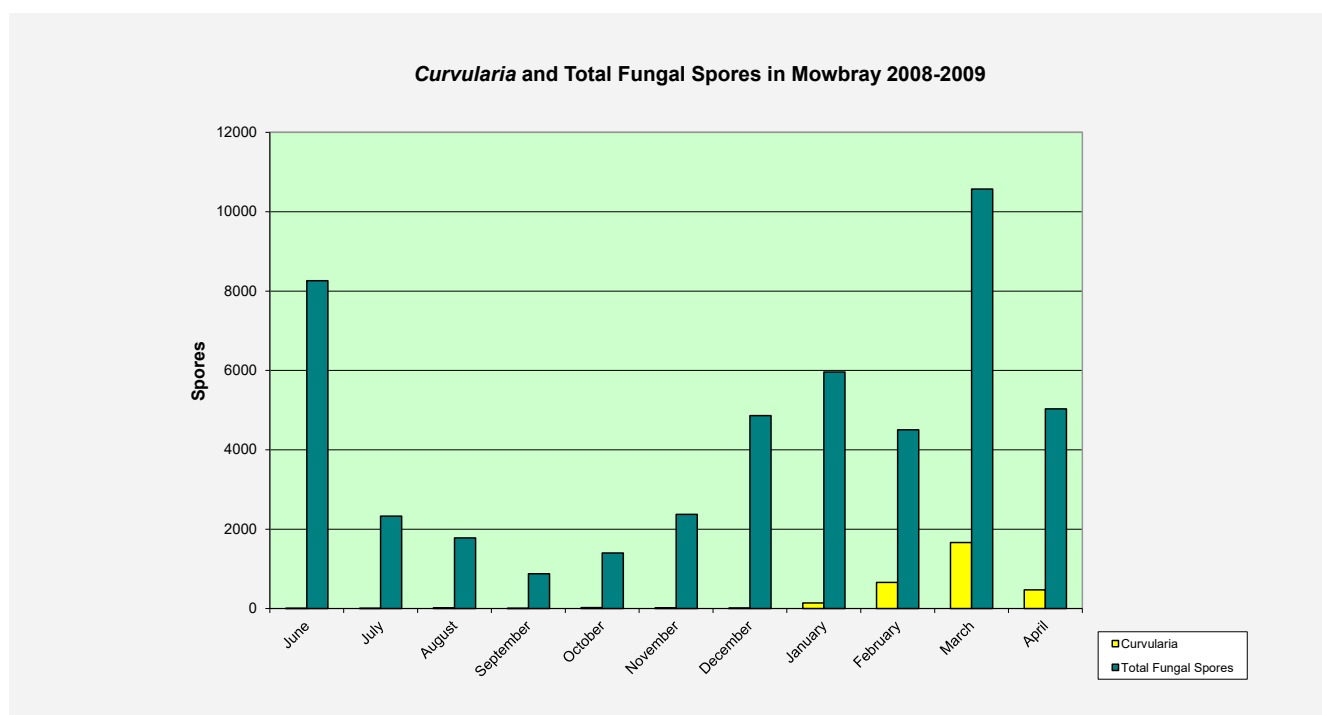


Figure 2: *Curvularia* and total fungal spores for Mowbray (2008–2009)

levels of *Rhus* (kareeboom) pollen were recorded. The grass-pollen load appeared to be slighter than previously measured levels at the Rondebosch site, but this may have been attributable to meteorological conditions and as the spore traps were not run concurrently, grass levels at the two sampling sites could not be compared.

MOWBRAY FUNGAL-SPORE LEVELS

The most important difference between this site and the other sites was the *Curvularia* peak each autumn when significant levels were seen for this taxon (see Figure 2).¹¹

THE OBSERVATORY SAMPLING SITE (2010 TO DATE)

OBSERVATORY POLLEN LEVELS

The most important difference regarding the pollen trapped at this site was that there was a longer tree-pollen season with a larger tree-pollen load. Significant levels for *Cupressus* (cypress), *Quercus* (oak), *Rhus* (kareeboom) and *Platanus* (plane) tree pollen were recorded from early August until late October.

OBSERVATORY FUNGAL-SPORE LEVELS

The Observatory fungal-spore levels were unremarkable and showed the usual increases for *Alternaria*, *Cladosporium* and *Epicoccum* that are usually seen during spring and autumn months (D Berman – unpublished data).

THE TABLEVIEW SAMPLING SITE (1985 TO DATE)

The City of Cape Town added a pollen and fungal-spore monitoring system to their Air Quality Monitoring Project in

1985 and this has been continued intermittently.

TABLEVIEW POLLEN LEVELS

In keeping with the climate of this West Coast sampling site, grass was the dominant pollen while the tree season was scant and fleeting (September–October). For the sampling years 1995–2003 the grass season began two weeks earlier at this site than at the inland sites. Weed pollen was not significant but higher scores for weeds were obtained from this coastal site when compared with the weed-pollen levels at inland sampling sites.

TABLEVIEW FUNGAL-SPORE LEVELS

The fungal-spore levels were moderate overall at this sampling site, with sporadic autumn and spring peaks for *Alternaria* and *Cladosporium* (D Berman – unpublished data).

POLLEN MONITORING IN GAUTENG

ATMOSPHERIC POLLEN LEVELS

Ordman's aerobiological studies in Gauteng were extended by Cadman, who noted that the climate zone of this city is grassland, bordering savanna. Pretoria North is situated in the savannah belt. Despite the strong presence of northern hemisphere trees, which have been introduced and naturalised, the tree-pollen season is short (October–November).¹² Trees that make up the spring tree-pollen peak in this region are the following taxa:

- *Fraxinus* (ash);
- *Pinus* (pine);
- *Populus* (poplar);

- *Platanus (plane)*;
- *Alnus (elder)*;
- *Celtis (stinkwood)*.

It is not surprising that the dominant pollen allergen in the sampled areas of Johannesburg and Pretoria is grass. The season runs from October to March, peaking later than the Cape grass season, as would be expected in this summer rainfall area. Similarly to Cape Town, weed pollen was not significant although weed-pollen allergens such as *Platanus* (English plantain) and *Tagetes minuta* (khaki weed) were present in the atmosphere.¹² Cosmos pollen would be identified as *Asteraceae*, a constant background presence in pollen assemblages and pollen-monitoring studies.

POLLEN RECORDS FROM KWAZULU-NATAL

Sampling sites have been set up in and around Durban and Richard's Bay in this subtropical region. These east coast towns enjoy milder temperatures, with abundant rainfall and increased relative humidity (RH) levels, and consequently higher perennial fungal-spore levels were recorded. Grass was a dominant aeroallergen and the dominant tree pollen was found to be *Morus*. The dominant weed pollen was *Cannabis*. The levels of this taxon exceeded the grass-pollen levels.¹³

THE MPUMALANGA POLLEN RAIN

A pollen-sampling study was carried out in the vicinity of Secunda in this lowveld region from 2006 to 2009 in order to assess the pollen and fungal-spore content of the atmosphere. This area of Mpumalanga is characterised by flat grasslands which include *Themeda triandra* (thatching grass).²

GRASS POLLEN

In this summer rainfall region, grass-pollen levels peaked in January and significant levels for grasses were recorded.

TREE POLLEN

Low tree-pollen counts were obtained from this area which is characterised by scrub vegetation. Indigenous tree pollen is infrequently allergenic as trees are invariably insect- or bird-pollinated and the pollen is not windborne or produced in large amounts. The tree-pollen load was dominated by alien trees such as plane, oak and eucalyptus.

WEED POLLEN

Weed-pollen levels were low, but small peaks for *Asteraceae* were seen during the autumn months of March and April, probably contributed by cosmos, which flowers in abundance in that region. The area around Secunda is often referred to as 'cosmos country', because of the thickly massed fields of these plants (see Figure 3) that are found in the vicinity. Cosmos belong to the *Asteraceae* family, introduced to South Africa from Mexico and naturalised.



Figure 3: Cosmos

FUNGAL SPORES

The major aeroallergens for this study were fungal spores, particularly *Epicoccum*, *Alternaria* and *Cladosporium*. This lowveld area experiences high RH, which frequently exceeds 90%. When this high RH coincides with temperatures that are >20°C, ideal conditions for the proliferation of fungal spores occur. The highest fungal-spore counts were recorded in February when counts >30 000/m³ for *Cladosporium* were recorded (see Figure 4). This is in keeping with findings from other countries, where *Cladosporium* is often the dominant fungal spore.

GUIDELINES FOR THE SELECTION OF AEROALLERGEN-TESTING PANELS

AEROALLERGEN TESTING IN A NEW CLINICAL SETTING

It is difficult to select allergens for testing in a new environment. Ideally, skin-testing profiles are selected, based on pollen-monitoring records from the region. These pollen counts indicate the important pollen and fungal-spore levels in the atmosphere as well as the months of the year when the aeroallergens peak. It is sensible to choose testing panels for aeroallergens based on the experience of allergologists in other regions of southern Africa. A thorough knowledge of the seasonality of the major trees, grasses and weeds of the new study area is helpful. In cities, the allergenic pollen load has invariably been composed of alien pollen from northern hemisphere trees, which have been introduced and naturalised, particularly *Platanus* (plane) and *Quercus* (oak), but also *Olea* (olive). *Olea europaea* and *Olea capensis* are found in the Western Cape and the pollen may be an important allergen in areas where olives are cultivated, such as in Paarl in the Western Cape.

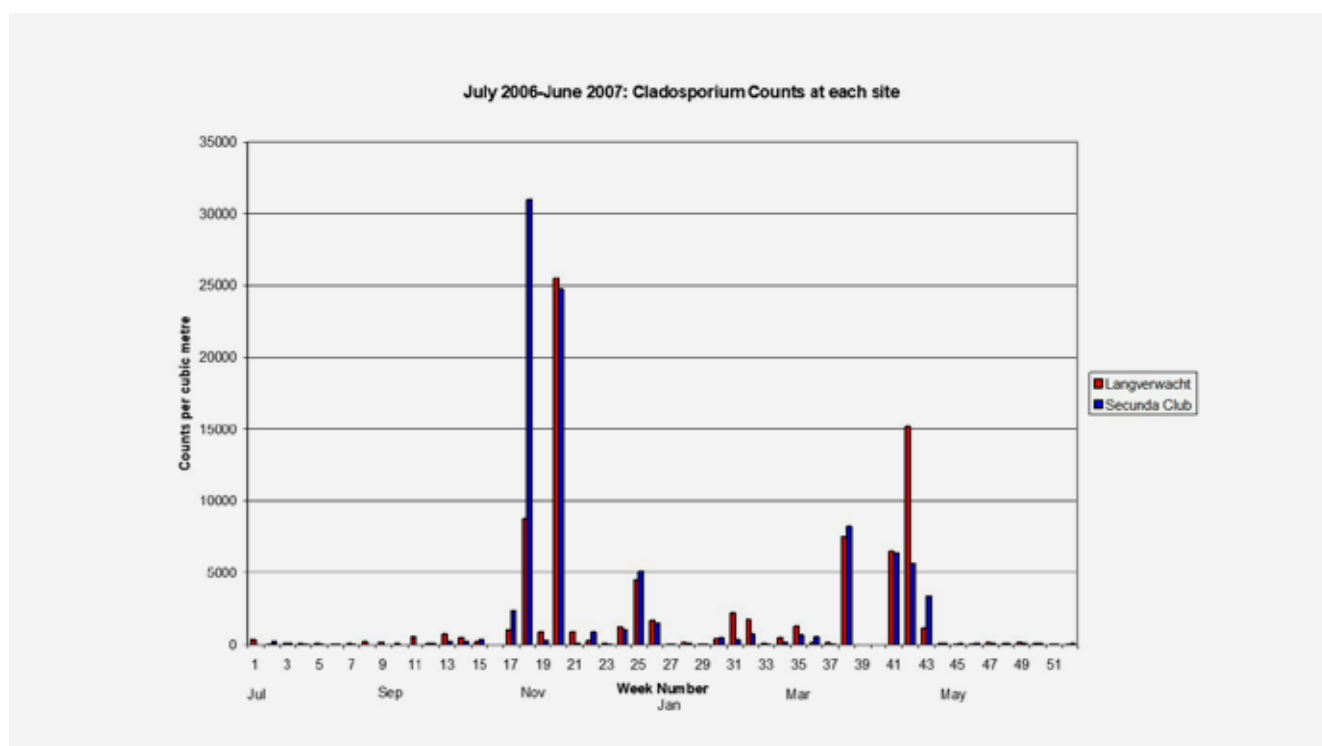


Figure 4: Annual Cladosporium levels (weeks) from Mpumalanga sampling sites

SUMMARY OF SUGGESTED GUIDELINES FOR THE CHOICE OF POLLEN/FUNGAL SPORE-TESTING PANELS IN A NEW ALLERGY CLINIC

1. If no pollen monitoring data exist for a new clinic, select pollen and fungal-spore allergens that have been found to be important allergens in other regions of southern Africa, that is, with a similar biome to the new clinic.
2. Audit the frequency of aeroallergen-specific sensitivity from positive skin-prick or ImmunoCAP RAST testing in the new clinic. This may prove useful when diagnosing patients with symptoms of seasonal allergic rhinitis (AR).
3. Set up contact with staff members of the Botany Department of the nearest university, technikon, botanical garden, parks and forest department or garden plant nursery. This will be invaluable when identifying allergenic plants, or plants that may cause contact dermatitis in your area. Pollen-flowering calendars are a very useful guide and are usually available from local botanists or botanical garden bookstores.
4. If there is a municipal air pollution department, a mutually beneficial relationship may develop between the staff of the allergy clinic and the air pollution personnel, in assessing triggers for seasonal allergy.
5. Take note of the local vegetation and record the flowering times of trees, weeds and grasses in the

new area.

6. Note the weather patterns in your region. Weather parameters that influence pollen counts include the rainy season, humidity levels, temperature fluctuations and wind speed and direction.
7. If large, important sporting events especially running and cycling marathons, are held in your region, it is important to be informed about the seasonal allergens that may trigger symptoms of allergy in these elite athletes, so that they may be able to take appropriate and permitted medications.
8. Consider adding *Zea mays* to the testing panel in farming areas where maize is grown. It is interesting that sugarcane pollen does not appear to be allergenic.

POLLEN CALENDAR

Figure 5 summarises in calendar form the pollen frequencies from the sampling sites.

DISCUSSION

In Europe, pollen calendars are constructed for the benefit of travellers who suffer symptoms of seasonal AR. It has not yet been possible to design a comprehensive pollen calendar for South Africa because of the dearth of sampling sites in this country; however, pollen calendars of allergenic plants should be constructed when aerobiological studies are unavailable for a particular region.

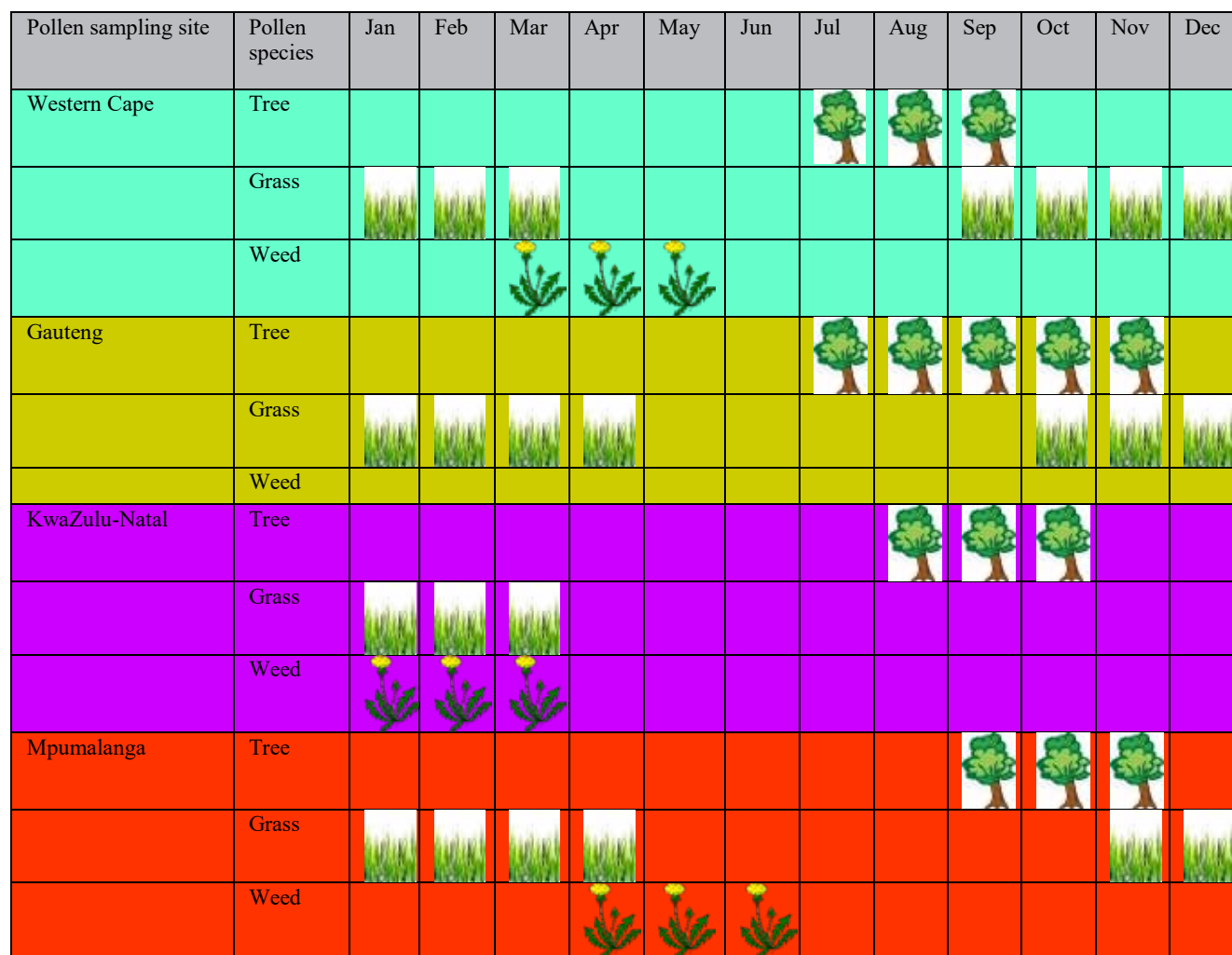


Figure 5: Calendar of pollen from South African sampling sites

DECLARATION OF CONFLICT OF INTEREST

The author declares no conflict of interest.

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