

A NOTE ON ANTHERSIS IN SOME COMMON GRASSES NEAR JOHANNESBURG, AND THE RELATION OF ANTHERSIS TO COLLECTION OF POLLEN FOR MEDICAL PURPOSES.

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I. INTRODUCTION AND OBJECTS.

During the past two years I have been studying a certain ecological problem necessitating work in the field at all times of the day and night. The opportunity was thus provided to observe anthesis, and notes were kept of the time of flowering in various grass species. This paper is a preliminary record of the daily and seasonal phenology of the grasses studied, together with a discussion of how pollen of grasses and possibly other anemophilous plants can be collected from plants growing naturally in the field, if advantage be taken of this knowledge.

II. A COMPARISON OF PRINCIPLES OF COLLECTING.

This discussion applies to anemophilous plants only. The accepted methods are described by Wodehouse (1935). Wherever possible the plants are picked and kept indoors until anthesis takes place. But many species do not respond; also, it appears that most species do not shed nearly as much in such conditions as they would in the field, because fewer spikelets ("flowers") seem to open. The nearest approach to the method advocated in the present paper is that called by Wodehouse "the Plant-breeder's Method"; the latter is not popular and is used only when the other fails. In this method paper bags are tied over the inflorescences.

It is my view that, provided it is known at what time anthesis usually begins in each species, by far the most satisfactory procedure is to wait until the spikelets have opened and the extended anthers have opened their pores, and then gently to bend the inflorescences down singly or in bunches into a packet held in the collector's hand. In this way it is possible to go quickly from plant to plant and collect a few cubic centimetres of pure pollen in about half an hour. The method suggested seems to have several advantages over both the accepted methods for anemophilous plants. It would no longer be necessary to waste time on individual plants that are either past the flowering stage or a few days

too immature—an almost impossible thing to determine rapidly while working in the field. Fungal infection, too, should be less than in artificially shed pollen. Also, the pollen can be relied upon to be perfectly matured, which is of immense importance to the medical research worker. The method, however, entails working in the field at such time as anthesis may take place.

III. DISCUSSION OF ANTHESIS, AND TABLE.

No facts about anthesis in grasses in Africa have been published. The following discussion deals with some botanical facts of importance to students of allergy.

Description.—Each inflorescence in grasses consists of a number of flower units called spikelets. These do not all open in one day, but a few open on each of several occasions during as many days. When a spikelet opens, it does so rapidly; and in the space of a few seconds the bracts open out, the plumed stigma spreads out and the two or three anthers are extruded and hang suspended on the end of the long filaments. The two sacs comprising each anther are closed at the time they are extruded, but open (by a terminal pore in each) soon after, and when there is a strong breeze blowing all the pollen is scattered in about ten seconds. The bracts close around the ovary soon after opening, and leave the stigma and anthers protruding until these drop off—within ten to thirty hours. Each anther, when full, contains many cubic millimetres of pollen, and on this fact depends the suggested method of collecting. If caught at the right time and in the right weather, a few spikelets on one inflorescence (the day's spikelets on every inflorescence open all at the same time) will yield about a quarter to half a salt-spoon of pollen when tapped gently three or four times.

Daily Rhythm.—Throughout the flowering period of every grass species, pollen is shed once in twenty-four hours. The same inflorescence will usually continue to shed pollen on successive days until all the spikelets on it have opened.

Each species sheds its pollen at its own time of day, and often with clock-like regularity. Examination of temperature and humidity charts shows that normally these factors both *rise* and *fall* once in twenty-four hours; the relative humidity decreases as the temperature increases towards mid-day, and increases as the temperature falls towards a minimum about dawn. But grasses shed their pollen at all times of the day. Some do so at the first signs of a change in the morning, others at 10 a.m., at noon, in the late afternoon, at 8 p.m. and at 2.30 a.m. So there are no two classes into which the different species can be grouped

according to their time of anthesis. The only basis of classifying the mechanisms of anthesis seems to lie in the possibility that some grasses require a maximum temperature and the rest require a maximum humidity. Some grasses shed pollen as the temperature is increasing (between 4 a.m. and 1 p.m.) and all others as the humidity is increasing (between 1 p.m. and 4 a.m.).

A knowledge of the physical factors responsible for operating this mechanism involved in anthesis would assist appreciably in the collection of pollen. Anthesis is probably controlled by some combination of temperature and humidity,* rather than any rhythm inherent in the plant. It is therefore understandable that there are variations of an hour and more in the time of anthesis in any one species on different days. *Hyparrhenia hirta* was observed to be shedding pollen at 9.30 p.m. on 11th February, but on the night of 23rd—24th February this species did not shed pollen until 2.15 a.m. Other examples could be given to illustrate this variation due apparently to irregularities in the daily rhythm in evaporating power of the air. Large quantities of pollen have been collected from *Andropogon amplexans* between 11.45 p.m. and 12.15 a.m. and yet the spikelets of this species have been observed to remain closed until 5.45 a.m., when the spikelets were watched as they opened. Again, rain during the time that anthesis usually takes place in *Monocymbium* may have been responsible for the complete lack of flowering that day, because a few days before and a few days after this the same patch of the grass was shedding much pollen. Insufficient work has been done as yet to permit of any more definite suggestions, but it does appear so far that the time of anthesis depends on the attainment of a somewhat exact evaporating power of the air. This exactness is shown by the repeated observation that all the grasses that open in the morning, for example, do not do so at the same hour. On a certain day, *Andropogon amplexans* was shedding pollen at 7.45 a.m., but *Cynodon* and *Pogonarthria falcata* not until about 8.30 a.m. and *Eragrostis gummiiflua* not until about 8.45 a.m. The conditions necessary may be heralded or followed by a breeze, but the fact that on a perfectly calm afternoon *Monocymbium* was shedding pollen in a superlative manner belies the possibility that a breeze markedly influences anthesis. The possible importance of the gradient of the change in the above factors (*i.e.* the relation to minimums) rather than the actual temperature and humidity must be borne in mind.

Different individuals of the same species all shed their pollen within the same half-an-hour or less on any one day if in the same locality. (Precocious spikelets, which are uncommon and *extremely useful as*

* Wind + Temperature + Humidity = Evaporating power of the air.

indicators, are excepted.) This, together with the fact already noted above about the day's spikelets on each inflorescence, is of importance in collecting. Remember, too, that the time taken from when the spikelet opens for the pollen to be dispersed depends entirely (after the first few seconds or minutes, as the case may be, required for the anthers to dehisce) on the wind, except on such occasions as the misty night on which the spikelets of *Andropogon amplexans* opened at 2 a.m., but the anthers did not open until about 6.30 that morning. (See Table I.)

Seasonal Rhythm.—The length of the flowering period of each species is about a month or two, excluding stragglers that are found as much as three months out of date. The exact date each year depends on the locality, and, in any one locality, on the lateness or earliness of the particular season (Altona, 1939) and the treatment that year; burning (Cook, 1939), grazing (Altona, 1940), fertilizing (Altona, 1940) and sowing or otherwise starting of germination in nature and farm practice each affect the time of flowering. Glover (1937) gives the seasonal phenology of most Highveld grasses.

The duration of the flowering-life of each plant depends on the number of inflorescences, that is whether an annual grass with a few stems or a tussock grass. A single inflorescence, however, flowers for from a few days (*e.g.* *Trachypogon* and *Harpechloa falx*) to a week or so (*e.g.* *Zea mays*). (See Table I.)

IV. PRACTICAL DETAILS.

Most of the following points refer to a procedure that has been found to be quite suitable. The collector must observe the patch of grass chosen until anthesis begins, which usually happens very suddenly; and then the plants with open spikelets can be visited one by one as they come into flower.

Noted below for the sake of completeness are two suggested alternative methods of collecting.

1. The most suitable sizes of collecting bag seem to be flat envelopes about 6 inches long by 5 inches high, or 5 inches long by 9 inches high, or 12 by 12 inches when collecting from large bunches of inflorescences.

2. Cellophane-paper envelopes were used so that it could be seen when the pollen collected began caking due to the moisture absorbed. A sheet of paper twice the size of the envelope is cut and folded double, and the two edges are stuck with rubber solution and folded over again to give a clean edge inside. It may be better to use porous paper envelopes.

3. For the same reason that pollen often absorbs moisture from the

atmosphere, it was found to be impossible to collect pollen of *Zea mays* or *Trachypogon*, for example, without using a desiccator in the field. The packet is emptied into a watch-glass every minute or two. A portable desiccator is easily made from a wide-mouthed tin partially filled with Calcium chloride.

4. It is suggested that the planting of grasses in nursery plots may facilitate collecting. But the plants must not be too near together, because it is then difficult to work without wasting the pollen of many plants.

5. Pollen must not be stored without having been given prolonged desiccation. The desiccator may be a convenient storage place.

6. As an alternative method of collecting, it may be preferred to collect the anthers themselves after the spikelets have opened in the veld, but before the anther-sacs have dehisced.

7. Secondly, the flowering culms can be cut before anthesis sets in, and placed in water indoors in the usual way.

V. SUMMARY.

1. The process of anthesis in certain grasses in the veld near Johannesburg has been discussed, and details have been given of the time of day and time of year that some thirty grass species can be expected to flower. The reasons for variation are suggested.

2. All this is of value to medical research, in connection with both the incidence of certain allergic discomforts and its application to the collection of pollen for allergy tests.

3. A preliminary account of this successful method of collecting is given.

4. Naturally local conditions of climate will require study, region by region.

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TABLE I.

Pollen-shedding in Highveld Grasses: Johannesburg—Germiston 1940—41.

SPECIES.	HABITAT(S).	TIME OF DAY.	FLOWERING PERIOD.	REMARKS.
<i>Alloteropsis semialata</i> .	Undisturbed veld.	Early morning before 8 a.m.	Jan. and Feb.	
<i>Andropogon amplexens</i> .	Disturbed and undisturbed veld.	10 p.m. to 6.15 a.m.	Jan. to March.	Spikelets sometimes open long before anther-sacs. Pollen collected before mid-night and after sunrise.
<i>Andropogon schirensis</i> .	Undisturbed veld.	6 a.m. to 7.30 a.m.	Jan. and Feb.	Not the same as <i>A. amplexens</i> , but some doubt as to time.
<i>Cymbopogon excavatus</i> .	Disturbed and rocky veld.	9.30 p.m. to 1 a.m.	Jan. and Feb.	
<i>Cynodon dactylon</i> .	Roads, ploughed lands and lawns.	5 a.m. to 7.30 a.m.	Dec. to end Feb.	Usually about 7 o'clock; much pollen is shed by the wind at 8 a.m.
<i>Digitaria horizontalis</i> .	Old roads and lands.	2.30 a.m. and probably earlier.	Jan. and Feb.	Apparently not much pollen produced.
<i>Eleusine indica</i> ..	Old roads and lands.	After sunrise before 7 a.m.	Feb. and Mar.(?)	
<i>Eragrostis brizoides</i> .	Undisturbed veld.	5 a.m. to 6 a.m.	End Nov. to Feb.	
<i>Eragrostis</i> c.f. <i>chloromelas</i> .	Old fallows and old roads.	8 p.m. to 10 p.m.	Dec. to end Feb.	
<i>Eragrostis</i> c.f. <i>curvula</i> .	do.	do.	Nov. to end Feb.	
<i>Eragrostis gummi-flua</i> .	Disturbed and undisturbed veld.	7.30 a.m. to 8.30 a.m.	Jan to end Feb.	
<i>Eragrostis plana</i>	Old roads and along paths.	4.30 a.m. to 6.30 a.m.	Jan. and Feb.	Sometimes a little later on misty mornings.
<i>Harpechloa falx</i>	Undisturbed veld.	7 a.m. to 8 a.m.	Nov. to mid Dec.	Possibly earlier, too.

SPECIES.	HABITAT(S).	TIME OF DAY.	FLOWERING PERIOD.	REMARKS.
<i>Hyparrhenia hirta</i>	Old fallows and along roads and water-courses.	9 p.m. to 2.30 a.m.	Mid Nov. to Feb.	Usually sheds pollen a few hours before midnight, but often about dawn in misty weather.
<i>Monocymbium ceresiiforme</i> .	Undisturbed veld, especially moist patches.	5 p.m. to 6 p.m.	End Jan. to Mar.	Large amount of pollen produced; the weather (apparently) frequently prevents anthesis more than once every few days.
<i>Panicum laevifolium</i> .	Recent fallows.	6 a.m. to 7.30 a.m.	Jan. and Feb.	Abundant on farms and used as hay; also a weed in gardens.
<i>Pogonarthria falcata</i> .	Fallows and along paths.	2.30 a.m. to 8 a.m.	End Jan. to Mar.	A common weed on garden paths. Usually sheds pollen between 7 and 8 a.m.
<i>Setaria</i> sp. . .	Recent fallows.	5 a.m. to 6 a.m.	Jan. and Feb.	Occasional garden weed.
<i>Sporobolus indicus</i> ,	Fallows and especially beside paths.	1.30 a.m. to 6 a.m.	Dec. to end Feb.	Usually sheds pollen about sunrise, and later if calm.
<i>Trachypogon plumosus</i> .	Exclusively undisturbed veld.	11 a.m. to 2.30 p.m.	End Jan. to Mar.	Anthesis usually at about noon; pollen shed very soon after spikelet has opened.
<i>Urelytrum squarrosus</i> .	Undisturbed veld.	Early morning before 8 a.m.	Jan to end Feb.	

APPENDIX : *Certain Grasses Introduced to the Highveld; observed Johannesburg—Germiston, 1940—41.*

<i>Acroceros macrum</i>	Grazing and hay.	About sunrise.	Jan. and Feb.	
<i>Chloris gayana</i> . .	Artificial pasture grass; exotic.	11.45 a.m. to 12.30 p.m.	Dec to end Feb.	Pollen shed very soon after anthesis, because anther-sacs open soon and it is usually windy.
<i>Cynodon</i> "Star-grasses."	Grazing and erosion works.	do.	Dec. to Feb.	Introduced from Kenya.

SPECIES.	HABITAT(S).	TIME OF DAY.	FLOWERING PERIOD.	REMARKS.
<i>Panicum deustum.</i>	Ensilage and hay.	do.	Jan. and Feb.	
<i>Panicum maximum.</i>	Ensilage and hay.	do.	do.	
<i>Setaria</i> spp. ..	Ensilage and hay.	do.	Dec. to Feb.	Introduced from Tropical Africa.
<i>Urochloa</i> sp. ..	Grazing and hay.	do.	Jan. and Feb.	Introduced from the Bushveld.
<i>Zea mays</i> ..	Crop plant (maize); exotic.	8 a.m. to 3.30 p.m.	Dec. to Mar.	Unusual behaviour, because although majority of pollen is shed between 12 and 2.30 very many anthers open as early as 8 a.m. and as late as 3.30 p.m. on the same day.

Notes :—(i) The times given refer to the opening of the anther-sacs (by the apical pores) and not to the opening of the spikelet or the extrusion of the anthers.

(ii) Time of opening of the anther-sacs has not been confused with the time at which the pollen is dispersed; the latter may be as much as a few hours after the former on calm days. Observations were made before and after anthesis, or on windy days, or of the whole process as anthesis took place.

(iii) The range of time given for each species indicates the limits within which the half-hour or so required for anthesis can be expected to fall on different days. The period suggested is based on about five observations in most cases, but is still no more than an approximation. It does not include such obvious irregularities as the occasion on which *Cymbopogon excavatus* shed a maximum quantity of pollen between 5 and 5.30 in the afternoon; these variations are infrequent.

(iv) The time at which the pollen is usually shed by the wind, rather than the time of anther-sac opening given in the table, is of importance in studying the incidence of Hay-fever and Asthma. Such incidence depends not only on the time and amount of anthesis, but on the daily distribution of winds. At the Botanical Research Station, Frankenwald, where the work was done, there is a light breeze that does not last long just before dawn, another just after eight in the morning and very often at about mid-day, at 7 p.m. and at about midnight. Pollen therefore is most commonly shed at these times; for example, in all the species in which anthesis takes place between dawn and 8 a.m. the pollen is usually shed by the wind at about 8 a.m., because it is usually calm previous to this hour of the day. Grass pollen is comparatively light (Wodehouse, p. 307), but some of the species examined seem in the veld to have heavier pollen that sinks to the ground a few yards from the plant; *Zea mays* is an example of the latter.

(v) Especially in towns, where there is always weeding and mowing, many grasses continue flowering much later into the season than shown in the table.



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