

**THE IMPORTANCE OF OKLAHOMA'S WIND-BORNE
POLLINATED PLANTS FROM A MEDICAL
STANDPOINT**

With Special Reference to Hay-Fever and Asthma

**Ray M. Balyeat, University of Oklahoma Medical School
Oklahoma City**

About 1.5 per cent of all people of the state of Oklahoma have either asthma or hay-fever, or both. At least one per cent of those who suffer from such diseases have hay-fever, either seasonal or perennial. My records show that pollen from the wind-borne pollinated plants is the chief cause of ninety-six per cent of the cases of hay-fever that I have examined. In other words, about 20,850 people in this state suffer from pollen hay-fever. My records also show that sixty-three per cent of the asthma patients, that I have examined, suffer from pollen asthma. About sixty-five per cent of all hay-fever patients finally become asthmatics. In other words, in the state of Oklahoma about one per cent of the population suffers from pollen asthma. When one realizes that about 48,000 people in the state of Oklahoma suffer from pollen asthma or hay-fever and considers the discomfort produced by hay-fever and the depleting effects of asthma on the individual, thereby interfering seriously with their lives, surely it is not difficult to see the importance of a careful investigation of the chief cause.

The flora in the different districts, of course, varies not only with the geographical situation itself, but also with altitude, climate, the seasons, rain fall, topography of the land, soil conditions and many conditions that result from cultivation and habitation. For that reason the plant life of this state varies materially from other states. The wind-borne pollinated plants of the state of Oklahoma are many but in this paper the writer wishes to discuss only the chief ones that have to do with the cause of hay-fever and asthma.

Through the assistance of Mr. T. R. Stemen we have been able to study the pollinating season, the mode of pollination, the amount of pollen produced, the size of the pollen, the period over which the plant pollinates and the extent of growth of the various wind-borne pollinated plants in every county in the state of Oklahoma. It is interesting to note that there are many. As an example, we found in one county seventy-three species of grasses whose pollens are all wind-borne. Similar studies

were made of the trees, amaranths, chenopods, the ambrosia groups and other minor groups.

Our experience has taught us that the plants chiefly responsible for hay-fever and asthma are those which produce the greatest abundance of dry light pollen which can be held in the air for a long period of time. **Heavy and oily pollen** is relatively unimportant inasmuch as it can be carried into the air only on windy days. The amount of pollen in the air during the pollen season varies widely with weather conditions. We have found that the percentage of sunshine has much to do with the pollen produced, and that the velocity of the wind has a great deal to do with getting the pollen into the air. The profuseness of plant life, of course, is very important. It would appear that the rain fall would have much to do with removing the pollen from the air, and we learned that it did providing it extended over a considerable length of time, but a heavy rain during the night with gale of from twelve to eighteen miles per hour the next morning with a clear sky changed the pollen contents of the air the next day but little. It was a common experience to find that on cloudy days pollination of plants that were taken into the green house practically ceased, and that pollen counts on cloudy days, especially on days that had been preceded by two or three cloudy ones, were very low. One or two sunshiny days, however, was sufficient to increase our pollen count to a high point. Observation has shown us that the date of onset and the duration of the pollen season varies somewhat from year to year but it is fairly constant, however it may be mentioned further that the commencement of a pollen season does not correspond exactly with the beginning of the symptoms of hay-fever patients. The date of pollination frequently antedates clinical hay-fever by ten days to two weeks. Symptoms usually begin not on the date of pollination, but on the date in which the pollen gets into the air in sufficient quantity to be toxic to the individual, therefore some patients sensitive to ragweed may have their symptoms on the eighteenth day of August, others who are not so sensitive may not have symptoms until the twenty-eighth day of August at which time the concentration of the pollen in the air is frequently several times greater.

It is very interesting to note that the onset of pollination of one plant differs very little from the date of the onset of the pollination of that same plant in different sections of the country. This explains why doctors in times past considered hay-fever a neurosis because some patients came to their office with a

history that each year on the seventeenth day of August, at three o'clock in the afternoon, or some other day specified, they began to have itching eyes, discharging nose, itching of roof of the mouth and so on, although they had lived in different sections of the country. The date of pollination of various plants has been reported by different men in different sections of the United States and it seems that the giant ragweed begins its pollination about the thirteenth or fourteenth day of August. The western ragweed begins to pollinate a few days later and the short ragweed a few days later than it. In doing pollen plating this year, the first ragweed pollen observed on our plates was on the thirteenth day of August. A botanist, working in Anas City, sent me a pollen curve he had made and I was interested in noting that the first ragweed pollen he found was on the thirteenth day of August. In doing pollen plating in Chicago and Indianapolis similar dates were found.

In discussing the plants, they will be taken up somewhat in order as to the time of year in which they pollinate.

Trees

In this state there are several trees that could be the cause of hay-fever and asthma, but comparatively speaking trees play a minor part. The most active ones that we have are the cottonwood and the oak.

Cottonwood (*Populus deltoides*), usually begins to pollinate about the seventh day of April and continues about three weeks. Most of the patients whose hay-fever is caused by pollen from cottonwood begin to suffer from the seventh to the ninth. In some sections, especially along the rivers and in a few of the western towns where the cottonwood trees are used abundantly for shade, this pollen is a fairly common cause of hay-fever. It is quite toxic and those who suffer from it have marked symptoms.

Oak (*Quercus marilandica*), is the most common tree in Oklahoma. Its pollen is small, 20 to 30 microns in diameter, and its pollen is fairly profuse. It is a minor factor in the cause of hay-fever and asthma, inasmuch as the period over which it pollinates is very short, being from about April fifteenth to May the first. The usual abundance of rain and the lack of wind during this period also decreases the pollen of the oak as a factor in the production of these two diseases.

Grasses

Within a radius of forty miles of Oklahoma City, we found seventy-nine species of grasses pollinating profusely in Sep-

tember. Some of these are abundant making them a very common cause of hay-fever and asthma. A few of our grasses begin to pollinate in the latter part of April and many of them the first part of May. Some of them will pollinate off and on and almost continuously throughout the summer until a killing frost, which in Oklahoma is usually the fore part of November. The earliest pollen we ever found was a slender fescue grass (*Festuca octoflora*), and chess grass (*Bromus secalinus*), but the amount of pollen is small making them clinically unimportant. About May the fifteenth, Bermuda (*Capricola dactylon*), begins its season of pollination and will continue throughout the entire summer until frost. Bermuda grows on approximately ninety-eight per cent of the lawns in this state. Its pollen is small being twenty-two microns in diameter. It is wind-bourne and the plant is located near the homes of the sufferers, thereby making it a very important factor. In the southern and eastern portions of the state Johnson grass (*Andropogon halepensis*) must be considered as the amount of plant life is abundant and the pollen profuse. It would be a much greater factor in these sections if it were not for the size of the pollen, which is more than 40 microns in diameter. The growths is chiefly in the lowlands, away from many of the homes, which also decreases materially its importance.

Indian grass (*Sorghastrum nutans*) is by far the most common grass in our State, but, not unlike Johnson grass, the pollen is very heavy making it only an occasional offender. In our pollen plating we seldom pick up the pollen of Indian grass but the pollen of Bermuda can be found in the air on most any day. Many of the grasses that produce a small amount of pollen would not in themselves produce hay-fever symptoms, but patients sensitive to one gras are so frequently sensitive to many so that the combination of several along with their long period of pollination makes the grasses important.

Chenopods

Lambsquarter (*Chenopodium album*) is widely distributed throughout every ection of this state, both the prairie and the wooded sections. The pollen is small, wind-borne and commonly found on pollen plates. Patients are frequently found sensitive to it on testing, but clinically we believe that the pollen is not a very toxic one therefore causing little trouble.

Russian Thistle (*Salsola pestifer*) is very abundant in the north and western sections of Oklahoma and its pollen is very toxic. The onset of pollination of this plant is about July 1st.

Most patients do not have symptoms from it before July 15th, inasmuch as the concentration of the pollen in the air is not great enough to produce clinical symptoms until that time.

Amaranthus

The amaranths, including *Amaranthus spinosus*, *Amaranthus retroflexus* and *Amaranthus Palmeri*, are widely distributed but in some sections they grow very much more profusely than in others. For instance, in Purcell, Lexington and Hominy, Oklahoma, they are all extremely profuse compared to most sections. These three plants begin their pollination about June 20th, and they continue to pollinate until the middle of September. The amount of pollen that actually gets into the air sufficient to cause symptoms is usually not before July 10th.

Western hemp (*Acnida tamariscina*) belongs to the amaranth family and is one of the most abundant plants in this state except the ragweeds. The number of plants is probably twenty times greater than all of the amaranths put together and the amount of pollen produced is much more profuse than the amaranths, thereby making it the most important cause of hay-fever and asthma appearing in July. We have learned that during July and the fore part of August, except for Bermuda pollen hay-fever and asthma are chiefly due to the amaranth and chenopod families.

Ragweeds

Throughout the eastern half of the state of Oklahoma there can be found growing two species of ragweeds and likewise throughout the western half of this state are two species. In the eastern half giant ragweed (*Ambrosia trifida*) and short ragweed (*Ambrosia elatior*) are very common, while in the western half giant ragweed and western ragweed (*Ambrosia psilostachya*) are common with the western ragweed predominating. All three of the ragweeds are prolific producers of pollen. The average size of the pollen granules of the short ragweed is 15 microns, that of the western is 25 and that of the giant is 20 microns. Our plant survey has shown us that we have never found a stalk of western ragweed east of Harrah, nor have we found the short ragweed west of El Reno. The dividing line seems to be through Oklahoma City and Guthrie, then bends east taking in Payne and Osage counties. From this line to the eastern coast, the short ragweed is very prevalent. From this line west to the western coast, the western ragweed predominates. Due to the size of the pollen, the abundance of the plant and the large amount of pollen produced, patients have a great deal of difficulty in getting away from

their pollens. The three ragweeds probably produce sixty per cent of the pollen hay-fever and asthma in this state. In the cities and villiages nearly all the vacant lots are covered with either the short or the western ragweed bringing these plants in close contact with their victims. Our records show that seveny-three per cent of the hay-fever patients tested are sensitive to one, two or three of the ragweeds.

Minor Causes

There are several other weeds such as marsh elder (*Iva ciliata* and cocklebur (*Xanthium commune*) which must be considered as factors in certain localities. In some sections of the lowlands along a few of the river bottoms, especially those that overflow, hundreds of acres are covered with *Iva ciliata*. This is especially true of the Deep Fork Valley. In those sections many patients suffer from asthma and hay-fever due to the pollen from this plant. The cocklebur does not produce a great deal of pollen but it is toxic and those who are sensitive to it living nar lowlands where the plant is prevalent may have symptoms caused by it.

One sage (*Artemisia kansana*) is distributed over the entire state but it is usually only found along the roadside. The amount of pollen produced by this sage is small and the period over which it pollinates is short, running from September 10th to 25th. A great many people are sensitive to it, but clinically I feel it is not a factor in this state.

Corn (*Zea mays*) is of course very abundant everywhere and it is a very prolific producer but the pollen is from 80 to 90 microns in diameter and it is oily so that it seldom gets into the air. It is very toxic and patents are frequently sensitive to it, especially farmers, but they do not suffer from it unless they are actually in the corn field.

Methods of Collecting Pollen

Since it has been quite definitely proved that the pollen of one plant cannot be used for desensitizing a patient who is sensitive to pollen of some other plant, it becomes necessary that pollens from all the different plants to which patients may be sensitive should be collected. The collecting of such pollen must be done in a painstaking way if good pollen is obtained. Only a well trained botanist can do this work successfully. He cuts the plant low pulls it up by the roots and places the roots or stems in buckets of water as soon as possible after collecting them so as to prevent wilting. Wilting interferes very much with the opening up of the pollen sacs. The plants are placed in such a

position that the flowering top hangs over glass plates so that each morning the pollen can be swept up with a camel's hair brush. The pollen of only one plant can be collected at one time in the house, toherwise there would be danger of mixing. Usually after about two days the plants cease to pollinate and must be removed and replaced with other plants, although a great many sacs are still filled with pollen. One interesting observation we have made is the fact that most of the pollen falls between the hours of 2:00 a. m. and 10:00 a. m. Clinically this is the time of day that the symptoms of hay-fever patients are more marked.

After the pollen is collected in what is termed a green state it requires careful drying. It is dried for six hours at 100 degrees. From this dried pollen, pollen antigens are made up for desensitizing. Desensitizing is a process of building up a tolerance in thoe patients who are sensitive to them.

Methods of Determining the Relative Amount of Pollen that is

Actually in the Air

There is a method by which one can actually determine the pollens that are in the air, on any day. By means of white vase-line plates exposed to the air, the dust, pollen or any other materials in the air will be collected. Rain on the plates does not interfere. By means of Lugol' solution and a microscope we can identify the different pollens that are collected. Without Lugol's practically all of them can be identified so that counting can be done. It is not possible to differentiate between species of ragweed, or between grasses, but one can easily differentiate between the amaranths and ragweeds, and so on. Pollen plating is very important for the reason that many times one dealing with asthma or hay-fever feels that a patient's symptoms may be coming from a certain pollen, but if a polle nplate that has been left near the patient's home is brought to the office and the pollen suspected is not found on it, one should look for other pollens as the cause of that patient's symptoms.

A definite method of counting has been agreed on by several of us working in this field so that we can compare results in different sections of the country. Counting is done by using eye piece number 10 with the barrel of the microscope raised as high as possible. Ten trps across the slide are made and the pollens counted. Pollens from various families can be easily differentiated and individual counts made.

**A CHART SHOWING THE DATES OF POLLINATION OF THE IMPORTANT HAY-FEVER AND
ASTHMA PRODUCING GRASSES, WEEDS AND TREES IN OKLAHOMA**

	April	May	June	July	Aug.	Sept	Oct.
Cottonwood -----	- xx-	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -
Bermuda Grass -----	- - - -	- - xx	xxxx	xxxx	xx xx	xx xx	xx xx
Oak -----	- - - x	xx	- - - -	- - - -	- - - -	- - - -	- - - -
Walnut -----	- - - -	xxxx	xx	- - - -	- - - -	- - - -	- - - -
Orchard Grass -----	- - - -	- - - x	xxxx	- - - -	- - - -	- - - -	- - - -
Lamb's Quarter -----	- - - -	- - - -	xxxx	xxxx	xx xx	xx xx	- - - -
Sudan Grass -----	- - - -	- - - -	- xxx	xxxx	xx xx	xx xx	- - - -
Johnson Grass -----	- - - -	- - - -	- xxx	xxxx	xx xx	xx xx	- - - -
Russian Thistle -----	- - - -	- - - -	- - xx	xxxx	xx xx	xx - -	- - - -
Spiny Amaranth -----	- - - -	- - - -	- - xx	xxxx	xx xx	xx xx	- - - -
Water Hemp -----	- - - -	- - - -	- - xx	xxxx	xx xx	xx - -	- - - -
Pigweed -----	- - - -	- - - -	- - xx	xxxx	xx xx	xx - -	- - - -
Redroot -----	- - - -	- - - -	- - xx	xxxx	xx xx	xx - -	- - - -
Palmer's Amaranth -----	- - - -	- - - -	- - xx	xxxx	xx xx	xx - -	- - - -
Giant Ragweed -----	- - - -	- - - -	- - - -	- - - -	- - xx	xx xx	xx xx
Short Ragweed -----	- - - -	- - - -	- - - -	- - - -	- - xx	xx xx	xx xx
Western Ragweed -----	- - - -	- - - -	- - - -	- - - -	- - xx	xx xx	xx xx
Cocklebur -----	- - - -	- - - -	- - - -	- - - -	- - xx	xx xx	xx xx
Marsh Elder -----	- - - -	- - - -	- - - -	- - - -	- xxx	xxx -	- - - -
Prairie Sage -----	- - - -	- - - -	- - - -	- - - -	- - x	xx - -	- - - -
							- xx-

x Represents each week over which the plant pollinates

Factors Which Determine the Production and Distribution of Pollen

As has been mentioned before in this paper unless the plant life is profuse the amount of pollen produced will not be great. Large stalks of ragweed, Bermuda, etc., will naturally produce more pollen. Continuous rain through the summer is conducive to the production of many plants, and large plants. Dry weather in the latter part of the summer will cause more pollen to remain in the air after it is carried into it, inasmuch as rain will cleanse the air of the pollen. We have noticed frequently, however, that if a rain, and it makes no difference how abundant, should come the forepart of the night, and the sky be clear the next morning, our pollen plates will have a high count. The rain that interferes with the pollen getting into the air is the one that comes early in the morning and extends well towards noon.

We have frequently filled the pollen house with plants on a day that was followed for a couple of days by cloudy weather with the collection of practically no pollen, which is very excellent evidence that plants require sunshine for the opening up of the pollen sacs. On cloudy days we also find very little pollen on our plates. For pollen to be of very great importance as a hay-fever and asthma producer it must be from flowers that are small and inconspicuous, devoid of nectar, without fragrance and in many cases so reduced anatomically that only the stamen and pistils remain; the pollen grains must be very abundant, small, light and dry and therefore easily carried by the wind and capable of floating in the air many hours. A great deal of pollen may be produced but there must be a means of getting it into the air, thereby coming in contact with the eyes or some part of the respiratory tracts of the sensitive person in order to produce symptoms. This is done by the wind and we have learned that the amount of pollen which appears on our pollen plates is almost in direct proportion to the velocity of the wind, assuming that other factors, that is, the rainfall and sunshine are the same.

The pollen curve (Fig. 14) shows the relation that exists between the rainfall, percentage of sunshine and average velocity of the wind. It will be noted that on the days in which the percentage of sunshine was high and the velocity of the wind was fairly great the peak of the pollen curve appears; also that even if the wind velocity is fairly high but the sun is not shining the pollen curve drops.

After the plants have been produced, the percentage of sunshine is the greatest factor in determining the amount of pollen that will actually fall, and without any question the wind is by

far the biggest factor in determining how much pollen will get into the air. The percentage of sunshine and the wind velocity in the west is much greater than in the east and north. These are the reasons why hay-fever and asthma, due to pollen is very much more prevalent and more severe in the west and mid-west than in the east. Assuming that the plant life is the same, the very fact that the velocity of the wind and the percentage of sunshine is so much greater would naturally increase very materially the amount of pollen that actually gets into the air. As to whether or not a patient will have hay-fever or asthma depends largely upon the number of pollen granules that actually comes in contact with the mucous membrane of the respiratory tract. It is like any other irritant, the greater the concentration the greater the irritation. If the wind blows at ten miles an hour it will bring in contact with a certain area of the mucous membrane a definite number of pollen granules, assuming for the sake of illustration twenty-five granules. This might not be sufficient to cause symptoms but if the wind was blowing at the rate of twenty miles an hour it would bring in contact with the same surface of mucous membrane twice the number of pollen granules, or fifty. This might be sufficient in quantity to produce severe hay-fever symptoms.

Conclusion

After seven years of study of the wind-borne pollinated plants in this state, along with the other factors that cause asthma and hay-fever, I have been greatly impressed with their relative importance, inasmuch as my records show that they are the cause of about 96% of the hay-fever and about 63% of all the asthma. The investigation will be continued with the hope of throwing more light on the relative value of different plants as a cause of asthma and hay-fever.