Airborne Pollen and Fungus Spores in Oregon

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Introduction

There has been an active investigation of the windborne allergenic agents in the State of Oregon since 1917. Dr. Helen M. Gilkey while curator of the Herbarium, Oregon State College (Oregon Agricultural College), and Dr. Charles T. Chamberlain, a physician in Portland, collaborated in studies to determine which of the wind-transported pollen grains were the important causes of allergy symptoms. Collections of pollen from a large number of species of plants, many of them from wind-pollinated plants, were made for Dr. Chamberlain by Dr. Gilkey in 1919 and by Dr. Albert N. Steward in 1920 while a student of Dr. Gilkey.

From 1921 through 1925 active experimental work was undertaken on the preparation of pollen extracts for the treatment of hay fever patients. During the latter years of this period, the Herbarium, under Dr. Gilkey's supervision, prepared and sold such extracts at cost to physicians in Oregon. By 1925 commercial laboratories were able to take over the preparation of the pollen extracts. Experimentation with the toxicity of the different airborne pollen grains continued over the period from 1926 to 1932.

The State of Oregon is divided from west to east into unequal areas by the Cascade Mountains, Chamberlain (1927), Stier et al. (1930), and Schonwald (1937) treated these natural divisions separately in their studies and this pattern is followed here. The crest of the Cascades contrasts greatly with the more moist western area. This area includes several large valleys and is typified by relatively low elevation, mild winters, and relatively high rainfall. Approximate yearly rainfall varies from about 2,000 mm, in the north to 1,100 mm, in the Willamette Valley, to about 875 mm, in the Umpqua Valley in the south. The rainfall comes principally during the late fall and winter months. The summers are dry. The native vegetation is predominantly one of quite dense coniferous forests. Representative native plants of this area include the following: Pseudotsuga menziesii (Mirb.) Franco, Douglas Fir; Abies grandis Lindl., Grand Fir; Picea sitchensis (Bong.) Carr., Sitka Spruce; Thuja plicata Donn., Western Red Cedar; Libocedrus decurrens Torr., Incense Cedar; Tsuga heterophylla (Raf.) Sarg., Western Hemlock; and Chamaecyparis Lawsoniana Parl., Port Orford Cedar. Accompanying these coniferous trees are a number of genera of ferns. The deciduous trees, Populus trichocarpa Torr. & Gray ex Hook., Black Cottonwood; several species of Salix, Willows; Fraxinus latifolia Benth., Oregon Ash; Corylus californica (A. D.) Rose, Hazel nut; and Alnus rubra Bong., Red Alder, are usually found along the stream banks. Quercus garryana Doug., Oregon Oak; Acer macrophyllum Pursh., Big Leaf Maple, and numerous grasses, Agrostis spp., Bromus ssp., Festuca ssp., Dactylis glomerata L., and Lolium multiflorum Lam., are to be found in the drier habitats of the Willamette Valley.

Vegetation Areas

Consensus of current opinion of allergists practicing in this area is that fern spores are of no allergenic importance. Stroh also points out that Seattle had a very low average season total of Alternaria spores while Durham (1937) in his nationwide survey found great numbers of these fungus spores in the more eastern part of the nation.

Drs. Merle W. Moore, Robert L. Benson, and Frank Perlman have recorded pollen and fungus spore counts from slides exposed in the Portland area. (Unpublished data)

Schonwald (1937) stated that “West of the Cascades we are fortunate not to have among our flora the producers of the most abundant and most virulent pollen, namely the ragweeds.” Perlman (1952) discussed the invasion of ragweed in western Oregon.

Extensive efforts to control the infestations of ragweed in Oregon were begun in August 1957. This project is supervised by George H. Moose as agent of the Department of Agriculture, State of Oregon. Some 4,600 acres of ragweed infestations were treated in 1957. The program of ragweed control is to be expanded in 1958 to include certain areas which, either because of large size or lateness of the season, were not treated in 1957.
This comes chiefly as snow during the much more severe winters or as sudden drenching thunderstorms during the otherwise dry, hot summers. Much of this region is considered to be a northern extension of the Great Basin. Representative plants of this semiarid vegetation include many species of the Gramineae (the Grass Family), the Compositae (the Composite or Aster Family), and the Chenopodiaceae (the Goosefoot Family). These three families cover immense acreages in the eastern portion of the state. Abundant trees of Juniperus occidentalis Hook. (Juniper) occur at slightly lower elevations than the extensive forests of Pinus ponderosa Laws. (the Ponderosa or Western Yellow Pine). Western Yellow Pine forests are found at medium elevations. At higher elevations, receiving more moisture, the forests are composed of species of Abies, Picea, and Pseudotsuga while other species of Pinus are rare. Irrigation is necessary in this area. As a result, several important hay fever plants have been introduced into this region.

Procedures

During the spring of 1957, 12 pollen-sampling devices for trapping airborne pollen and fungus spores were placed at various sites throughout the state (Fig. 2). The sampling device consists of a stand which supports a microscope slide on a platform about 39 inches from the ground (Fig. 1). The pollen devices are similar in design to those used by the "Maine Airborne Pollen and Fungal Spore Survey" of 1950 and 1951, and the "Survey of Airborne Pollen and Fungal Spores of New York State" in 1953 and 1954. The design is regarded as standard by the committee on National Pollen Surveys of the American Academy of Allergy.

Microscope slides 3 inches by 1 inch were coated with a very thin film of an adhesive which consisted of a mixture of 75% petrolatum (Vaseline) and 25% USP grade mineral oil. Slides were prepared with the adhesive applied and then mailed at intervals to the cooperators. The cooperator applied and then were mailed at intervals to the cooperators. The cooperator marked the date of exposure on the slide and a cover slip added. One square cm. (99 cm²) of the slide was examined. This area was examined microscopically by making six evenly distributed traverses across the area covered by a 22 mm. square cover slip. For cursory identification a magnification of 150 X was used; higher magnifications were available as required. Results were recorded for each station on daily tally sheets and at the end of the pollen season graphs were prepared.

Pollen devices were constructed by the Physical Plant and the Mechanical Engineering Department at Oregon State College, from plans furnished by Abbott Laboratories, Chicago, Illinois. Only a few of the pollen stands were available for the early pollen season. Thus, certain stations did not become operative until May and one in June. Pollen devices were placed, therefore, first at locations believed earliest in the western Oregon region and last in the later developing eastern Oregon area. As a result, data are not available for pollen from certain early plants at these stations. For example, the pollen of the native and cultivated species of Corylus (Hazelnut or Filbert) was not encountered in this study. These are common airborne pollen plants of the western Oregon area and pollination occurs near Corvallis from December to early February.

Table 1 gives the average date of beginning and terminating pollen production of certain species of plants from the areas west and east of the Cascade Mountains. This table provides data from as many as 15 stations and for a period of, in some cases, 13 years observations. Since pollen production of a particular species of plant varies considerably from year to year depending upon a multitude of environmental conditions, it is felt that this table provides valuable information as to what might be expected with several years study of airborne pollen. It should be noted that data contained are obtained from stations both in Oregon and Washington, thus the beginning date of pollen production may be listed several days later than if only Oregon station data had been used. Also, pollen dispersal would have ceased several to many days before the date given when the flowers had all fallen.

FIGURE 1: Pollen and spore trapping device

1 Made up of 5 cc. of glycerin, 10 cc. of 95% alcohol, 15 cc. of distilled water and 2 drops of a saturated aqueous solution of basic fuchsin.
Table 1. Average day that phenological development occurred in given species

West of Cascade Mountains

<table>
<thead>
<tr>
<th>Plant name</th>
<th>No. of stations</th>
<th>Pollen production begins</th>
<th>Av. no. years obs.</th>
<th>Pollen production ends</th>
<th>Av. no. years obs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abies amabilis (Doug!. ex Loud.) Forbes</td>
<td>3</td>
<td>April 28</td>
<td>7</td>
<td>May 9</td>
<td>6</td>
</tr>
<tr>
<td>Abies grandis (Doug!. ex D. Don) Lindl.</td>
<td>4</td>
<td>April 27</td>
<td>8</td>
<td>May 9</td>
<td>8</td>
</tr>
<tr>
<td>Picea sitchensis (Bong.) Carr.</td>
<td>2</td>
<td>April 25</td>
<td>1</td>
<td>May 11</td>
<td>8</td>
</tr>
<tr>
<td>Pinus contorta Doug!. ex Loud. var. latifolia Engelm.</td>
<td>1</td>
<td>May 6</td>
<td>11</td>
<td>May 18</td>
<td>13</td>
</tr>
<tr>
<td>Pinus monticola Doug!. ex D. Don</td>
<td>5</td>
<td>May 18</td>
<td>10</td>
<td>May 20</td>
<td>10</td>
</tr>
<tr>
<td>Pseudotsuga menziesii (Mirb.) Franco</td>
<td>13</td>
<td>April 21</td>
<td>9</td>
<td>May 3</td>
<td>9</td>
</tr>
<tr>
<td>Tsuga heterophylla (Raf.) Sarg.</td>
<td>7</td>
<td>April 30</td>
<td>8</td>
<td>May 11</td>
<td>8</td>
</tr>
<tr>
<td>Thuja plicata Donn ex D. Don</td>
<td>6</td>
<td>April 20</td>
<td>8</td>
<td>April 30</td>
<td>8</td>
</tr>
<tr>
<td>Acer macrophyllum Pursh</td>
<td>14</td>
<td>April 17*</td>
<td>12</td>
<td>May 13</td>
<td>10</td>
</tr>
<tr>
<td>Alnus rubra Bong.</td>
<td>15</td>
<td>April 1*</td>
<td>9</td>
<td>April 30*</td>
<td>9</td>
</tr>
<tr>
<td>Cornus nuttallii Audobon</td>
<td>13</td>
<td>April 22*</td>
<td>13</td>
<td>May 29</td>
<td>11</td>
</tr>
<tr>
<td>Populus trichocarpa Torr. &amp; Gray ex Hook.</td>
<td>7</td>
<td>April 27*</td>
<td>9</td>
<td>May 14*</td>
<td>9</td>
</tr>
</tbody>
</table>

East of Cascade Mountains

<table>
<thead>
<tr>
<th>Plant name</th>
<th>No. of stations</th>
<th>Pollen production begins</th>
<th>Av. no. years obs.</th>
<th>Pollen production ends</th>
<th>Av. no. years obs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abies concolor (Gord. &amp; Glend.) Lindl. ex Hildebr.</td>
<td>1</td>
<td>May 20</td>
<td>5</td>
<td>June 3</td>
<td>5</td>
</tr>
<tr>
<td>Juniperus occidentalis Hook.</td>
<td>2</td>
<td>May 8</td>
<td>6</td>
<td>June 19</td>
<td>7</td>
</tr>
<tr>
<td>Larix occidentalis Nutt.</td>
<td>1</td>
<td>May 30</td>
<td>5</td>
<td>June 16</td>
<td>6</td>
</tr>
<tr>
<td>Picea engelmannii (Parry) Engelm.</td>
<td>1</td>
<td>May 22</td>
<td>6</td>
<td>June 6</td>
<td>6</td>
</tr>
<tr>
<td>Pinus contorta Doug!. ex Loud. var. latifolia Engelm.</td>
<td>4</td>
<td>June 5</td>
<td>9</td>
<td>June 21</td>
<td>7</td>
</tr>
<tr>
<td>Pinus ponderosa Laws.</td>
<td>8</td>
<td>June 8</td>
<td>7</td>
<td>June 22</td>
<td>7</td>
</tr>
<tr>
<td>Pseudotsuga menziesii (Mirb.) Franco</td>
<td>2</td>
<td>May 20</td>
<td>5</td>
<td>June 8</td>
<td>8</td>
</tr>
</tbody>
</table>

1 This table was abstracted from data collected as a project of the Pacific Northwest Forest and Range Experiment Station, United States Department of Agriculture, Forest Service, Portland, Oregon and compiled by W. G. Morris of that station. This project included data obtained at 29 stations in Oregon and Washington.


Interpretation of Graphs

Figure 2 shows location of stations at which slides were exposed for collection of pollen grains and fungus spores. The mid-point of the city name of Figure 2 approximates the location of the station. The station graphs (Figures 4-15) are arranged alphabetically according to the city at or near which the exposing station was located.

Each square represents 5 grains per square centimeter of slide surface which had been exposed for a period of 24 hours. A minimum of approximately 20 grains, season total, was ordinarily required before a particular entity would be represented on a station graph. If a particular pollen was known to be from an important hay fever plant, as in the Ambrosiae, it would be graphed regardless of the number of grains encountered.

Botanical terms were used as much as possible for labeling graphs. Whenever this was not practical, a more inclusive term was applied. Family categories used in the graphs end in -aceae with the exception of the Gramineae. The Compositae (Aster Family) is subdivided into tribes or to genus. The tribes end in -eae. It was sufficient in this study to identify the spore or pollen to some category which could be of varying rank. Time did not always allow for the identification of the particular taxon to its ultimate and most precise rank in classification. For example, the Ambrosiae, Anthemideae, and Cichoreae of the Compositae, each include several genera of plants. Yet identifying the pollen grain to the particular tribe as the case might be was satisfactory and possible in the amount of time available to this investigation. A more precise determination of each pollen grain or spore would have multiplied the time required many-fold without making a significant contribution to the information obtained. The Ambrosiae in this region include the genera Iva (Poverty Weed), Pranisia (False Ragweed), and Ambrosia (Ragweed), all important hay fever plants. The Anthemideae is represented for the most part by the genus Artemisia (Sagebrush), yet some grains observed belong to the genus Anthemis (Dog Fennel). The tribe Cichoreae includes such genera as Tragopogon (Salsify) and Taraxacum (Dandelion) which often have airborne pollen.

Coniferous plants produce a considerable amount of airborne pollen. Because of great similarities in the pollen morphology, it was necessary to group pollen from the genera: Thuja (Arborvitae), Chamaecyparis (Port Orford Cedar), Libocedrus (Incense Cedar), and Juniperus (Juniper) to-
gether under the family name Cupressaceae. “Pinus” includes the winged coniferous pollen grains of the genera *Pinus* (Pines), *Picea* (Spruce), and *Abies* (Firs). Some grains listed in this category may include some produced by the genus *Cedrus* (True Cedar). Preponderance of this winged pollen, though, is due to the pines. At such stations as John Day and Baker, the pollen of “Pinus” is almost exclusively due to one pine, *Pinus ponderosa* (Western Yellow Pine).

Because of their great degree of similarity, the pollen of all grasses are grouped together under the family heading, Gramineae. In the summary chart the grass pollen has been broken arbitrarily into five size classes. This does not imply that these groups represent five species of grasses. On the contrary, certain species of grasses may produce pollen which would be found in more than one of the size groupings. Peck (1940) lists over 300 species of grasses native to Oregon and none of these can be identified to species when studying only their pollen.

The Chenopodiaceae includes such genera as *Salsola* (Russian Thistle), *Chenopodium* (Goosefoot), and *Grayia* (Hop Sage). This family may also include quite similar pollen of the Amaranthaceae (Amaranth). In the summary, the pollen from this group is divided according to the approximate number of pores found in the wall of the pollen grain.

The Ericaceae (Heath Family) is typified by a tetrahedral tetrad of pollen grains (see Fig. 3, number 21). Similarity of pollen within this family of plants makes it nearly impossible to identify a particular pollen tetrad to a certain genus and as far as is known, these are not important hay fever plants.

Three genera of ferns were identified by their spores: *Pteridium* (Bracken Fern), *Polystichum* (Sword Fern), and *Polypodium* (Loricick Fern). Their spores were found in quite large quantities. These spores are designated on the graphs merely as “Fern.” The summary includes a grouping before segregation to genera was attempted, about August 25, and after this date when the genera were segregated. No attempt was made to check on previous determinations, although it is considered that nearly all of the fern spores noted prior to this date were those of *Pteridium aquilinurn* (Bracken Fern).

Many genera of fungi produce spores which are so much alike that without following culturing procedures, it was necessary to group the spores into large and very arbitrary “classes.” “Spore Class 1” includes those genera of fungi which produce cylindrical, 1-celled spores, such as *Hormodendrum* and *Cladosporium.* “Spore Class 1” was not established as a separate group until the early part of May. Previous to this date the spores of this type were recorded in “Spore Class 2.” This would affect the following stations: Astoria, Hood River, Klamath Falls, Medford, Pendleton, Redmond, and Roseburg. “Spore Class 2” includes the small, globose, 1-celled spores. Examples of genera found in this group are *Aspergillus* and *Penicillium.* “Spore Class 3” includes the many-celled forms, such as *Alternaria* and *Stemphylium.* “Spore Class 4” includes the 4-celled spores, such as *Fusarium,* and “Spore Class 5” consists of the 2-celled forms of cylindrical shape. “Spore Classes 3, 4, and 5” are listed separately in the summary and are grouped together and graphed under the heading of “Miscellaneous Fungi.” Although the Smuts and Rusts are classified together as “Smuts,” they are summarized separately.

For clarity it was necessary when preparing certain graphs, to arbitrarily truncate certain entities. Whenever this occurred, a number is presented near the truncation, giving the correct daily total for that particular spore or pollen grain. This was particularly necessary for the graphs for John Day, Ontario, Pendleton, and Union. Overlapping areas such as occurred during the early part of June at Ontario, are indicated by the white area superimposed on the extensive black graph which in this case represents the great quantity of grass pollen occurring at this time.
Pollen Grains

All pollen grains are shown at the same magnification of approximately 380 X. These illustrations were prepared originally to show the variability in structure to be found in pollen grains. Certain forms illustrated were not observed in the course of this investigation. *Acacia*, number 16, is an important hay fever pollen found south of Oregon. *Epilobium* pollen, number 18, was not encountered and only two grains of Malvaceous pollen, such as number 24, were observed. *Ephedra* pollen, number 6, was not observed probably because no station is located in the southeastern portion of Oregon.

<table>
<thead>
<tr>
<th>Number</th>
<th>Taxonomy</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Abies procera Rehd.</td>
<td>Noble Fir</td>
</tr>
<tr>
<td>2</td>
<td>Picea sitchensis (Bong.) Carr.</td>
<td>Sitka Spruce</td>
</tr>
<tr>
<td>3</td>
<td>Cedrus libani Loud.</td>
<td>Cedar of Lebanon</td>
</tr>
<tr>
<td>4</td>
<td>Pseudotsuga menziesii (Mirb.) Franco</td>
<td>Douglas Fir</td>
</tr>
<tr>
<td>5</td>
<td>Pinus ponderosa Laws.</td>
<td>Ponderosa Pine</td>
</tr>
<tr>
<td>6</td>
<td>Ephedra nevadensis S. Wats.</td>
<td>Ephedra</td>
</tr>
<tr>
<td>7</td>
<td>Typha latifolia L.</td>
<td>Cattail</td>
</tr>
<tr>
<td>8</td>
<td>Phleum pratense L.</td>
<td>Timothy</td>
</tr>
<tr>
<td>9</td>
<td>Alnus sinuata (Regel) Rydb.</td>
<td>Thin-leaf Alder</td>
</tr>
<tr>
<td>10</td>
<td>Corylus californica (A. DC.) Rose</td>
<td>Hazelnut</td>
</tr>
<tr>
<td>11</td>
<td>Ulmus americana L.</td>
<td>American Elm</td>
</tr>
<tr>
<td>12</td>
<td>Quercus sp.</td>
<td>Red Oak</td>
</tr>
<tr>
<td>13</td>
<td>Juglans nigra L.</td>
<td>Black Walnut</td>
</tr>
<tr>
<td>14</td>
<td>Salsola kali L. var. temnifolia Tausch.</td>
<td>Russian Thistle</td>
</tr>
<tr>
<td>15</td>
<td>Chenopodium album L.</td>
<td>Pigweed</td>
</tr>
<tr>
<td>16</td>
<td>Acacia sp.</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Elaeagnus angustifolia L.</td>
<td>Russian Olive</td>
</tr>
<tr>
<td>18</td>
<td>Epilobium sp.</td>
<td>Fireweed (?)</td>
</tr>
<tr>
<td>19</td>
<td>Acer circinatum Pursh</td>
<td>Vine Maple</td>
</tr>
<tr>
<td>20</td>
<td>Acer macrophyllum Pursh</td>
<td>Bigleaf Maple</td>
</tr>
<tr>
<td>21</td>
<td>Rhododendron sp.</td>
<td>cultivar “Elizabeth”</td>
</tr>
<tr>
<td>22</td>
<td>Fraxinus latifolia Benth.</td>
<td>Oregon Ash</td>
</tr>
<tr>
<td>23</td>
<td>Plantago lanceolata L.</td>
<td>English Plantain</td>
</tr>
<tr>
<td>24</td>
<td>Malva rotundifolia L.</td>
<td>Round-leaved Mallow</td>
</tr>
<tr>
<td>25</td>
<td>Tragopogon porrifolius L.</td>
<td>Salsify</td>
</tr>
<tr>
<td>26</td>
<td>Artemisia tridentata Nutt.</td>
<td>Sagebrush</td>
</tr>
<tr>
<td>27</td>
<td>Franseria acanthicarpa (Hook.) Coville</td>
<td>False Ragweed</td>
</tr>
<tr>
<td>28</td>
<td>Ambrosia artemisiifolia L.</td>
<td>Ragweed</td>
</tr>
</tbody>
</table>
FIGURE 9: Pollen grains (explanation on facing page)
The John Jacob Astor Branch Experiment Station is located about 5 miles east of Astoria. Elevation at the station is approximately 350 feet. The pollen device was located about 75 feet east of the Experiment Station office in a clover-grass plot area.

It is significant that this station, situated only a few miles from the Pacific Ocean, revealed the presence of great quantities of pollen and spores in the atmosphere. Thus for someone suffering from some of the so-called "hay fever plants," relief can only be approximated if one lived even a shorter distance from the ocean.

The pollen season at the Astoria Station may be given as an early tree pollen period, consisting mostly of pollen from representatives of the Cupressaceae, which are not considered hay fever plants; and Alnus which causes many people great discomfort. As is shown in the graph for the latter part of March, large quantities of Alnus pollen were present in the air and this was during a period of quite heavy rainfall. Production of "Pinus" pollen follows, and then during the middle of the season an abundance of grass and Plantago (Plantain) pollen was collected. Only a very few grains of the troublesome late summer pollen of the Anthemideae were found.

Note: Each square on the graph represents 5 grains.
The Baker District Ranger compound is located in the northwest quarter of the city of Baker. Elevation is about 3,440 feet. This station was the only one where the pollen device was not at or near ground level. The pollen collecting device was placed atop a machine building about 25 feet above the ground. This placement was deemed necessary because of the dust created by the abundant motor vehicle movement occurring in the area.

The Baker station was the last station activated. As a consequence, the early season pollen production can only be assumed. A great deal of similarity is to be found in data from the Burns area. Particularly, "Pinus," Anthemideae, Ambrosieae, and the Chenopodiaceae show much the same seasonal activity. Similar order of appearance, peaks, and termination of pollen production occur in much the same sequence and at approximately the same date at both stations. The quantities of corresponding spores or pollen would naturally vary considerably.

Data from Baker appear to indicate a pollen season of 3 parts. An early season of grasses and Pines, a mid-season of Russian Thistle, and other Chenopods, which extends into a late season due to pollen from the Anthemideae, in this case nearly exclusively Artemisia (Sagebrush).

Note: Each square on the graph represents 5 grains.
Burns is located at the northern edge of the Great Basin. Elevation is about 4,150 feet. The pollen collecting device was located in the city park and was placed on a higher stand about 6 feet above the ground to be above a sprinkler system. Winds are from the northwest.

Certain surprising and unexpected data become evident from the graph for Burns. It had been expected that Burns and other stations in the eastern portion of the state would have a much greater incidence of pollen from the representatives of the Chenopodiaceae, Anthemideae, and Gramineae. Also unexpected amounts of Juglans (Walnut) pollen were found which supposedly had been carried for some distance by the wind, for, according to Sawyer, no walnut trees are to be found in Burns.

Note: Each square on the graph represents 5 grains.
The Mid-Columbia Branch Experiment Station is located a short distance south of and at a higher elevation than the city of Hood River. Elevation at the station is about 550 feet. Winds are from the west.

During the first of the season, the pollen collecting device was located in a young orchard near a blueberry planting. Because of the dust encountered on the slides due to the nearness of a dirt road, it was necessary to move the stand to a site near the main buildings of the station.

Pollen not represented on the graph because of the late start would include representatives of the Cupressaceae, Pseudotsuga, Populus, Alnus, and Betula. Even without these early pollinators, three definite pollen seasons can be determined. The early tree pollen season of Fraxinus, Juglans, and Quercus, all hay fever plants, followed by a mid-season of grasses, Pines, and Plantago, grading into a late season of Composites and Chenopods.

Note: Each square on the graph represents 5 grains.
The pollen device was located about 20 feet north of the gravel drive of the warehouse area, at the southwestern edge of John Day. Elevation is about 3,100 feet. This location is approximately 3 miles from the edge of the *Pinus ponderosa* forest. John Day is surrounded by hills covered by an abundance of *Artemisia tridentata* Nutt. (Sagebrush), *Chrysothyamus nauseosus* (Pall.) Nutt. (Rabbit Brush), and various members of the Chenopodiaceae. Scattered trees of *Juniperus* (Juniper) are present on the hillsides with *Populus* and *Salix* common along the banks of the streams. Pollen from the last two genera was not recorded because these are early pollinators and had completed pollen production prior to the establishment of the pollen collecting device.

An unexpectedly large quantity of small, globose, 1-celled spores, fungus "Spore Class 2," was consistently found throughout the season. Significance of this occurrence is not known.

The gap between the 10th and 25th of September is due to the breakage of a box of slides during transit. It is assumed that the peak of pollen production of sagebrush occurred during this interval. This would agree with the peak for sagebrush at Baker, Burns, Klamath Falls, Ontario, and Union.

Note: Each square on the graph represents 5 grains.
The Klamath Branch Experiment Station is located about 6 miles south of Klamath Lake. The pine forests are about 10 miles to the northwest and the native plants near the station include large numbers of grasses, rabbitbrush, and sagebrush. *Elaeagnus angustifolia* (Russian Olive) pollen is due to the planting of this tree in a windbreak on the north boundary of the station. It is surprising to find such low amounts of *Plantago* pollen at this and at other of the eastern Oregon stations. Also, the low quantities of Chenopodiaceae, Anthemideae, and Ambrosieae pollen were not expected.

Note: Each square on the graph represents 5 grains.
The southern Oregon Branch Experiment Station is located at Talent, approximately seven miles southeast of Medford. Prevailing winds in the summer are from the northwest. Elevation is 1,625 feet. The pollen stand was located some 200 feet from the buildings, on level ground, with no trees within 100 yards. Crops immediately surrounding the stand were barley, alfalfa, and lawn grass plots. A corn field was located about 150 feet from the stand.

It is believed that the starting date of the station at Medford coincided quite well with the beginning or before the beginning of the pollen production of most plants. An early season of tree pollen, Fraxinus, Ash; Quercus, Oak; and Juglans, Walnut, is succeeded in turn by a midseason pollen group of grasses, Plantago, Plantain; and Chenopods. A late season consists in part of a reduced rejuvenation peak in certain plants believed due to the late fall rains coming after the prolonged dry summer. The early tree pollen season is typified by appearance - peak - disappearance within a period of about 18 days.

Note: Each square on the graph represents 5 grains.
The Malheur Branch Experiment Station is located approximately seven miles southeast of Ontario, in the Snake River Valley. Elevation is about 2,140 feet. Winds are usually from the northwest.

The nearest field to the northwest was planted to several species of grasses, including *Dactylis glomerata*, Orchard Grass; *Festuca* spp., and *Bromus* spp. A windbreak is present at the station and is composed of several species of *Pinus*, *Thuja*, *Elaeagnus*, *Pseudotsuga*, *Juglans*, and *Populus*. The pollen stand was located beneath a medium sized tree of *Elaeagnus angustifolia* (Russian Olive) and near a machine building. It is believed that the location of the pollen collecting device would be improved if it were within the city of Ontario, in order to collect pollen more representative of the region.

The nearness of the field of grass is indicated by the great peak of grass pollen occurring between the 22nd of May and the 12th of June. This is in part to be expected, inasmuch as certain of these grasses are widely planted in this region, Ontario, as well as John Day, Pendleton, Redmond, and Union, shows great quantities of the small, globose, 1-celled fungus spores of "Class 2." It is possible that the grasses and the fungi producing this type of spore are associated. The graph for "Spore Class 2" was arbitrarily truncated on several days to prevent the interference of this group with the individual graphs of other entities.

The early tree pollen season had passed before the activation of the Ontario station.

Note: Each square on the graph represents 5 grains.
The Pendleton Branch Experiment Station is located about 10 miles east of Pendleton. The station is surrounded by large plantings of wheat with alternating summer fallow areas. The pollen stand was placed on a former grass test plot. The winds are from the south and southwest. Elevation is about 1,300 feet. The distance to the edge of the Blue Mountains is about 3-5 miles. A windbreak is located at the station and consists of species of Pinus, Elaeagnus, Ulmus, Platycarya, Acer, Ulmus, Populus, and Juglans.

Three pollen seasons are shown. The first consists of pollen of the early trees followed by grasses and Pines, later succeeded by the Chenopods, and finally in turn by the late Composites.

The large quantities of "Smut" and "Spore Class 2" spores are probably due to the predominance of wheat in this region. The low numbers of grass pollen are probably due to cultural practices and to the fact that wheat is self-pollinated and its pollen ordinarily does not become airborne.

It is believed that the pollen device should be located in Pendleton in order to be more representative of the area. This would then be expected to show evidence supporting the belief that Pendleton itself receives much more pollen from species of the Chenopodiaceae and Compositae, such as are found within the canyon of the Umatilla River where Pendleton is located.

Note: Each square on the graph represents 5 grains.
The pollen stand was located on a vacant lot in the residential area of Redmond until September 21. From that date it was located at the airport, one mile east of Redmond. Elevation is about 3,000 feet. The airport is located in a Juniper-forest type zone.

Pollen from only two of the early season trees was abundant enough to be graphed. The midseason pollen was represented by the grasses and Pines, with the Plantago and Chenopod pollen later appearing to be succeeded in turn by only a few grains of the late season Composites.

Note: Each square on the graph represents 5 grains.
The pollen device was located near the weather instruments about 20 feet north of the Municipal Airport Building, 2 miles north of Roseburg. Elevation is about 500 feet and the prevailing wind is north.

Three pollen seasons are evident from study of the Roseburg figure. The early season of tree pollen, *Juglans*, Walnut; *Alnus*, Alder; *Quercus*, Oak; and *Fraxinus*, Ash; all important hay fever plants, is succeeded in May and June by the grasses, Pines, and *Plantago*. These plants in turn are succeeded by a small number of the late pollen plants, *Plantago*, Plantain, at Roseburg is a very consistent and long season producer of pollen with no definite peak evident.

_Note:_ Each square on the graph represents 5 grains.
The Eastern Oregon Branch Experiment Station is located near the west city limits of Union. Elevation is about 2,780 feet. Winds at the station are from the south, thus coming principally off the nearby sagebrush covered hills, while the winds in the Grande Ronde Valley in general are from the north. The fields nearby have both native and cultivated species of grasses present. The pollen stand was located at the edge of a grass-alalfa plot.

The pollen production of most of the early trees had evidently been completed before the activation of the Union station in May. Thus the grass

and Pine pollen appear as the early season group to be replaced by the Chenopods which in turn are succeeded by the late flowering Composites.

Note: Each square on the graph represents 5 grains.
The collecting device was placed on a roof one story above the ground. This building is in the residential section of the city. Corvallis is near the center of the Willamette Valley, an area of heavy winter and spring rainfall. July, August, and September are dry. The wasteland is overgrown with grass and much land is planted to grass pasture. Grass seeds are an important crop. Poplar, Alder, and Willow line the creeks. Filberts and Walnuts are widely planted. Important weeds are Plantain and Rumex.

Two chief pollen seasons are present. Tree pollens are found from March until June. Grass pollen is the abundant pollen from May through mid-July. Plantain pollen is usually more abundant than this year’s records indicate; June is the period of its heaviest pollen production.

After mid-July the pollen drops off considerably and there is no fall pollen season. The Compositae are only rarely found. Mold spores are also not abundant. Cultures have shown Fusarium and yeasts to be important among the miscellaneous fungi.

The following table summarizes the pollen and spores found in Corvallis. The scale for the pollen represents the total number of grains under a 4.84 square cm. cover slip. The mold and fern spores are expressed in the same terms as were used by the other stations.

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<tr>
<th>Pollen Type</th>
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<td>Juglans</td>
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<td><strong>Total</strong></td>
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</table>

All pollen data, identification, and counts were made by C. E. Reed, M.D., and E. A. Wellman, Corvallis, Oregon.
Conclusions

In general three pollen seasons can be recognized. The earliest consists of pollen from trees which complete pollen production by about May 20. A second season consists of pollen from grasses and Chenopods and "Pinus". This season is succeeded by a late season of Composite pollen.

Alnus, the Cupressaceae, Fraxinus, Quercus, and Plantago pollen and the spores of the several Ferns reach their highest incidence in the area west of the crest of the Cascade Mountains. This is to be expected since few of these plants are present in the area east of the Cascades. Of the Plantago pollen, 95% was counted from the several Western Oregon stations. Pollen of Rumex acetosella was practically undetected (only 4 grains identified), yet this species of Rumex is an exceedingly common weed to Western Oregon and is also found widely in Eastern Oregon. The Chenopodiaceae, Compositae, "Pinus" pollen and the Smuts and "Spore Class 1" are produced in greatest quantity in the area of the state east of the Cascades. At several stations in Eastern Oregon "Pinus" pollen, believed principally from Pinus ponderosa, coincides with the season of greatest abundance of grass pollen. Pollen from the several species of the Chenopodiaceae and Compositae found in Eastern Oregon had been expected in much higher numbers than were actually counted. The numbers of pollen grains from these plants may have been reduced because of the "washing out" effect of rains occurring at the time of pollen production.

The Smuts and spores of "Spore Class 1" are most evident in those areas which have an agriculture based service, removed, and returned for identification of the trapped pollen grains and fungus spores. Exposure of slides began at some stations as early as March and ended at all stations in October.

Graphs were prepared at the end of the season for each of the stations showing the seasonal distribution and incidence of the various groups of airborne pollen and fungus spores.

Summary

A preliminary survey was undertaken during the pollen season of 1957 to determine the incidence of airborne pollen and fungus spores at 12 stations, located according to vegetational areas and population distribution. The station locations were: Astoria, Baker, Burns, Hood River, John Day, Klamath Falls, Medford, Ontario, Pendleton, Redmond, Roseburg, and Union. Coated microscope slides were exposed at daily intervals in a pollen de-vator, prepared and exposed for identifications. Nearly 180,000 spores and pollen grains were identified. Since culturing methods were not employed in conjunction with this study, it was necessary to group the greater number of the fungi into 5 arbitrary spore classes.

Data obtained from this study should aid physicians in diagnosing and treating specific allergic reactions due to certain airborne pollen and fungus spores.

References


Table 2. Summary of Pollen Concentrations

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Fungus Spore Counts, 1957.
Acknowledgments

The methods and procedures reported in the University of Maine "Air-Borne Pollen and Fungous Spore Survey," 1953, have been followed extensively.

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   S. M. Dietz, Chairman of the Department, Coordinator.
   S. Conrade Head, Research Assistant in Systematic Botany.
   C. M. Leach, Assistant Plant Pathologist.
   A. N. Steward, Associate Professor of Botany and Curator of the Herbarium.
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      H. B. Howell, Superintendent.
      Miss Frances Evans, Cooperator.
      Sydney W. Pryor, Cooperator.
   b. Burns, Squaw Butte-Harney Branch Experiment Station.
      W. A. Sawyer, Superintendent.
      Mrs. Virginia Cobb, Cooperator.
      Thomas Anderson and staff of the local office of the Weather Bureau took care of the pollen device on Saturdays and Sundays.
   c. Hood River, Mid-Columbia Branch Experiment Station.
      W. W. Mellenithin, Superintendent.
      Wilmer K. Meyle, Cooperator.
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      A. E. Gross, Superintendent.
      Mrs. Laverne Kendall, Cooperator.
      Virgil Koch, Cooperator.
   e. Medford, Southern Oregon Branch Experiment Station.
      H. H. White, Superintendent.
      Ted Kenyon, Cooperator.
      C. Leroy Welch, Cooperator.
   f. Ontario, Malheur Branch Experiment Station.
      E. N. Hoffman, Superintendent.
      Mrs. E. N. Hoffman, Cooperator.
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      H. K. Fisher, Cooperator.
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