Analysis of Airborne Pollen Grains in Annaba, (Northern-East Algeria)

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ABSTRACT

Some biological particles present in the atmosphere, such as pollen grains, give rise to human health problems, allergies. Airborne pollen distribution in Annaba was measured gravimetrically during 3 consecutive years, 2007, 2008 and 2009, on a daily basis. A total of 29745 grains/cm² belonging to 18 taxa were determined. In 2007 the total was 4906 pollen grains/cm² and in 2008 it was 6580 pollen grains/cm² and in 2009 it was 8569 grains/cm². Among the taxa recorded, 10 belong to arboreal and 8 to nonarboreal taxa. At the end of the 3 years total pollen counts comprised 33.86 % arboreal, 64.71 % nonarboreal, and 1.43 % unidentified taxa. The number of pollen grains/cm² among arboreal plants was as follows: Pinaceae (12.07 %), Cupressaceae (6.59 %), Oleaceae (4.35 %), Eucalyptus sp. (4.22 %), Salicaceae (3.02 %), Betulaceae (2.25 %), and for nonarboreal representatives: Poaceae (14.46 %), Asteraceae (16.37 %), Brassicaceae (14.35 %), Ericaceae (6.84 %), Plantaginaceae (5.20 %), Chenopodiaceae (2.16 %), Myrtaceae (1.44 %) and Apiaceae (0.19 %). The distribution of pollen in the atmosphere of Annaba was highest in May, followed by April and March. The results indicate that pollen grains of plant disperse extensively and transports widely in the lower atmosphere. Also, annual pollen indices do not decline even when the distance over a wide area with humans, resulting in allergic reactions [15].

INTRODUCTION

The release of amounts of pollen grains in the atmosphere by the male reproductive units of plants for the purpose of pollination is a natural phenomenon. However, during this release pollen grains come into contact with humans, resulting in allergic reactions [15].

Airborne pollen data have been used in recent years as phenological indicators of the timing of flowering over a wide area [16], and to evaluate delays or advances in the onset of pollination in major delays or advances in the onset of pollination in major wind-pollinated species. Although airborne pollen counts are strongly influenced by the vegetation sur-rounding the pollen trap, year-on-year variations may be attributed to a wide range of parameters, particularly weather conditions both before and during pollination.

Recent changes in the above-mentioned pollen season characteristics were reported concerning an earlier onset [21]; [9]; [19] and [17], earlier end date [20] and [19], a longer pollen season [20], an increase in the daily peak pollen counts [19] and an earlier incidence of peak day [20].

In each bio-geographic area, different species make up the characteristic airborne pollen calendar [14], the composition of which is controlled by meteorological conditions that are changeable among years and microclimates.

Aerobiological studies are of a great interest from an ecological and agricultural point view, but they are of special interest to clinicians and allergy patients as a means of establishing a chronological correlation between the air pollen concentration and hay- fever and asthma symptoms [13].

A large number of studies of the pollen contents in the air have been conducted in the worldwide (I4; [10]; [16]; [4]; [3] and [5]). All of these studies found the relationships between pollen’s concentration in the air and expansive ability in the urban environment.

The aim in the present study was to investigate the airborne pollen distribution in the region of Annaba. A characterization of anemophyllous taxa in the region was undertaken and variation of pollen production recording during 3 consecutive years, 2007, 2008 and 2009, and to determine the effect of weather parameters...
on daily pollen concentration. The results obtained are expected to provide a pollen distribution calendar for the area in order to help in prevention of allergic reactions in individuals with pollen hypersensitivity.

**MATERIALS AND METHODS**

Annaba (36°49’58"N, 7°48’40"E) is situated in north eastern part of Algeria, covering approximately 1439 km² with a population of around 621,021 inhabitants, has a typical Mediterranean climate. The area shows a rich plant diversity of both wild and cultivated forms. This diversity is exhibited in the pollen spectrum as well. The majority of the sources of airborne pollen are present in the local and regional flora.

Mean annual temperature in Annaba is 22 °C. More precipitation is recorded annually 650m.

In Annaba, for the period 2007-2009 atmospheric pollen distribution was recorded using gravimetric method and Durham sampler [8] on a daily basis by placing a trap at a height of 20 m.

The pollen concentration is expressed as the daily average of pollen grains per cm² of surface. The types of pollen recorded in the atmosphere of Annaba are presented as a pollen calendar in figure 6, based on total weekly counts of pollen grains/cm² in 2007, 2008 and 2009.

**RESULTS AND DISCUSSION**

During pollen monitoring, there was demonstrated a greater diversity of airborne pollen in Annaba. 18 taxa were identified, marked quantitative differences were also found.

The numbers recorded on a yearly basis were 4096 pollen grains/cm² in 2007, 6580 grains/cm² and 8569 pollen grains/cm². Among the taxa recorded, 10 taxa were arboreal and 8 nonarboreal. The total percentage of pollen grains in the atmosphere during the 3 studied years was 33.86% arboreal (10073 pollen grains/cm²), 64.71% nonarboreal (19245 pollen grains/cm²), and 427 pollen grains/cm² unidentified plant taxa (table1).

Among woody taxa, maximum daily pollen concentrations were as follows: Pinaceae 3593 pollen grains/cm², Cupressaceae 1960 grains/cm², Oleaceae 1298 grains/cm², Eucalyptus sp. 1256 grains/cm², Salicaceae 899 grains/cm², Betulaceae 669 grains/cm², Juglandaceae 190 grains/cm², Fagaceae 134 grains/cm², Rosaceae 60 grains/cm² and Mimosaceae 14 grains/cm².

Among the herbaceous taxa the concentrations were found to be: Poaceae 5491 pollen grains/cm², Asteraceae 4896 grains/cm², Brassicaceae 4267 grains/cm², Ericaceae 2035 grains/cm², Plantaginaceae 1547 grains/cm², Chenopodiaceae 644 grains/cm², Myrtaceae 334 grains/cm² and Apiaceae 58 grains/cm².

The highest airborne pollen concentrations in Annaba were found in May followed by April.

The total pollen counts in the atmosphere during May, April, March, June was 32.23%, 21.01%, 12.4%, 12.10 % and 8.12 % respectively. These values amount to 90.08% of the total pollen content in the atmosphere. Monthly variations in the number of arboreal and nonarboreal airborne pollen are presented in Figure 2. The frequency of pollen from both groups on a monthly basis shows that nonarboreal pollen dominates in May and April.

**Table 1:** Total pollen content (cm³) and their percentage on annual basis (during 2007, 2008 and 2009).

<table>
<thead>
<tr>
<th>Arboreal taxa</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>Total</th>
<th>%</th>
<th>Days with max. concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pinaceae</td>
<td>474</td>
<td>1512</td>
<td>1607</td>
<td>3593</td>
<td>12.07</td>
<td>23 Apr.</td>
</tr>
<tr>
<td>Oleaceae</td>
<td>267</td>
<td>431</td>
<td>600</td>
<td>1298</td>
<td>4.36</td>
<td>2 May</td>
</tr>
<tr>
<td>Eucalyptus sp.</td>
<td>108</td>
<td>840</td>
<td>308</td>
<td>1256</td>
<td>4.22</td>
<td>4 Apr.</td>
</tr>
<tr>
<td>Salicaceae</td>
<td>84</td>
<td>290</td>
<td>525</td>
<td>899</td>
<td>3.02</td>
<td>13 May</td>
</tr>
<tr>
<td>Betulaceae</td>
<td>180</td>
<td>202</td>
<td>287</td>
<td>669</td>
<td>2.25</td>
<td>15 Apr.</td>
</tr>
<tr>
<td>Juglandaceae</td>
<td>13</td>
<td>64</td>
<td>113</td>
<td>190</td>
<td>0.64</td>
<td>12 May</td>
</tr>
<tr>
<td>Fagaceae</td>
<td>23</td>
<td>43</td>
<td>68</td>
<td>134</td>
<td>0.45</td>
<td>29 Apr.</td>
</tr>
<tr>
<td>Rosaceae</td>
<td>19</td>
<td>04</td>
<td>37</td>
<td>60</td>
<td>0.21</td>
<td>6 Apr.</td>
</tr>
<tr>
<td>Mimosaceae</td>
<td>02</td>
<td>10</td>
<td>14</td>
<td>14</td>
<td>0.05</td>
<td>15 Mar.</td>
</tr>
<tr>
<td>Total</td>
<td>1325</td>
<td>3563</td>
<td>4491</td>
<td>10073</td>
<td>33.86</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Nonarboreal taxa</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>Total</th>
<th>%</th>
<th>Days with max. concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poaceae</td>
<td>1406</td>
<td>1543</td>
<td>2542</td>
<td>5491</td>
<td>18.46</td>
<td>25 Apr.</td>
</tr>
<tr>
<td>Asteraceae</td>
<td>1259</td>
<td>1726</td>
<td>1884</td>
<td>4869</td>
<td>16.37</td>
<td>17 Apr. - 3 May</td>
</tr>
<tr>
<td>Ericaceae</td>
<td>346</td>
<td>775</td>
<td>914</td>
<td>2035</td>
<td>6.84</td>
<td>4 Apr.</td>
</tr>
<tr>
<td>Plantaginaceae</td>
<td>312</td>
<td>523</td>
<td>712</td>
<td>1547</td>
<td>5.20</td>
<td>2 Apr. - 5 May</td>
</tr>
<tr>
<td>Chenopodiaceae</td>
<td>50</td>
<td>213</td>
<td>381</td>
<td>644</td>
<td>2.16</td>
<td>17 May</td>
</tr>
<tr>
<td>Myrtaceae</td>
<td>54</td>
<td>137</td>
<td>143</td>
<td>334</td>
<td>1.14</td>
<td>21 Apr.</td>
</tr>
<tr>
<td>Apiaceae</td>
<td>14</td>
<td>21</td>
<td>23</td>
<td>58</td>
<td>0.19</td>
<td>23 May</td>
</tr>
<tr>
<td>Total</td>
<td>4096</td>
<td>6580</td>
<td>8569</td>
<td>19245</td>
<td>64.71</td>
<td></td>
</tr>
</tbody>
</table>

Pollen N. D. | 59 | 119 | 249 | 427 | 1.43 |
In January and February only Poaceae and Asteraceae pollen was found in the atmosphere. In March, pollen of 7 taxa was recorded and among these Poaceae were dominant. In April, 17 taxa were identified, the dominant ones being Poaceae (4.82%), Pinaceae (4.23%) and Asteraceae (3.25%) and Cupressaceae (2.92%). The highest number of taxa (18) releasing pollen was recorded during May, the maximum being Oleaceae (9.7%), Poaceae (8.2%) and Asteraceae (6.4%). Seven taxa were recorded in June, dominated by Poaceae and Pinaceae. The number decreased to 7 taxa in July, including mainly Poaceae, Chenopodiaceae and Asteraceae. The number was very low (2 taxa) in August, dominated by Asteraceae and Poaceae.

Fig. 1: Monthly variation in the total number of arboreal and nonarboreal airborne pollen taxa in Annaba (2007-2009).

Out of the total of 18 taxa recorded in the atmosphere, 90.3 % belonged to only 7 taxa. The following taxa produced the greatest amounts of pollen in the atmosphere of Annaba (Figure 1, 3; Table 1).

Poaceae:
This is the family with the highest number of pollen, found between the 2 \textsuperscript{nd} week of February and 1st week of August. The values reached a peak in the last week of April.

Asteraceae:
Asteraceae pollen was found in the atmosphere of Annaba from the 3 \textsuperscript{rd} week of January up to the end of August. The highest values were found in the 3 \textsuperscript{rd} week of April and the 1\textsuperscript{st} week of May.

Brassicaceae:
Brassicaceae pollen in Annaba atmosphere dominated from the 2 \textsuperscript{nd} week of February until the last week of July. The highest values were recorded during the 3 \textsuperscript{rd} week of April.

Pinaceae:
This is the taxon with the highest number of pollen among arboreal taxa. Pollen of Pinaceae was found in the atmosphere of Annaba from 1\textsuperscript{st} week of March until the 2\textsuperscript{nd} week of June. The highest values were recorded during the 3\textsuperscript{rd} week of May.

Ericaceae:
The pollen of Ericaceae dominated the atmosphere of Annaba from the 1\textsuperscript{st} week of March to the 3\textsuperscript{rd} week of May. The highest values were recorded during the 1\textsuperscript{st} week of May.

Cupressaceae:
Cupressaceae pollen was found in the atmosphere of Annaba from the 2\textsuperscript{nd} week of February up to the end of April. The highest values were recorded during 2\textsuperscript{nd} week of March.

Plantaginaceae:
Plantago species pollen dominated in the atmosphere of Annaba from the 3\textsuperscript{rd} week of February until the 1\textsuperscript{st} week of June. The highest number was found during the 2\textsuperscript{nd} and 4\textsuperscript{th} weeks of May.

Other taxa with comparatively low percentages from the typical Mediterranean plant group distributed in the atmosphere of Annaba are: Oleaceae (4.36%), Eucalyptus sp. (4.22%), Salicaceae (3.02%), Betulaceae (2.25%), Chenopodiaceae (2.16%), Myrtaceae (1.14%) and Apiaceae (0.19%).

Pollen disposition reflects the vegetation occurring in a given area. Concentrations of airborne pollen in the atmosphere of Annaba vary both for the annual total amount of pollen and for the annual values of different species for the 3 years period of records.

A comparison of the present findings with gravimetric studies undertaken by our research laboratory in Annaba [18], [2] shows that there is not much difference in the percentage distribution of plant taxa in the
atmosphere. Specifically, the highest numbers of pollen of the arboreal plants followed the trend \textit{Pinaceae}, \textit{Cupressaceae} and \textit{Oleaceae}, and for nonarboreal \textit{Poaceae} were followed by \textit{Asteraceae} and \textit{Brassicaceae}.

In many other Mediterranean countries several aeropalynological studies have been conducted for many years using different types of samplers (Burkard or Lanzoni types samplers). In Porto (Portugal) the total pollen content was 88\% and all the pollen producing taxa belonged to woody taxa \cite{1}. In Cagliari (Italy) the pollen distribution was as follows: \textit{Cupressaceae} (51.13\%), \textit{Pinaceae} (20.39\%), \textit{Urticaceae} (5.13\%), \textit{Oleaceae} (3.58\%) and \textit{Polygonaceae} (2.76\%). The pollen spectrum in Nerja (southern Spain) has been reported as \textit{Pinus} (25.04\%), \textit{Olea} (19.93\%), \textit{Urticaceae} (14.03\%), \textit{Cupressaceae} (13.89\%) and \textit{Poaceae} (7.21\%) \cite{7}. In Córdoba (southern Spain) the pollen spectrum has been reported as \textit{Quercus} (59.81\%), \textit{Poaceae} (13.2\%), \textit{Olea europaea} (10.99\%) and \textit{Plantago} (4.71\%) \cite{8}.

An evaluation of these results reveals that pollen taxa reported from these countries resemble ours. The main reason for this is that all these countries experience a Mediterranean climate and have plant taxa typical of the Mediterranean region \cite{11}; \cite{22} and \cite{12}. Moreover, in all these studies woody taxa are best represented in numbers. For Annaba, the pollen concentrations of herbaceous taxa is the higher than that woody taxa. The reason for this is the high amount of pollen production by various herbaceous taxa. However, in Vinkovci (Croatia), again a country with a Mediterranean climate, similar studies showed that there is a predominance of herbaceous pollen like \textit{Urticaceae} (46.58\%) and \textit{Poaceae} (11.01\%) \cite{21}.

The taxa with reported allergic effects were recorded by us in Annaba as well, the types of pollen present in the atmosphere of Annaba are shown in the form of a pollen calendar in Figure 4 based on total daily counts of pollen grains/cm$^2$ during 2007-2009, in the list of the 18 taxa with the maximum number of atmospheric pollen.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{pollen_calendar}
\caption{Arboreal pollen concentrations (in percentage) per taxon.}
\end{figure}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{pollen_calendar}
\caption{Nonarboreal pollen concentrations (in percentage) per taxon.}
\end{figure}

\textbf{Conclusion:}

The results set out here are a good indication of the behavior of airborne pollen captured in the air of Annaba through the year, and over the three years. These ascertain is based on the reasonably long period (3 years) of observations, which moreover included a period of drought - a frequent feature of the Mediterranean climate.

With regard to allergy prevention, high concentrations of allergenic types are recorded at three moments in the year: February (\textit{Cupressaceae}), March (\textit{Poaceae}), and May (\textit{Olea}). The composition of the Annaba pollen spectrum reflects the natural vegetation surrounding the city (\textit{Fagaceae}), agricultural lands (\textit{Oleaceae}), reforestation with alien species (\textit{Eucalyptus}), and the ornamental flora of the city itself (\textit{Cupressaceae}).

Records of 18 allergenic pollen species were conducted in the area of Annaba during the last 3 years (2007-2009) and are presented in a pollen calendar, a fact very important for our city and country both from medical
and biologic view. All data are presented in our area for the first time and could comprise the infrastructure of many medical, biologic and other scientific fields’ applications.

Fig. 4: Pollen calendar of Annaba (2007-2009).

Finally, a detailed study of the aeropalynology of types having important socio-economic implications in the region (such as the olive), in which palynological, meteorological, and agronomical data are contrasted, offers the possibility of forecasting when pollen will start to be present in the air (which is very important in the field of allergies) and the size of the crop (which is very important for agriculture).

REFERENCES


