BIOLOGY OF AEROALLERGENS IN LATIN AMERICA

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1. Biological Air Pollution

Atmospheric particles in the air play a crucial role in any global climate scenario. Aerobiology is the science of organisms or biological particles with airborne biological activity (viable or nonviable), their origin, transport and deposition in relation to weather conditions and their impact on humans, animals or plants. The quantitative and qualitative assessment of biological particles in the air has local and temporal variations. Hence the validity and importance of aerobiological studies in different geographic locations and at different times of the year. The particle size ranges from 0.01 to 100 microns. Viruses belonging to the smallest particles, pollens to the largest. Biological particles such as those from the skin, bacteria, pollen, fungi, and similar ones, are a component of air pollution more significant than had been thought until now, being so, of total air pollutant particles, up to 25% may be biological (1).

Adverse effects of ultrafine particles are linked to their ability to gain access to the airways, eyes, skin and circulation causing damage and inflammation. Among them, those that are capable of producing an immediate inflammatory reaction, such as pollens and fungal spores, common in the atmosphere are called aeroallergens, often very powerful and involved in allergic respiratory diseases (2). The analysis of aerosol particles in the Earth's atmosphere constitutes important challenge, as particle concentrations are low, the particles are small and have a highly complex composition. Therefore, the knowledge of their properties is crucial to understanding how they influence the climate and human health (3).

2. Hay Times

Man is attacked by epidemic fevers by inhaling air with "pollutants that are hostile to the human race," said Hippocrates (460-377 BC) (4). With an interesting integration of different professions, English physician and botanist Nehemiah Grew (1628-1711) (5), made the first morphological descriptions of pollen. The study of pollinosis has had a significant clinical advance, when Van Helmont (1577-1644) described the so-called "summer asthma" and recognized the symptoms of asthma that it suffered, as caused by a substance carried in the air (6).

Years later, the English physician John Bostock (1773-1846), who suffered from childhood nasal and ocular symptoms presented annually and bronchial symptoms at 16 years old, made before the Royal Medical Society, a classical description of his own rhinitis and seasonal allergic conjunctivitis (only expressed during summer), calling it "summer cold" and acknowledged in writing "A case of a periodical affection of the Eyes and Chest" (1819) the possibility of fresh hay as their cause, citing further exposure to irritants and other airborne odors (7). In 1819 the english physician Charles Blackley suffered an attack of hay fever by picking up a bundle of grass, relasing the pollen dust, describing pollen, especially the grass pollen, as the cause of this condition and dyspnea of asthma ("Experimental Research on the Causes and Nature of Catarrhus aestivus - Hay Fever and Hay Asthma - 1873) (8). Blackley, in his early pursuit of scientific evidence on the causality of their own pollen hay fever, performed the first immediate hypersensitivity skin test applying a bit of grass pollen on his skin scarification demonstrating for first time the relationship between pollen and allergy. Blackley went further and wanted to demonstrate the presence of pollen floating in the air, using a sticky substance on a kite, to which pollen was trapped at different heights and then observed under a microscope, becoming the initiator and converting the kite in the first aerobiological monitoring tool (9). The time has proved right in recognizing Blackley as the first observer of grass pollen as the most important cause of seasonal allergic rhinitis (mainly in countries with marked seasons) due to its widespread distribution in much of the world and its high allergenicity.

3. Aeroallergens: Air Bioparticles

For high-allergenicity pollens from grasses, a concentration of 50 grains per m3 of air is considered capable of producing symptoms almost in 100% of patients susceptible to them (10). Once in the air, a minority of particles can be transported over many hundreds of miles before settling. In general, the clinical effects are intimately associated with the proximity of the source, but as with ragweed pollen and some herbs, easily cause allergic symptoms to several dozens of kilometers away (11). The fungal spores and conidia usually occur throughout the year in the air outdoors and can even exceed the concentrations of pollen grains in 100 to 1000 times, depending on environmental factors and the availability of nutrients, moisture, temperature and wind (12). There are fungi in the air permanently, more common in indoor environments, among which are some of the greatest importance to man as Aspergillus, Penicillium or Alternaria. The distribution of fungal spores and pollens varies annually because their behavior is influenced by different weather conditions such as altitude and latitude, among others. In recent decades, and as a result of increased respiratory allergies in the human population, especially children, interest in this type of research has been increasing.

In connection with the fungi are forms of life known to be widely distributed in nature. Unlike pollinating plants, not evolutionary cycles are defined, but grow as a function of temperature and humidity. Its habitat may be in open spaces, depending on the weather or in small spaces (microhabitat) regardless of the weather variables. Most of them take place in optimal conditions between 20-40 ° C and relative humidity ranging from ideal 75-95%, although many of land fungi can survive in prolonged droughts. Rain, fog and relatively humid conditions that prevail during the hours of darkness favor high levels of spores. In the domestic environment are areas where there is moisture and organic matter. The spores have also proteins, glycoproteins and polysaccharides and are released by many fungal species of interest allergy (13).

4. Global Warming: Impact on Aeroallergens

Due to global warming that has been happening in recent decades there has been an increase in the concentration of certain pollen allergens. Most likely the carbon dioxide (CO2) will double the current levels over the next century. Studies show that with a high CO2, plants respond with an increase in photosynthesis and biomass production and reproductive effort. This increase exposure to airborne pollens. In experimentally controlled environments

Ambrosia pollen production of a potent allergen, produces up to 90% more pollen in the presence of high CO_2 conditions. Similar effects occur at high temperatures. Finally, there are changes in the distribution of certain plants in response to environmental changes, resulting in individuals exposed to greater amounts of pollen (14).

Fungi also have higher growth and sporulation with prolonged exposure to elevated CO_2. With the expected increase in CO_2 in the coming decades we can infer that there will be an increase in fungal biomass, which could result in a change in the behavior of many individuals predisposed to fungal allergy. Anticipated changes in rainfall patterns, bringing more floods, rising sea levels, indicating that a high likelihood of wet interior surfaces for growth of fungi. Increased exposure to airborne allergens and pollutants can act synergistically to increase the allergic response and breathing problems in the years ahead. These are real influences on climate change that have been impacting and will continue doing in aeroallergen behavior (15).

5. Prevention: The Best Medicine.

You can use predictive models for forecasting short and long term changes in concentrations of pollens. Fungal sprays indoors are largely a reflection of the concentrations that occur in outdoor spaces. The best prevention of fungal growth is, so far, the control of humidity in indoor environments (12). The complex interaction between multiple climatic parameters are perhaps the key to the relationship between meteorology and Aerobiology allowing a prognosis of the patterns of aeroallergens in places where there is regular monitoring carried out for several years (16, 17, 18) (17: see Appendix 1) (18: see Appendix 2). This provides reliable parameters for taking preventive measures by public health policies and individual, according to the specific environment and the sensitivity of the pediatric patient.

6. Aerobiology of Colombia and Latin America

In Latin America, the first study of pollen allergens was published in 1958, conducted by Dr. P. Naranjo (19). In Colombia, Dr. Mario Sanchez Medina, a true pioneer in the field, concludes that the most common allergenic pollens in Bogota, associated with asthma and rhinitis, are pasture grasses, some weeds such as Chenopodiaceae and Amaranthaceae and a group of trees as acacia, poplar and cedar (20,21,22,23,24,25). In Cali R. Alvarez, M.A. Kings and C.D.

Madriñan do a study in 1965 on spores (26), not including rust, a fungus common in different crops like coffee, and in 1969 was performed a study of environmental fungi in Bucaramanga by M. Rincon and M. Macias (27). Two decades later, in Colombia was published a study of pollen and spores for one continuous year, held in Bogotá by Ines Hurtado and colleagues in 1989 (28), and then FJ Leal and his team make a pollen calendar for two years (29), followed by an interesting study on the fractionation of proteins allergenic Oleaceae (30). In Barranquilla pollen and mold calendars have been doing for several years (31, 32) (31: see Appendix 3) (32: see Appendix 4) and a correlation between fungi spores and rain during six years was carried out (33) (33: see Appendix 5). Finally, in Bucaramanga, Cabrales and colleagues make the first aerobiological study of the city (34) (35).

As we can see, there are several stations in Latin America that monitor air particles of pollen and molds daily. There is an increasing necessity of working in the characterization of the biological properties of local aeroallergens. Then, by way of concise information, we do a very brief account of some of the key findings in aerobiological studies in Latin American.

ARGENTINA

Bahía Blanca, Murray MG. (36)

Pólenes
1. Amaranthus/Chenopodiaceae *2.* Myrtaceae *3.* Poaceae

Buenos Aires, Nitiu DS (37),

Pólenes
1. Arboles: *Cupressus, Fraxinus, Myrtaceae, Casuarina, Celtis, Morus* 2. Gramíneas 3. Malezas: *Ambrosia,* Urticaceas, Cheno-Amarantaceae

La Plata, Nitiu DS (38, 39, 40)

Pólenes
Acer, Fraxinus, Platanus, *Ambrosia*, Cyperaceae, Chenopodiaceae-Amaranthaceae, *Plantago*, Poaceae and Urticaceae. Cupressaceae, Poaceae, Myrtaceae, *Celtis, Casuarina* and *Morus*

Mar del Plata, Latorre (41, 42, 43, 44)

Pólenes
1. Arboles: *Cupressus* (74%), *Platanus, Ulmus, Quercus, Myrtaceae, Fraxinus.* 2. Gramíneas : *Avena, Bromus, Lollium, Hordeum, Festuca ,Poa, Cynodon*

Rosario, Gatusso S. (45, 46)

Pólenes
Arboles: *Platanus, Acer, Fraxinus, Cupressus, Casuarina,*

COLOMBIA

Barranquilla, Cepeda AM, Villalba S. (31. 32, 33)

Pólenes	Hongos
1. Arboles: Moraceae*, Cecropia* 2. Pastos (gramíneas). Varias. *Typha dominguensis. Typha angustifolia*: herbáceas acuáticas; enero-mayo 3. Malezas	1. Deuteromycetos(72%): *Cladosporium, Aspergillus/Penicillium* 2. Ascosporas (23%) 3. Basidiosporas (5%)

Bogotá, Leal FJ et al. (28, 29)

Pólenes	Hongos
1.Arboles (75%). Urapan, ciprés, pino. 2. Malezas (13%) 3. Pastos (gramíneas) (10%). Urticaceae	5 veces más esporas de hongos que pólenes *Cladosporium, Penicillium/Aspergillus*

Bucaramanga, Cabrales CC, y cols. (34, 35)

Pólenes	Hongos
1. Arboles (6.5%): yarumo *(Cecropia pultata),* árabol *del pan(Artocarpus altilis, (Moraceae,* ciprés *(Cupressus lusitanica).* 2. Gramíneas (pastos) (19%). 3. Malezas(2.4%).	85% de las partículas encontradas en el aire

CHILE (47, 48)

Santiago de Chile, Rojas G, Ibáñez V.

Pólenes	Hongos
Arboles: *Platanus, Acer, Cupressus, Morus, Fraxinus.* Poaceae, Chenopodiaceae, Urticaceae, *Plantago* and Oleaceae	*Cladosporium* (70.9 %), *Alternaria, Stemphylium, Torula*

MEXICO

Mexico, DF, Mejía Ortega, Orozco S. (49, 50, 51, 52)

Pólenes
Arboles: *Pinus, Fraxinus, Agnus, Juniperus*, Myrtaceae. Abetos (*Abies*), robles (*Querucs*), álamos (*Populus*). Gramíneas : bermuda, ballico. Malezas : *Cosmos, Helianthus.*

Monterrey, Gonzalez A., Herrera D, Rodriguez P., Gonzalez SN et al (53), DF, Rocha A, Alvarado M. et al. (54)

Pólenes
Amaranthaceae-Chenopodiaceae, Ambrosia , Cupressaceae-Taxodiaceae, Fraxinus sp, Parietaria Pensolvanica Poaceae.

URUGUAY

Montevideo, Tejera L. (55)

Pólenes
Poaceae, *Platanus,* Cupressaceae, Cyperaceae, Urticaceae, Myrteceae, *Artemisia, Ambrosia*

VENEZUELA

Caracas, Hurtado I., Perdomo-Ponce (56, 57, 58, 59)

Pólenes
Arboles: *Cecropia, T.celtis, T. pusenia, T. chlorosphora, T. sortea, Myrtaceae* Gramineas Malezas

Altos de Pipe, zona vecina a Caracas, Hurtado I. (60)

Pólenes
Arboles (63%): *Curessus, Pinus, Cecropia, Casuarina, Artocarpus, Eucalyptus.* Gramineas: Capim melao (*Melinis minutflora).* Pastos (3.7%)

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Appendix 1.

Correlation between Atmospheric Grass Pollen Levels and Three Weather Variables during 2002-2004 in a Tropical Urban Area

A.M. Cepeda, M. Wilson, S.E. Villalba, H. Avila, J. Hahn

RATIONALE: We explored the relationship of atmospheric grass pollen levels (grains/m^3) with precipitation (mm), wind velocity (m/s) and temperature (Celsius) in Barranquilla, Colombia. We are unaware of any similar studies in this region.

METHODS: The data were collected from January, 2002 to December, 2004. We collected the pollen data using a Rotorod at the Universidad Metropolitana. We obtained the local weather data from IDEAM. Statistical analyses consisted of regression diagnostic plots, the Durbin-Watson statistic and linear regression.

RESULTS: The Durbin-Watson statistic was 1.53, indicating no significant problems with autocorrelation. Regression diagnostics showed linearity with only minor deviations from normality. The r^2 revealed that about 41% of the variability in atmospheric grass pollen level is explained by the model. Wind velocity was not significantly correlated with grass pollen in the presence of the other two variables. The coefficient for precipitation was -0.272 (std. error=0.082, p-value=0.002). Thus, when temperature is held constant, for every millimeter increase in precipitation we expect an average decrease of 0.272 grass pollen grains/m^3. The coefficient for temperature was -22.995 (std. error=9.578, p-value=0.022). Thus, when precipitation is held constant, for every degree increase in temperature we expect an average decrease of 22.995 grass pollen grains/m^3.

CONCLUSIONS: Grass pollen levels were negatively correlated with temperature and precipitation, but were not significantly correlated with wind velocity during the period of this study. This study reveals that even in a tropical region with perennial warm weather, some weather variables can have a marked effect on grass pollen variability and be used in predictive modeling.

Appendix 2

Correlation between Atmospheric Tree Pollen Levels with Three Weather Variables during 2002-2004 in a Tropical Urban Area

M.D. Wilson S.E. Villalba H. Avila J. Hahn A.M. Cepeda

RATIONALE: This study explores the relationship of tree pollen (grains/m^3) levels with precipitation (mm), wind velocity (m/s) and temperature (Celsius) in Barranquilla, Colombia. We are unaware of any existing similar studies in this region.

METHODS: The data were collected from January, 2002 to December, 2004. We collected the pollen data using a Rotorod at the Universidad Metropolitana. We obtained the local weather data from IDEAM. Statistical analyses consisted of regression diagnostic plots, the Durbin-Watson statistic and linear regression. A $\log_{10}$ transformation of the pollen variable was used to correct for non-linearity and heteroscedasticity.

RESULTS: The Durbin-Watson statistic was 1.186, indicating no significant problems with autocorrelation. Regression diagnostics showed only minor deviations from normality.

The *r square* value revealed that about 53% of the variability in atmospheric tree pollen level is explained by the model. The coefficient for precipitation was b_1=0.003 (std. error=0.001, p-value=0.001). The coefficient for temperature was b_2=0.362 (std. error=0.077, p-value=0.000). The coefficient for velocity was b_3=0.129 (std. error=0.052, p-value=0.018). For every unit increase in each predictor variable, all others held constant, we expect average atmospheric tree pollen to increase by a factor of 10^b. That is, an increase of 0.7% for precipitation, 230% for temperature, and 35% for wind velocity.

CONCLUSIONS: Tree pollen levels were positively correlated with temperature, wind velocity and precipitation during the three years of this study. This study reveals that even in a tropical region with perennial warm weather, some weather variables can have a marked effect on tree pollen variability and be used in predictive modeling

Appendix 3

POLLEN CALENDAR OF BARRANQUILLA, COLOMBIA, 2004-2005.

A.M. Cepeda*, S.E. Villalba, *Barranquilla, Colombia.*

INTRODUCTION. Many airborne pollens can cause allergic diseases such as allergic rhinoconjunctivitis and allergic asthma in sensitive patients. The aim of this study was to create the 2004-2005 pollen calendar of Barranquilla, Colombia, South America. METHODS. Barranquilla is the main city in the north or Caribbean coast of Colombia, with 1.400.000 inhabitants and a warm temperature the whole year, located 18 m. above sea level. Aeroallergen recordings were carried out from 1 January 2004 to 31 December 2005 using a Rotorod sampler. The samples were identified using an Axioscop 2 optical microscope. RESULTS. We provide the pollen calendar of this city, which shows the annual distribution of the most important pollen types. Grain pollens were present during the whole year. Some of them had a perennial pattern. The main group of pollens both in 2004 and 2005 were trees (58.86% of total pollens in 2004 and 62.31% in 2005), followed by gramineae (26.23% and 19.63%) and weeds (14.9% and 18%). Among the tree pollens, the most frequent in both years were Moraceae, Cecropiaceae and Leguminosae, followed by Myrtaceae, Betulaceae, Anacardiaceae, Cupressaceae and other less frequent types. The highest concentrations of airborne tree pollen grains occurred from March to September in 2004 and 2005. Gramineae had a perennial pattern with some variations during the year. The acuatic herbaceae, Typha angustifolia, was present abundantly from January to July. The two main weeds we found in 2004 and 2005 were Asteraceae and Chenopodiaceae. CONCLUSIONS. The atmosphere of Barranquilla shows airborne pollen during the whole year with some peaks that could explain the exacerbations in many perennial allergic patients. Our data confirms the importance of knowing the frequency and periodicity of airborne pollens as an essential tool in the diagnosis and therapy of pollen sensitized patients in our region.

Appendix 4

FUNGAL PREVALENCE IN THE ATMOSPHERE OF BARRANQUILLA, COLOMBIA.

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INTRODUCTION. It is known that several fungal spores have allergic effects on humans. These spores cause allergic diseases such as allergic rhinitis, allergic conjunctivitis and allergic asthma in sensitive persons. The goal of this study was to know the 2004-2005 spore concentration in Barranquilla, Colombia, South America. METHODS. Barranquila, the main city in the north or Caribbean coast of Colombia, is a city with 1.400.000 inhabitants, with a warmtemperature the whole year, located 18 m. on sea level. Aeroallergen sampling was performed in this city during the years 2004 and 2005 using a Rotorod sampler. The samples were stained with Calberlas solution and the particles were identified using an Axioscop 2 optical microscope. RESULTS. There were high counts of spores along the 24 months of this study, half of them represented in Deuteromycetes, with the total spores having two peaks in 2004: May and August to December and four peaks in 2005: March, May, September and December. The most significant single type of spore was Cladosporium: 33.88% of the total in 2004 and 29.61% of the total in 2005. Other significant Deuteromycetes were Aspergillus/Penicillium, Cercospora, Nigrospora, Alternaria, Curvularia and Dreschlera. There were some Ascospores as Leptosphaeriae, and Basidiospores, mainly represented in Ustilago. From the spores found in our study, Deuteromycetes represented 53.83 %, Ascospores 29.76%, and Basidiospores 16.4% of the total of fungal particles encountered in 2004. In 2005, Deuteromycetes corresponded to 49.59%, Ascospores to 27.29%, and Basidiospores to 23.1% of the total of fungal particles for that year. CONCLUSIONS. The result of the present study may provide timely information on fungal concentrations for patients with allergic fungal rhinoconjunctivitis or asthma and provide useful data for allergists to reach accurate diagnosis.

Appendix 5

Six Year Survey of Airborne Mold Spores during the Dry and the Rainy Seasons in Barranquilla, Colombia. A.M. Cepeda, S.E. Villalba.

Introduction

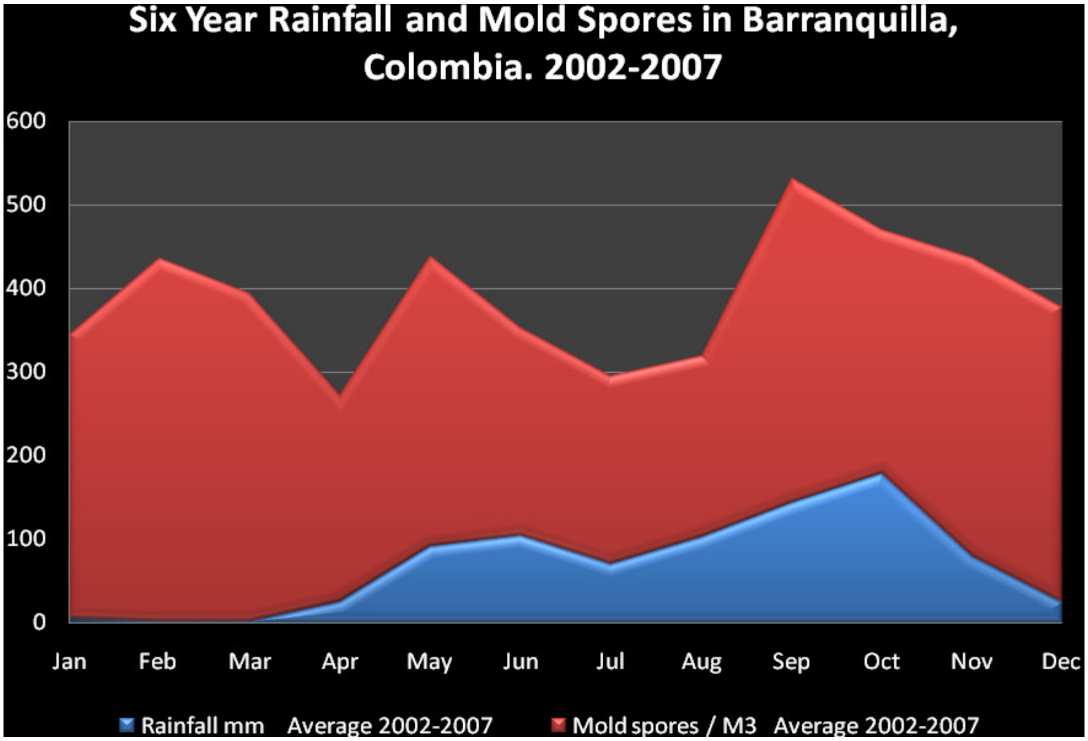
As in the major part of the Colombian Caribbean coast, the tropical climate in Barranquilla has a warm perennial pattern along the year, with two characteristics periods: from December to march, in which the drier Alisios Winds, coming from the northeast, produce dryness, and the rainy season (60-178 mm/month), from April to November, with short periods of dryness. During the rainy season, scarce of winds, there is high humidity. The high humidity is also due to the nearness to the ocean, to the wet deltas of the mouth of the Magdalena River and to the Natural Salamanca Island National Park, nearby the city. Many respiratory allergies in this region have a perennial pattern, with exacerbations in different months of the year. We wanted to know the pattern of the atmospheric molds as a tool for better diagnosis of our patients.

Methods

Aeroallergen sampling was performed using a volumetric rotating arm impaction Rotorod Sampler as a part of a continual aeroallergen survey in our city. We wanted to observe the variations of molds along the dry and the rainy periods during a six year interval, from 2002 to 2007.

Results

Over the 6 years observed, mold concentration showed some correlation with the main rainy months (September: 143 mm, and October: 178 mm on average), having the main peaks during those two months. October has the higher humidity (84%) and a hot climate (33.3° Celsius). Nonetheless, levels of molds were stable along the rest of the months, on the average, even during the dry period from December to March. Some of the main spores collected during these six years where Deutoromycetes: *Cladosporium, Penicillium-Aspergillus, Alternaria, Dreschlera, Curvularia, Nigrospora* and *Corynespora.* Ascospores are the second group of collected molds and Basidiospores the least frequent group. Many allergic patients of the Colombian Caribbean coast have sensitivity to *Penicillium, Aspergillus, Alternaria and Cladosporium.*



Conclusions

Our data was consistent with the observations about the perennial pattern of mold spores in tropical climates. Peak counts appear in the main rainy months. This could explain some exacerbations of many patients sensitive to molds in our region. Further studies are needed to establish a correlation between these findings and allergic disease outcomes.