

Bioaerosols and environmental factors in allergy and asthma



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CAUSES OF ALLERGY

MANY POSSIBLE INFLUENCING FACTORS, INCLUDING:

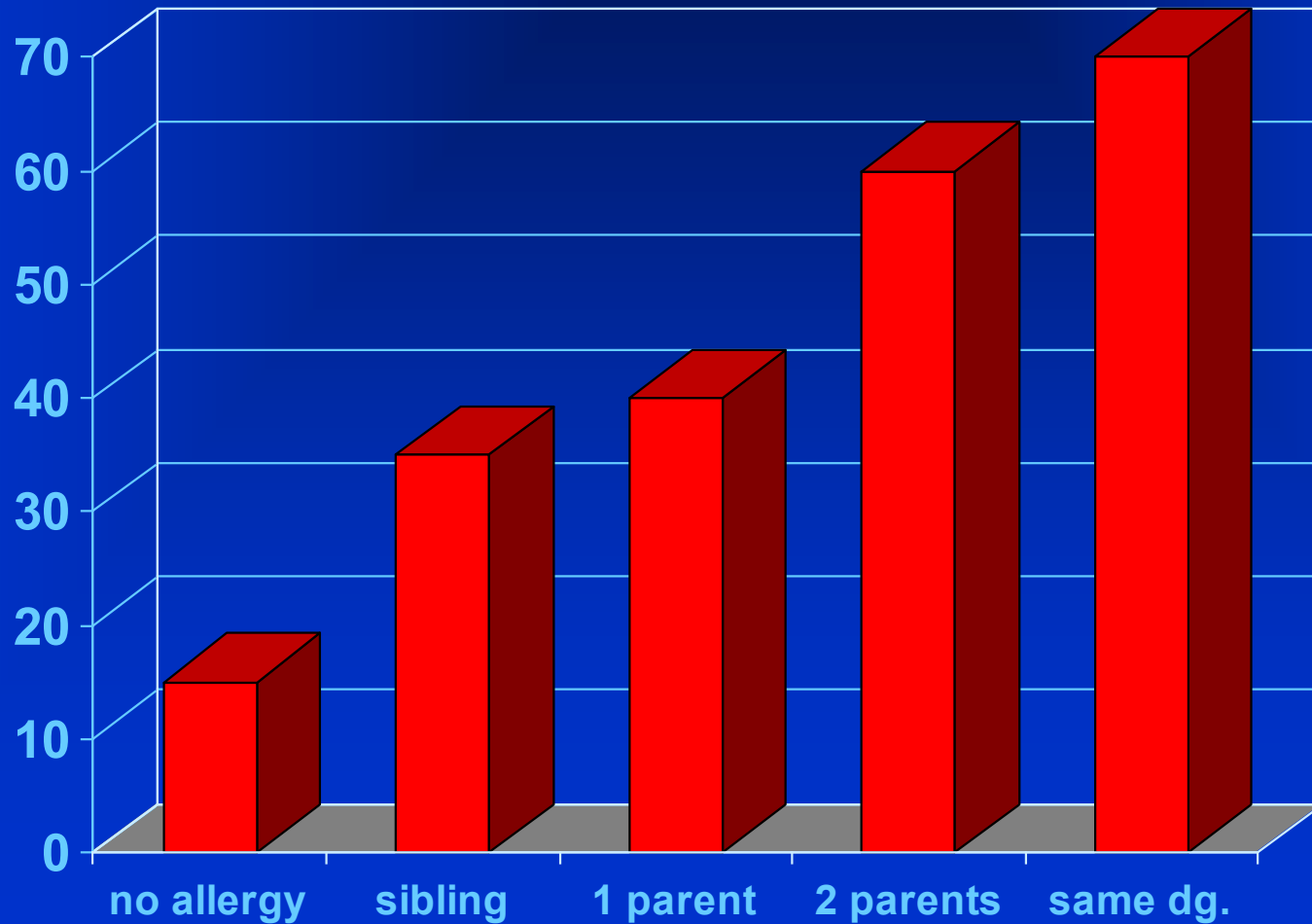
- **Genetical predisposition**
- **Time and intensity of allergen exposure**
- **Nonspecific factors, mainly:**
 - **diet and gut microflora**
 - **air pollution, cigarette smoke**
 - **respiratory viral infections**

ALLERGY - RISK FACTORS

CLEARLY DEMONSTRATED

- **genetical predisposition**
- **living in a city**
- **month of birth**
- **age (5-20 years)**

RISK OF ALLERGY



ALLERGY - RISK FACTORS

SO FAR NOT SO CLEAR

- **air pollution**
- **perinatal factors, breast feeding**
- **sex, race**
- **number of siblings and order of birth**
- **socioeconomical factors**
- **smoking and alcohol consumption**
- **respiratory infections**

AIR POLLUTION

Three groups of factors:

- **physical** (temperature, humidity, atmospheric electrical status, dust)
- **chemical** (anorganic x organic)
- **biological** (microbs, moulds, mites, epitelia, pollen...)

CHEMICAL FACTORS

ANORGANICAL GASES

Nitrogen oxides

- Indoor sources
 - gas stoves and heating
- Outdoor sources
 - motor vehicles
- Proallergic influence on immunity system



CHEMICAL FACTORS

ANORGANICAL GASES

Sulphur oxides

- Indoor sources
 - less common, helpful - whitewash, ventilation pattern
- Outdoor sources
 - industrial areas, indicator of pollution
- Respiratory infections more common, maybe even immune system changes



CHEMICAL FACTORS

ORGANICAL GASES

Volatile organic compounds

Indoors – building materials, furniture, carpets... (formaldehyde, styrene, xylene, acetone...)

Other sources – cigarette smoke, cosmetics, electronic devices...

Carcinogenes, immune changes, psychical changes...

Polycyclic aromatic hydrocarbons

Less dangerous, mainly irritation



BIOLOGICAL FACTORS

While physical and chemical factors act mainly as irritants and modulators of allergic reactions, biological factors can act as allergenes and may trigger the specific immune reaction.

- **Viruses and bacteria**
- **Moulds (both indoors and outdoors)**
- **Biological dusts**
- **Pollen**

BIOLOGICAL FACTORS

VIRUSES AND BACTERIA

- possible pathogens
- bacterial allergization
- viral infections - important trigger of asthma attacks
- some viruses (rhinovirus, RS-virus) may switch the immune reaction towards allergy



BIOLOGICAL FACTORS

MOULDS

- **Small size of mould spores**
- **Excellent air dispersion**
- **Good penetration to lower airways**



BIOLOGICAL FACTORS

HOUSE DUST

A mixture of different particles specific for each household. It contains both organic and anorganic particles.

Possible sources of allergens :

- house dust mites, moulds, pollen grains
- pet detritus
- other in/outdoor allergens



BIOLOGICAL FACTORS

HOUSE DUST MITES

- Main allergens of the house dust in the majority of households.
- Most common in bedding.
- Optimal ambient temp. ca 25⁰ C
- Optimal humidity > 50% (80%).
- Allergens mainly in faeces.

Prevalent in the Czech Republic:
Dermatophagoides pteronyssinus



BIOLOGICAL FACTORS

PETS - CAT

- Very aggressive allergens
- Persist in the household environment for months.
- Main allergen: **Fel d 1**
(in skin scales, saliva)
- Urine and serum –
different allergens



PETS - DOG

- **No breed-specific allergen has been found**
- **Allergens of different dogs of the same breed have a variable antigen structure.**
- **Even dogs with short hairs and hairless breeds have allergenic potential (epithelium)**
- **5-30% of allergic people show a positive SPT reaction with dog allergens.**



Matthews K.P. in Middleton E. Jr. et al. 1988

SHEEP and COW

- **Sheep wool – predominantly mechanical irritation, allergic problems rather due to contamination with mites.**
- **Cows – similar allergens as with horses**



•Matthews K.P. in Middleton E. Jr. et al. 1988

RODENTS

- **Allergens predominantly in urine, they can become airborne after urine dries up (cages cleaning).**
- **Mouse** – urine allergen **Mus m 1**
 - MUP (major urinary protein)
 - a member of lipocalin superfamily
- **Rat** – a mixture of serum and urinary allergens - **Rat n 1** (prealbumin), **Rat n 2** (alfa_{2m} - globuline)
- **Guinea pig** – 3 identified major allergens, **Cav p 1** – some 57 % identity with MUP



BIRDS

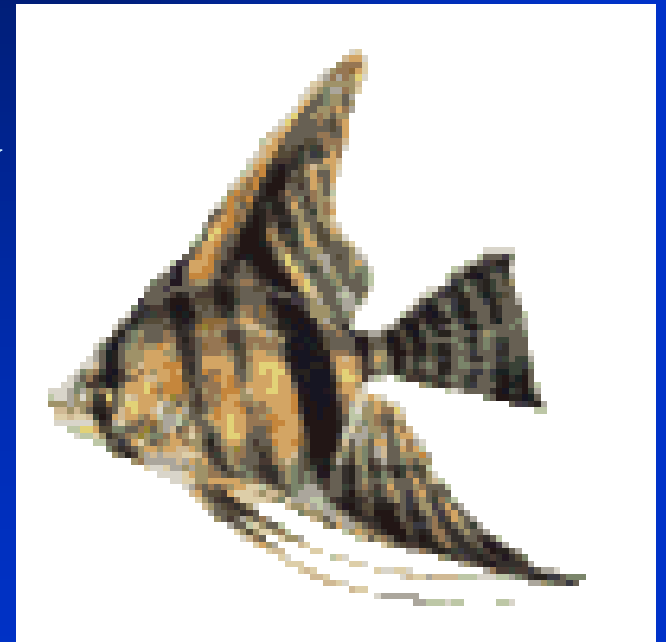
- **Hypersensitivity pneumonitis**
- **Chicken coops, attic nests - important sources of mites**
- **Meat, eggs - usually safe to consume**



•Matthews K.P. in Middleton E. Jr. et al. 1988

AQUARIUM FISH

- Allergens in dry fish food, mostly mites.
- Moulds and water algae can also trigger allergy problems



TURTLES and TORTOISES

Turtles

Possible source of mite allergens from dry food, algae and moulds in water



Tortoises

Possible source of mite allergens

BIOLOGICAL FACTORS

- **Animal allergens – both genera-specific and common to various mammals (cross-reactivity).**
- **Hypersensitivity to some aeroallergens (mainly pollen and moulds) increases the risk of allergy progression to animal allergens up to 3,4 times.**
- **Replacement of any allergy problems triggering pet with another pet cannot be recommended (cross-reactivity).**

- Viander et al. *Int Arch Allergy Appl Immunol*. 1983
- Špičák, Vondra. *Asthma bronchiale...*1988

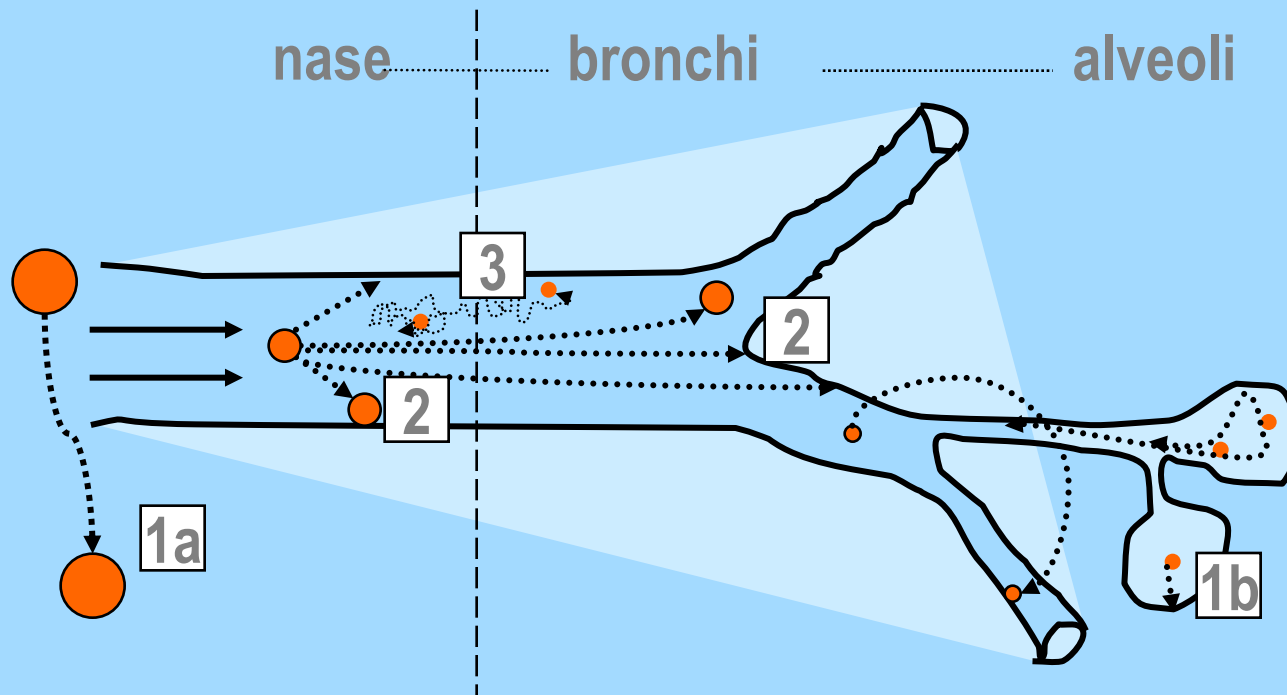
AEROBIOLOGY

- **Study of various atmospheric bioaerosols, their**
- **origin (source)**
 - **land x water**
 - **natural x anthropogenic**
- **release and transport**
- **dispersion – in area and in time**
- **seasonality**
- **deposition**
- **impact on human health**

BIOAEROSOL

- **suspension of biological airborne particles** (spores, pollen, other biological detritus)
- **impact on human health depends on:**
 - chemical composition
 - physical features
 - antigenic features
 - including the antigen release speed after its deposition on mucosal surface
 - distribution in the atmosphere
 - quantity
 - particle size (respirability)

RESPIRABILITY OF BIOAEROSOL, MECHANISM OF DEPOSITION



🕒 gravitation sedimentation

1a: $> 50 \mu\text{m}$

1b: $1-10 \mu\text{m}$

🕒 impaction

$5 - 50 \mu\text{m}$

🕒 diffusion

Brownian movement

$< 1 \mu\text{m}$

particles $5 - 50 \mu\text{m}$ sediment $v = 2-5 \text{ cm/s}$: in still-air only shortly airborne (indoors), in case of air turbulences they remain airborne for a long time (normal situation outdoors)

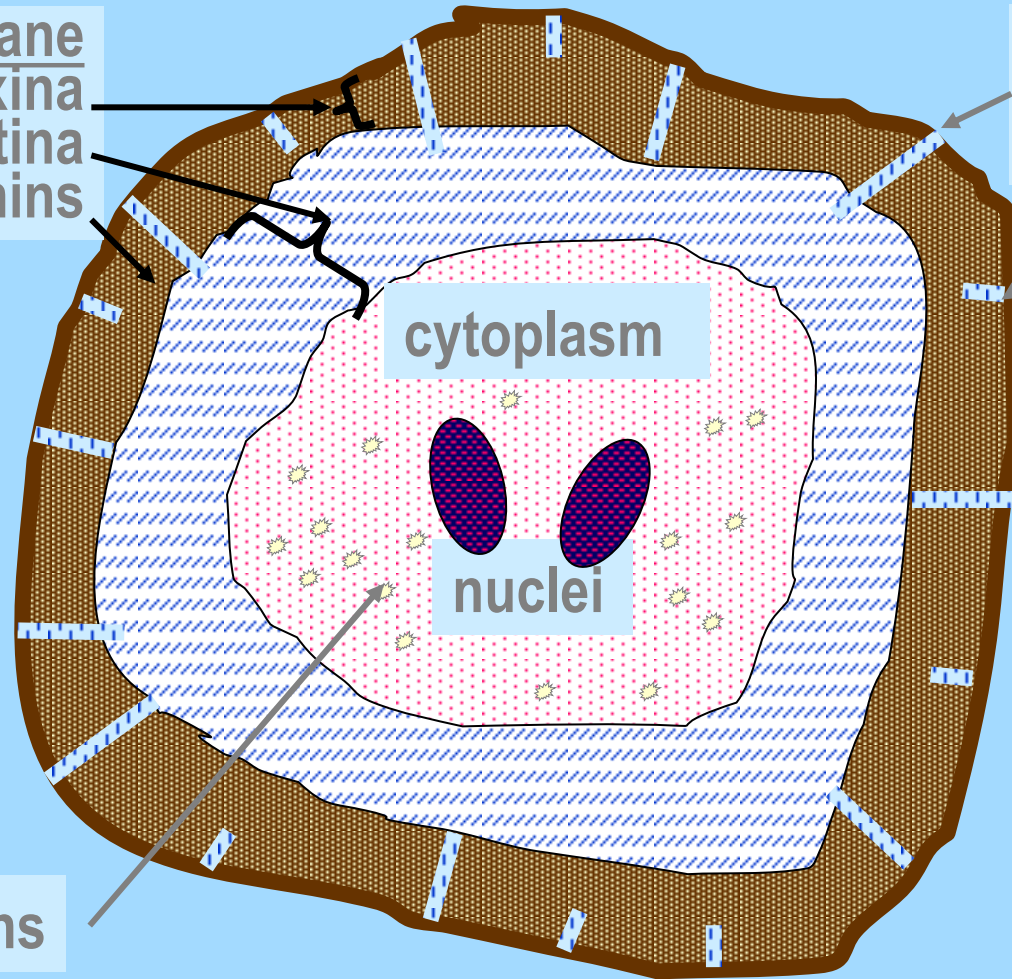
POLLEN GRAINS - NATURAL PART OF THE ENVIRONMENT

- **Pollen grains exist much longer than humans**
- **Pollen grain** = male sex organ product of seed-bearing plants (*Spermatophyta*)
 - cytoplasm, haploid nuclei, cell membrane
- **pollen grain transport patterns (towards female organs)**
 - insects: *entomophilic* plants
 - wind: *anemophilic* plants
 - vast production of pollen
 - mixed transport pattern

STRUCTURE OF POLLEN GRAIN

cell membrane
exina
intina
sporopollenins

microcanals
pores
gyri



starch grains

cytoplasm

nuclei

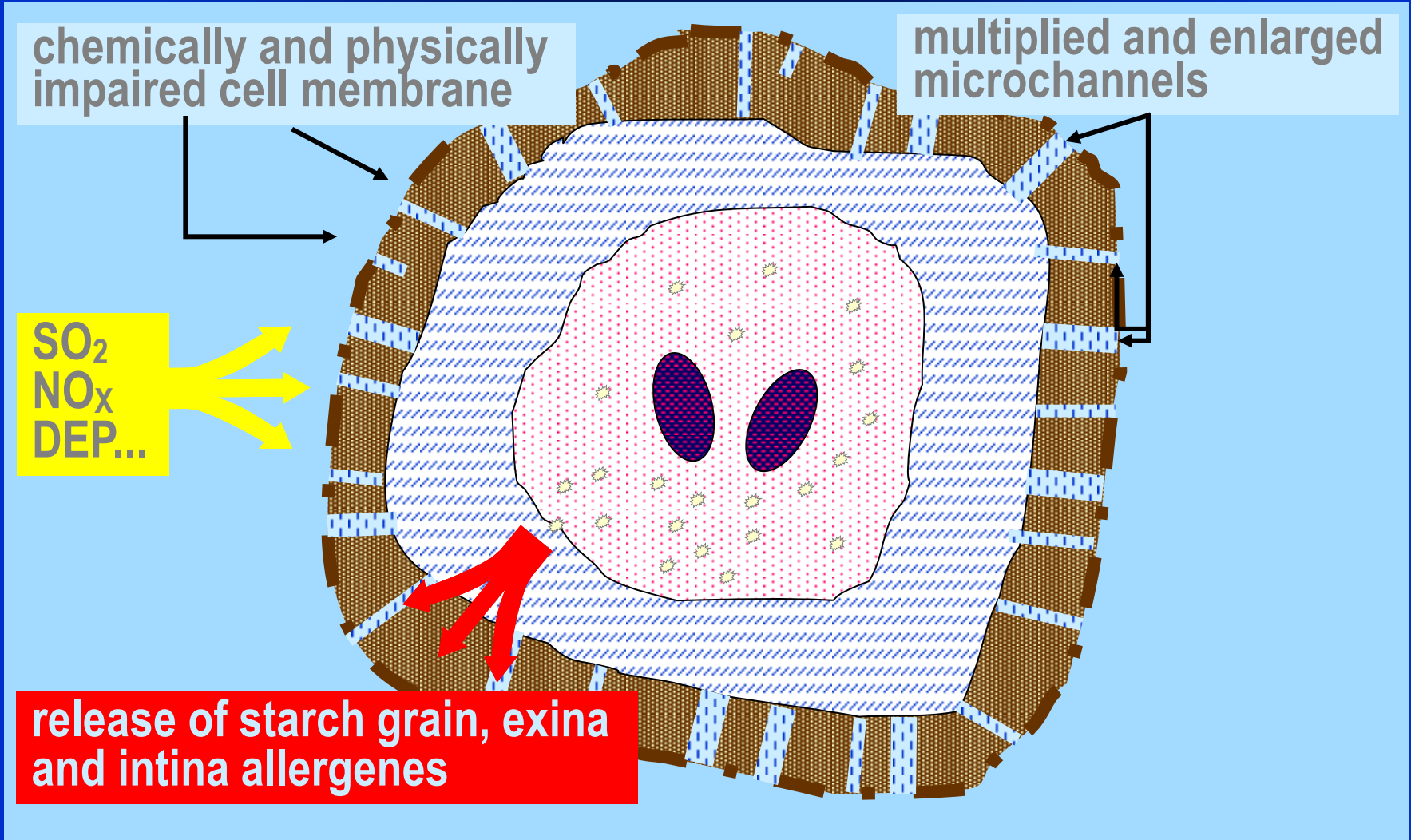
THOMMEN'S POSTULATES

- **1. The pollen must be allergenic.**
- **2. The pollen must be windborne.**
- **3. The pollen must be produced in large quantities.**
- **4. The pollen must be sufficiently buoyant (between 10 and 50 μ in diameter) to be transferred over a considerable distance.**
- **5. The plant producing the pollen must be widely and abundantly distributed close to the human environment.**

INFLUENCE OF POLLUTED ENVIRONMENT ON PLANTS

- **plants**
 - produce > allergenes in pollen grains (Bet v 1, Lol p 1)
 - amount of produced pollen?
 - submicronic particles
 - (flower, leaf,... fragments)
- **disintegration of pollen grains**
 - in damp environment releasing > allergens (thunderstorms!)
 - particles of 0,01 - 2 μm

POLLEN GRAIN IMPAIRED BY POLLUTED ENVIRONMENT



TYPES OF POLLEN ALLERGENS

- **recognizing substances of pollen grain**
 - species specific - no cross-reactivity
- **enzymes**
 - common or chemically similar for botanically related groups of plants (they facilitate the penetration of male gamete to female egg)
- **panallergens**
 - profilins (common or chemically close even for non related plants/animals)

CROSS-REACTIONS

- **botanically related**
 - spring-flowering trees
 - grasses
 - some weeds
- **botanically non related**
(responsible allergens - profilins)

BOTANICALLY NON-RELATED CROSS-REACTIONS

- **birch**
 - vegetables (carrot, celery, potato, watermelon)
 - fruits (apple, cherry, pear, kiwi), insect venom
- **mugwort**
 - birch, hazel, timothy grass
 - root vegetable (celery, carrot), spices (cumin, coriander, fennel, thyme..), sunflower oil
- **ragweed**
 - plantain, watermelon, banana

AIRBORNE POLLEN MONITORING

- **gravimetric spore trap** (impactor)
 - results from various areas not comparable
 - not a standardized method
- **volumetric spore trap** (standardized)
 - active suction and a rotating drum principle
 - constant speed of drum rotation
 - enables precise analysis of pollen types and quantity for every hour of the day

AIRBORNE POLLEN MONITORING

- **Volumetric spore trap in combination with cascade impactor**
- **immunochemical techniques for allergen assessment (RAST / ELISA)**
- **time-consuming and expensive**
- **mainly for scientific purposes**
- **enables to show correlation between the pollen/mould spore amount and the total atmospheric allergen concentration**

TOTAL ALLERGENICITY OF THE ATMOSPHERE

- many **pauci-micronic particles** in the air:
 - allergenes released from pollen grains
 - plant detritus (organic dust, juice, hairs, ...)
 - airborne dust or DEP adsorbed allergenes...
- these particles can be detected in the air
 - **already before the pollen season starts**
 - **long after the end of pollen season**
- Pollen and mould spore concentration, as collected by the spore traps, does not reflect the total allergenicity of the atmosphere

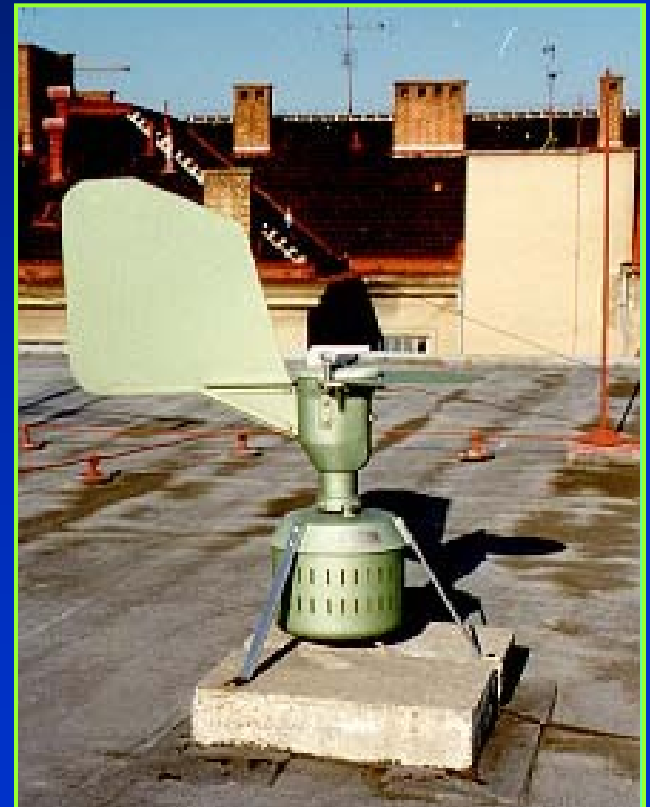
POLLEN INFORMATION SERVICE

Europe

Development of pollen services since the 60., currently more than 400 pollen stations interconnected via Internet

Czech Republic

Start of operation in 1992 (Brno), currently 12 pollen stations



Volumetric spore trap

POLLEN SEASON

- **SPRING - trees**
 - hazel, alder, birch
 - ash-tree, beech, oak
 - pine, spruce
 - lime-tree, elder...
- **SUMMER - grasses**
 - more than 200 species
(high cross-reactivity)
 - plantain, sorrel...
- **AUTUMN - weeds**
 - goose foot
 - mugwort, ragweed...

