



Strengthening Teaching Competences
in Higher Education
in Natural and Mathematical Sciences

WORKSHOP
NOVI SAD MARCH 21.-22.,
2022



KATARÍNA TRNKOVÁ

*MATEJ BEL UNIVERSITY, FACULTY OF NATURAL SCIENCES,
BANSKÁ BYSTRICA, SLOVAKIA*



EDUCATION AND PROFESSIONAL CAREER

M.Sc. degree in study programme **General Ecology**

Ph.D. (in external form) of study programme **Ecology**, on the Faculty of Environmental Sciences, Technical University Zvolen



2001– 2013 work position as **laboratory diagnostics specialist** (public health monitoring of water, indoor and outdoor air quality) in The Regional Authority of Public Health (RAPH) in BB, Department of Medical Microbiology: (in 2006 the **specialization** in study programme

Investigation methods in Microbiology and Biology of the Environment, Slovak Medical University in Bratislava

2014 – till now: Assistant Professor, Faculty of Science, Matthias Belius University, Banská Bystrica
Department of Environment, but closely cooperated with Department of Biology and Ecology

I was participate in the teaching in the **previous study programs Environmental safety and Environmental management, Ecology and ecosystem protection** till 2020/2021

of subjects such as

Health and Environment
Environmental Epidemiology
The Global Environmental Problems
Bioindications in the Environment
Biological and Chemical Terrorism Safety
Introduction to the study of Environmental Sciences

Monitoring of Environmental Compartment
Environmental Loads and Brownfields
Remediation of Environmental Loads



Faculty of Natural Sciences, MBU in B. Bystrica obtained accreditation in field

Ecological and Environmental Sciences

new Study program (2021/2022): **Environmental Biology** (bachelor, master, doctoral degree)

Characteristics of the study program:

„From molecules to ecosystems“ - to know the basic organizational levels of life (genes, cells, organisms and ecosystems and their relationships with the environment),

to learn about the processes that shaped nature in the past and affect it today,

find out what and how life-threatening systems on Earth threaten

you will understand how to solve the environmental problems of water, soil, air, even with the effective help of living organisms - bioindication

ENVIRONMENTAL BIOLOGY

SUBJECTS THAT I LEAD

- Environmental Health
- Epidemiology
- Molecular Ecology
- Microbiology
- Global Problems of Environment
- Abiotic components of the Environment part II. (Water and Air)

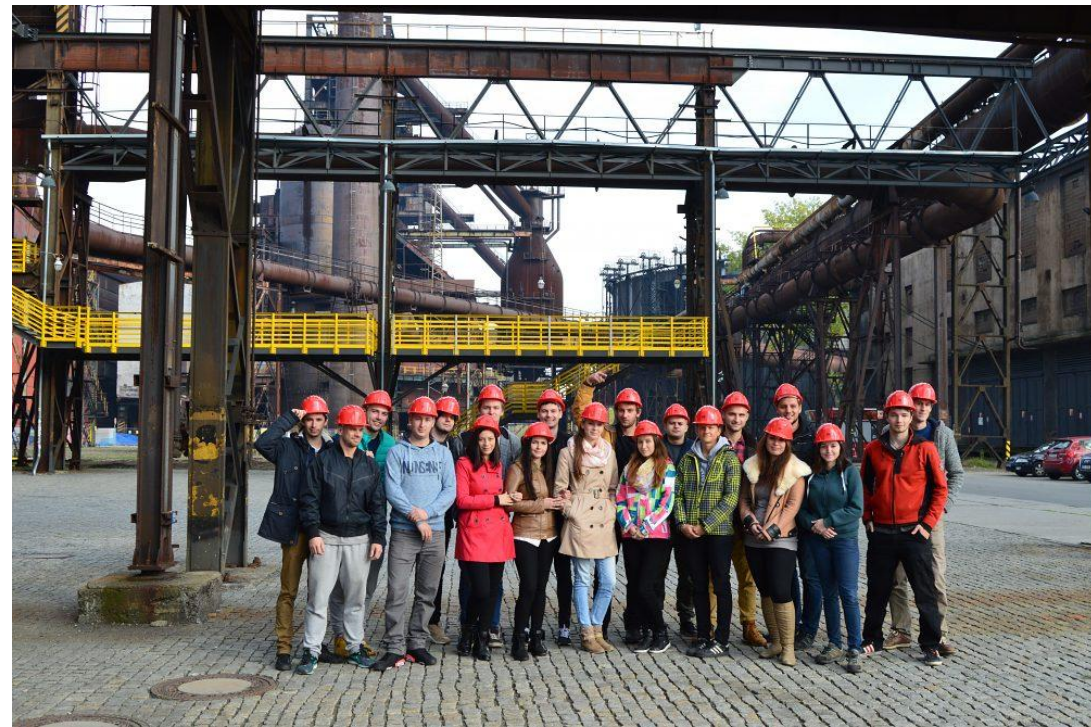
practice exercises, excursions and internships

presentation skills (Student scientific conference, Researchers night, Open day of Faculty NS, etc.)

Our students will use the acquired knowledge and skills

in research, nature protection, the environment and other professions

Cooperation with, government organizations, institutions, and the third sector





WE TEACH DIFFERENTLY,
WE TEACH FOR PRACTICE



SEMESTRAL GROUP WORK

CONNECTING THEORY WITH PRACTICE



learning, practical training and cooperation with businesses (contracting authority Nestlé, Veolia - local waterworks company), institutions (SHMÚ Slovak hydrometeorological institute), and the third sector (Ekopolis foundation)

The idea of our team was to proposed **artificial pond** supplied with **rainwater drained** from the **roof** of an industrial building in Sewage treatment plants area using climatic, pedological, biotic technical-material and economy calculation data

National competition of student teams - theme „For water“ (we won 2. place)



Stredoslovenská vodárenská
prevádzková spoločnosť, a.s.



nadácia
ekopolis

PREVÓDU



PROJECT IDEA AND GOALS

BIODIVERSITY INCREASING – to create conditions for increasing the natural biodiversity of the environment



WORKFLOW

1. introduction of project goals, working meeting with contracting
2. work schedule, division of partial project tasks into groups of students
3. soil sampling, laboratory analyzes, collection and interpretation of data, project promotion
4. second working meeting - summarization of documents and data to create a technical proposal project of the pond
5. risk processing of project, preparing information panels design and content
6. project finalization, and presentation



DESIGN OF TECHNICAL PROJECT OF THE POND

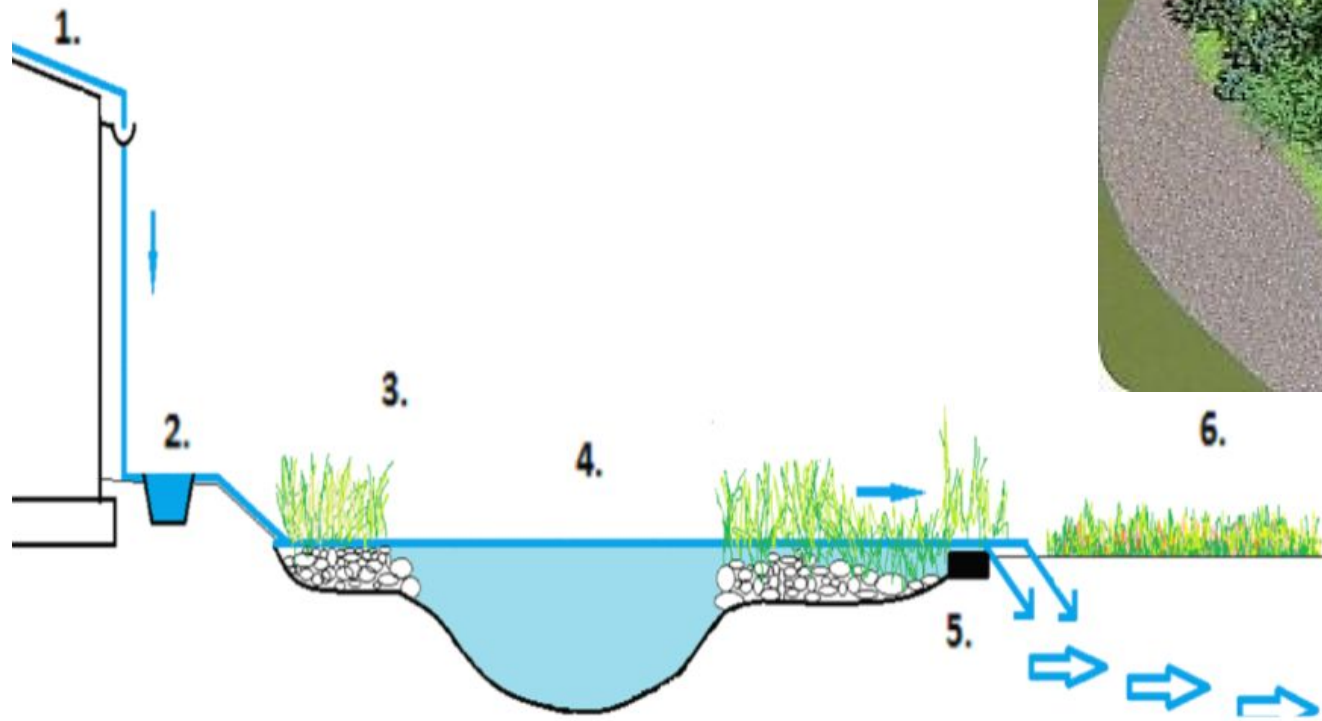


FIG. 2 Visualization of the pond after the planting of plants

FIG. 3 Scheme of implementation of the pond, legend: 1. roof as a source of rainwater, 2. mechanical pre-treatment, 3. wetland - filter part of the pond, 4. pond, 5. overflow, 6. wet meadow

PROJECT COSTS CALCULATION

Work / material	Price
Technical work (excavation of the pit, modification of the pond)	800 €
Material (pond foil, geotextile, river gravel, sewer pipe, roof drainage catcher)	1884.20 €
Bacteria Starter	20 €
Plants	625 €
Information panels	400 €
Sum	3729.20 €

HOW INCREASE BIODIVERSITY?



PREVODU nadácia ekopolis

ZADRŽANIE DAŽDOVEJ VODY A JEJ VÝZNAM PRE KRAJINU

Prejavy nestabilného počasia, striedanie obdobia sucha s obdobím prudkých privalových dažďov, či významný nárast rozlohy nepriepustných plôch z dôvodu výstavby parkovísk, nákupných centier, komunikácií, domov je veľkým problémom súčasnosti. Pri lokálnych búrkach dochádza ku začatému mestskej kanalizácie privalovou vodou zo spevnených plôch, čo potom spôsobuje vzostup vody v potokoch a riekach, dochádza k záplavám.

Velký a malý vodný cyklus

Ekosystémovo založené prístupy k adaptácii sú možnou alternatívou oproti doplnkom ku tradičným technickým prístupom, tzv. sivým opatreniam. Ekosystémovo založené prístupy sú prírodne bližšie opatrenia, ktoré využívajú biodiverzitu a ekosystémové služby ako hlavný element celkovej adaptatívnej stratégie prispôbenia sa nepriaznivým dopadom zmeny klímy. Tieto opatrenia upravenosti sú prírodne bližšie riešenia, ako napr.:

- 1) prvky zelenej infraštruktúry (zelené opatrenia) – obnova a vytváranie zelených plôch – parkov, alej ale aj mieste prístrojov na uliciach a verejných priestoroch, budovanie zelených stien a zelených terás budov, výstavba stromov a nariadenie spevnených plôch trávnení, budovanie sadových zón, využitie stojatých aj tekúcich vôd v urbanizovanom prostredí, obnova mokraľ
- 2) prvky modrej infraštruktúry – regulácia vodných tokov, zvyšovanie zadržávania vody v urbanizovanej či voľnej krajine, zvyšovanie priepustnosti terénu v mestách, ...

JAZIERKO, zásobovavé zadržkou vodou prítlačujúcu zo strechy má rozlohu 40 m², pričom pokrýva plochy tvorené regeneračnou zónou - MOKRAĎ. Veľná hĺbková jazierka má rozlohu 20 m². Jazierko má funkciu ekologickú, environmentálnu aj estetickú, vytvára vhodné podmienky pre rozmanitosť druhov zlepať mikroklimu svojím výparom a vytvára estetický prvok vhodný aj na vzdelávanie

MOKRAĎ je najdôležitejšia časť vodného biotopu. Filtračnou funkciou zabezpečí správne samočistiace procesy a fungovanie ekosystému.

VĽHĽÁ LÚKA pre vyššiu biodiverzitu by mala obsahovať maximum autochtonných (pôvodných) hygrotolných (vlhkomilných) druhov rastlín.

SPÔSOBY VYUŽITIA VODY

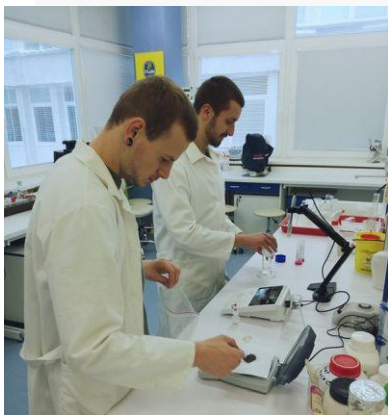
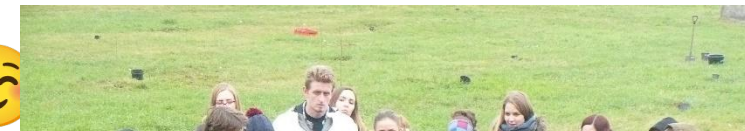
zavlažovanie, kúrenie a umývanie áut, vytvorenie dažďov

Legenda:

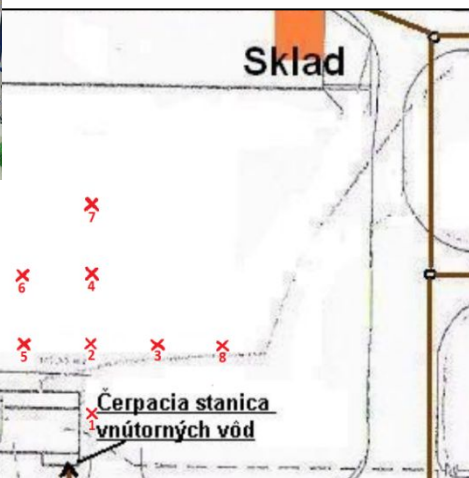
1. strecha ako
2. mechanizmus
3. mokraď
4. jazierko
5. prapad
6. vlnka lúka



WE HAVE LEARNED A LOT, WE HAVE DONE A LOT 😊



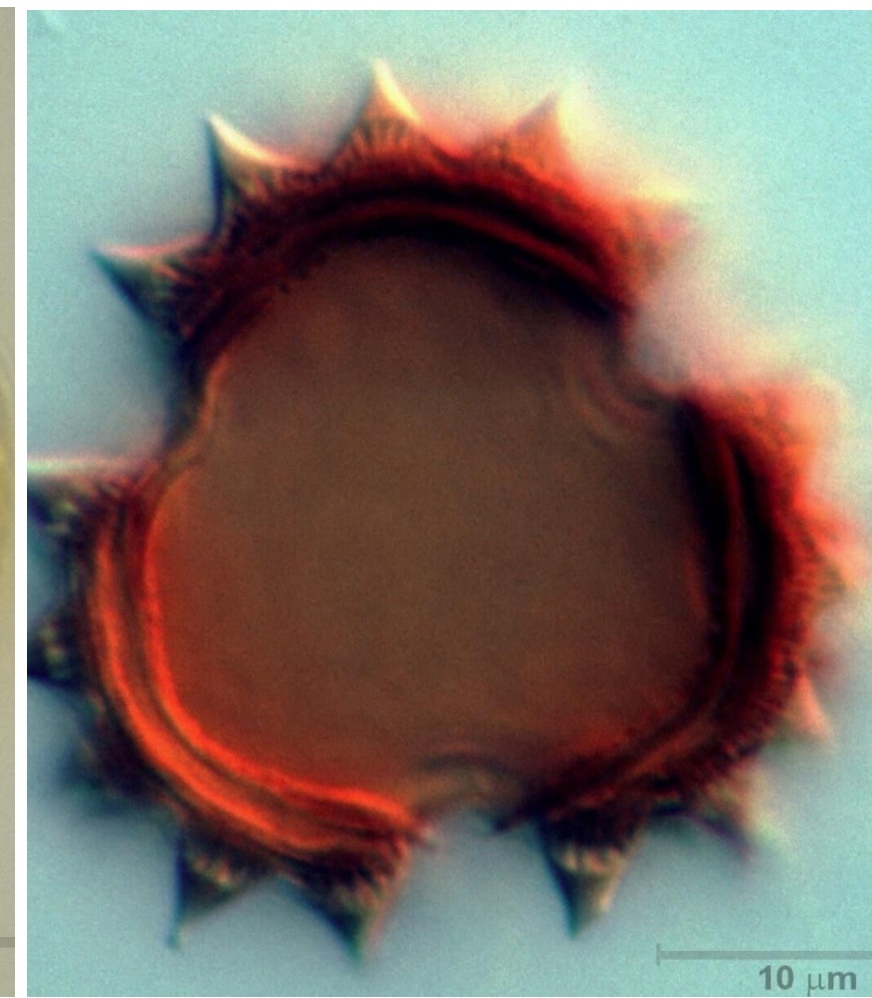
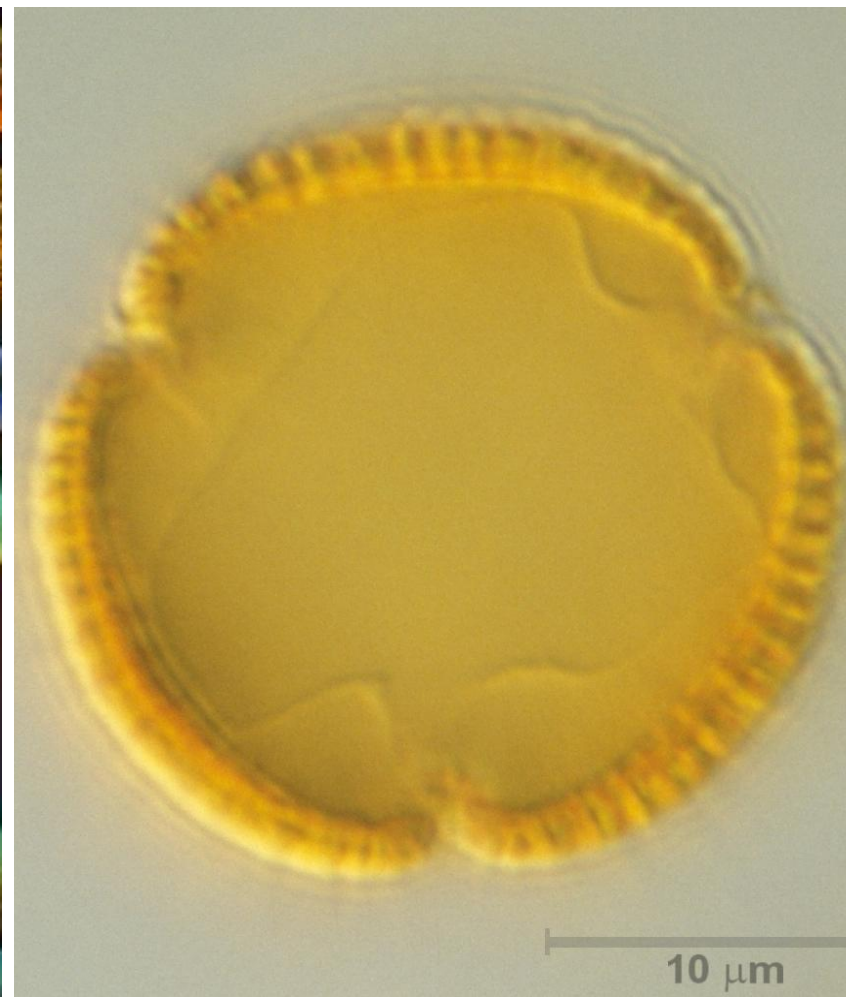
Ecology, Remediation
Biodiversity pro



WHAT NEXT?

I will introduce you with the topic of **paleoecology**, I will explain the basic concepts and its application,

I will tell you how I **connect research activities with the teaching** and assignment of final theses and the involvement of students in research.



PALYNOLOGY - *USE TODAY TO KNOW THE PAST*

TERMINOLOGY /GLOSSARY

- **Palynology** is the "study of dust" (from Greek *palunō*, "strew, sprinkle" and -logy) or "particles that are strewn"
- A classic palynologist analyses particulate samples collected from **the air**, from **water**, or from deposits including **sediments** of any age
- The condition and identification of those particles, organic and anorganic, give the palynologist clues to the life, environment, and energetic conditions that produced them
- Palynology is an **interdisciplinary science** and is a branch of earth science (geology or geological science) and biological science (biology), particularly botany
- Stratigraphical palynology is a branch of micropalaeontology and **paleobotany**, which studies fossil palynomorphs from the Precambrian to the Holocene (to the Anthropocene 😊)

APPLICATIONS

- **Biostratigraphy and geochronology.** Geologists use palynological studies in biostratigraphy to correlate strata and determine the relative age of a given bed, horizon, formation or stratigraphical sequence
- **Palaeoecology** and climate change - palynology can be used to reconstruct past vegetation (land plants) and marine and freshwater phytoplankton communities, and so infer past environmental (palaeoenvironmental) and palaeoclimatic conditions
- Palynology also allows scientists to infer the climatic conditions from the vegetation present in an area thousands or millions of years ago. This is a fundamental part of research into **climate change**
- **Organic palynofacies studies**, which examine the preservation of the **particulate organic matter** and palynomorphs provides information on the depositional environment of sediments and depositional palaeoenvironments of sedimentary rocks
- **Limnology** studies. Freshwater palynomorphs and animal and plant fragments, including the (green algae, pollen, chironomids head capsules, diatoms, cladocera, ostracods) can be used to study past lake levels and long term climate change
- **Allergy studies.** Studies of the geographic distribution and seasonal production of pollen, can help sufferers of allergies such as hay fever
- **Archaeological palynology** examines human uses of plants in the past. This can help determine seasonality of site occupation, presence or absence of agricultural practices or products, and 'plant-related activity areas' within an archaeological context
- **Melissopalynology:** the study of pollen and spores found in honey

WHAT ARE WE GOING TO TALK ABOUT?

- Palynology (Aerobiology) use at present – „Pollen information service in Slovakia“

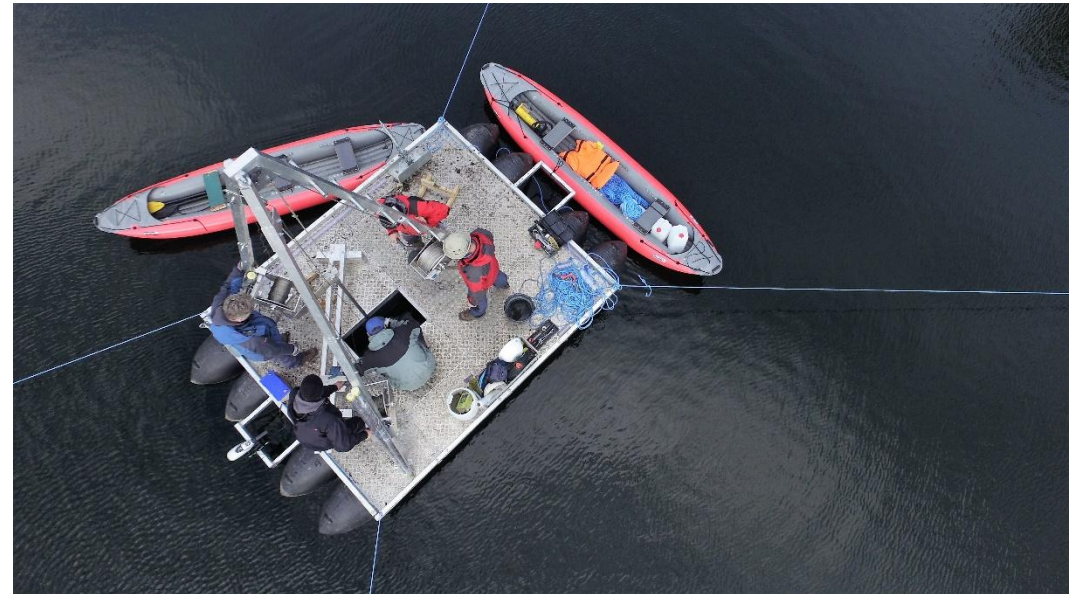
analysis of **recent** pollen grain

- Pollen analysis – reconstruction of past environmental conditions – „Tracking Environmental Change Using Lake Sediments“

analysis of **fossil** pollen grain



⇒

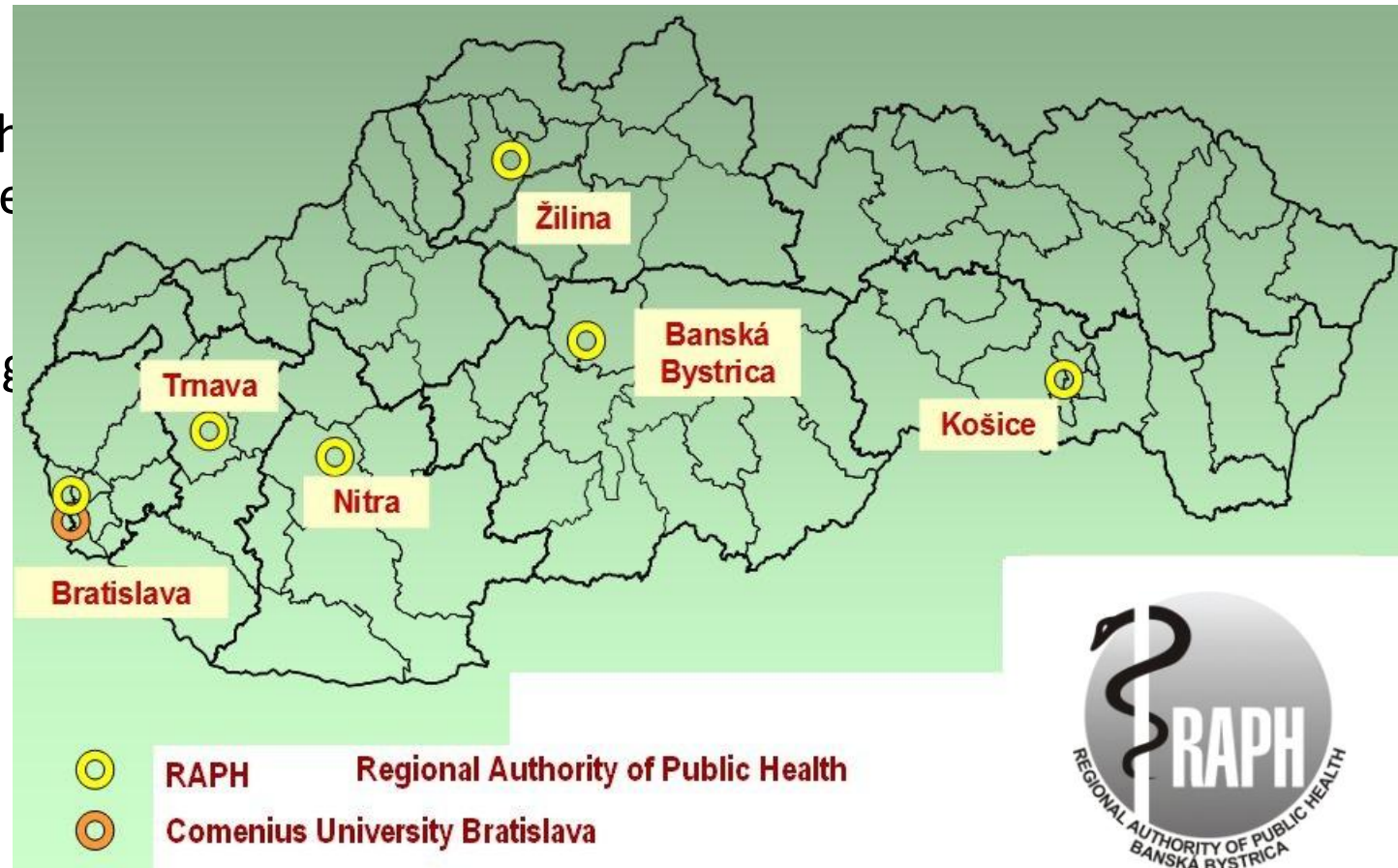


TERMINOLOGY

- **Aerobiology** (from Greek ἀήρ, *aēr*, "air"; βίος, *bios*, "life"; and -λογία, *-logia*) is a branch of biology that studies organic particles, such as **bacteria**, fungal **spores**, very **small insects**, **pollen** grains and **viruses**, which are passively transported by the air
- **Aerobiologists** have traditionally been involved in the measurement and reporting of airborne pollen and fungal spores as a service to **allergy sufferers** (Hayfever affects 1 in 5 people with symptoms like: itching mouth and throat, swelling of mouth, tongue and lips, hoarseness, numbness, swelling of eyelids, digestion problems)

POLLEN INFORMATION SERVICE IN SLOVAKIA

- The negative trend of an increase of allergic diseases, especially pollen allergy, has been an incentive for physicians, botanists and aerobiologists to initiate building of a **network of PIS monitoring** stations in Slovakia working since 2006 on public health authorities responsibility
- Based on laboratory analyzes of the pollen of the allergenic relevant genera, **reports** are processed
- Pollen reports are published for both, **current** and a **forecast** for the next week (via national electronic and print media)



POLLINATION SPECIES OR ALLERGENIC RELEVANT SPECIES

A **six basic groups** of plants producing pollen allergens, to which the majority of polinotic are sensitive, have been identified in Europe:

- **birch** (*Betula*) + related species **alder, hazel, hornbeam** (*Alnus, Corylus, Carpinus*) **beech** (*Fagus*), **chestnut**(*Castanea*) a **oak** (*Quercus*)
- **grasses** (*Poaceae*) + **wheat** (*Gramineae*)
- *Oleaceae* + **ash** (*Fraxinus*), **olive** (*Olea*) + **maple** (*Acer*), **walnut** (*Juglandaceae*) and (*Platanaceae*)
- weed plants (*Artemisia*) + (*Ambrosia*), (*Asteraceae*), *Chenopodiaceae*, *Plantaginaceae*)
- (*Parietaria officinalis*) + nettle (*Urtica dioica*)
- (*Cupressaceae*) + related species (*Taxaceae*) + *Cryptomeria japonica*

POLLEN PERIODS IN CENTRAL EUROPE

In **Central Europe** to split the season into:

- **spring** season - dominated by a pollen of trees, especially **birch** (*Betula*) and **hazel** (*Corylus*)
- **summer** season - the dominant allergens are **grasses**
- and **autumn** - with the dominance of high-bred weeds, especially *Artemisia*, and in recent years also *Ambrosia*, even though their considerable production of pollen is still in the late summer

POLLEN PERIODS IN MEDITERRANEAN AREA

In the Mediterranean area there are three pollen seasons:

- A low winter pollen season (December - March) with pollens from trees such as Cypress and Juniper, Hazel, Mimosa and Birch
- A high spring-summer pollen season (April - July), dominated by the pollination of Grasses, some members of the nettle family and olive trees. Between March and May, *Platanus* pollen (such as the American sycamore) may effect some people in Mediterranean areas
- A summer- autumn season (August - October) involves a second flowering of the nettle family and pollination of herbaceous plants, such as mugwort *Artemisia* and plants such as beet, sugar beet, and chard, and wild spinach Chenopodiaceae)

POLLEN MONITORING METHODS - METHODOLOGY OF AEROBIOLOGY

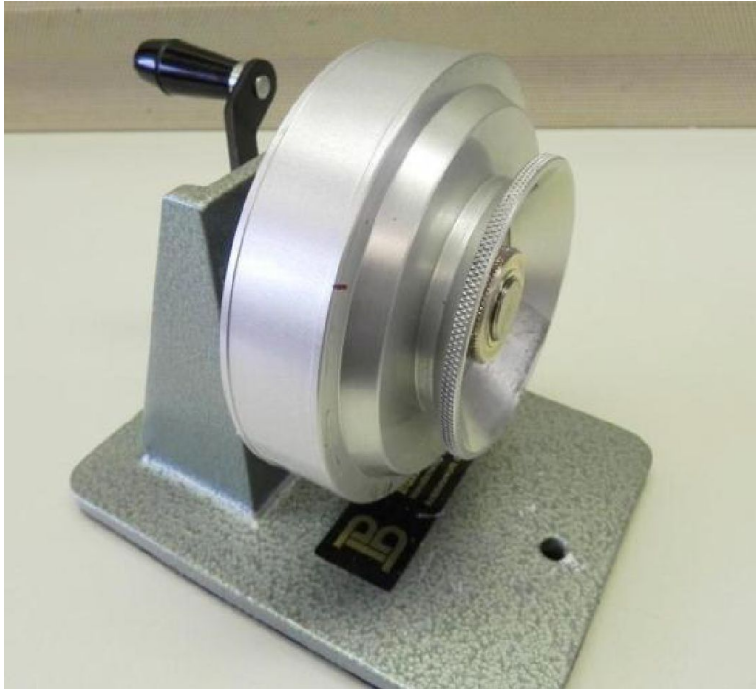
- **Volumetric method** - standard monitoring method of PIS - allows to express the concentration of biological particles in volume units of air (an important value for expressing the **possible patient load**) Measurements of the pollen content in the air are the fundament of every pollen forecast
- **Pollen traps (pollen sampler)** are used in aerobiology for this purpose and answer the question of what was and is in the air
- continuous and volumetric (Hirst type, e.g. Burkard, Lanzoni)
flow rate of 10 L/min
sampling height between 15-20 m above ground

location distant from high buildings or other obstacles,
trees and other local pollen sources

a description of the surrounding (urban/rural area,
valley/hill side, vegetation) should be available

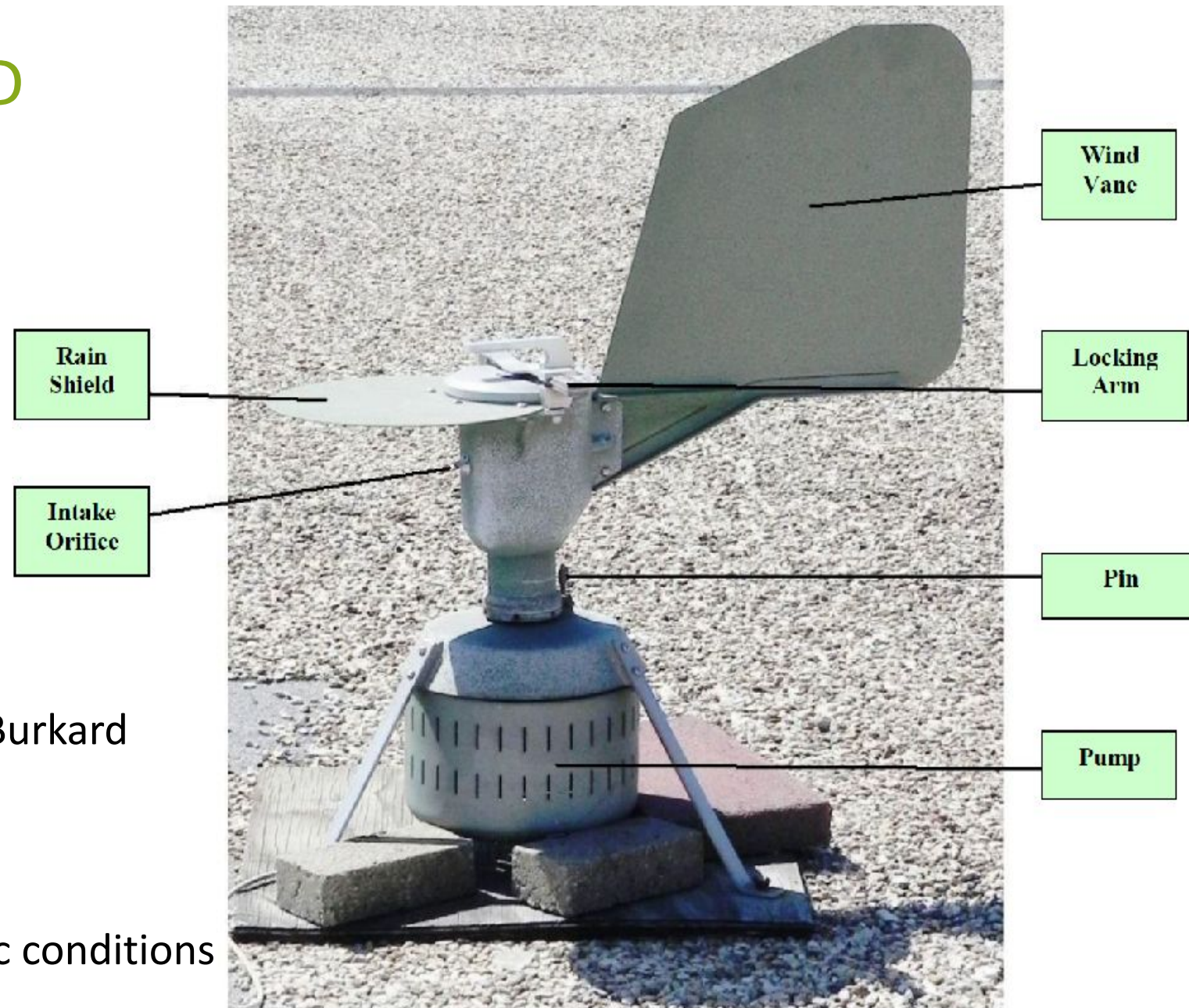


POLLEN TRAP BURKARD



Adhesive tapes as capturing surfaces in Burkard sampling

Adhesives: **vaseline** and **silicon oil** are recommended depending on the climatic conditions



Rain
Shield

Intake
Orifice

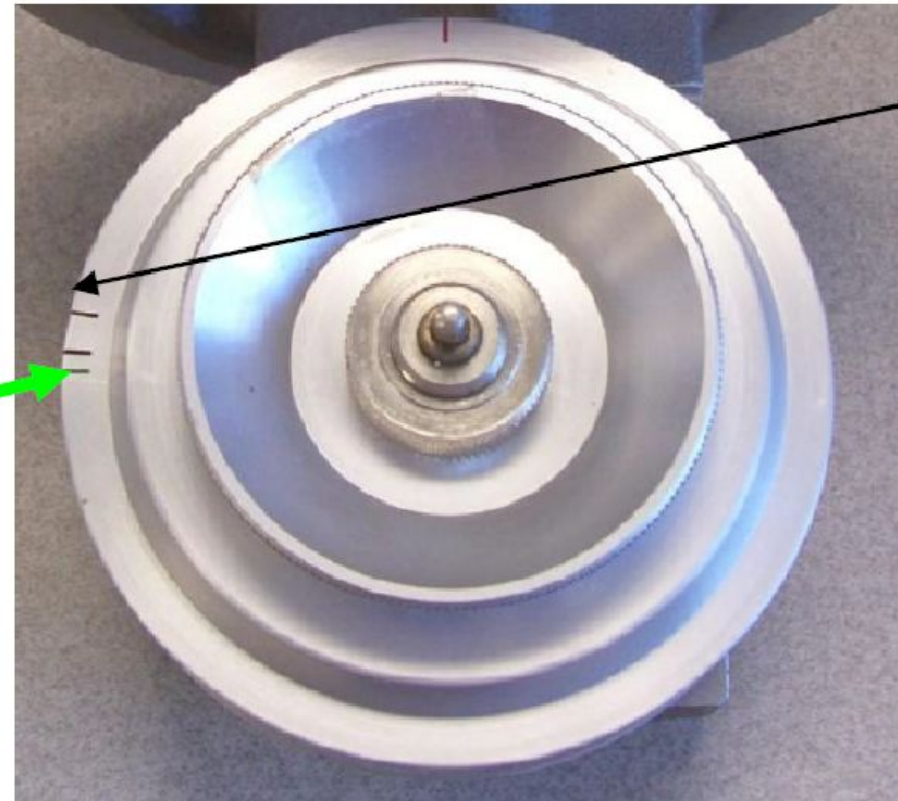
Wind
Vane

Locking
Arm

Pin

Pump

SAMPLES PREPARING



Green line is at the beginning of day one

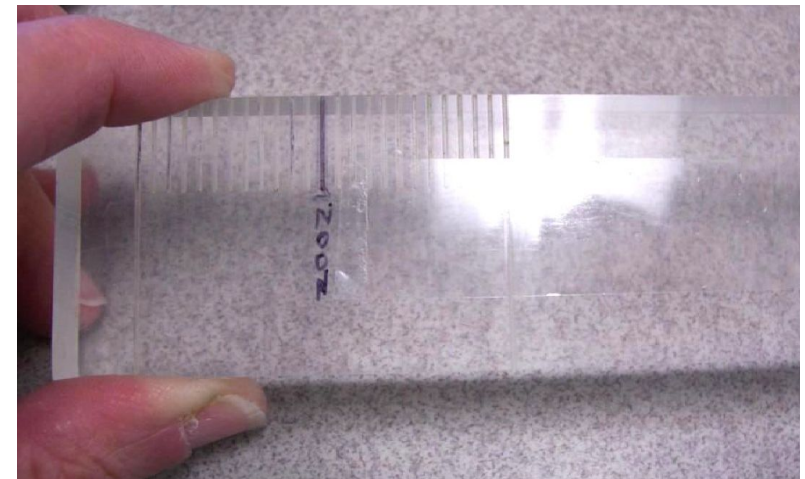
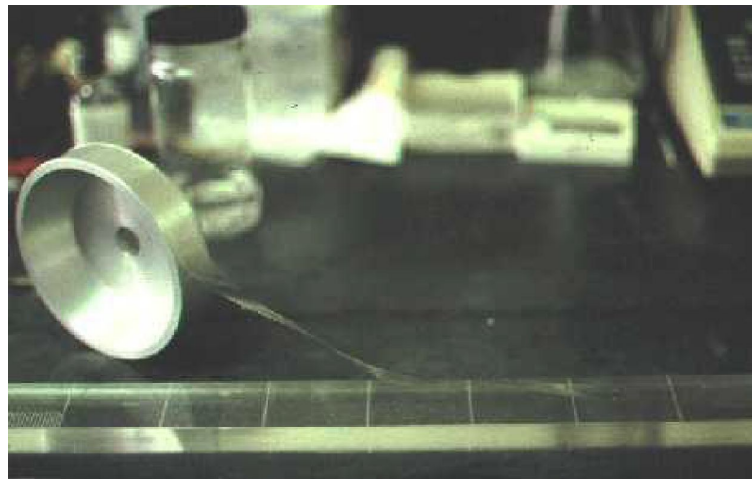
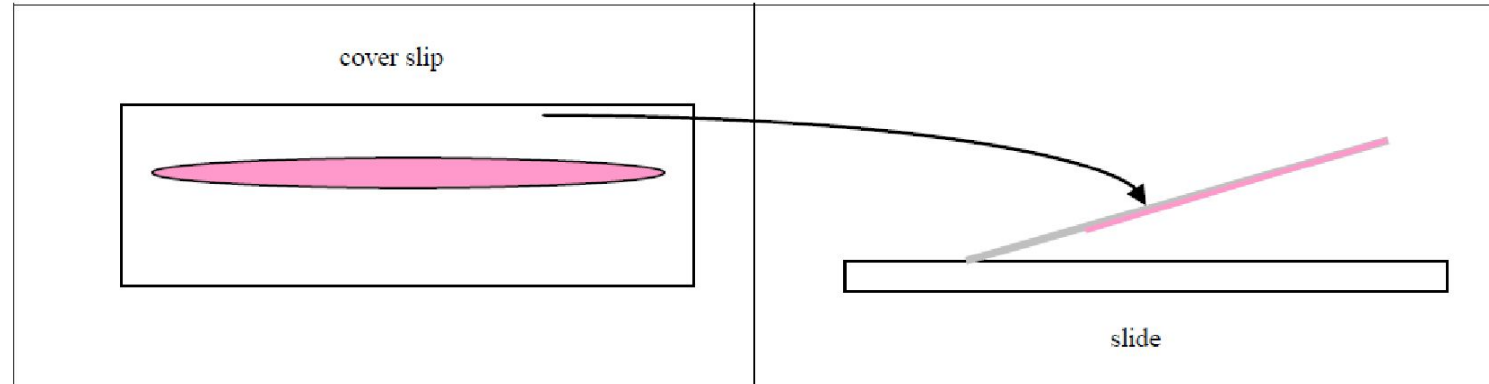
End of the week

SAMPLES PREPARING

Tapes is cutting - each sample is divided in days and bi-hourly sections

Imbedding medium: most often **gelvatol** or **glycerine jelly** are used

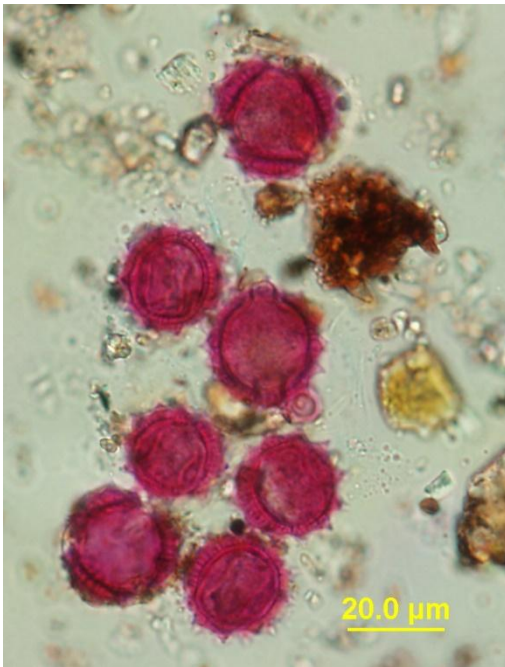
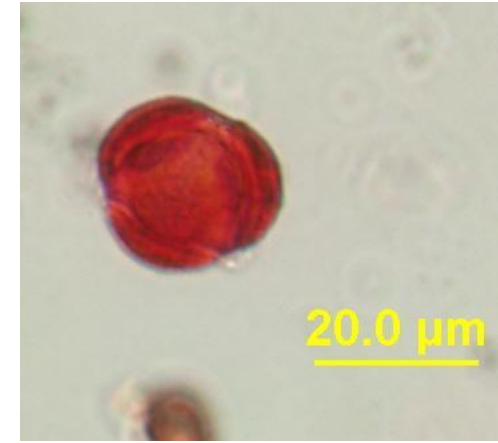
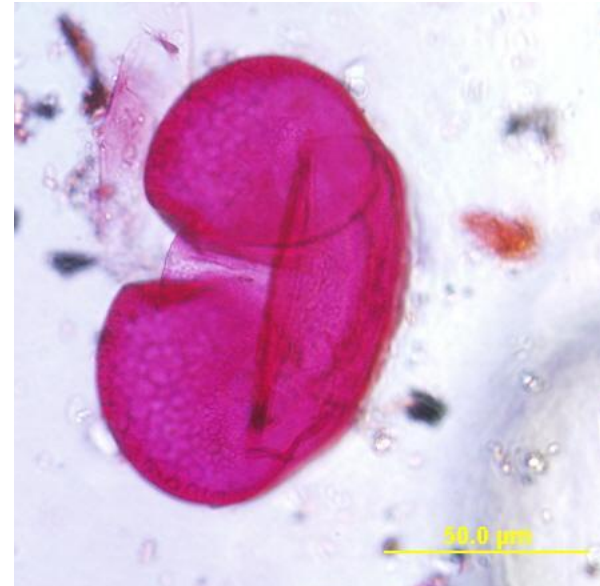
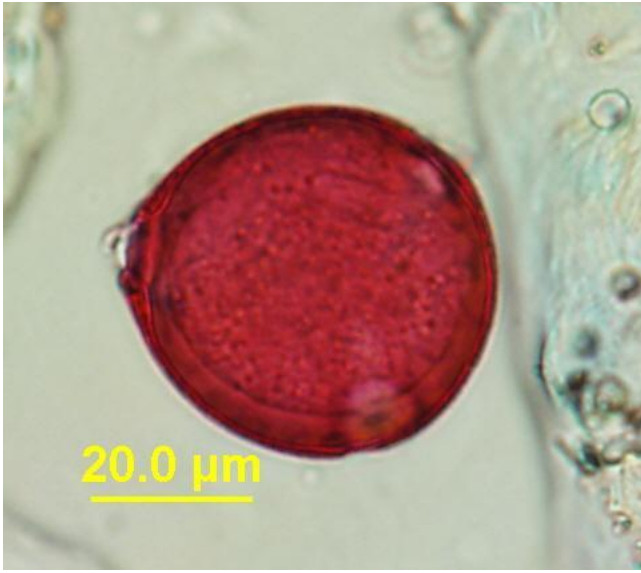
Staining: mostly basic **fuchsin** or **saffranine**



POLLEN COUNTING

- Pollen is determined and counted on the slide by the **light microscope** compound light microscope magnification **400 x resolution** (numerical aperture of the objective) not below 0.65
- **Counting method:** In the qualitative and quantitative analysis of the daily sample, the method of horizontal strips of touching fields is used at least 10% of the sample has to be analyzed (this means **4 longitudinal bands, 12 transverse (vertical) bands** (a conversion factor has to be applied depending on the microscope and the method used to receive daily averages and **daily concentration** (pollen per m³ air) corresponding to the average daily content of pollen grains and spores
- Those values are used for the **pollen forecast**, the **graphs, models** and many more services

And so I learned to know the pollen spectrum ... 7 years practice with pollen monitoring 😊



POLLEN REPORTS AND FORECAST

<https://www.polleninfo.org/country-choose.html>

The screenshot shows a web browser window with the URL alergia.sk/index.php?page=aktuality&id=314. The page features a navigation menu on the left with items: Alergia v kočke, Svet alergie, Alergény, Liečba alergie, Mám alergiu?, and Peľové spravodajstvo. The main content area is titled "Peľová situácia za 17 týždeň 2017" and includes a date "03.05.2017". Below the title is a sub-heading "Peľová situácia v SR za 17. týždeň 2017" and a section "Aktuálne druhy najvýznamnejšie z alergologického hľadiska:". The text lists pollen types: Breza, jaseň trávy z čeľade lipnicovité, cyprusovité-tisovité, javor, dub, buk, platan, orech, borovicovité. It also mentions mold spores: *Cladosporium, Alternaria, Epicoccum, Stemphylium, Helminthosporium*. A paragraph describes the pollen situation, noting that pollen concentrations were lower than in previous years, with birch pollen season ending. The highest concentrations were recorded in Banská Bystrica and Bratislava. The most critical pollen situation occurred on May 26, 2017, in Banská Bystrica, with a total daily pollen concentration of 948 grains per cubic meter of air, dominated by birch pollen (330 grains/m³) and boraginaceae pollen (220 grains/m³). A new pollen type, grass pollen from the Lipniaceae family, was first detected. Other pollen types like buck, maple, plane, birch, and hazelnut were also present. Mold spores (fungi) were also present, primarily Cladosporium. A forecast for the 18th week of 2017 is provided, stating that the birch pollen season has definitively ended and that pollen levels will be lower than in previous years. The forecast also mentions that birch pollen will continue to dominate, but that other pollen types and mold spores may cause mechanical irritation. The pollen season will start slowly. The forecast is attributed to RNDr. Janka Lafférová, Regional Public Health Office, Banská Bystrica.

23 000
dobrých dôvodov
aby sa dnes
astma neprihlásila

Čo spôsobuje astmu | Priznaky a spúšťače astmy | Diagnostika astmy | Liečba astmy

denne sa
každý z nás nadýchne a vydýchne
približne 23 000 krát

POLLEN INFORMATION SERVICE IN EU

- **Pollen Information Service** - monitoring of biological allergens in the air

In Europe, peer monitoring is provided through interconnected national networks of PIS stations

- European Aeroallergen Network initiative in building of

A **central European pollen database** with European Aeroallergen network Server (EANS) started activity in 1988, Vienna

So, the isolated pollen services of each member of European countries have been linked to a pan-European network

At present, around 300 pollen stations from around this area are contributing to the European pollen database

<https://www.polleninfo.org/country-choose.html>

PALYNOLOGY AND ITS USE FOR RECONSTRUCTION OF PAST ENVIRONMENTAL CONDITIONS

Paleolimnological research presented through our national projects focused to climatic evolution of the Central Europe in post glacial period.

Why can we use pollen in research?

Bioindicators

Pollen grains preserved in sediments are very resistant to environmental influences, which allows them to remain preserved and intact for a long period of time. The ability of long inertia is enabled by their outer shell called **exina** (for pollen grains) and **exospores** (for spores) (Moore et al., 1991). **The chemical compound** that allows the exine of pollen grains to withstand mechanical, physical and chemical influences is called **polenin**. In spores, this compound is referred to as **sporenine**

OUR PALEOLIMNOLOGY RESEARCH

latest ongoing project named

- **TAMARA** - acronym (Reading in natural archives: **Thous**Ands of years of environmental history and **cliM**Ate change **R**ecorded in **A**lpine lakes of the Ukrainian Carpathians)

The project aims to provide a detailed reconstruction of climate and environmental changes during the Holocene in this mountain region

Specifically, the research will be focusing on the following topics:

1. Reconstruction of the mean July air temperature trends over the Holocene
2. Identification of the timing and range of long-term human-induced effects on the lakes and alpine landscape
3. Defining the timing and intensity of stressors affecting the lakes during last century (acidification, eutrophication)

OUR PALEOLIMNOLOGY RESEARCH

- „A 250 year history of human impacts on a landscape of the Banská Štiavnica mining territory: a palaeolimnological reconstruction using biotic and abiotic indicators from lake sediments“

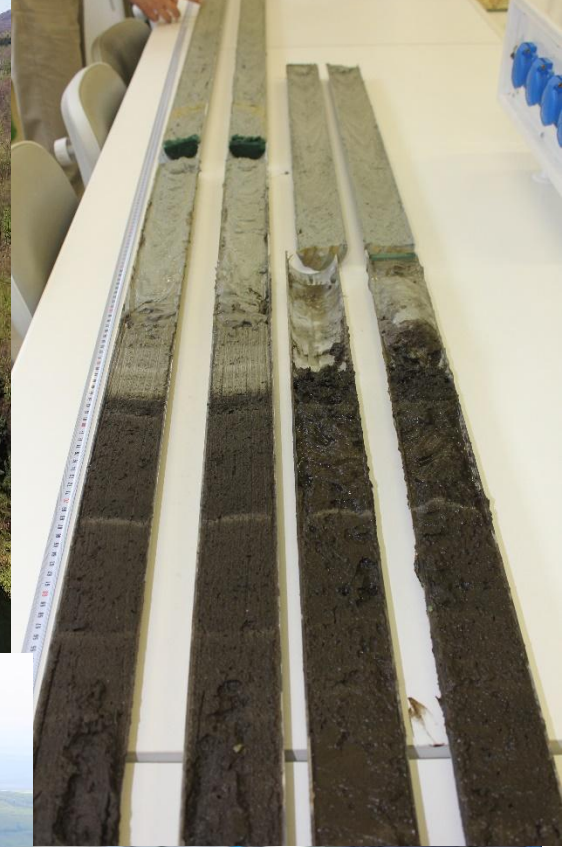
The aim: (mining, multi-proxy approach, catchment vegetation changes, reservoir ontogeny, heavy metals, Anthropocene)

- „Deglaciation and postglacial climatic development of the High Tatras recorded in the lake sediments“

The aim: climatic evolution of the Central Europe in post glacial period

Pollen analysis is very valuable paleoclimate proxy and it was used for paleoenvironmental reconstructions of the High Tatras landscape, in this project, pollen analysis were used as a proxy to identify changes in plant communities at the transition from clay (glacial) and to organic (post-glacial) sedimentation

<http://www.geo.sav.sk/en/depovyt-apvv-15-0292/>





MINNING RESHAPED THE RELIEF

Hundreds of years of the ore mining reshaped the relief and has left a legacy of abandoned **surface mines**, **subsidence pits**, mine adits, abandoned heap of metallurgical **slag**, **dumps**, and **reservoirs** and **rests of the canal system**

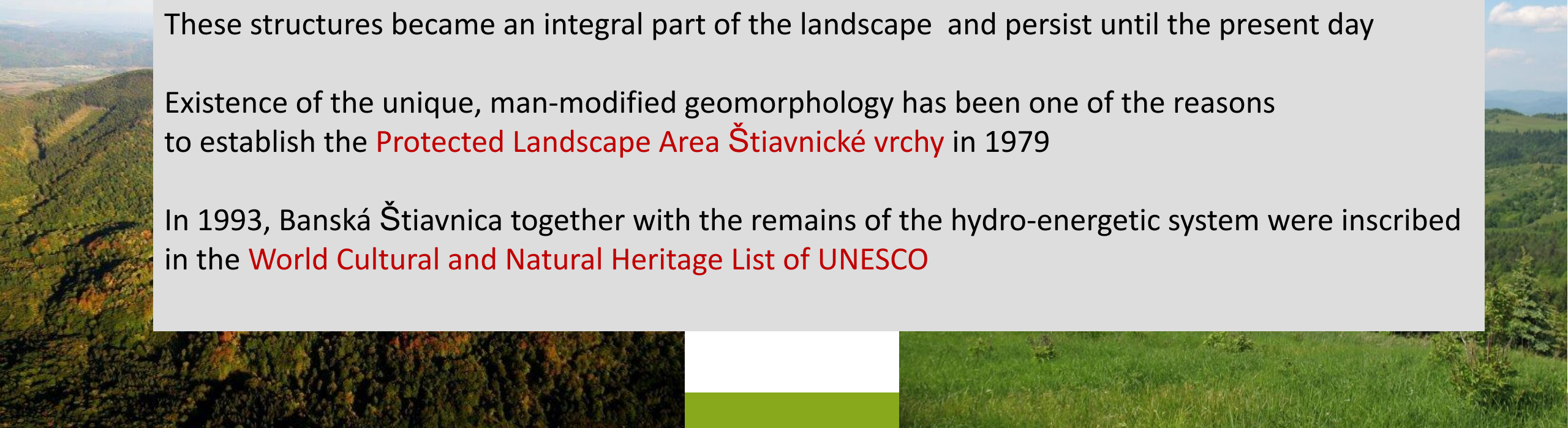




These structures became an integral part of the landscape and persist until the present day

Existence of the unique, man-modified geomorphology has been one of the reasons to establish the **Protected Landscape Area Štiavnické vrchy** in 1979

In 1993, Banská Štiavnica together with the remains of the hydro-energetic system were inscribed in the **World Cultural and Natural Heritage List of UNESCO**



RESERVOIRS AND RESTS OF THE CANAL SYSTEM

- Because the fundamental and extensive changes in the Banská Štiavnica region have occurred back in the past before scientific observation was possible, **palaeolimnological methods** have to be employed to study the timing, severity and extent of human impacts
- At the present time, 30 reservoirs of the former hydro-energetic system are preserved and serve mostly for recreation and angling. They potentially contain **deposits** that represent an important and unique **archive of reservoir and watershed dynamics**
- **To get an overview of the natural and anthropogenic events recorded in the sediments** we have to look back into the past by disentangling the changes in sub-fossil organisms and sediment characteristics (i.e. 'proxy' data)

SCIENTIFIC GOALS

- 1) To reconstruct changes in vegetation cover in the reservoir watersheds as a response to intensity of human impacts: from heavy mining practices to natural and managed reforestation
- 2) To determine the anthropogenic impacts on past sediment delivery from the deforested watersheds during the mining period and to identify changes in sediment transfer related to with the development of vegetation
- 3) To figure out (based on the chemical composition of the sediments) the impact of mine wastes, especially heavy metals, on the environment over time, and in connection with the findings to assess the potentially toxic risk for humans e.g. via food chain (drinking water, fish)
- 4) To find a stratigraphic marker from which the beginning of Anthropocene in the northern part of the Austro-Hungarian Monarchy could be identified
- 5) To reconstruct changes of lake ecosystems over time: how aquatic organisms responded to extreme conditions prevailing in the period of the biggest boom of mining (water-level fluctuation, extensive influx of allochthonous material, toxic effects of pollutants) and how the succession advanced after mining activities ended?

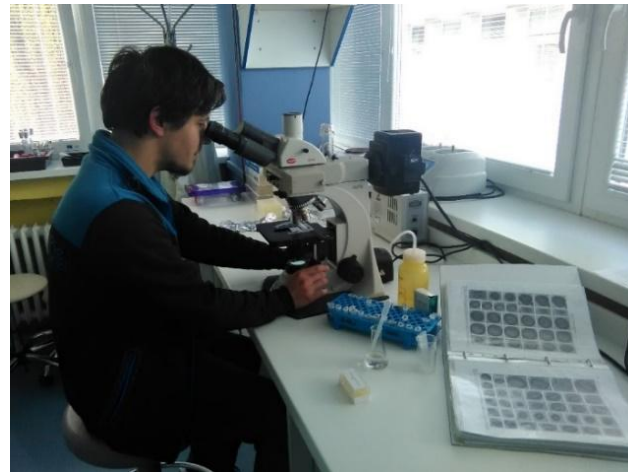
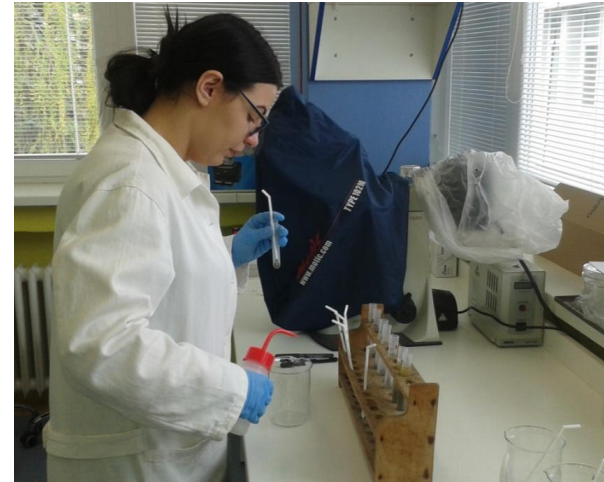
We will track the development trajectories of two model reservoirs under different management conditions over the past ~ 100 years

SEDIMENT EXTRACTION

- Year 2015 and 2016 **steel coreworker** working on a hydraulic principle
- **Sonar survey** - selecting the site with the largest sediment thickness
- Length of sedimentation cores (**V. Richňava 184 cm**, Vindšachta 120 cm, **Rozgrund 420 cm**)



LABORATORY ANALYSIS



Determination skills, evaluation and interpretation of results, to train presentation skills on Student research conference - competitions - winner of scholarship

