The integrated natural sciences approaches to the protection of medieval ruins

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Introduction

Medieval ruins are considered as important architectural and cultural monuments and heritage

- not only for their landscape position as a dominant of the region
- also as integral part of cultural awareness of inhabitants

often the objects with high natural value

At first is necessary to get informations about the **position of the building in the country**, to know the characteristics of the background of the monument:

- what type of rocks/soils forms the ground under the walls,
- risk of landslide,
- earthquakes,
- volcanic activity,
- floods.

Very important is to know the state of statics and about the state of roofing.

The next step is to study the building material:

1. types of rocks, bricks, wooden and metal structures etc.

2. determine the state of the building material: if and how seriously is damaged, weathered etc.

For suitable recovery of the building needs one to know the **source of the building material**, e.g. of the bricks or rocks.

In case of bricks is suitable to use bricks made from the same clay material and by same technology.

In case of stone material is necessary to know the source of the rocks.

We need also informations about
the type and composition of mortar,
plaster coating,
external rendering, etc.

and know, how the interaction of mortar, plaster coating, external rendering with building material (bricks, stone, wood etc.).

It is important also know if the building is attacked by some chemical (acidity, carbonation, salinization, oxidation, capillary action...)

or biological factors (fungi, cyanobacteries, lichens, moss, vascular plants).

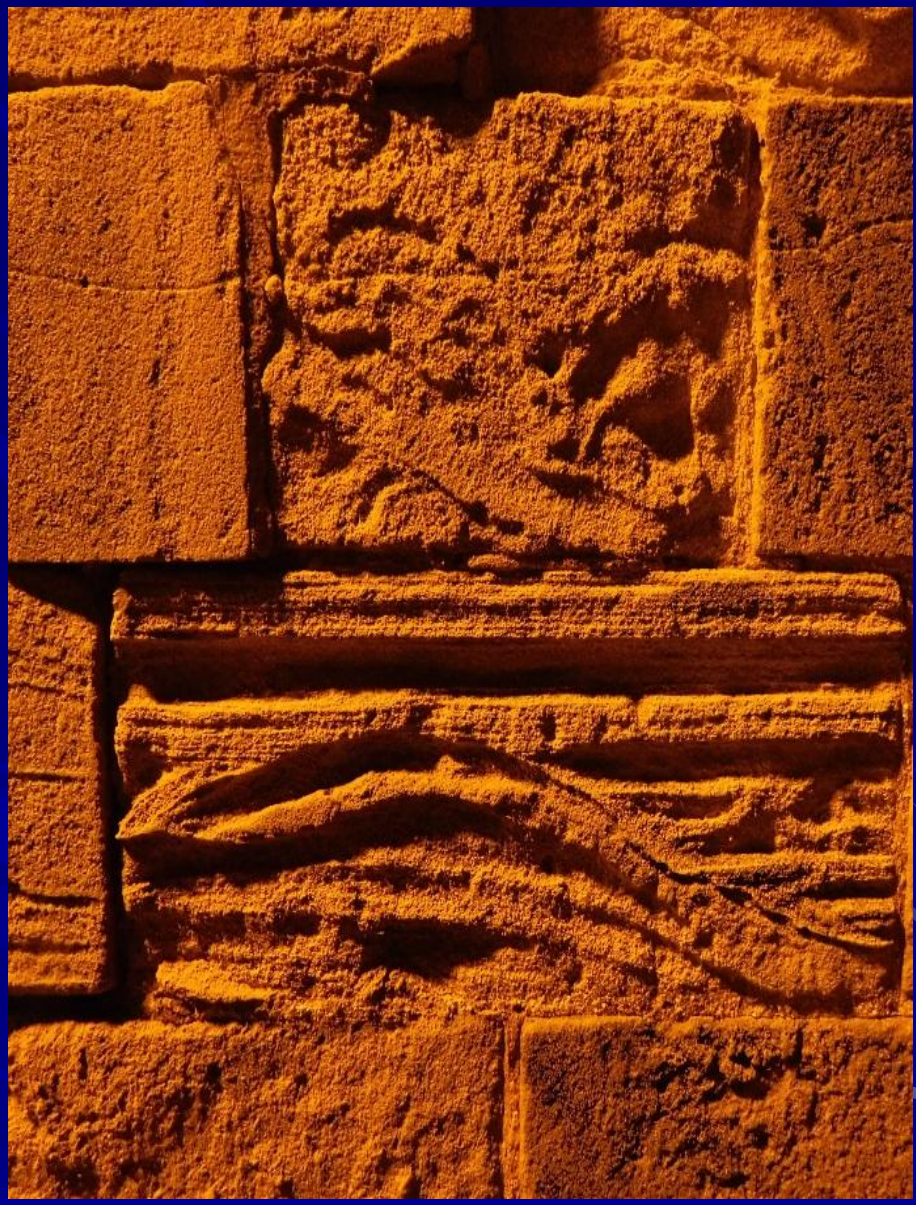
Chemical factors

Water from various sources:

rain, fog, floods, surface water,
groundwater, capillary action,
moisten,
destabilization of foundations,
leaching of some wall components,
damage of roofs,
leaking of interior,
destruction of external and internal
rendering etc.

Acid rain

acids have
a dissolving, leaching
and corrosive effect
on rocks (first of all
on limestone/marble),
bricks, concrete
and lot of other
building materials.



Patterns of acid rain on sandstone

$$CO_2 + H_2O – H_2CO_3$$

$$SO_2 + OH\cdot \rightarrow HOSO_2\cdot$$

$$HOSO_2\cdot + O_2 \rightarrow HO_2\cdot + SO_3$$

in the presence of water, SO_3 is converted to sulfuric acid:

$$SO_3\,(g) + H_2O\,(l) \rightarrow H_2SO_4\,(aq)$$

Presence of iron sulphides in the rocks in building material (e.g. rocks or concrete) or in rocks underneath buildings.
Moisture in connection with air oxygen may cause decomposition of the sulphides and formation of sulfuric acid.

Carbonatation may influence the quality of the building material (mainly of concrete or cement).

Efflorescence various salts, transported by wind and water droplets on the surface of the building materials, as well as the **capillary action** forms powerful minerals which are able cause great problems.

Patterns of efflorescence both on rocks and on mortar

Sulfur dioxide – SO_2 – often cause on the surface of buildings is a black crust composed of gypsum, as a result of the reaction between calcite, water and sulfuric acid.

$$CaCO_{3(s)} + SO_{2(g)} \rightarrow CaSO_{3(s)} + CO_2$$

$$CaSO_{3(aq)} + 2H_2O_{(l)} + \tfrac{1}{2}O_{2(g)} \rightarrow CaSO_4 \cdot 2H_2O_{(s)}$$

Fire and **soot contamination**

is able effect secondary damage possible due to the acidic nature of soot (discoloration, corrosion...)

BIOLOGICAL FACTORS

- Medieval ruins are anthropogenic habitats in which many species of **plants** and **animals** find suitable living conditions
  - specific ecological conditions
  - rock substrate, shallow soil, slopes orientation, slope terrain, evaporation of water...
- The subject of biological research has been since the 18th century (flora and fauna, then ecology)

Medieval Ruins and Biodiversity

The vegetation and local environmental conditions within individual sites are generally highly variable

- small area and a variety of habitats:
  - clumps of trees or shrubs, xerothermic grassland, arable field, ruderal habitat, meadow, moat (filled with water all the time or only periodically wet), and/or walls (of a castle) with some plants growing on them.

Monastery Bzovík, Slovakia

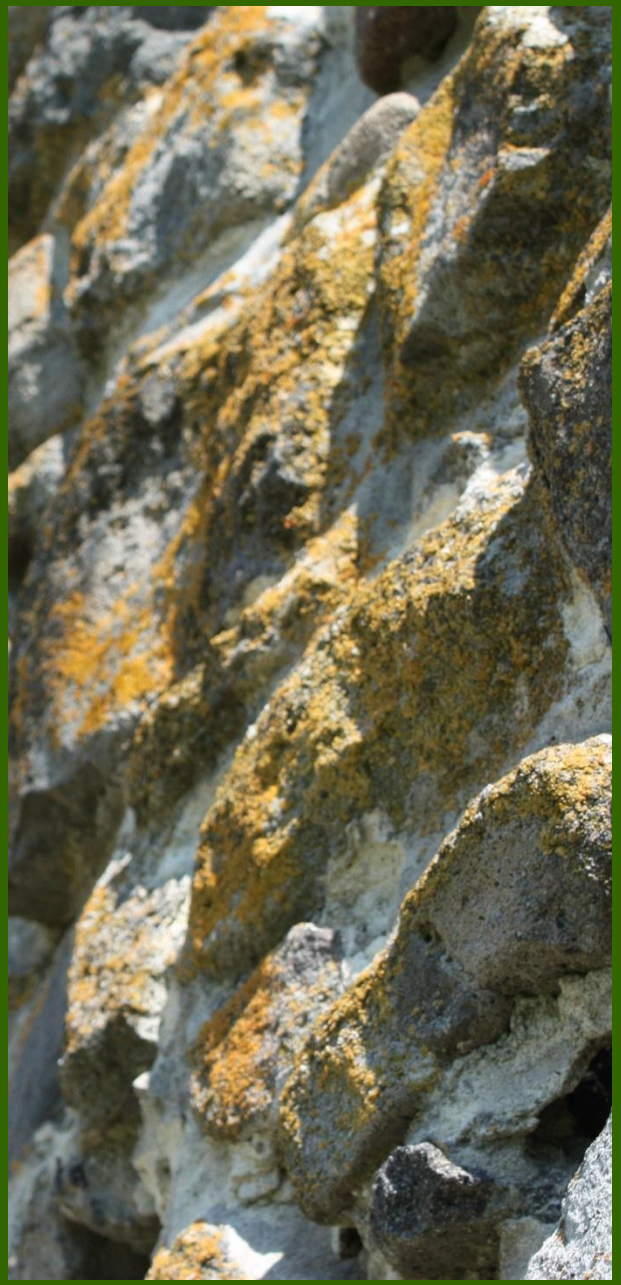
Medieval Ruins and Biodiversity

- The ruins were reported as refuges of many **rare and endangered species...**
- ...as well as habitats and centers of spread of synanthropic species, esp. **alien invasive species**
- Conservation and restauration of the ruins alter the local flora and fauna by increasing of plant species number (**25 – 30 % of new species after restauration**).
  - for comparison research before restauration is very important

...and it is not all

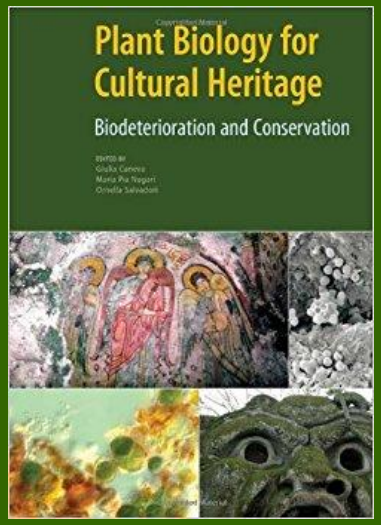
- **non-vascular plants (cyanobacteries, algae, bryophytes), fungi and lichens**
  - the first colonizators
  - the first producents of biomass and secundary metabolits
  - biopathologist of ruins

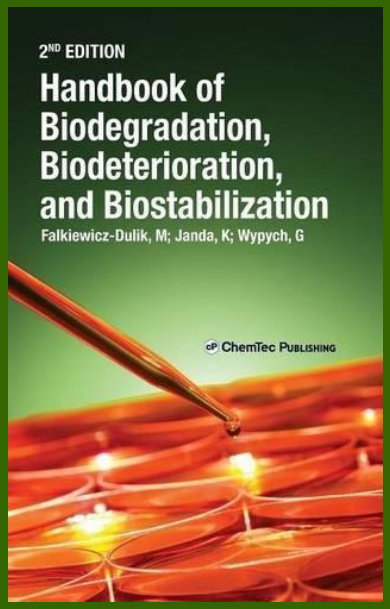
biocorrosion, biodeterioration, bioreceptivity, bioerosion, bioabrasion, biodeformation...



HOW TO INTERPRET BIOLOGICAL DATA?

- to evaluate the risks
  - fires
    - sites with high abundance of woody plants
  - disruption masonry
  - high values of synanthropization and apophytization
    - negative impacts on biodiversity and aesthetics
  - occurrence of invasive taxa
  - acidification, etc.
- to evaluate the natural richness, values
  - rare, endangered, endemic, protected species





Management

The most effective measure is the regular care of vegetation

VASCULAR PLANTS

- by mowing, removal of trees and shrubs or by grazing small herds of sheep, cows or goats in view of the risk of higher nutrient accumulation in the soil.
- biological competition between the species

NON-VASCULAR PLANTS (BIOFILMS)

- mechanically, physical-mechanically, chemically (biocidal agents)

- it is important to know the character of vegetation
- liquidation must not lead to the loss of material of ruins

Management

Management

Conclusion

Scientific knowledge, technological innovation and the development of new materials will provide useful tools for stakeholders to apply effective strategies and to plan on time proper preventive conservation measurements to the improve the condition of the ruins and enjoyment of cultural heritage.

... not forgetting an integrated and holistic approach to protecting (not only) cultural heritage

Thank you for your attention