biomediated approach needs to be improved; from one side by increasing the very low yield of organic-matrix macromolecules, as actually produced with sea shells extraction, and from the other side avoiding the secondary negative effects due to the application of viable microorganisms.

The molecular biology and the bacterial genetic engineering are the innovative technologies chosen to improve the bioinducing calcite precipitation method. These tools will be applied for finding the genetic expression of crystal formation in bacteria. This will be cloned and the bio-inducing proteins will be produced, in sufficient amounts, in an appropriate expression vector (host cell). At the end of the project we will have a great availability of inducing organic macromolecules produced by biotechnological method. With these a Bio-Mediated calcite Treatment (BMT) will be developed and validated in laboratory and outdoor conditions, evaluating its efficiency in the stone reinforcement, due to new calcite precipitation inside porosity induced by specific bio-derived low cost renewable macromolecules.

Expected impacts

Public and private institutions involved in historical buildings repair and maintenance need safer methodologies for stone materials and the environment. Once the new method is successfully validated we can apply, for the restoration of monumental stones, a new treatment based on a product of the same nature of stone substrate, with the prospective of a longer lasting efficiency and a lower environmental impact. The safeguard of the cultural heritage is awaiting for scientifically endorsed new materials and procedures for conservation and if this problem will not resolved the monumental stones are exposed to a serious chance of loss or damage.

The new method will demonstrate its maximum efficiency for calcareous stones (like marble and limestones), but also for other lithotypes having a certainly carbonatic component (i.e. secondary calcite cement) or with a partially calcitic matrix. The successful of the project will furnish, in very short time, the end-users with a new tool to improve their skilful to perform safer and more reliable restoration interventions of monuments in line with a sustainable development.

Participants

- **CSCOA** - CNR - Centro Studi Opere Arte (Firenze, Italy) (Co-ordinator)
- **WIS** - The Weizmann Institute of Science, Department of Structural Biology (Rehovot, Israel)
- **LCM** - Loughborough University, Department of Chemistry (Loughborough, United Kingdom)
- **DBG** - Dept. of Animal Biology and Genetic, University (Firenze, Italy)
- **UBM** - University of Barcelona, Department of Crystallography and Mineralogy (Barcelona, Spain)
- **TRI** - Trivella spa, (Milano, Italy)
- **QUE** - Quélin SA, (Rueil-Malmaison, France)
- **KIK** - Institute Royale du Patrimonie Artistique (Brussels, Belgium)
- **CPP** - Circles des Parteinaires du Patrimoine, Laboratoire de Recerche des Monuments Historiques, (Champs sur Marne, France)

CYANOBACTERIA ATTACK ROCKS: CONTROL AND PREVENTIVE STRATEGIES TO AVOID DAMAGE CAUSED BY CYANOBACTERIA AND ASSOCIATED MICROORGANISMS IN ROMAN HYPOGEAN MONUMENTS (CATS – EN4-2000-00659)

Patrizia Albertano
Università di Roma "Tor Vergata", Rome, Italy

The proposal CATS focuses on the control, prevention and monitoring of cyanobacteria-dominated biofilms that cause damage to rock surfaces in Roman hypogea. It develops and integrates physical and biotechnological methods

intended to limit the growth of microorganisms on valuable archaeological surfaces, and applies analytical methods to monitor the presence and the extent of the microbial damage.

The overall objective of CATS will be to achieve a better understanding of biotransformation and biodecay processes of lithic substrata caused by the growth of biofilm-forming cyanobacteria in hypogean monuments. In addition, CATS intends to evaluate the applicability of a two-phase (physical plus biotechnological) strategy to decrease and inhibit the growth of phototrophic and heterotrophic microorganisms that cause severe damage mostly to calcareous rock surfaces in Roman hypogea. Accordingly, CATS will answer the following two major and essential questions in order subsequently to develop control and preventive strategies:

- How does microbial activity alter the mineralogical, textural and geochemical features of rocks?
- What conditions limiting growth of cyanobacteria can be safety applied in Roman hypogea?

To achieve these central objectives different types of microsensors will be developed. These will be used to quantify biologically induced variation of gases and ions on the colonised lithic substrata. Data on the petrological and geochemical characteristics of rocks and on structure, function and diversity of biofilms will be integrated with those obtained using microsensors in order to describe and model the damage of rock surfaces. This part of the project will end with the construction of a multiparametric portable device based on microsensors that will be produced as a new tool for microbial monitoring.

In the other part of the project, a pilot study will be set up to investigate the possibility of using a new lighting system providing wavelengths poorly used by cyanobacterial photosynthesis. This will drastically decrease the growth of cyanobacteria and therefore the quantity of organic matter available to the associated heterotrophic populations. Subsequently, the new lighting system will be experimentally set up *in situ* in order to confirm the laboratory results. At the end of this part, the public response to the innovative strategies proposed will be tested and the benefit to cost ratio of a new illumination system in Roman hypogea will be evaluated.

In addition to the physical approach, newly identified biomolecules related to iron metabolism and cell-to-cell signalling pathways will be checked for their ability to interfere with bacterial and, especially, cyanobacterial metabolism by removing factors indispensable to microbial development. The application of these environmental biotechnologies under laboratory conditions should provide a new method to control and prevent growth of phototrophic biofilms.

Specific objectives of the project are:

- to characterise the geological, geo- and hydrochemical, and physical environment of rocks unaffected or colonised by cyanobacterial communities inside Roman hypogea, and to evaluate possible preferences of cyanobacteria and associated microorganisms for specific lithologies;

- to describe the architecture and functioning of biofilms built by cyanobacteria and associated microorganisms on different types of lithic surfaces;

- to ascertain the most critical physical, chemical and biological factors that control colonisation of rock surfaces;

- to assess and quantify the damage caused by cyanobacterial biofilms to different types of surface;

- to develop new physical methods to control and prevent biofilm growth using wavelengths in the visible part

of the light spectrum that are, at best, poorly used by photosynthesis;

- to identify siderophores and cell-to-cell signalling biomolecules and experimentally to test their potential to interfere with biofilm development;

- to develop an innovative monitoring method using a multiparametric microsensor device for the measurement of biogeochemical parameters on endangered rock surfaces;

- to test the response and expectation of citizens to the innovative strategies proposed.

Participants

- **URTV.DB.LBV** – University of Rome "Tor Vergata", Department of Biology, Laboratory of Plant Biology, (Rome, Italy).
- **UNITOVRM** – University of Rome "Tor Vergata", Department of Science and Chemical Technology (Rome, Italy).
- **CSIC-IRNAS** – Instituto de Recursos Naturales y Agrobiología (Sevilla, Spain).
- **UB** – University of Barcelona, Department of Natural Products, Plant Biology and Soil Science, Faculty of Pharmacy (Barcelona, Spain).
- **UNIME01** - University of Messina, Istituto Policattedra di Microbiologia (Messina, Italy).
- **HKI** – Hans-Knöll-Institut für Naturstoff Forschung e.V. (Jena, Germany).
- **VTT** – Tecnical Research Centre of Finland, VTT Biotechnology, (Espoo, Finland).
- **U W Swansea** – University of Wales Swansea, Biochemistry Research Group (Swansea, United Kingdom).
- **IDRONAUT, S.R.L.** (Brugherio, Italy).
- **PCAS** – Pontificia Commisione di Archeologia Sacra (Rome, Italy).

3. Forthcoming activities

Steering Commitee Meeting S1: Barcelona (Spain), December 1-2, 2000.

First Coalition Workshop: Development, update and preparation of database: Gent (Belgium), March 8-10, 2001.

4. Call for papers

This newsletter is open to external contributions, including short communications and notes (maximum 2 pages), or critical comments (1 page) on the topics covered by COALITION.

5. Dissemination of this newsletter

This first issue is being sent to a wide list of people related with Cultural Heritage. However, for receiving the second and subsequent issues we request you to send us an e-mail to coalition@irnase.csic.es with the message: Subscribe COALITION.