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Hellenic Foundation for Research & Innovation

Description of the funded research project

1st Call for H.F.R.I. Research Projects to Support Faculty Members & Researchers and Procure High-Value Research Equipment

Title of the research project: “Exploiting the unique microbial diversity of Etoliko Lagoon to improve our understanding of the microbial community assembly, evolution, and global carbon cycle in sediments”

Principal Investigator: George Tsiamis

Reader-friendly title: Exploiting the unique microbial diversity of Etoliko Lagoon

Scientific Area: Environment and Energy

Institution and Country: Lab of Systems Microbiology and Applied Genomics, School of Engineering, University of Patras

Host Institution: University of Patras

Collaborating Institution(s): University of Ioannina

Project webpage: http://uniquelt.org

Budget: 161.266,94

Duration: 36 months

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Research Project Synopsis

Etoliko lagoon is part of a complex wetland in Western Greece extremely rich in biodiversity. The physical characteristics of Etoliko Lagoon include a permanent thermocline, halocline and anoxic conditions in the hypolimnion. This anoxic zone extends from 10m to 28m and a steep oxycline is evident between 5m and 10m.

Etoliko lagoon is unique regarding: (a) the distribution of sulfates, which increases towards the bottom of the Etoliko lagoon while it decreases in all other well-known anoxic basins such as Framvaren Fjord, Cariaco Trench, Black Sea, Rogoznica Lake, and (b) the sediment of Etoliko lagoon is rich in microbial diversity as it has been discovered by 16S rRNA gene studies and single cell genomic approaches.

These molecular studies from the sediment of Etoliko lagoon revealed the presence of more than 20 highly divergent representatives from bacterial and archaeal candidate phyla. In this research proposal we plan to examine the microbial community assembly and evolutionary process in the transition from shallow to deep sediment. The results from this project will have implications for understanding microbial life in one of the largest, yet most inaccessible, ecosystems on Earth: the deep biosphere.

This will be achieved by deploying a single cell genomics/metagenomics/metatranscriptomics approach, combined with a detailed 16S rRNA/ITS2 amplicon sequencing from anoxic deep sediment of Etoliko lagoon, targeting bacteria, archaea, and microalgae. The advanced molecular approach will be matched with an anaerobic culture-dependent approach, using several electron donors.

Project originality

Most of Earth's crust is covered by sediments ranging in thickness from meters to kilometers and distributed from vast oceans to limnic systems on continents. These sediments are the largest global organic matter (OM) sink and as such play a pivotal role in controlling atmospheric gas composition, terrestrial and aquatic chemistry, and global climate.

Most of the OM deposited to aquatic sediments is produced in overlying water or imported from land via streams. Whether this OM is remineralized or preserved over geologic time is controlled by microorganisms. *These microorganisms consist largely of Bacteria and Archaea and recently it was found that microalgae are dominant as well*. *They occur widely from the sediment surface to >2.4 km below, and account for a significant fraction of Earth's microbial biomass*.

The subsurface microbial communities are isolated from fresh detrital organic matter that is deposited on the sea floor. This phenomenon decreases rapidly the energy available for cellular maintenance and growth as the depth and the age of the sediment increases. As a result, the microbial abundance and cell-specific metabolic rates decrease by orders of magnitude already within the top few meters of sediment.

In this research proposal, we will explore the microbial community assembly and evolutionary processes in the transition from shallow to deep marine sediment in order to test these hypotheses. The results from this project will have implications for understanding microbial life in one of the largest, yet most inaccessible, ecosystems on Earth: the deep biosphere. At the same time, sediments are considered as the least investigated environments, harbouring unknown and undescribed microorganisms. In addition to that, Etoliko lagoon displayed a great, yet unknown, microbial community. *It is considered as a "hot spot" for identification of novel microbial life and this work will assist our ongoing effort to establish Etoliko lagoon as part of the global genomic observatory network.*

Expected results & Research Project Impact

A key element of the UniquELT study is that it will enable us to understand the microbial community assembly and evolutionary processes in the transition from shallow to deep subfloor sediments. Although deep biosphere and subfloor sediment exploration is still in its initial stage, it became a focus for the scientific community and a concern for governments and public society due to its potential great impacts, as the subfloor sediment may be the largest ecosystem on Earth. It has been estimated to harbor one tenth to one third of all biomass, and two-thirds of all microbial biomass on Earth.

The subfloor sediment is not isolated - it has intimate connection with water cycles, with enormous potential for influencing global-scale biogeochemical processes, including carbon and nutrient cycles, energy fluxes, and climate. Our knowledge on the diversity of who is there in the subsurface environments is increasing rapidly, owing to the fast development of DNA amplification and sequencing techniques.

Study of the Etoliko lagoon will enable us to understand how subsurface microbial communities are assembled and whether populations undergo adaptive evolution or accumulate mutations as a result of impaired DNA repair under such energy limited conditions.

UniquELT will be able to extend our knowledge on unknown aspects like a) to what extend the microalgae influence microbiome assembly and b) shed light to the characterization of candidate phyla and microbial dark matter. The results from this project will have implications for understanding microbial life in one of the largest, yet most inaccessible, ecosystems on Earth: the subfloor/deep biosphere. At the same time by shedding light in describing life and potential biochemistry in deep anoxic aquatic sediments, the biggest organic carbon sink of the planet UniquELT will provide a better understanding of the global carbon cycle.

The importance of this funding

The continuous and planned funding of research in Greece is one of the most critical elements for the production and utilization of new knowledge. In recent years, significant steps have been taken to address the lack of funding and the outflow of scientific potential abroad. The effort that has been started by ELIDEK is promising and should be intensified.

In this context, the funding of the UniquELT project enables my research team, but also the collaborating bodies, to answer critical questions related to the environment and vital geochemical cycles. At the same time, it will enhance the development of collaborations and the employment and training of young researchers in specialized cutting-edge methodologies such as single-cell genomics, metagenomics and metatranscriptomics.

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