Worldwide demographic and socio-economic development is reliant on the construction and building industry. While residential and commercial buildings are typically constructed from brick, due to its strength, insulation properties and aesthetic appearance, this brick layer is usually covered with a facade made of plaster to meet cultural tastes, and to give the building an individual character. However, as this facade is constantly exposed to atmospheric conditions and various organisms, ensuring its durability represents a significant architectural problem. As such biodeterioration, i.e. the formation of undesirable changes in the structure and chemical composition of building materials associated with the activity of living organisms, is commonly accelerated by bacteria, cyanobacteria and fungi, these groups have hitherto attracted the greatest attention from researchers, at the expense of the algae: a pioneer group that forms the first link in the energy and matter cycles and one that readily colonises harsh terrestrial environments that are inaccessible to other organisms. Microscopic algae, spread by wind, massively colonise building materials, and as a result of cell growth and division, gradually form photosynthetic biofilms visible to the naked eye. Some of these species, living in the temperate climate zone, have a broad range of tolerance to changes in environmental conditions; therefore, their biofilms are widespread and persist throughout the year. Such persistence begs the question of how the life processes of the algae colonizing building materials affect the structure and chemical composition of substrates, leading to the deterioration of their technical state.

The aim of the project is to determine how the algae forming terrestrial photosynthetic biofilms in the temperate climate zone affect the technical state of brick and plaster, i.e. the most commonly-used building materials, and to evaluate their impact on the materials.

In determining the biodeterioration potential of microorganisms, it is important to confirm whether a given organism is commonplace across a broad spectrum of environmental conditions, and whether its growth causes any mechanical and / or chemical damage to the colonized substrate. The foreground research carried out within the project will characterise the taxonomic diversity of the aerophytic algae colonizing selected building materials and identify the ecological preferences of individual taxonomic units. Taken together, the two research aims will clarify whether the studied algae possess the ability to easily spread between surfaces and grow throughout the year.

Following this, the algal strains cultured in the laboratory will be applied to fragments of new technical materials. As microorganisms can grow into the substrate and cause changes on its surface, brick and plaster with algal biofilms will be microscopically examined for the presence of microfractures, and the changes in optical, mechanical and physicochemical parameters of substrates will be investigated. In addition, some of the metabolites produced by the cells can pose a great threat to the technical state of building materials. Hence, the project will also investigate the terrestrial algal metabolites present in the brick and plaster. The new substrates on which the algae were cultured, and the samples exposed to field conditions, will be subjected to metabolomics analyses. Such a wide spectrum of research will allow for the identification of algal metabolites from the metabolome profile of various substrates and to confirm whether they produce corrosive compounds based on proper scientific references. In addition, the share of algal metabolites in the total metabolome profile of environmental samples will be estimated by comparing the metabolomes of samples obtained from the laboratory experiments and environmental conditions.

The project includes four comprehensive research issues, the implementation of which will allow to identify the diversity of aerial algae, and designate the genetic barcodes as a footprint of species and to determine the biodeterioration potential of aerophytic algae. It will yield a measurable effect, this being the knowledge of whether, and how, these organisms participate in biodeterioration processes; such knowledge will allow quick and easy assessments of whether a given photosynthetic biofilm growing on a building poses a significant threat to its technical state.

Although biodeterioration causes many economic and social problems, it is widely believed by environmental microbiologists that algae are not participants in this phenomenon, and that their negative impact on building materials is purely aesthetic. To address the current lack of detailed, comprehensive and multi-aspect studies confirming this hypothesis, the proposed research will examine the most important life processes of the algae taking part in biodeterioration, thus highlighting the influence of this highly significant yet poorly-understood group of organisms.