One of the major signs of global warming is the decline of Arctic sea ice cover. According to the latest climate simulations, Arctic Ocean may be free of ice by 2040. The thinning and the reduction of the extent of sea ice significantly affects the oceanographic and environmental conditions, e.g., the albedo of oceanic waters, water mass circulation, productivity and biodiversity of the ecosystems. Regarding the pace and consequences of observed changes, the studies regarding the sea ice loss are among the the major directions in the environmental and climatic research. However, the present-day observations cannot provide answers about the major forcing of sea ice loss and about the magnitude of recently observed changes, compared to the magnitude of sea ice variability in the geological timescale. For better understanding of recent sea ice trends, it is necessary to study a long-term changes of Arctic sea ice based on proxy records, to provide perspective from which we can better understand the Arctic's natural variability and response to external forcing over time.

The knowledge about distribution of sea ice cover in the last tens of thousands to millions years is still scarce and incomplete, mainly due to the lack of unequivocal proxy. Therefore, the relevant reconstructions of past sea ice conditions require to develop a multi-proxy strategy, which comprise methods providing complementary records. The developments in DNA sequencing technology offered a solution to overcome limits of currently used approaches. Environmental DNA, defined as genetic material obtained directly from environmental samples (soil, sediment, water etc.) has proven to be efficient method in biodiversity surveys, biomonitoring and environmental impact assessments. Recent studies demonstrated the preservation of DNA in marine sediments over tens to hundred thousand years. An ancient DNA (aDNA) approach was successfully applied for tracing the Holocene history of various groups of organisms, including those that have no fossil record. Until now, the studies on the application of aDNA in paleoceanographic reconstructions in the Arctic comprised analysis of foraminiferal aDNA. The results of these studies are very promising showing that the marine sediments are an excellent DNA repository, that can be used for the assessment of marine biodiversity. The novel aDNA-based approach may be adapted to any group of organisms and could provide a powerful means to reconstruct past environments more comprehensively. The proposed project will allow to reconstruct the biodiversity of various groups of eukryotes, including taxa that are indicators of the presence of sea ice cover or open water conditions.

The aim of the project is to reconstruct the variability of sea ice cover in the Nordic Seas since the end of the last glacial (during the last ~ 30 000years) in the context of oceanographic changes in the area. Multi-proxy reconstruction of palaeoceanographic conditions in the Nordic Seas will be based on sedimentological, microfossil and molecular records. The reconstruction will comprise analysis of aDNA of eukaryotic organisms, especially foraminifera and diatoms. The study will be strengthened by analysis of fossil foraminiferal assemblages, stable isotope composition of foraminiferal tests and sediment grain size. To our best knowledge, the proposed project will be the first molecular-based regional-scale paleoceanographic reconstruction comprising the late glacial and postglacial period.

By integrating the classical paleoceanographic methods with innovative molecular approach, the projects results will have a strong impact on the development of paleoceanographic studies in the Arctic region. Bringing together the data on contemporary and fossil species will allow us to create a simple method of monitoring the past and present sea environment. The obtained results will be used in further paleoclimatic studies as well as for predicting the direction of future climate changes in the Arctic and will support future environmental assessments and policy responses to the changes caused by the global warming, necessary to facilitate global sustainable development.