Museum Pests and Climate Change in Austria

Parallel monitoring of fungi, insects and microclimate in historic collections to assess future risks of biodeterioration

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Introduction

To date, many studies exist on the effects of different climatic environments on historical objects preserved indoors [Leissner et al. 2015]. Models and simulations to assess possible effects of a (future) changing climate on biodeterioration in museum collections are still underdeveloped and require a much more substantial data basis.

Xerophilic and xerotolerant species of filamentous fungi, for example from the genera Aspergillus/Eurotium or Penicillium, usually found in these comparatively dry indoor spaces are specifically adapted to growth at lower water activities and keep challenging Preventive Conservation efforts and finding strategies concerning climate conditions for the safe preservation of collections. Reports of mould infestations within rooms with overall “safe” conditions of below 60% relative humidity (RH) still occur regularly. More extreme weather events, especially a projected increase in heavy rains and flooding events, will almost definitely have an impact on the overall humidity levels within buildings. Even short-term increases of humidity on the micro-environmental scale can already have a strong influence on germination and growth of fungi. Higher mean temperatures and maxima also favour biological growth, of microorganisms and insects alike. This can, among other things, result in faster metabolism and shorter generation cycles, meaning a heightened risk of and faster spread of infestations [Brimblecombe & Lancester 2013; Sterflinger 2012].

This study is part of a larger project aiming to fill in some of the knowledge gaps through broad monitoring approaches for major museum pests – insects and fungi – and (micro-) climate within different cultural heritage collections in Austria, in combination with climate chamber experiments and building simulations [Querner et al. 2022].

Scope of the Project

Over the course of two years (Winter 2022 – Summer 2023), a broad monitoring campaign already took place in 20 different locations in and around Vienna. These comprise a variety of buildings housing heritage collections, from monastic libraries and historic museum buildings to modern art depots. They were divided into four main building categories, according to building type/function, building envelope and availability of indoor climate control [Fig. 1]. Their interiors contain large and valuable collections of historic books and manuscripts, as well as objects from natural, cultural and art history, to a large extent consisting of hygroscopic organic material, which are especially vulnerable to biological infestations.

Methods

The indoor climate (temperature and RH), abundance, diversity and activity of fungi and insects were monitored in selected rooms of all 20 locations over the course of two years. Classic microbiological as well as molecular methods (Nanopore Sequencing) were used to assess viable cultivable but also non-cultivable fungi in the rooms and to gain a closer insight into the present biodegradative potential. Quantitative and qualitative biological data were collected from air- and surface sampling (cultivation, count, and morphological identification) and through the extraction of DNA from dust in the vicinity of the objects and bioinformatic analyses. These were then analysed in correlation with monitoring data from thermohygrometric sensors placed throughout the rooms to gain an insight also into niches, behind books, or on the top and bottom of shelves, to further identify risks and potential sources of mould growth. All sampling points were set in close correlation also to the insect monitoring, taking place in parallel, using pheromone and sticky blunder traps. Biological “field data” will be complemented by more detailed growth data acquired from climate chamber experiments with selected species and materials (cellulose, animal glue, …).

Per category/building type mentioned above, one model building was selected for more in-depth analyses and will further receive a thermohygrometric building simulation. The entire dataset of biological and climatic data will finally feed into these models, together with projections from available climate change emission scenarios from the Intergovernmental Panel on Climate Change, IPCC [Fig. 2].

Results & Outlook

As the project is still ongoing, only preliminary results can be mentioned here. However, these results already show that, even in rooms with seemingly overall “good and stable climate”, microclimatic and short-term fluctuations can still have significant impact on the (micro-) organisms present, posing a latent risk for objects. Especially for collection spaces without any climate control, it is proposed to consider the possibility of regular monitoring of fungi, perhaps in parallel to insect monitoring, an already well-recognised and often implemented part of Preventive Conservation strategies in the scope of Integrated Pest Management (IPM).

Rising temperatures and moisture are two of the most important biological growth factors which can contribute to the proliferation of species in areas that did not support their growth before. Apart from physicochemical parameters, also biological factors might need to be taken more into account than before, especially when planning possible necessary future infrastructure developments such as the installation of HVAC systems. Our research aims to provide a more substantial data basis, to support decision makers faced with these questions regarding the potential current and future risks of biodeterioration and finding sustainable, cost- and energy-efficient preventive solutions.

References

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