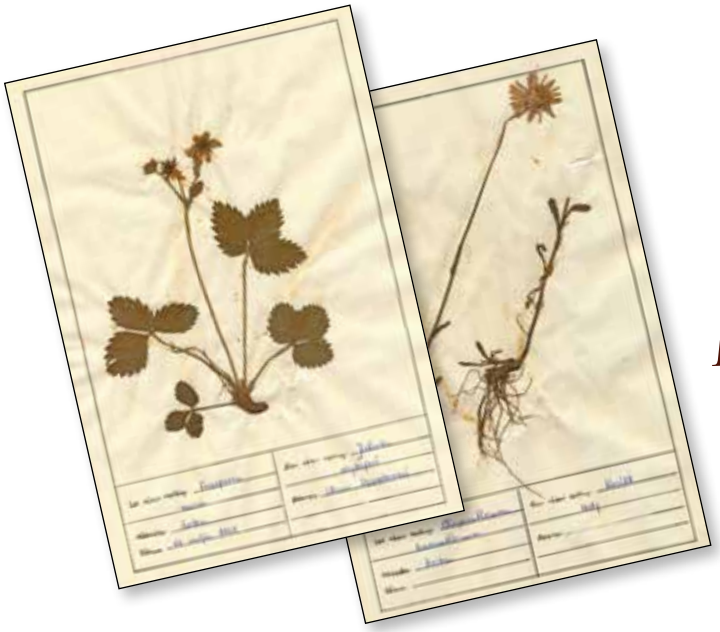


Preserving the Past: Modern Threats to Herbaria and Fungaria

Britt A. Bunyard

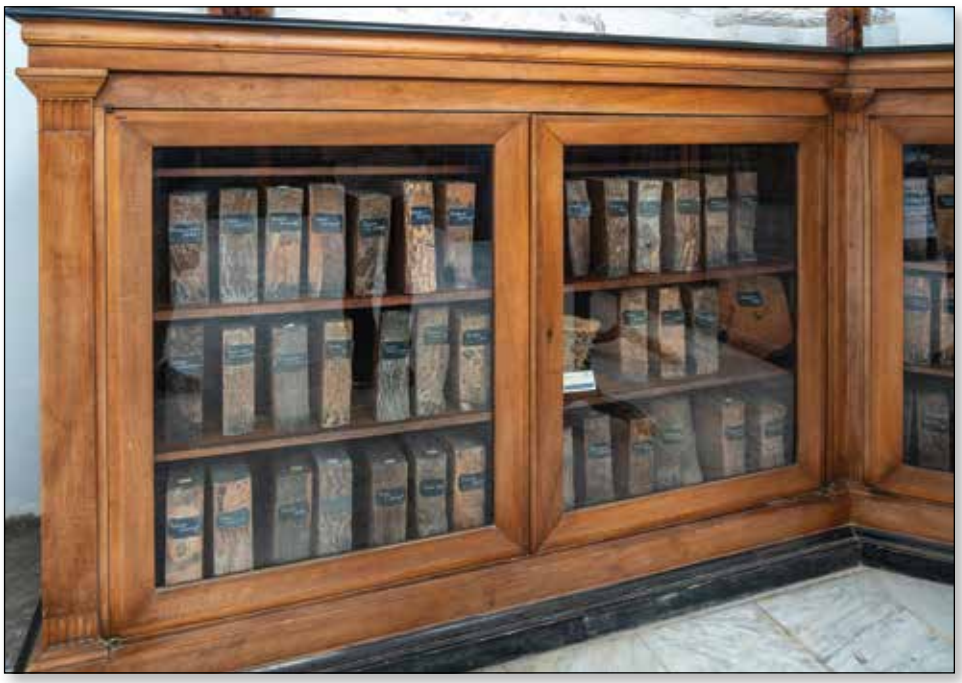
Introduction

Herbaria and fungaria are more than dusty archives—they are living libraries of biodiversity, ecological history, and evolutionary insight. These institutions house millions of preserved plant and fungal specimens, some dating back centuries, and serve as foundational resources for taxonomy, conservation, climate research, and cultural heritage. Yet despite their immense scientific and historical value, they face a constellation of threats that jeopardize their integrity and future. From environmental degradation and pest infestations to institutional neglect and political instability, the challenges are varied and complex. This essay explores the most pressing dangers confronting herbaria and fungaria today, emphasizing the urgent need for preservation, modernization, and global cooperation.

Environmental and Physical Vulnerability

Natural disasters pose a significant risk to herbaria and fungaria. Floods, fires, earthquakes, and hurricanes can cause irreversible damage to collections, especially when specimens are not digitized or backed up. Climate change intensifies these threats, increasing the frequency and severity of extreme weather events. Rising humidity and temperature fluctuations also promote mold growth and pest infestations, which can silently devastate specimens over time.

Many institutions lack the infrastructure to mitigate these risks. Outdated buildings, poor climate control systems, and inadequate fire suppression technologies leave collections exposed to slow degradation. In some cases, specimens are stored in basements or attics, where environmental conditions are difficult to regulate. Without investment in modern facilities, even the most prestigious herbaria and fungaria remain vulnerable.



Pest Infestations and Biological Decay

Arthropod pests are among the most insidious threats to preserved specimens. Dermestid beetles, silverfish, booklice, and mold can infiltrate storage areas and feed on dried organic material. Fungaria are particularly susceptible to mold outbreaks due to the nature of fungal specimens and their storage conditions. Once an infestation begins, it can spread rapidly and silently, often going unnoticed until significant damage has occurred.

Integrated pest management systems are essential but costly. Monitoring requires constant vigilance, and effective interventions may involve chemical treatments, environmental adjustments, and physical barriers. Even with these measures, some pests—like *Trogoderma angustum*—are resistant to insecticides and capable of surviving long periods in diapause (see callout box). The biological

resilience of these organisms makes them formidable adversaries in the battle to preserve scientific collections.

Institutional Fragility and Administrative Neglect

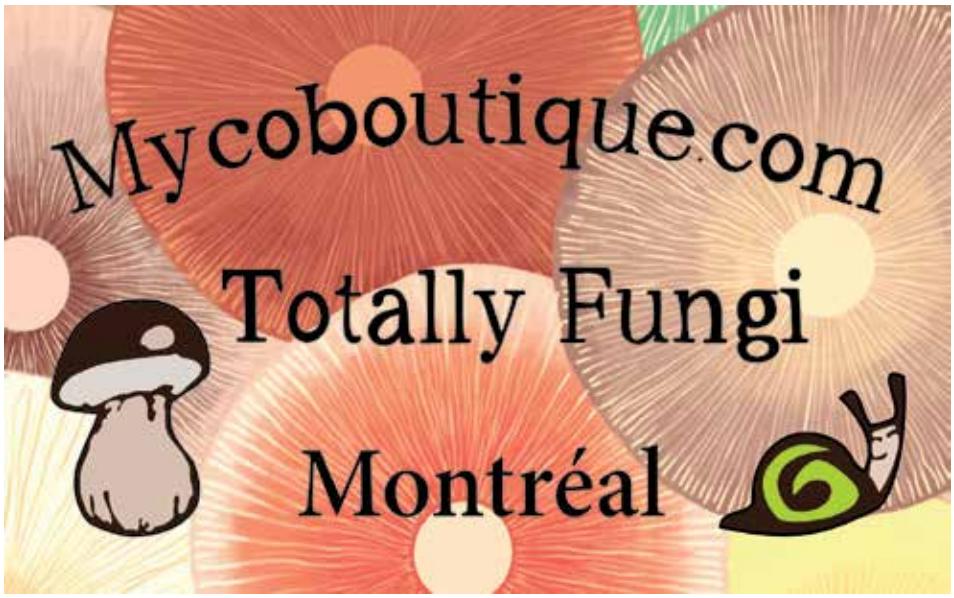
One of the most persistent threats to herbaria and fungaria is institutional neglect. These collections often depend on universities, museums, or government agencies for funding, staffing, and space. When budgets are cut or priorities shift, herbaria and fungaria are frequently among the first to be downsized or shuttered. Decisions are sometimes made without consulting curators or considering the long-term consequences for biodiversity research.

Recent examples highlight this vulnerability. Duke University's herbarium faced closure despite its scientific importance, and similar cases have occurred across Europe and South America. Barbara Thiers of the New York Botanical Garden has documented over 3,800 herbaria worldwide, noting that many are at risk due to administrative decisions (Thiers, 2020; see also the previous edition of FUNGI). Smaller institutions are especially fragile, and when they close, their collections must be absorbed by larger herbaria—often without adequate resources or space.

Digitization Gaps and Data Inequity

Digitization offers a powerful solution to many preservation challenges. By creating high-resolution images and metadata for each specimen, institutions can safeguard their collections against physical loss and make them accessible to researchers worldwide. However, digitization efforts are uneven. Wealthier institutions have made significant progress, while others lack the funding, staff, or technical infrastructure to begin.

This disparity creates global inequities in data access and scientific collaboration. Many specimens from biodiversity-rich regions remain undigitized, limiting their visibility in global databases and conservation assessments. Without comprehensive digitization, the scientific value of these collections remains locked behind physical barriers, vulnerable to decay and disaster.



Trogoderma angustum and the Hidden Threat to Herbaria

Among the many threats to herbaria, few are as stealthy and destructive as *Trogoderma angustum*. This dermestid beetle, originally native to South America, has spread globally through trade and human activity. It thrives in human environments—particularly museums, libraries, and herbaria—where it feeds on dried organic matter. Though small in size, its impact is outsized, especially during its larval stage.

Adult *T. angustum* beetles measure just 2.2 to 3.9 millimeters and are dark colored with three bands of whitish hairs across their elytra. The larvae, covered in brownish arrow-shaped hairs, are the most destructive. They chew through dried plant specimens, targeting flowering and fruiting parts, and leave behind frass, cast skins, and chewed tissues. Their ability to enter diapause makes them resistant to many insecticides.

Infestations have been documented in major institutions, including the Royal Botanic Gardens, Edinburgh and Kew. At Kew, between 2000 and 2006, sightings of *T. angustum* increased dramatically, with beetles found in multiple areas of the herbarium. Damaged specimens confirmed larval activity, and sticky traps revealed adult beetles. Similar infestations have occurred in Germany's Museum Ludwig, affecting both entomological and vertebrate collections.

Detecting *T. angustum* is difficult due to its cryptic behavior. Larvae hide in crevices and may remain dormant for extended periods. Monitoring systems—such as sticky traps and light traps—are essential but not foolproof. Environmental management, including humidity control and sealed storage, helps deter infestations. Physical barriers like Tyvek® bags offer additional protection.

The taxonomic ambiguity surrounding *T. angustum* further complicates control efforts. Its close resemblance to other dermestids has led to misidentifications, delaying response and allowing infestations to spread. Genetic studies suggest polyphyly within *Trogoderma*, with implications for pest management and regulatory policies.

Trogoderma angustum exemplifies the hidden threats facing scientific collections. Its small size, cryptic habits, and destructive larvae make it a formidable pest. Vigilant monitoring, accurate identification, and integrated control strategies are essential to safeguard herbaria from this silent menace.

Taxonomic and Geographic Biases

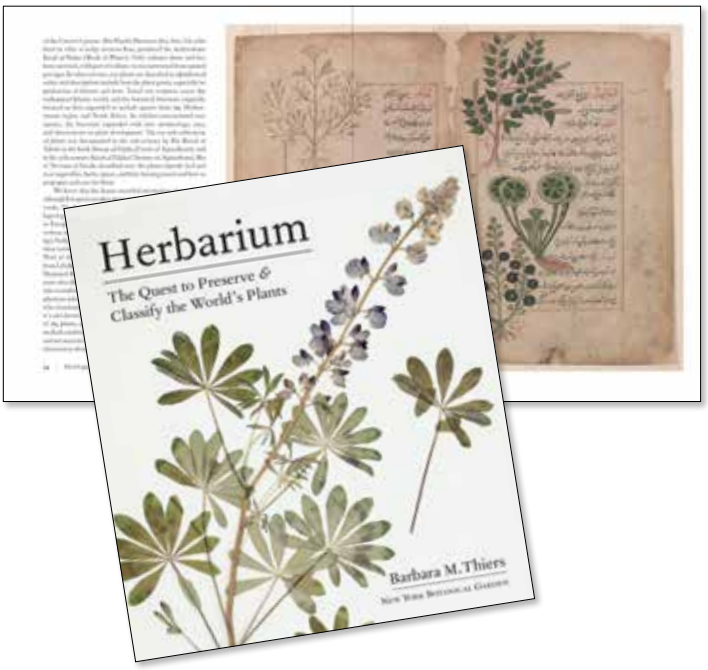
Global assessments of plant and fungal extinction risks are riddled with biases. Well-known species and economically useful plants are overrepresented, while single-country endemics and cryptic fungi are underrepresented. This skews conservation priorities and leaves many vulnerable species unprotected.

Fungal conservation is especially neglected (Antonelli et al., 2024). Despite fungi's ecological importance—as decomposers, symbionts, and nutrient cyclers—over 90% of fungal species remain undescribed. Only a fraction have been assessed for extinction risk. Conservation mycology is still an emerging discipline, and fungaria often lack the institutional recognition that herbaria enjoy. As a result, fungal specimens are sometimes deprioritized in funding and research agendas, despite their critical ecological roles.

Political Instability and Cultural Loss

In regions affected by war, civil unrest, or political instability, herbaria and fungaria may be abandoned, looted, or destroyed. Even in peaceful countries, shifts in political priorities can lead to funding cuts or repurposing of scientific institutions. These threats are difficult to predict but devastating when they occur.

Historical examples abound. During conflicts in the Middle East and Eastern Europe, scientific collections were lost or displaced. In some cases, specimens were smuggled out or hidden to protect them from destruction. These events



underscore the fragility of cultural and scientific heritage in times of crisis and the need for international cooperation to safeguard vulnerable collections.

Loss of Expertise and Succession Planning

Many herbaria and fungaria rely on a small number of expert curators and taxonomists. As these specialists retire, institutions often fail to replace them, leading to knowledge loss and mismanagement. Without trained personnel, collections become static archives rather than dynamic research tools.

Succession planning is critical but often overlooked. Training the next generation of botanists and mycologists requires investment in education, mentorship, and career development. Without these efforts, the expertise needed to curate, interpret, and expand collections will dwindle, leaving specimens underutilized and at risk.

Ethical and Equity Concerns in Collecting

The history of botanical and fungal collecting is intertwined with colonialism and extractive practices. Specimens were often gathered without the consent or involvement of local communities, and benefits rarely flowed back to the regions of origin. Today, ethical concerns are reshaping the way institutions approach collecting and collaboration.

The 2030 Declaration on Scientific Plant and Fungal Collecting calls for equitable and coordinated global strategies (Antonelli et al., 2024). It emphasizes the importance of local knowledge, capacity building, and benefit-sharing. Future collecting efforts must prioritize ethical collaboration, ensuring that scientific advancement does not come at the expense of cultural sovereignty or ecological integrity.

Conclusions

Herbaria and fungaria stand at a crossroads. They are indispensable to science, conservation, and cultural heritage,

yet they face a multitude of threats that challenge their survival. Preserving these collections requires more than technical solutions—it demands institutional commitment, ethical reflection, and global cooperation. As climate change accelerates and biodiversity loss intensifies, the role of herbaria and fungaria becomes ever more critical. Their protection is not just a scientific imperative—it is a moral one.

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