Mini Review

The role of museum of biological collections in environmental research: a short note

Abstract

This paper summarizes the use of museum of biological collection (MBC) in comparison of chemical contaminants between the past and the present specimens. It is inferred that MBC provides a unique and crucial insight into the spatio-temporal trend of environmental contamination by establishing a historical reference point.

Keywords: environmental contaminants, herbarium specimens, museum collections, spatio-temporal trends

Volume 7 Issue 2 - 2022

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Received: April 09, 2022 | **Published:** April 25, 2022

Introduction

The museum of biological collection (MBC) is the keystone for biodiversity research and a sustainable supply of scientific data. MBCs are well-identified, categorised, and systematised repository of biological specimens.[1–3] The majority of these repositories are housed at natural history or science museums, but they can also be found in universities, research institutes, or even private collections either in parts or whole specimens. There are many well-established prominent museums, such as the Natural History Museum in London, American Museum of Natural History in New York City, and the Museum of Zoology located in the Department of Biology, Faculty of Science, Universiti Putra Malaysia.

According to Suarez and Tsutsui,[4] several museums house exceptional biological collections which include preserved whole organisms, DNA libraries and/or cell lines. These MBCs significantly contribute to science and society in various sectors, including national security, public health and safety, environmental change monitoring, taxonomy, systematics, ecology, and evolutionary biology. The value of MBCs in the sectors mentioned above has been well documented. In Japan, museum specimens had been utilised for maritime education.[5] Nowadays, new and innovative applications of MBCs are continually expanding the impact of natural history collections on biodiversity science and global sustainability.[6] Furthermore, these collections have been critical in domains at the cutting edge of biology, such as the study of biodiversity and its loss, biological invasions, and global climate change.[5] Nakahama[3] recommends genetic analysis methods are the key factors for using MBCs for future conservation genetics investigations.

This note focuses on environmental research due to many such studies related to the use of MBCs. Schmitt et al.[6] emphasised the importance of avian, mammalian, and amphibian specimens in the Anthropocene record and presented examples of why MBC is necessary. The classic study by Berg et al.[7] determined the quantities of accumulated mercury in conserved bird specimens at the Swedish Museum of Natural History during the 1940s and 1950s. They concluded that the increased mercury levels were most likely due to increased anthropogenic activity. Similarly, based on a specimen of eggs from MBCs, the chlorinated hydrocarbons in DDT were linked to the declining population of bird species in the 1960s. Researchers[8,9] collected data on eggshell thickness over time and reported a significant drop in shell thickness when DDT use in the fields increased extensively.

Another prominent study by Hayes et al.[10] used MBC to show that sexual abnormality in natural frogs and found increased cases after the herbicide atrazine was widely employed. By examining the museum specimens of tuna and swordfish, scientists recently discovered that hazardous chemicals such as mercury did not accumulate in all oceanic species.[11]

This communication note aims to provide an overview of selected studies on the use of MBC to compare environmental pollutants between the past and the current specimens.

Environmental contamination

There is relatively limited research published in the literature (based on Scopus database searched on 22 April 2022 with keywords 'Museum specimen pollution or contamination') utilizing MBCs to assess the magnitude and patterns of environmental contamination. The estimation of contamination levels in specimens is typically conducted by comparing historical specimens with current collections (Figure 1). For instance, by using museum specimens of *Lophuromys aquilus*, a mouse species complex found across the African Albertine Rift, Askay et al.[12] investigated fluctuating asymmetry (FA) and body condition (BC) as two markers of environmental stress. They suggested that groups with greater than average BC lived in more anthropogenically impacted locations. In general, they found that FA and BC were ineffective indicators of environmental stress in low to moderate habitat disturbance situations.

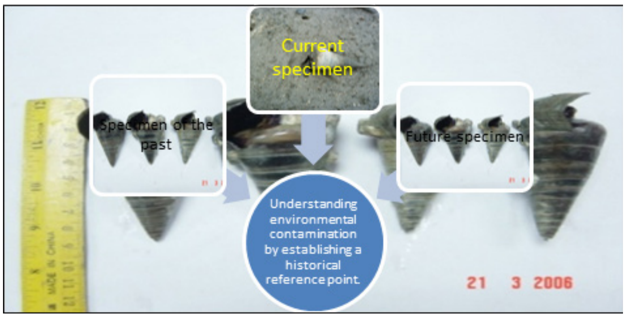

Figure 1 A conceptual model of comparison of specimens of the past, current and future in Understanding environmental contamination by establishing a historical reference point.

The use of specimens in documenting the effects of environmental change is an excellent example of their critical importance, which is especially relevant given the alarming rate at which we are currently altering our planet in the Anthropocene.[6] In their contamination investigations, Rocque and Winker[13] utilised avian specimens. DuBaya and Fuldnerc,[14] for example, employed photometric reflectance data from almost 1,300 bird species from natural history museums. By using this data, they discovered the relative ambient concentrations of atmospheric black carbon in the US Manufacturing Belt, an area traditionally reliant on coal and densely populated with industry, between 1880 and 2015.

In the marine environment, microplastic fibres are common pollutants. Their presence was recently discovered in the MBC of sponges gathered almost 20years ago[15] Microplastics were present in more than half of the tested samples, allowing for establishing a historical reference point.[15] Studying microplastic in historical collections of organisms is critical for establishing reference points and constructing temporal trends, especially given the paucity of research prior to 1980. The approach of examining animals kept in natural history museums to search for reference points or historical baselines could be expanded to other contaminants such as heavy metals and radionuclides.

Lang et al.[1] published one of the most extensive reviews on the subject. They emphasised the relevance of herbaria, which can provide information on the long-term consequences of at least four of the primary drivers of global change, including pollution, on plants. They also discussed how herbarium specimens were employed in global change studies and other fields. Herbarium specimens maintain the time cycles of many of their reactions to environmental change, providing unique spatio-temporal data for investigating global change.[2]

Molluscs shells provide an excellent research subject in the spatio-temporal trends assessment of environmental contaminants. Recently, there has been an increase in number of experiments utilising molluscs shells for metal pollution biomonitoring, comparing current metal bioaccumulation in molluscs shells with prior history. Compared to the use of soft tissues, the shell of molluscs provides a more reliable and practical biomonitoring material for reconstructing pollution history.[16–20] A freshly collected molluscs shells can be conveniently stored without being kept in a freezer, while the shells of past records are typically common in museum collections – this allows for the practical establishment and construction of contamination history. However, cautious should be taken into consideration with the possibility of contamination during preservation of museum collections.[21]

Concluding remarks

Based on the above review, it is clearly shown that the MBCs provide unique and crucial insights into the spatial-temporal trends of environmental contamination. By assessing MBCs, researchers can estimate past pollution levels by providing a historical reference point. We have reasons to believe that the MBCs can be used to understand the environmental monitoring of emerging hazardous pollutants in the environment between the past and the current specimens.

Acknowledgments

None.

Funding

None.

Conflicts of interest

Authors declare that there is no conflict of interest.

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