Biological collections and its applications: a narrative review.

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Abstract. Biological collections are an essential tool for research in life sciences, however, they also can be used for teaching and scientific divulgation. These are usually categorized by subjects such as botanics, zoology, anatomy, microbiology, histopathology, archaeology, and paleontology. Therefore, this study aimed to do a brief narrative review of the importance and application of biological collections. Usually, biological collections are most known when they are applied most for research, however, it also was present as a teaching tool used for school and college, and for non-formal education places, and in this kind of situation plays a scientific divulgation role. We concluded that the biological collections have a great use for scientific research, teaching tools, and scientific divulgation.

Keywords. Life sciences, museum, teaching tool.

1. Introduction

Biological collections are an essential tool for life sciences studies, the organization provides a library of information about the organisms of a group such as anatomical characteristics, species diversity, period, and distribution of species [1]. It may be used for research, teaching, and scientific divulgation. The collection can be broad with great biodiversity or even focused on a specific group it depends on infrastructure and objective. Biological collections consist of important records and are a historical form of storing information, some of these places are established over 100 years ago [2,3].

Collections are usually categorized in great areas as archaeological, paleontological, botany, histopathological, microbiological, zoological, or anatomical [4]. These are present in universities, museums, herbariums, or even in private collections, and when open to public visitors, they can be useful for specialized audiences, for teaching, or even for audiences outside academia interested in science. Therefore, they have potential for research, teaching, and scientific dissemination [5].

Biological collections play a fundamental role in the formation of environmental awareness, bringing biodiversity from different environments closer to places where the environment is degraded. In this way, introducing and bringing organisms closer to people who have never had contact, and would not even have the opportunity to have contact in the environment in which they live [6, 7, 8].

Furthermore, the existence of biological collections comprises some of the UN's sustainable development goals. For example, objective 4 – Quality Education, 11 – Sustainable cities and communities, 12 – Sustainable consumption and production, 13 – Action against global climate change, 14 – Life in water, 15 – Life on land. Biological collections interrelate with multiple objectives and consist of fundamental tools for understanding the world in which we live [9]. Therefore, even though they are ancient forms of storing biological information, collections are current tools for combating misinformation, improving the quality of teaching, and providing greater support for scientific research.

This study aimed to do a brief narrative revision of the importance of the biological collection applied for research, teaching, and scientific divulgation.

2. Research Methods

A narrative review through articles and books that are related to the use of biological collections and their applications for research, teaching, and scientific divulgation was performed [10].

3. Results and Discussion

A brief review revealed the importance of biological collections and their applications, such as in research, teaching in school and college, and science divulgation.

3.1 Applications in Research

The biological collections enable a sample of specific organisms from a place and time [4]. Pyke and Ehrlich show the growing relevance of the collections over the years due to the increase in published articles addressing ecological and environmental issues [1].

The records of botanic samples in herbariums all around the world enable the understanding of speciation, anatomic characteristics, and distribution [11, 12, 13]. Therefore, it is essential for taxonomy, biogeography, anatomy, and evolution. However, recent publications appoint the use of "living collections" such as botanical gardens [14].

Paleontological records, such as fossils, are usually deposited in museums and are a source of new records and studies [15]. It becomes a consistent and constant information repository for now and future generations [16]. Archaeological findings are essential for the research on culture and human evolution, the preservation of biological remains in museums is a form of information repository [17, 18].

Zoological collections provide study arguments for activities with great environmental impact [1]. And thus understand how we modify our environment and the consequences that this generates for other animals [5]. And as the botanical gardens for botanic, in zoology, the zoos are a kind of "living collections", essential for genetic and behavioral research [19, 20].

Microbiological collections are essential to provide the replication of experiments and biotechnological applications for the formation of new products, as well as the taxonomic understanding of the organisms analyzed [21, 22].

Histopathological collections are essential for recording cataloged information of health tissues and how pathologies affect them and providing new analyses according to the development of new methods [23].

Anatomical collections focused on human anatomy, consist of records of general characteristics of human beings, but also, of unique aspects, which consist of anatomical variations, and are also used for research into material conservation methods [24].

3.2 Applications in School and College

Teaching based exclusively on the presentation of phenomena and theories without a clear relationship with everyday life and strenuous memorization of concepts makes the area of natural sciences uninteresting for many students [5].

For concepts, phenomena and theories to be understood, they must be associated with different forms of activities such as dynamics in theoretical classes, games, laboratory practices, and the formation of didactic biological collections, thus encouraging greater student participation and contact with the environment. object of study [6].

Biological collections can be applied in two main and different forms of activity. The first consists of using the collection created and which is part of the collection of a university, school, or museum. It is used to exemplify and enable greater contact between the object of study and the student, thus providing a more immersive experience compared to traditional expository classes that do not use this tool, generally applied to schools [7].

The second form of use consists of students creating their biological collection, in this kind of activity some rules are stipulated and students must be active subjects in the construction of their knowledge [5]. This form can even be applied as an assessment and generally tends to be applied in college for subjects such as zoology, botanic, and ecology [8].

Usually, these activities in which students produce their collections are for the areas of entomology and botany, given the characteristics of the collected materials, the ease of finding them, and the low cost of producing a biological collection. In the case of entomological collections (Fig. 1), the collections can still be incorporated into the collections of universities and museums, and used for research, teaching, and dissemination [8].

Fig. 1 – Entomological collection made by university students as an assessment.

Some studies characterize the importance and effectiveness of the use of biological collections, with tests and interviews to understand the student's perspective. Most of the answers are related to the importance that such activity had and how this kind of thing is "memorable" in contrast to the usual approach for other topics [5, 6, 7].

Santos and Souto describe the application of the activity in elementary school, and the effectiveness of collection to teach morphological aspects such as

head, thorax, and abdomen, and also structural characteristics such as the correct number and position of wings, legs, and antennae [7].

3.3 Applications in science divulgation

Scientific dissemination consists of forms of communicating science, whether among peers or even to non-specialized audiences, generally external to the scientific community [25].

Museums, botanical gardens, and zoos are fundamental places for scientific dissemination. And there are also traveling exhibitions that enter shopping centers and public squares, some of these places are usually local to biological collections [13, 15, 16, 26].

The main objective of scientific dissemination is to assist in the general understanding of how science works and to demystify incorrect understandings that lead to its denial [25].

For botany, the importance of understanding diversity. The botanical gardens and herbaria tend to be fundamental in combating "plant blindness", a term by Wandersee and Schussler to explain the lack of knowledge among the non-specialized public about the biodiversity of existing plants [26, 27, 28]. Furthermore, botanical knowledge is essential to avoid the incorrect use of plants under the justification of medicine, or even for food.

For zoology, zoos and zoology museums are fundamental for presenting biological diversity and justifying the protection of the environment, as some species gain strong popular appeal, and are conceptually called umbrella species [29].

The areas of paleontology and anthropology are essential for understanding the geological age of the planet, biological evolution, and the diversity of human species that have existed throughout history. In recent discussions about species extinction and global climate change, this kind of biological collection is essential (Fig 2. and Fig. 3) [16].

Fig. 2 – Fossilized jaw of a crocodyliform for public exposition in the Stratigraphy and Paleontology Museum of São Paulo State University, Geosciences Institute, Rio Claro, Brazil.

Fig. 3 – Fossilized fish for public exposition in the Stratigraphy and Paleontology Museum of São Paulo State University, Geosciences Institute, Rio Claro, Brazil.

Exhibitions on human anatomy are very important for the respect of the own and other bodies, comprehension of biological and cultural diversity, and the composition of human species, and also to combat racism [30].

For the areas of microbiology and histopathology, the diversity of microorganisms, the understanding that not all of them are pathogenic, but also respect for them and the possibilities of the emergence of new diseases as a result of deforestation, or even the inappropriate use of antibiotics. In the case of histopathology, the understanding of healthy biological tissues, but also the characteristics they present when affected by a certain pathology [21; 31].

In general, the spaces determined for the presentation of scientific concepts are related and are important to maintain as a permanent source of information and justify the importance of science for society.

4. Conclusions

Biological collections enable great possibilities for research, teaching, and science divulgation. Its importance is related to nowadays discussion topics such as the one health concept (the relation between environmental, human, and animal health), environmental conservation, and climate change.

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6. References

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