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Why do museums have natural history collections?

Natural history collections include specimens from the subject areas of zoology, botany, entomology, palaeontology and mineralogy (Figure 1), as well as any documentation associated with them (e.g., card indexes of related museum collections, field notebooks, correspondence files, diaries, etc). Such collections exist not only in museums and herbaria, but also in botanical gardens, arboretums, zoos and aquaria. However, live animal or plant collections are outside the scope of this short essay. It is worth mentioning though that more than 70 known British zoos and aquaria house some 64,000 vertebrate species.

There are more than 200 public and private museums in the UK with natural history collections, 50 of them hold significant foreign material. Recent estimates suggest that the number of natural history specimens in British museums exceeds 100 million. Worldwide, there are more than three billion! Many of the natural history collections in the UK, such as those of the Natural History Museum in London, the Natural History Museum of Oxford University or the Manchester Museum, are of global importance. However, the vast proportion of large museum collections (c. 95%) are kept in storage, behind the scenes, and their full diversity

Figure 1. View of an insect collection area in the Manchester Museum.

will never be displayed. But does this mean that the majority of collections are not used? Far from it, these collections are stored carefully because of their dual role as a resource for research and for education (see Table).

Basic roles and values of natural history collections

Basis for research

- Accumulation of data
- Material for study
- Reference material (type and voucher specimens)
- Means for understanding environmental issues
- Means for understanding diversity and evolution
- Insight to medical-biological studies

Basis for education

- Public inquires and awareness
- Exhibitions
- Special-interest groups (e.g. foresters or artists)
- Reference material for education
- Undergraduate teaching
- Graduate training
- Social history value (associated documentation)

Collections as biological libraries

The fundamental value of natural history collections is related to our understanding of the Earth's diversity. Taxonomic museum collections underpin the accumulation of biological knowledge, providing references to discovered natural units (species), and indeed represent an ecological database through the data associated with specimens. Therefore, natural history collections act as 'biological libraries', in which a separate specimen can be seen as a prototype of a letter and an individual collection as that of a paragraph or section in the ultimate 'Book of Knowledge'.

Natural history collections represent an irreplaceable resource for taxonomic and biodiversity research. Such research aims to answer three fundamental questions: (1) what is the organism under study, (2) where is it found in nature, and (3) why is it found there. Without collections most taxonomic research cannot be conducted. Since the rigour of the scientific process is based on repeatability, the specimens used in research are preserved in museums to ensure that they are available for future reference and study.

As centralized repositories of reference material, the collections reduce the need for fieldwork in remote and/or poorly accessible regions, saving both time and money. Furthermore, museums liberate researchers from the time

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and expenses of maintaining all the specimens necessary for a functional reference collection. Given that unlike library books we cannot copy natural history specimens that were preserved, natural history collections are indeed unique locations for information. With more species becoming rare or extinct, such collections are often the only source of information for such species (Figure 5), becoming frozen glimpses of a bygone past. For instance, it is known that during the last 600 years, 129 birds (or 1.3% of all known living bird species) have become extinct.

The scientific value of a natural history collection is usually measured by the number of type specimens it contains (Figure 2). A type specimen is a reference specimen selected by a scientist during the description of a new species. Type specimens serve as the primary and unique references for all known species names. They play a key role in stabilizing the use of species names. Museums also hold voucher specimens, which are examples of organisms collected during biodiversity surveys, taxonomic inventories and other research. These specimens are physical proof that species have been recorded from the studied site and identified accurately, and they are always available to be referred to or checked upon when/if necessary.

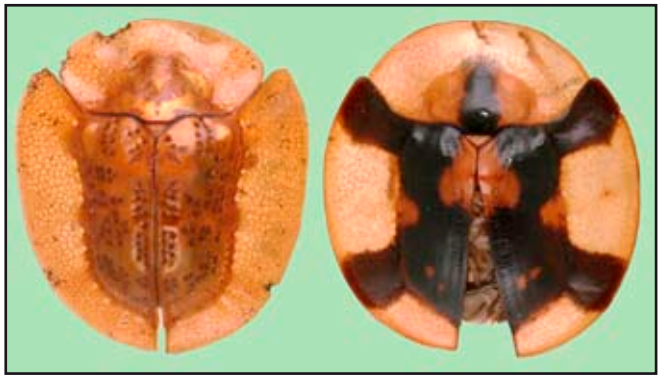

Figure 2. Two of the type specimens of the Manchester Museum's collection of tortoise beetles (Cassidinae). The Manchester Museum holds more than 22,000 type specimens, representing 8,000 species names.

Conservation and environmental studies

Conservation programmes, particularly those aimed at mapping priority areas for protection or conservation purposes, require a reliable knowledge of the distribution of species. Yet, for the vast majority of species known to science, most of the available information relating to them exists in the form of taxonomic collections. Sometimes such collections form the only source of data for particular species. Therefore, the most common way distribution information is collected is by examining labels of voucher specimen and databases in museums. These contain essential information about where (locality and habitat/host), when (an exact date) and by whom the specimens were collected (Figure 3). Every natural history specimen with good data thus provides a physical snapshot of a species at a particular point in time and space. This highlights the need for correct and accurate labelling of museum specimens. A specimen without a label is usually worthless. The practice of utilizing the wide spectrum of information associated with specimens has been referred to as 'museum ecology'.

Figure 3. The scientific value of a natural history specimen depends on the reliability of information written on its label; illustrated is a blister beetle.

Reference collections of voucher specimens and other taxonomic information on invasive species and pests can be used for their accurate identification and for understanding their current distribution and invasion history. In addition, they can be used for assessing the ecological impact of invaders and their potential public health threats. The famous example is the grey squirrel which was introduced to Britain from the USA in the 19th century, and as a result this species has caused native red squirrel populations to die out in most parts of England and Wales.

Natural history collections offer a unique perspective, providing data over a vast time span ranging from millions of

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years ago (in geological and palaeontological collections) to the present day. Specimens may have been collected over many decades and so record changing environmental conditions and their consequences. For instance, comparative genetic analysis of ancient museum specimens of brown bears with those from isolated populations today provides evidence of reduced levels of genetic diversity in the current populations, which negatively affects the survival potential of this species (Figure 4).

Figure 4. The brown bear became extinct from Britain by the 10th century, only museum specimens can help us to understand its history here.

Figure 5. The Sloan's Urania, an extinct species of which only three specimens are deposited in the Manchester Museum.

In some circumstances museum specimens are the only record of species that are already extinct: e.g., Sloan's Urania (*Urania sloanus*), one of the most spectacular day-flying moth species that was endemic to the island of Jamaica (Figure 5). The moth was last reported in 1894 or 1895, but it possibly survived until at least 1908. Habitat loss, when Jamaica's lowland rainforests were cleared and converted to agricultural land, may have caused its extinction. Most probably, this species disappeared due to the loss of one of its larval foodplants, as the *Urania* larvae fed exclusively on rainforest lianas belonging to the genus *Omphalea*.

By examining museum specimens, it is also possible to analyze environmental impacts of climate change or a historical level of pesticide use. This is because historical collections provide baseline data against which modern observations can be compared in order to produce predictive models. For instance, an analysis of preserved bird specimens and their eggs (Figure 6) can help to monitor the accumulation of toxins, such as mercury or DDT (a famous synthetic pesticide, the use of which is now banned), in the environment resulting from the impact of industrial processes. It has been shown that a marked decrease in eggshell thickness is coincident with the onset of the widespread use of DDT.

Figure 6. The egg collection such as that of the Manchester Museum can help in the estimation of historical levels of toxic contamination in the environment.

Education and cultural value

Natural history museums are places where a visitor can have a unique experience of seeing authentic objects. Therefore, these museums play an important role in education through their exhibits and outreach programmes which use real specimens. Specimens are also used for illustrating natural history books, in which colourful plates are made on

the basis of museum specimens (Figure 7). Natural history specimens, especially beetles and butterflies, are regularly used by designers and artists who draw inspiration from their remarkable variety of forms, colours and patterns. Some natural history specimens or collections have their own historical and/or even high monetary value that makes them important items of the national heritage (Figure 8). Overall, larger and more comprehensive natural history museum collections form better educational resources.

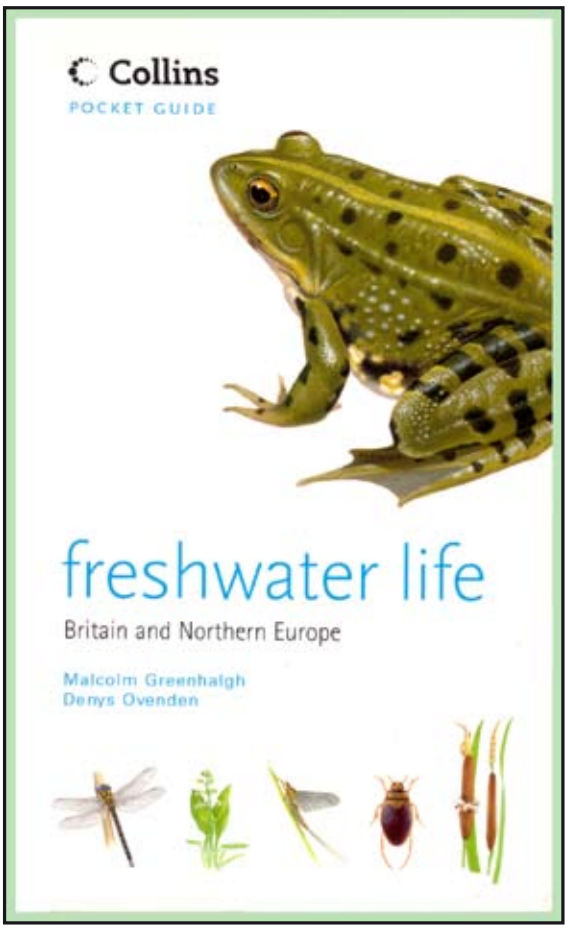

Figure 7. The recent guide to the freshwater life of Britain contains at least 45 colourful plates of hundreds of insects illustrated from the Manchester Museum's insect specimens.

Historic natural history collections are directly related to social history through their links to people and places. They are indeed a cultural phenomenon rather than dusty artefacts of professional science. The labels assigned to specimens and the documentation associated with them (e.g., information on the network of collectors, the distribution of collecting across the world, etc.) are commonly used in biographical and historical studies. Hence, natural history collections provide an outstanding and unique resource for a wide variety of client groups.

Figure 8. Apollo butterflies are often restricted in distribution, many of them being threatened and red-listed.

Nowadays, opening cabinet doors and examining museum specimens kept there is not the only way of consulting natural history collections. All large natural history museums make their searchable collection databases and other collection-related information (i.e., images of type specimens) widely available on the Internet, so that collections can be searched and seen online. Such online access to networked data is especially important both for casual and professional users who, for various reason, may be unable to visit a particular museum. Nevertheless, whatever modern advanced technologies can offer us museum natural history specimens have been and always will be the only physical proof and irreplaceable primary documentation of life on Earth. This is what makes museum collections so valuable. Finally, nobody can extract DNA from an online image or test it for pesticide residues, but a physical specimen can provide a wealth of unexpected and inexhaustible information.

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