FEEDBACK ON PRESERVATION IN FLUIDS: THE EXPERIENCE OF THE MARINE INVERTEBRATE COLLECTION AT THE MUSÉUM NATIONAL D'HISTOIRE NATURELLE

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Key words.——collection management, conservation, fluid collection, marine invertebrates.

The *Invertébrés Marins* (Marine Invertebrates) collections of the *Museum national d'Histoire naturelle* (the French National Museum of Natural History; MNHN) are composed of about 1.5 million lots (containers of one or more specimens of the same taxonomic level) of at least 5 million specimens. The collections include a significant number of species from numerous geographical locations. Approximately 50,000 lots are types (*sensu lato*) with significant heritage value and covering the principal phyla and subphyla of marine invertebrates. Though the collections are mainly from marine environments, they also contain specimens from freshwater and terrestrial habitats. These organisms might be free-living, parasitic, vagile, or sessile, and might live individually or form colonies; they display a great diversity of morphologies and sizes (Castro and Huber 2008).

Collection management is carried out by a team of eight conservation technicians, assisted by four imaging and databasing technicians and several volunteers. The work is done in collaboration with fifteen scientific curators.

The history of the MNHN began with the *Jardin royal des plantes médicinales* (Royal Garden of Medicinal Plants) created in 1635 by order of the King Louis XIII. In 1729, the pharmacy officially become the *Cabinet d'histoire naturelle* (Natural History Cabinet) (Laissus 1995). During the French Revolution, the National Convention reorganized the Royal Garden (including the Natural History Cabinet) and transformed it into the Museum of Natural History. In 1793, 12 chairs were established, including the "Lower Animals" (*Animaux inférieurs*) chair, assigned to Lamarck, who organized the first collections of marine invertebrates (Fischer-Piette 1944).

From that time onward, the collections of marine invertebrates at the MNHN have been enhanced with specimens collected all over the world during oceanographic expeditions. The French tradition of marine scientific exploration started in the 18th century with several circumnavigation voyages (Bauchot et al. 1997) and continues today with diverse marine expedition programs led by MNHN research teams (MNHN website 2019). These programs, such as Tropical Deep-Sea Benthos (formerly MUSORSTOM), Our Planet Reviewed, and the Antarctic expeditions, cover a large part of the planet, aimed at exploring marine biodiversity (MNHN website 2021a, 2021b, 2021c). Current collection growth is from recent expeditions, but there are also noteworthy one-time contributions, including individual collecting events, donations, exchanges, and purchases.

The Marine Invertebrate collections are housed in different locations at MNHN. Ninety percent of the collections are stored in the Zootheque (an underground building), under

Collection Forum 2020; 34(1):139–142

Figure 1. Historical collections preserved in sealed glass cylinders, Mollusca (Nassariidae) collection, MNHN (© MNHN; P. Martin-Lefèvre).

controlled temperature, humidity, and light conditions. The rest of the collections are stored in several specially equipped collection rooms in three different buildings.

The collections are preserved in different ways. Half of the Marine Invertebrate collections are preserved in fluid (about 95% in ethanol, 5% in 1 : 9 formaldehyde and water), and the remainder are preserved as dry material, mounted on slides, or mounted on paper in a manner similar to herbarium specimens (for a small part of the Cnidaria and Bryozoa collections). The collections that date from before World War I, as well as the type, cited, and illustrated specimens, are preserved in all these forms. The molecular collection, created in the 2000s, contains tissue samples from recently collected specimens, all of which are preserved in 95% ethanol.

In the fluid collections, the types of containers have changed over time, but the preventive conservation issues regarding the air tightness of container seals remain the same. Historically, fluid collections were preserved in sealed glass cylinders or jars (Figs. 1, 2) but over the last 50 yr the containers have been diversified to include the use of glass jars with a variety of lids, as well as plastic drums (Fig. 2). However, the historical containers such as sealed glass cylinders have been retained whenever possible, even though they are fragile and more difficult to handle, because they have the advantage of being air tight. The more recent borosilicate glass containers include threaded jars with metal or Bakelite lids and Le Parfait jars with ethylene propylene diene monomer (EPDM) rubber black gaskets. These come in a wide variety of sizes and are easier to handle. Lastly, plastic drums in high-density polyethylene (HDPE) were introduced 12 yr ago, and these provide significant space sav-

Figure 2. Different types of glass jars and drums, Crustacea (Brachyura) collection, MNHN (© MNHN; P. Martin-Lefèvre).

ings and are lighter and easier to handle. However, all these newer containers require close monitoring of the fluid levels due to the less efficient seals or lids, and the opacity of the plastic drums.

The inner containers that allow the grouping of many lots in a single jar or drum have also changed over time. Glass tubes have been used for this purpose since the beginning of the 20th century. However, for the past 10 yr, perforated zip plastic bags (60 μm low-density polyethylene [LDPE]) have become widespread for nonidentified material because they allow for an optimization of space in jars and drums.

A difficulty of working with historical, and sometimes contemporary, material is uncertainty regarding the preservation fluid. Typically, fixation and preservation fluids are not indicated on container labels. However, the Schiff's reagent method allows detection of the presence of formaldehyde (Sigma-Aldrich 2020).

The preservation of data associated with the specimen is essential. The type of paper and ink used in the collection have evolved with technology, from India ink on parchment to thermal printed polyester labels for inventory numbers, and from tracing paper, cellulose paper and pencil, typewriter, and photocopy machines to 100% cotton Byron Weston paper (A4, 120 GSM; CXD France supplier, ref. PABWPA4001, Fontenay-sous-Bois, France) for geographical and taxonomic data. Modern technology does not always lead to improvement. For example, laser printers are less efficient at heating the Byron Weston paper and fixing the toner to the paper. One solution to this problem is to bake Byron Weston paper in a toaster oven for 15–20 sec at 180°C until the characters becomes slightly glossy, fixing

the ink to the paper (C. Rowley, collection manager, Museums Victoria, Australia, pers. comm., October 2012).

In summary, for a collection with a significant rate of expansion (around 20,000–40,000 lots per year) it is important to set effective management strategies which take into consideration the requirements of each group of organisms, for sustainable conservation over the long term.

Acknowledgments

The MNHN gives access to the collections in the framework of the RECOLNAT National Research Infrastructure. The work was also supported by national funding, E-RECOLNAT project (11-INBS-0004), managed by the French National Research Agency (ANR).

Résumé

La Collection d'Invertébrés marins du Muséum national d'Histoire naturelle est composée d'environ 1 500 000 lots (pour 5 millions de spécimens) dont 5% de matériel type (*sensu lato*) à haute valeur patrimoniale. Ces collections sont aussi remarquables par leur richesse spécifique et leur large distribution géographique. Beaucoup proviennent d'expéditions océanographiques réalisées depuis le XVIII siècle jusqu'à nos jours. Près de la moitié des collections d'Invertébrés marins sont conservées en fluide. Historiquement ces collections étaient conditionnées dans des flûtes scellées. Au cours des cinquante dernières années, les contenants se sont diversifiés avec l'utilisation de bocaux en verre avec couvercle et l'incorporation de fûts en plastique. La problématique de l'étanchéité des contenants reste toujours un point crucial de la conservation préventive. Par ailleurs, la préservation des données associées aux spécimens est aussi fondamentale. Les supports et encres utilisés pour les étiquettes ont changé au fil du temps, leur conservation nécessite une surveillance régulière.

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