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How to deal with 'orphaned' specimens in natural history collections – a malacological case study at the Arctic University Museum of Norway

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ABSTRACT

The Arctic University Museum of Norway houses more than 475,000 cataloged items in its natural history collections, including around 125 type specimens. Over the course of the museum's 150-year existence, orphaned specimens have accumulated alongside the registered material. These specimens were stored in various boxes at different locations within the collection. They have not been properly registered for various reasons, such as missing metadata, unidentified material from field campaigns, the departure of responsible curators, and donations that were accepted without the capacity to register them, among others. Deciding what to do with these specimens is not an easy process. Here, we provide a case study from the Arctic University Museum of Norway, which might serve as a guideline or inspiration on how to deal with orphaned specimens in a natural history museum context.

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Introduction

Orphaned specimens can be found in almost any museum. Usually, they are stored somewhere in the collection and forgotten until someone takes care of them. Dealing with orphaned specimens (or legacy specimens) is often a multifaceted problem. While some specimens will end up being accessioned (i.e., included in the collection), others will be discarded.

In this study, we define an 'orphaned specimen' as a specimen or specimen lot that has never been formally accessioned into the collection (i.e., it has not received a registration or accession number). These specimens can have various origins, such as: donations, material from past field studies (including unsorted sediment or partially sorted specimens), specimens from past exhibitions, or specimens that were originally part of the collection before there was a registration scheme in place.

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Deciding which orphaned specimens to keep (and accession) and which to discard is not a straightforward one-size-fits-all process as the danger of discarding valuable scientific material is ever-present. In the past, it was common to discard specimens considered to be 'aberrant' (e.g., albino, leucistic or melanistic specimens) or 'teratologic' (e.g., congenital or accidental deformations), as well as specimens that were not in perfect condition (e.g., broken or missing parts) (pers. obs.; Anonymous, pers. comm.). This is problematic, as most specimens, even if 'imperfect', can have scientific value that goes beyond their morphology to include spatiotemporal biogeographical data (Ewers-Saucedo et al. 2021; Lavoie 2013; Meineke et al. 2018) and molecular and chemical data (e.g., DNA, stable isotopes, heavy metals, and trace elements; (Byrnes and Bush 2016; Nakahama 2021; Peñuelas and Filella 2002; Webster 2017)) that can be used to answer a myriad of ecological and evolutionary questions. Furthermore, animal remains might hold meanings beyond the scientific (e.g., taonga species; (Collier-Robinson et al. 2019)).

Orphaned specimens are typically unregistered and not formally part of the museum's collection. However, in some cases, they may have been accessioned at some point, which means they cannot simply be discarded – they must go through a formal deaccessioning process if they are not to be kept. Deaccessioning is the process of permanently removing an object (specimens, in this case) from the museum's collection and register. There is ample literature on this topic (e.g., Miller 2018), though most focus is on the humanities and arts, where deaccession has typically been more prone to controversies in the public sphere (e.g., Besterman 1992).

Reasons for deaccessioning go beyond orphaned specimens and are as varied as museum collections themselves (Ladkin 2004; Miller 2018). However, a few reasons are of particular interest to (or more common in) natural history collections: (1) specimens are deteriorated beyond salvageability; (2) specimens are outside the scope of the collection; (3) storage problems or costs; (4) ignorance of the value or worth of the material (due to a lack of an expert on the museum's staff for the given biological group); (5) getting rid of fakes or forgeries; (6) donation or exchange, for instance, when the material is more appropriate for another museum; (7) restitution or repatriation. When compared to the disposal of specimens that have not been accessioned, deaccessioning is a more formalized process. It usually follows specific museum guidelines and policies, leaves a paper trail, and holds accountability (Ladkin 2004; Roberts 2004).

Here, we describe our approach to dealing with orphaned specimens at the Arctic University Museum of Norway. The museum was founded on October 16th, 1872, as Tromsø Museum, by passionate locals in Tromsø (Vorren 1972). It was the first scientific institution in Northern Norway, with the aim of collecting and documenting life, nature, and culture of the North. In its early days, the museum had around 150 zoological specimens that were purchased and exhibited in a zoological cabinet, as was typical for that time (Simmons 2017; Tromsø Museum gjennom 75 år 1947). Local people in Tromsø sent skeletons, birds, and exceptional specimens to the museum, among which were tropical snail shells and other rarities brought home by seamen (Brun 1972). These private collection efforts, conducted in a non-systematic manner, led to around 780 museum registry numbers (excluding the insect collection) by 1876 (Vorren 1972). In the early years, everything Tromsø Museum had in its collection was exhibited until the collection grew too

large due to donations, purchases, and collection efforts by museum personnel (Tromsø Museum gjennom 75 år 1947).

Over time, some of those nineteenth and early twentieth-century specimens lost their accompanying data, such as the time and place of collection, the identity of the collector, and whether they were donated or sold to the museum. There are various reasons why specimens might lose their provenance data (assuming they had it initially): the data may have been recorded on a paper museum label (typically stored with the specimen in a cardboard container) that was misplaced during exhibition, curatorial work, or research activities; or the specimens might have been marked with a number in ink corresponding to a master register (a notebook containing the numbers and the identity and provenance data of each specimen) that was likewise misplaced or lost. While misplacing or losing labels and registers might seem careless from a modern perspective, it should be noted that the Tromsø Museum building was requisitioned by occupying German forces during World War II, forcing the entire collection to be frantically evacuated and stored piecemeal in various locations (Tromsø Museum gjennom 75 år 1947).

> The Germans took possession of everything except the most valuable – the scientific material and the library. Fortunately, these came through the war years relatively well despite many relocations and somewhat unfortunate storage conditions

and

> In 1940, the Germans broke into the collection rooms to 'study' the Northern Norwegian collections. This mainly consisted of tearing open certain packages and spreading the contents across the floor.

Restoration of the museum collections after the war required significant effort, and some specimen information was never recovered, leaving several specimens with incomplete data and limited curatorial or scientific value. This issue was particularly pronounced in the Mollusca collection which has currently 27.639 registered specimen lots. Around the year 2000, the invertebrate collections started to be digitized, initially in a FileMaker database and later as data publications at the Global Biodiversity Information Facility (GBIF) (Altenburger and Bergersen 2021; 2022). During that process, around 20% of all Mollusca specimens were assigned new museum numbers, as it was not possible to reliably trace their original specimen numbers. Orphaned specimens that could not be entered in the database because of missing information were stored away in cardboard boxes.

The aim of this project was to address the challenges posed by orphaned specimens in the Mollusca collection at the Arctic University Museum of Norway (the name changed from Tromsø Museum to the Arctic University Museum of Norway in 2019. The international abbreviation for the zoological collections is TSZ, while the abbreviation for the gastropod collection is TSZG). Specifically, we sought to reconstruct the history of the collection, assess the value of the specimens, and develop a systematic approach for handling orphaned material. Specimens were evaluated on a spectrum ranging from potentially valueless (lacking any associated data) to highly valuable (with data retrieved through 'detective' efforts). In this manuscript, we document our working process for managing orphaned specimens, providing a detailed case study that highlights the steps taken to evaluate, organize, and make decisions about these specimens.

Our goal is to offer practical recommendations and inspiration for curators, collection managers, and technicians worldwide who face similar challenges, particularly when working with invertebrate taxa, including fossils. By sharing our experiences, we aim to contribute to the broader discussion on collection management and provide a framework for addressing orphaned specimens in natural history museums.

Materials and methods

Circa 30 cardboard boxes containing orphaned mollusk specimens have been stored in the TSZ collection (Figure 1), containing lots with varying degrees of metadata. Both specimens and their associated metadata need to be assessed before a decision can be made regarding accession into the collection.

The workflow consisted of four main tasks: (1) Obtain an overview of the material and specimens present. (2) Track the history of specimens and reconstruct their provenance when possible, including both geographical provenance and information on the original collector or owner of the specimens. (3) Identify the specimens to species level (or the closest taxonomic level possible) using current taxonomic literature (see below) and comparative specimens. If a specimen already had an identification, verify it and update it according to current taxonomic literature. (4) Decide whether a given specimen lot should be accessioned into the collection or not. Tasks 2–4 often occurred concurrently.

Processing the material

We began the process by taking the circa 30 cardboard boxes (Figure 1) from the collection and bringing them to a workspace. For this paper, we focus on the terrestrial and freshwater gastropods, which made up 6 of those boxes. The reasons for this choice, aside from our own expertise, will become clear as we determine the geographic provenance of the specimens below. We sorted the material according to the criteria outlined below.

Figure 1. Cardboard boxes with unregistered snails from the TSZ collection, and a closeup of a box containing land snails.

(1) Specimen preservation state. Shells without metadata that were too fragmented or otherwise compromised were discarded. Shells in good condition, even with minor breakages or 'imperfections', were kept.

(2) Quantity and quality of information (metadata). Each specimen lot contained varying degrees of collection information, provided in the form of labels (Figure 2). These labels may include details such as: collection number, taxon identification, locality of collection, date of collection, name of the collector, previous collections to which the specimen belonged (either private or institutional), and other miscellaneous data (e.g., habitat description, reference to a handbook, catalogue, or other

Figure 2. Label types found accompanying the orphaned specimens. The label on the bottom left corner is an example from the Wim Vader collection (see below). Scale bar = 2 cm.

taxonomic work). In some cases, a specimen lot has no data whatsoever. Each situation was dealt with individually, as follows:

(a) No data: Specimens without any associated data are typically not accessioned into the collection. Instead, they can be set aside and used for various activities, such as exhibitions, outreach, and teaching. These specimens can also be donated to other institutions, such as primary and secondary schools, where they can be used to teach biology and biodiversity. However, it is sometimes possible to infer the provenance of certain specimens based on their identity. For example, identifying the species in the present material can provide information about their provenance, as some species have restricted geographic distributions (e.g., Sri Lanka). This process is generally more feasible with land snail specimens than with freshwater or marine ones, which often have broader distributions. Specimens for which locality data could be inferred were accessioned into the collection.

(b) Only collection number available: these specimens have either a number written on them in ink or a small slip of paper with a number on it. These numbers can refer to old registration numbers from the present institution or to registration numbers from prior collections, including private ones. In these cases, we attempted to trace the meaning of the numbers using old museum registers and other archival documents (see below). Unfortunately, we were unsuccessful in most instances except for one series of specimens. For this series, the numbers (on round stickers glued to the shell) could be matched to a specific kind of label (Figure 3).

(c) Collection data available: all specimens with reasonably specific collection locality data were kept for accession. Specimens with very broad or vague locality data, such as 'Europe' or 'Asia', were set aside. Some specimens also included the date of collection, and a few had the collector's name. While it is always preferable to have as much detailed metadata as possible, for any given specimen, it can still be useful to retain specimens with broader locality data (e.g., 'Australia' or 'Brazil'). These specimens can serve as a reference collection for faunas from regions otherwise underrepresented in the collection. In our case, since the collection naturally focuses on northern Norway, specimens with locality data simply stating 'Norway' were not accessioned.

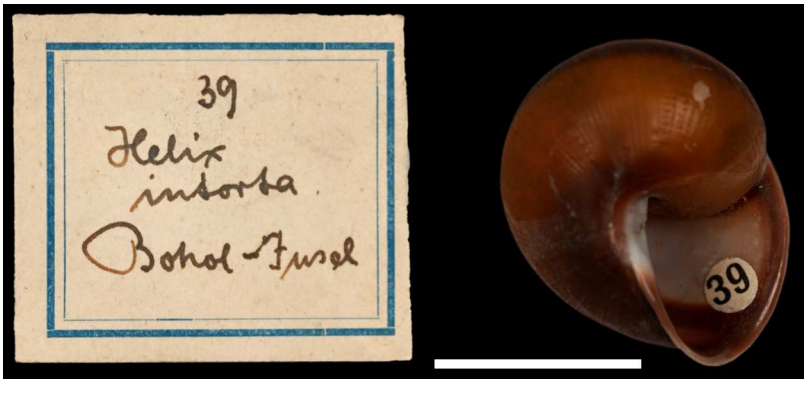

Figure 3. Example of a label with numbering that could be linked to a numbered specimen. The species shown is *Chloraea intorta* from the Philippines. Scale bar = 2 cm.

(3) Further incidental information: This additional information is often only obtainable by someone familiar with the institution's collections. For instance, the design of the labels or the type of container can give additional hints regarding the age of the specimen and/or date of acquisition by the museum (e.g., 'pre-1950' or '1950s–1960s') as well as its previous owner. Private collectors and specialized vendors, often used specific types of labels (Figure 2). Makeshift containers, such as match-boxes or chocolate boxes, can help narrow down a date interval and may even hold historical value themselves. Additionally, handwriting can reveal who wrote the label or who previously owned the specimen.

A decision tree illustrating this approach is provided in Figure 4.

Archival documents

All available documents in the TSZ archive and pertaining to natural history specimens (particularly mollusks) were thoroughly examined. These included registers, old journals, notebooks, yearly reports ('årsberetninger'), and miscellaneous notes (Table 1; Supplementary File 1, Table S4).

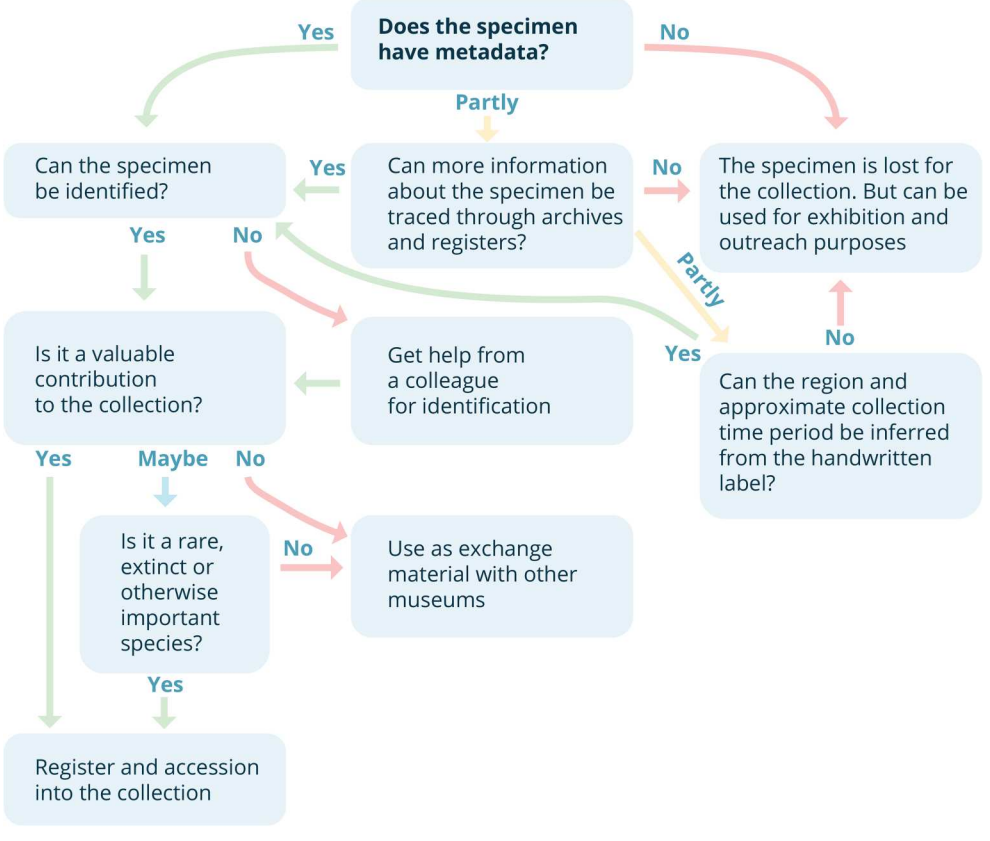

Figure 4. Decision tree when treating orphaned specimens

Table 1. Available journals and notes from the archives, digitized during this project.

Title	Year	Permanent URL
Tromsø Museum Gavefortegnelse 1872–1931	1872–1931	https://ubdigital.uit.no/handle/10037.2/763
Tromsö Museum Journal 1886–1889	1886–1889	https://ubdigital.uit.no/handle/10037.2/765

Species identification

All specimens selected for accession into the collection were identified using current taxonomic literature or by comparison with reference specimens. The reference specimens were either available in the TSZ collection or accessed through photographs in online collections from other museums (e.g., Muséum national d'Histoire naturelle, Paris, France; Naturalis Biodiversity Center, Leiden, The Netherlands; Natuurhistorisch Museum Rotterdam, Rotterdam, The Netherlands). The literature used included the following handbooks: (Abbott 1989; Cameron and Riley 2008; Delannoye et al. 2015; Rowson et al. 2021; Seddon 2008; Simone 2006; Welter-Schultes 2012; Wiese 2016). In some cases, additional and more specific taxonomic publications were also consulted (e.g., Birckolz et al. 2016; Horsáková, Nekola, and Horsák 2020). The current systematic classification follows MolluscaBase (https://www.molluscabase.org/).

Results

Details in the archival material

The museum was established on October 16, 1872, as Tromsø Museum. Initially, it was housed in a small building that today houses the restaurant 'Hildr', and later in a larger building that has since been demolished. The first paid scientific employee specializing in zoology was Hans Jacob Sparre Schneider, who worked at the museum from 1877 to 1918. His research focused on insects and marine organisms, including snails. In 1895, the museum relocated to a new building, which is now used by Tromsø Kunstforening.

During World War II, all collections had to be evacuated and hidden in various locations around Tromsø. After the war, plans were made for a new museum building, which was eventually established. The zoological collections were moved into this new building from 1961, where they remain to this day. Historically, zoological specimens were collected by curators from the area around Tromsø and exhibited without a proper index, making it impossible to trace the specimens over time.

In the report 'Beretning om Tromsø Museums Virksomhed i Aaret 1878', page 12 states: 'Ældre Exemplarer i Samlingen er kasserede og erstattede ved nye' which translates to 'Older specimens in the collection have been discarded and replaced with newer ones'.

Recollections from the collection manager, Robert Bergersen (working at the museum 1984–2022), regarding the digitizing process of the collection in FileMaker (Claris International Inc., USA) during the years 2000–2021:

> Both Gastropoda and Bivalvia (or about 4/5 of them) already had museum numbers as in the old paper journals (from 1950s and 1960s). These numbers were retained in the FileMaker databases, including a few hundred I could not find (these have no orig. text entered in FileMaker but are still included there and in GBIF). After making the databases from the paper journals, the file was checked against what occurred in the collection. Only about 1/5 (or a

> few thousands) then got new numbers, i.e., those that were not listed in the old paper journals but existed in the collection. (without any number) (R. Bergersen, pers. comm. 2023)

We conducted a thorough search of the museum archives but were unable to locate any old journals that could be linked to the numbers on the shells in the cardboard boxes. These old journals were likely lost during the chaos of the Second World War.

Overview of the material

Overall, 1,144 specimen lots of land and freshwater snails were present in the material, all containing dry shells (some containing 'mummified' soft tissue). Of these, 242 lots were bereft of information, meaning they lacked labels or any other information (e.g., written on the shell itself). Several lots (97 in total) contained only a number, either written on a label or directly on the shell surface, but these numbers could not be linked to any collection data recorded in the old museum notebooks and ledgers – with two exceptions where the format provided a clue: the number was written on a round sticker glued to the shell, which, in all other cases within the collection, was always accompanied by labels of a specific design (Figure 3). Lots that contained only a number and could not be linked to information in the museum archive were not accessioned.

A total of 369 specimens had labels with a species name but lacked any collection data. For 44 of these lots, the locality could be inferred based on the species identity, as the species have ranges restricted to specific countries, regions, or islands. Consequently, those 44 lots were retained for accession into the collection. Additionally, 3 lots of *Partula* spp. and *Papuina* sp. were also accessioned despite lacking data. This decision was made because, although they could not be identified with certainty, the specimens might belong to rare or possibly extinct taxa, prompting us to take a more cautious approach.

A total of 198 specimen lots had reliable locality information (and, in some cases, also the date and the name of the collector) and were accessioned into the collection. However, a few of these specimens with good collection data (14 in total) had to be discarded because the shells were completely broken, leaving only small fragments. Likewise, 2 lots with good data were discarded due to advanced stages of Bynesian decay (Cavallari, Salvador, and Cunha 2014), rendering the specimens unsalvageable.

Among the material, we found a private shell collection that belonged to Wim Vader (Willen Jan Marinus Vader, born 1937 in Krabbendijke, The Netherlands), a marine biologist specializing in amphipods and seabirds (Voous 1995). Wim Vader moved to Norway in the 1960s and eventually became curator and later director of the TSZ (Voous 1995), to which his snail collection was donated (though it was never completely accessioned). Most of the specimen lots from his collection found during our study were land and freshwater snails (236 in total), typically collected during the 1950s. As expected, most specimens originated from the Netherlands, but Türkiye and France were also well represented, with additional specimens from other countries, primarily in Europe.

Specimens from the Vader collection were originally housed in contemporary matchboxes (almost all of them Dutch; Figure 5) and each lot included a label with a distinctive design, generally containing reliable collection data (see example in Figure 2). Of these, 202 lots were accessioned into the collection, while the remaining 34 lots (which

Figure 5. Some examples of matchboxes from the Wim Vader collection.

contained only Vader's private collection numbers) were set aside for now, in case the original ledger for this collection is located in the future.

In summary, circa 70% of the lots present in the 6 cardboard boxes examined in detail represented land snails, while 30% were freshwater snails. These specimens were collected over a broad period, ranging from the late nineteenth century to the 1960s. Among the land snails, the most represented families were: Helicidae (c. 11%), Camaenidae and Clausiliidae (c. 9% each, with the former largely represented by species from the Philippines), Geomitridae (c. 8%), and Hygromiidae (c. 7.5%).

For the freshwater snails, Planorbidae and Lymnaeidae were the most represented families, as expected, accounting for approximately 42% and 17% of the specimens, respectively. The countries with the most representative lots were The Netherlands (c. 18%), Türkiye (c. 16%), Norway (c. 14%), France (c. 9%), and the Philippines (c. 5.5%). This result was largely influenced by the Vader collection, as The Netherlands, Türkiye and France were scarcely represented in the rest of the material. A detailed summary of families and localities is provided in Supplementary File 1 (Tables S1–S3).

Discussion

Here we have used 'orphaned' specimens of land and freshwater gastropods as a case study to demonstrate how such items can be managed in collections. While the realities of museum collections worldwide may vary, we believe that a few general guidelines can be derived from this exercise.

Leftover specimens accompanied by adequate collection data can be accessioned into the collection. It is important to note that 'adequate data' is a case-by-case assessment: in

some instances, the name of the country where the specimen was collected might suffice, while in others, more detailed information may be required. Even in collections with a focused scope (as in the present case, northern Norway), it is always beneficial to maintain a reference collection containing specimens from around the world, representing the whole taxonomic diversity of the group. Detective work can establish sufficient metadata to increase the value of a specimen from valueless (no associated data) to its true significance (Besterman 1992).

If appropriate, restitution or repatriation options can be considered. However, for invertebrates, such situations are quite rare, as there is an understanding of the importance of collections having representative specimens from beyond their national borders. Exchange with other museums is also a viable option, provided that a collection interested in the material can be identified.

Orphaned specimens in good condition but accompanied by poor data or no data should not be accessioned into the collection. However, they should not simply be discarded, as there are several ways to make use of them. For instance, they can be used in exhibitions or for outreach and educational activities in the museum. They can also be donated to biology courses at various educational levels, ranging from primary science classes to university-level zoology lectures.

The option of selling such items (and using the proceeds to improve the collection or its infrastructure) is common in art collections (Besterman 1992; Miller 2018), but in principle, it could also be applied to biological collections. However, even if the specimens are sold in the museum shop, the revenue generated would typically be minimal. Selling specimens in the museum shop, however, raises ethical concerns, particularly if the specimens are rare, endangered, or culturally significant. It sends a questionable signal to the public, suggesting that the museum is commercializing and undervaluing its collection. Additionally, it carries an inherent risk of misuse, especially in dire financial situations. Regardless of the fate of the non-accessioned specimens, the process should be documented to provide an overview of the material that was not accessioned.

Finally, it is important to note that orphaned specimens are occasionally housed in containers that may hold historical significance. It is advisable to consult with a historian to determine whether these containers should become part of an appropriate collection.

Conclusions

Orphaned specimens are a reality in most natural history museums. Donated specimens and fieldwork material are often set aside by staff due to more pressing priorities or simply because there is no specialist available to work on a particular taxon. As staff members come and go, the information about these specimens (often retained only in the memory of those who handled them) can be lost, if there was no proper data management plan in place. When material becomes dissociated from its metadata, it gradually loses its scientific value.

Here, we propose a workflow to aid in the decision-making regarding the management of orphaned specimens. Our case study focused on terrestrial and freshwater gastropod shells in the TSZ collection, but the principles are broadly applicable to most other invertebrates with hard parts. These include mollusks other than gastropods, brachiopods,

echinoderms, crustaceans, corals, and sponges. Furthermore, the guidelines can be extended to invertebrate fossils in general.

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Disclosure statement

No potential conflict of interest was reported by the author(s).

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