

Collections after Retirement: Addressing the Uncertain Fate of a Lifetime's Work

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When biological collectors and curators retire, pass away, or simply move on, the future of their research materials depends on space, funding, and labor—and a whisper network of passionate scientists.



A huge showcase displays stored specimens at the Natural History Museum of Berlin. Photograph: Rolf Brecher from Germany—The Cube II, CC BY-SA 2.0.

When Portuguese herpetologists Luis Ceríaco and Mariana Marques first walked into the tiny room housing an abandoned

collection of reptiles and amphibians at a defunct research institute in Lisbon, they paused for a moment of mixed awe and woe. Amid moldy walls

and ramshackle wooden cabinets were 5000 specimens, many swimming in half-filled jars of murky brown formaldehyde. Many were partially

BioScience 72: 718–724. © 2022 Donahue. All rights reserved.
<https://doi.org/10.1093/biosci/biac054>



Jars containing reptile and amphibian specimens from Angola, Mozambique and other former Portuguese colonies were in poor condition when Luis Ceriaco and Mariana Marques visited the collection in 2014. Photograph: Mariana Marques.

Specimens of young Nile crocodiles from Mozambique await inspection and transfer from their old holding jars to new collection containers during a rescue project in Portugal. Photograph: Mariana Marques.

desiccated or covered in a white rime of fungus. Some, they later found, were also extremely rare.

“If John Carpenter wanted to shoot a movie, he wouldn’t need to spend a cent on props in there,” Ceriaco said, referencing the horror film director. “It was in really bad shape.”

The herpetology collection was just one of a vast store of holdings at the Instituto de Investigação Científica Tropical (IICT), housed in a mansion by the Tagus River. From the late 1800s through the late 1990s, the public institute was the repository of specimens reflecting scientific collecting in Portuguese and other European-colonized regions of Africa and Asia. After a long, slow decline, the institute finally shuttered in 2015. There was a collective understanding that the collections should not be discharged or discarded, but there were many questions about where they would go. To museums? Another research center? To universities? Their fate was unclear.

Ceriaco, a researcher with the Museum of Natural History and Science at the University of Porto, and Marques, a graduate student at the same institution, learned of IICT’s holdings during a digitization project of Angolan and Namibian herpetofauna. They arranged a visit to IICT in

2014, by which time only a handful of curators remained on staff.

Fortunately, the herpetology collection had been well organized, primarily by Portuguese herpetologist and IICT curator Sara Manaças, who authored 20 papers from 1947 through the 1980s. After Manaças passed away and her successor Margarida Pinheiro retired, the herpetology and other collections fell into disrepair and neglect.

For many similar biological collections, that would be the end of the story: specimens from an earlier time or distant place moldering in a box on a dusty shelf. In some extreme cases, a parent organization might divest itself of a disused collection to prioritize other projects.

Ceriaco and Marques are just two of a cadre of scientists passionate about ensuring biological collections live on when the original caretaker is gone. More than a billion biological specimens are estimated to exist in the United States alone. This is the count of known, housed collections within museums, universities, and scientific research entities. The estimated count of privately held collections in Europe—more than 33 million—suggests there is probably a staggering undocumented reservoir in the United

States still awaiting inclusion in public repositories.

Locating those collections—and the work required to prepare and align them with modern collections standards—is a formidable challenge. But little by little, gems have emerged from labs, closets, cupboards, barns, basements, freezers, and garages, thanks to an ad hoc community of scientists passionate about the future of collections.

“A lot of it is word of mouth,” said Andrew Bentley, ichthyology collections manager at the Biodiversity Institute and Natural History Museum at the University of Kansas. “It’s a case of someone knowing there’s a researcher reaching the end of their career, realizing they have this material in their possession, understanding the value of that material, and then publicizing the fact that it is available.”

Labors of love

Resolved to rescue the rediscovered cache of lizard and amphibian specimens from further decay, Ceriaco and Marques worked out a transfer of the IICT herp collection to Portugal’s Museum of Natural History. With funding only to pay for new jars and ethanol, Ceriaco, Marques, and three volunteers nevertheless tackled the restoration process with passion.

After multiple trips between Porto and Lisbon in Ceriaco's tiny 1995 Opel Corsa car, the crew worked 12-hour days for 3 months to identify, clean, photograph, georeference, catalog, and relabel each of the specimens. At one point, Marques got an eye infection from fungus in one of the jars.

"We felt it was our patriotic duty to not leave this heritage in that state," Ceriaco said.

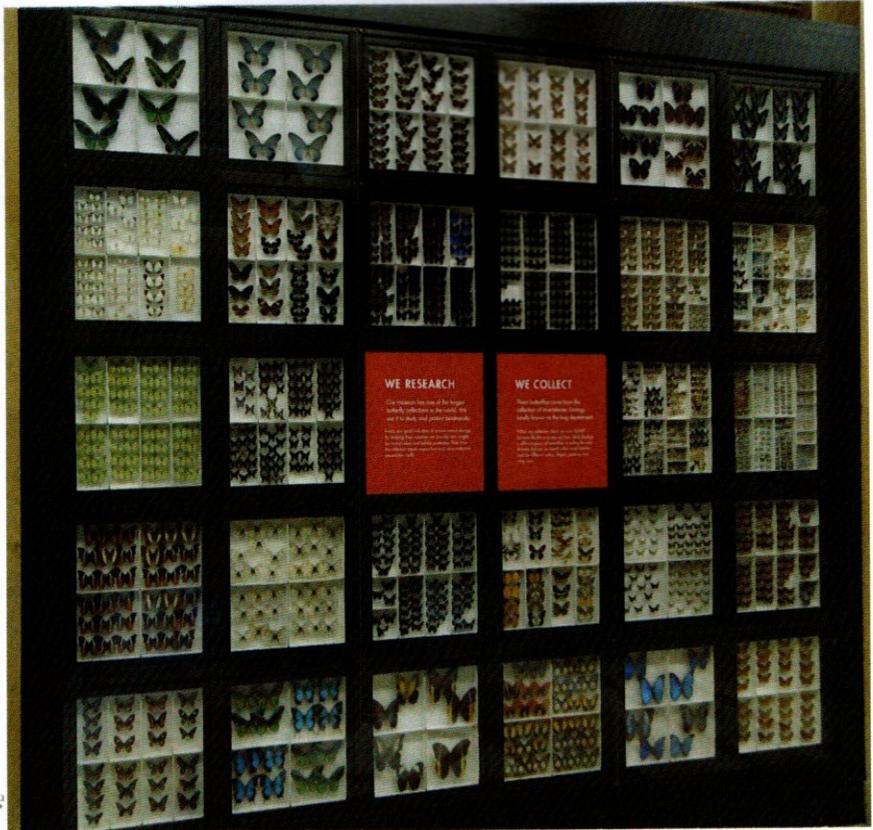
After fully restoring and documenting the collection, Ceriaco and Marques published a paper on their process and findings. Representing Angola, Mozambique, Guinea-Bissau, Cabo Verde, São Tomé and Príncipe, East Timor, and Macau, the specimens had been collected from 253 locations. The Cabo Verde portion turned out to be the most extensive collection of herpetofauna from that country in the world. At 1740 specimens, it far outstrips the next largest holding of 137 specimens. The rescued collection included six new species from São Tomé, including a species of *Naja* cobra.

Some of the collected material is the only information available from a region, such as Angola, a country closed to internal and external scientific research from 1975 through the early 2000s as a result of civil war. "It gives us an extra layer of responsibility. If we have these things, they have to be available and accessible for everyone," Ceriaco added.

The rescue project also yielded other unforeseen returns.

Researchers in other countries have reached out to Ceriaco and Marques to learn how to begin rescuing natural history collections at their own institutions. At the Dundo Museum in northeast Angola, the pair collaborated with local researchers to restore a collection containing some of the only known specimens of fauna endemic to Angola, the Democratic Republic of the Congo, and Zambia—a step toward reestablishing a research program at the museum.

Ceriaco and Marques' salvage work also addresses another concern with which museums and collections



The best way for collections to ensure continued use and care is for them to demonstrate their own value and utility, Bentley said. "Collections need to be their own advocates, and showcase why, how and how much it gets used."

Photograph: Cbaile19, C-C0 1.0, via Wikimedia Commons



*Fossil teeth of (*Galeocerdo aduncus*), an extinct relative of the modern tiger shark. Photograph: Diego Delso, delso.photo, CC-BY-SA.*

managers are currently grappling: the extractive, colonial origins of many Western-held collections. As stated in a 2020 talk by Hannah

Cornish, of the Grant Museum at the University College of London: "Empires helped to turn animals and plants into commodities and to form

networks to trade them around the world.”

The Smithsonian Institution, for example, recently acknowledged the importance of addressing the acquisition of collections objects stolen, taken under duress, or removed without owner consent. “This new policy is a cultural shift in our concepts of possession, ownership, and stewardship of collections,” the institution wrote in a May 2022 press release about their new ethical returns policy.

For others doing similar work with lost and rediscovered collections, the realities of economics and labor also create challenges.

In 2004, Bentley was involved in recovering an assemblage of freshwater fishes collected by Bill Pflieger, author of *The Fishes of Missouri* and a foundational figure in Missouri ichthyology. Alerted by a student at St. Louis University that part of Pflieger's collection was stored in a derelict barn scheduled for demolition, Bentley checked with the Missouri Department of Conservation. Their response: Come and get ‘em, or the fishes’ fate is sealed.

Bentley and his crew drove two and a half hours from Lawrence, Kansas to Columbia, Missouri, where conservation officers pointed them to a pile of 55 rickety five-gallon buckets in a corner of the barn, brimming with alcohol and fish.

Sixteen years on, a lack of funds and labor means the collection still awaits processing for addition to the University of Kansas's ichthyology collection, despite arriving with an accompanying digitized database.

Network effect

In the future, perhaps an emergency rescue of a disorganized collection of alcohol-filled buckets across state lines will not be necessary. At the University of Kansas, ichthyology researchers actively monitor and foster relationships with individuals nearing the ends of their careers.

This networking is vital in light of a 2020 paper highlighting the importance of small, regional collections to



One of the world's many colourful fiddler crabs, Uca heteropleura (American red fiddler crab), found along the coast of central and South America.



Carl Thurman's undergraduate research assistants are key collaborators in an effort to clean up, curate and prepare a collection of fiddler crabs for accession to the American Museum of Natural History's collections. From left to right: Samantha Hayer, Amber Finke and Dee Dee Pitzen. Photograph: Carl Thurman.

biodiversity research. Anna Monfils, of Central Michigan University, showed that small collections often contain endemic species not represented in larger regional accumulations.

Such local collections can make significant contributions, explained Bentley. For example, predictive models evaluating the effect of invasive

species and climate change on disease spread become more accurate with more data points at a finer scale. Research collections can significantly contribute to such efforts.

Relationships with meticulous, avid amateurs can be another fruitful means of ensuring a highly valuable collection becomes accessible. At the

Florida Museum of Natural History, vertebrate paleontology collections manager Richard Hulbert described how a long-running relationship with a former University of Florida (UF) graduate geology student led to one of the largest donations of fossils in the museum's history.

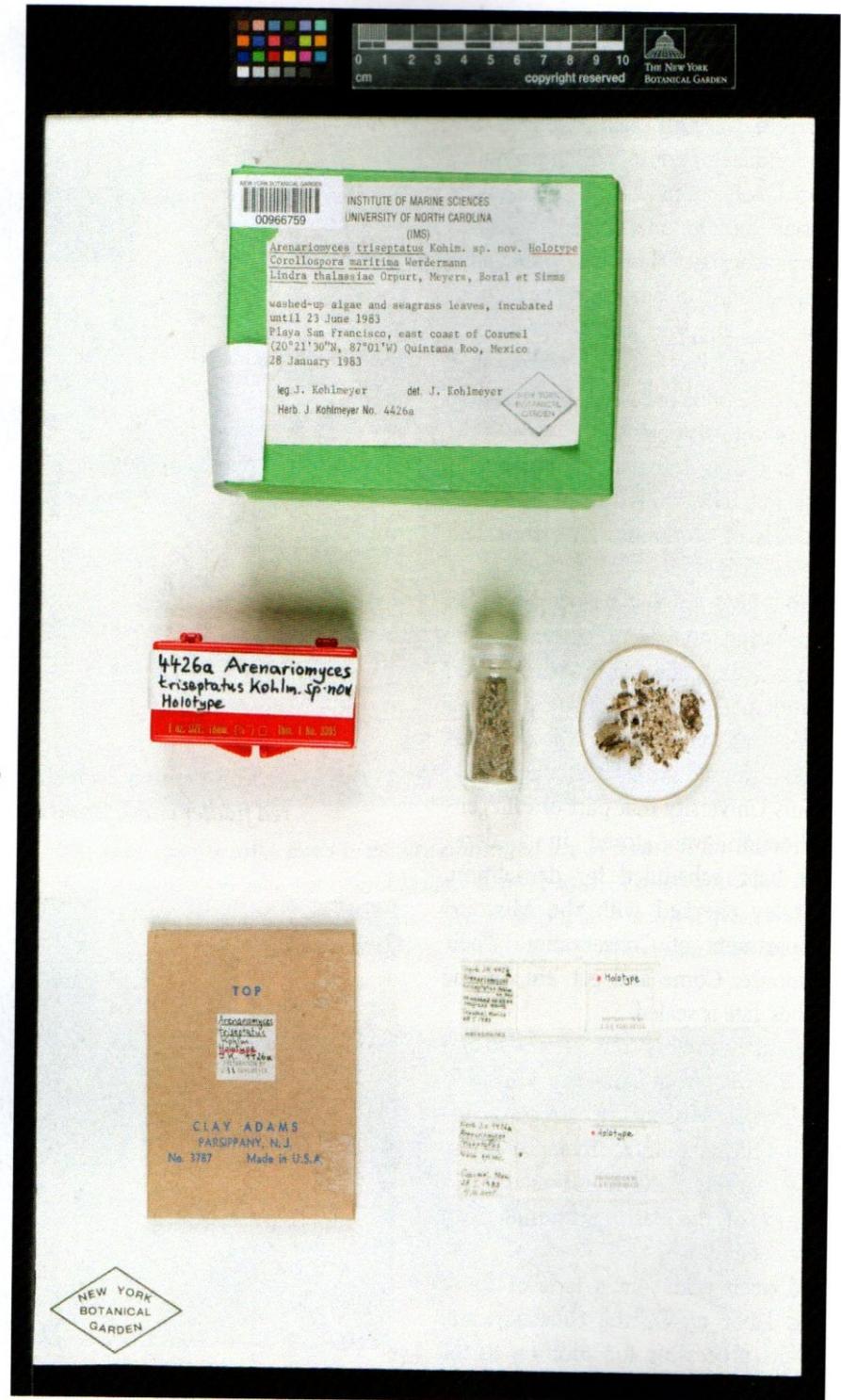
The late S. David Webb, noted UF paleontologist, made a point of periodically visiting private collectors to see what they were doing. Over many years, Webb convinced individuals to consider donating pieces when something valuable emerged. Hulbert said many at the museum follow the same approach, particularly because Florida's specimen collecting grounds are mainly on private land.

After earning a master's degree in geology at UF in the 1960s, John Waldrop became a high school and community college science teacher. Throughout his career, often with the aid of students who went on to become accomplished paleontologists themselves, Waldrop collected specimens ranging in age from 10,000 to 40 million years old, particularly from phosphate mines and shell pits subsequently covered over by new neighborhoods. When he retired, Waldrop donated to UF an estimated 50,000 vertebrate and around 250,000 invertebrate fossils gathered on private lands.

Webb's relationship with Waldrop paved the way for the UF museum donation. Throughout the years, Waldrop had opened his home for researchers to visit the collection, some of it unusually housed in repurposed Schlitz beer boxes from the corner store.

Hulbert knows of at least two other substantial collections promised to the museum by amateur collectors.

"Florida is still producing a vast number of fossils," Hulbert said. "You've got to find the right people who will allow you to collect on their lands, with permission." But when direct collections are not possible, Hulbert notes one common tool is an enormous aid: cell phone cameras. "I can go to a private collection and get a decent 3D scan of a specimen if a



Type specimen of the marine fungus *Arenariomyces triseptatus*, collected in Mexico and described as new to science by Jan Kohlmeyer. This collection contains the fungus on its original substrate. Photograph: Barbara Thiers.

collector isn't ready to donate right away," he added.

However, a large-scale alert network for researchers to learn about retirements or collections is unlikely to manifest any time soon. Tiffany Adrain, special collections manager at the University of Iowa, said discipline-specific listservs sometimes perform

this function. However, it's usually word of mouth or obscure connections in research interests that lead to one person's awareness of a collection that might be at risk of being shelved.

"There's definitely more scope for having a network where people can say: This collection is coming up," or note when someone is retiring,

Adrain said. She and coauthor Paula Work, a geologist with the Maine State Museum, coauthored a toolkit for the Society for the Preservation of Natural History Collections (SPNHC) concerning endangered and orphaned collections. Their wiki describes scenarios and approaches for collections in transition.

Next-generation curation

At the University of Northern Iowa (UNI), Carl Thurman had had his eye on his academic mentor Frank Barnwell's collection of fiddler crabs for years. Before Barnwell retired from the University of Minnesota, Thurman started laying the groundwork for possible donation by staying in close contact, especially as the senior academic became unsure about what to do with the 40,000-odd specimens of fiddler crabs he had collected around the globe.

Barnwell hoped the Smithsonian would take them. It turned out they were maxed out on fiddler crabs. However, Thurman convinced Barnwell to let him take over the curation and preparation of the crabs with an eye toward donating them to the American Museum of Natural History in New York, where he had a connection.

With support from an undergraduate research experience program at UNI and a scholarship from Barnwell, Thurman and his students picked up two batches of Barnwell's samples in April and June of 2021 and got to work. They made a third and final trip in mid-May 2022. Last year's cohort produced a research poster (<https://scholarworks.uni.edu/cgi/viewcontent.cgi?article=1054&context=surp>) on their work, and several team members will be on hand to assist in summer or fall 2022 when they deliver the specimens to AMNH.

At a handful of universities around the country, student-led involvement in curation and management has breathed new life into underused collections. The Natural History Collections Club Network started at Arkansas State University in 2013.



Diplulmaris antarctica under Antarctic sea ice. A survey sent to a network of Antarctic researchers, including Distel, revealed that researchers hold more samples than are cataloged in museum collections. Photograph: AMICE, Wikimedia Commons, CC 4.0 International.

An undergraduate student there, Kari Harris became familiar with her institution's natural history collections after digitizing herbarium specimens for her honors thesis. While the botanical and herpetological collections were in good condition, the mammals, fish, and insects were not so fortunate.

The only accessible data in existence were from Harris's digitization project. Faculty members gave a collective shrug when she expressed dismay about the state of the collection. "They said, 'It's a sad situation. There's nothing we can do. There's no money or anyone to take care of it,'" Harris recalled. However, after talking with other biology student friends, they decided, no, this is not okay.

Banding together in a one-semester independent study, the students dove into their university's collections to assess them and determine whether rehabilitation and modernization was possible.

"What came out of it was an understanding that the students felt the collections were important," Harris said. Matters snowballed from there. The faculty noticed, the students organized a club, and funding materialized. The

collections club idea tailed students to new institutions as they moved to graduate programs. So did National Science Foundation funding for the nascent national network. An emerging professionals mentorship program followed.

"That spark of the students saying, wait a minute, we want these collections, we're invested, and we'll do what we can to turn this situation around. That effected huge change at our university," Harris said. Compact shelving, new and appropriate storage materials, and a variety of student-led workshops in outreach, specimen prep, and collections reorganization have revitalized Arkansas' natural history collections. "It's amazing how many students are not afraid of doing gross tasks. Pulling turtles out of giant buckets and putting them into new ones is disgusting. But the day we did that, we had a crowd."

Although the expansion of the club network is currently on hold, other approaches are afoot. At the College of the Redwoods, in Eureka, California, Karen Reiss offers an independent study course in museum curation. Students learn basic curatorial and

database skills and then carry out a project based on the college's collections. "Much of the collection's current organization I owe to these students," Reiss said.

Filling the gap

However, a confounding effect of amateur collections is quality control of specimens and any accompanying data, especially if the curator or collector has died. Sheer dispersal of research records—Harris once found a professor's field notebook at a local yard sale—and legal issues, such as improper permitting, can also stymie collection transfers.

It is much more difficult to find relevant, research-applicable materials after the fact, explained Bentley. "It can literally be a Sherlock Holmes experience trying to piece together data, permits, notes, whether the material is valuable to anybody and where it should go."

Dan Distel, director of the Ocean Genome Legacy Center (OGL), a biobank housed at Northeastern University's Marine Science Center, agrees that tracking down the sources of field-acquired materials requires dedicated sleuthing. "Labeling can be cryptic, according to what's important to a researcher," Distel said. For some collections deposited at OGL, he and his team have used shipboard logs and cruise tracks to trace sample numbers back to their geographic source regions.

The flipside is an "ideal acquisition," as was provided by the Kohlmeyer family of North Carolina. After he retired from the University of North Carolina's Institute of Marine Sciences in 2001, Jan Kohlmeyer contacted Barbara Thiers, director of the Steere Herbarium at the New York Botanic Garden, to donate the marine algae collection he and his wife and collaborator, Brigitte, had assembled over their long careers. The collection featured over 17,000 slides and specimens "beautifully documented in every way you could imagine," Thiers said.

"It's a very specialized field," said Thiers. The collection, full of species-defining holotype specimens, "filled

a gap we couldn't have filled in any other way."

With Bentley and a dozen others, Thiers helped produce a report on biological collections published by the National Academies of Sciences, Engineering and Medicine in 2020. One noted idea gaining traction is that grant funding proposals include a specimen management plan for handling materials and where they will end up at the conclusion of the study or researchers' careers.

As always, funding is critical, too. The National Science Foundation has had various mechanisms to support collections management and digitization, such as the now-defunct Advancing Digitization of Biodiversity Collections and its successor programs, Sustaining Infrastructure for Biological Research and Infrastructure Capacity for Biological Research.

Bentley and Thiers both described philanthropic efforts leading to support for incorporating collections in need of institutional adoption, and note that requests can also be made directly to donors. Ideally, "a collection needs to come with some money to digitize it," Bentley said. Even small grant leftovers can support collections' next lives.

Proactive communication is key, as well, by groups like SPNHC and by

researchers preparing for field collecting. "People need to reach out to collections before they go out to the field," said Distel, to get recommendations from museums and biorepositories about protocols so collected materials are correctly prepared.

The view and approach to the value of collections, Distel added, has had a convoluted evolution. Specimens were once valued for their descriptive value, but the rise of biochemistry pushed preserved materials towards obsolescence. Now, with molecular techniques that can extract valuable data from even highly degraded specimens, preserved biological materials are once again regarded as a rich source to mine.

"Students were once taught the importance of preserving things and putting them into a public collection, but we stopped emphasizing that somewhere along the way," Distel said. While there are many more complex and nuanced conversations in progress about the ethics and ownership of collections and how to make them universally accessible, Distel notes, "It's interesting that we've begun to come full circle."

Michelle Z. Donahue is an independent science writer and communicator based in Frederick, Maryland. Her work has appeared in the New York Times, National Geographic, and Smithsonian.

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