

Regional Collections Are an Essential Component of Biodiversity Research Infrastructure

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Natural history collections (NHCs) archive and provide access to biodiversity records by preserving biological, paleontological, and geological specimens and their associated data. Worldwide, there are thousands of NHCs curating over 2 billion specimens that represent over a million taxa (Mehrhoff 1997). Varying considerably in size and scope, NHCs are united in curating specimens and data in support of biodiversity research. Larger collections have been reviewed and identified as being important to biodiversity research (Miller 1991), whereas smaller regional collections, which make up the vast majority of NHCs, have not received the recognition they merit for their contributions to biodiversity research infrastructure. In the present article, we make a case for the critical importance of smaller regional collections in creating the Global Museum and the Extended Specimen Network (Bakker et al. 2020, Lendemer et al. 2020).

Defining collections on the basis of size is problematic as it implies relative value, is arbitrary in its designation, and varies widely by taxonomic discipline. The American Society of Mammalogists reported in its most recent periodic survey that small collections (fewer than 10,000 specimens) formed 79% of all mammal collections and 88% of mammal tissue collections in the Western Hemisphere (Dunnum et al. 2018). Likewise, in a survey of

US arthropod collections, Cobb and colleagues (2019) found that 70% are small (fewer than 100,000 specimens) or medium (between 100,000 and 1,000,000 specimens) in size, and in a survey of mollusk collections based in the United States and Canada, Sierwald and colleagues (2018) found that 66% are very small (fewer than 9000 specimen lots) or small (between 9000 and 29,999 specimen lots). This pattern holds for plant collections as well, where Cahill and colleagues (2019) determined that 90% of US herbaria are small (at most 175,000 specimens). When examined across taxonomic disciplines, regardless of the designated size cutoff, “small” collections represent the majority of the individual NHCs. These small collections do not have a small collective impact, and a more representative name is needed. Given the number and broad distribution of these collections, and the emphasis on local collecting efforts and biogeographic expertise, we propose the term *regional collection* as a better descriptor and more fitting name for the “small” collections.

Regional collections contribute unique specimens that fill critical gaps in our taxonomic, geographic, and temporal understanding of global biodiversity. Regardless of taxonomic focus, when researchers map specimen data on continental scales, regional collections bridge critical geographic gaps (National Research Council 2014,

Dunnum et al. 2018, Sierwald et al. 2018, Cahill et al. 2019, Cobb et al. 2019, Marsico et al. 2020). In their review of arthropod collections, Cobb and colleagues (2019) found that regional collections curated unique specimens, and that these specimens best represented local diversity. Overall, regardless of the size of the arthropod collection, each individual NHC provided the majority of the specimens collected within a 50-kilometer radius of the institution. When Marsico and colleagues (2020) investigated herbarium specimens in eight states, on average 89% of specimens in regional collections represented unique occurrence records. In that study, regional herbaria were disproportionately representative of local flora. While regional collections only accounted for 12.5% of the total herbarium specimens in an individual state, when reviewing locally relevant specimens within a state (i.e., rare, introduced, and common native), 30% of those specimens were housed in regional herbaria. To look at the impact of data from regional herbaria, Glon and colleagues (2017) ran species distribution models with and without specimen data from regional collections. The regional collections contributed far fewer specimens, but those specimens represented unique information, and the addition of regional collections data resulted in more refined and robust predictions of ecological

niche. Sometimes a single specimen in a regional collection can lead to an important discovery. Dooley and colleagues (2019) defined a new species, *Mammot pacificus*, on the basis of a critical specimen from the Diamond Valley Lake fossil collection. This highly specialized collection of mastodon bones was excavated during the construction of a local reservoir and subsequently housed locally in a small museum. This regional collection is the impetus for a revised taxonomy of Pleistocene mastodons in North America. Collections from regional NHCs also influenced Belitz and colleagues (2018) in their investigation of potential causes for the decline of the critically endangered Poweshiek skipperling butterfly (*Oarisma poweshiek*). In this study, the authors found 40% of the historical entomological records in regional collections. Across taxonomic disciplines, regional collections provide critical geographic resolution for fine scale questions of diversity and unique occurrence records documenting species and distributions.

A discussion on the importance of regional collections must include the valuable role they play in promoting taxonomic, local, and indigenous knowledge. Researchers associated with regional collections represent a significant portion of the scientific community and workforce and contribute meaningfully to biodiversity research. The large number and distributed nature of regional collections provides critical access points to engage local and indigenous communities and, in turn, to disseminate proximate and contextual understanding of biodiversity. The 2019 IPBES Global Assessment Report emphasizes using local and indigenous knowledge to inform our understanding of regions, ecosystems, and biodiversity and was the first IPBES report to make specific reference to the importance of local and indigenous communities in pursuing conservation of biodiversity (Diaz et al. 2019). Reaching out and engaging on a local level is a critical step NHCs can take to address long-standing inequities caused in part by

a history of colonialism and ongoing systemic racism. Regional collections provide opportunities to acknowledge and incorporate the contributions of local and indigenous communities, improve the inclusivity of our NHCs, discover and democratize biodiversity data, and engage the diversity of our collections professionals and researchers.

The sustainability of biodiversity research is strengthened by the global network of NHCs linking specimens, associated data, and researchers in a dynamic community of practice. The general importance of regional collections to this network has been acknowledged in several summative reports addressing the future of NHCs (see Lendemer et al. 2020 and the references therein); this bears repeating as we look to the future of collections and consider next steps in the global digitization of NHC data. Regional collections provide the majority of access points to NHCs around the world, fill critical gaps in specimen coverage, and foster a distributed network of human expertise that has the potential to increase representation and diversity in our community. We are in a fast-paced and vibrant era for NHCs as biodiversity research and collections are at the leading edge of digital data mobilization, open data and open science initiatives, and biology reintegration and transdisciplinary collaboration. Now is the time to renew efforts to engage our entire community of collections and collections professionals in ways that leverage the diversity of expertise, scope, size, and institutional structure among NHCs. We are stronger, more creative, and more resilient as a community, and we enhance our collective research capacity, when we include regional collections in building a global network of NHCs.

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