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Dr. James Olds
Assistant Director
Directorate for Biological Sciences
US National Science Foundation
4201 Wilson Boulevard
Arlington, VA

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Dear Dr. Olds,

As President of the Entomological Society of America, I am writing to you on behalf of our 7,000+ members to express our collective dismay over the decision recently announced to place the National Science Foundation's Collections in Support of Biological Research (CSBR) program on hiatus for the second time in three years. We recognize the tremendous budgetary constraints under which NSF now operates; however, no explanation for this particular hiatus has been provided other than that "the CSBR hiatus will give DBI an opportunity to evaluate the program's role in the context of other programs, such as Advancing Digitization of Biodiversity Collections (ADBC), which includes iDigBio, and the Collections track of Postdoctoral Research Fellowships in Biology (PRFB)" (from https://dbinsfblog.wordpress.com/2016/04/04/csbr_guidance). Why this unique, and frankly irreplaceable, program has been specifically targeted has never been explained, nor for that matter has the outcome of the 2013 hiatus, presumably conducted for the same reason, ever been released. It is this lack of transparency, which hitherto has characterized program prioritization discussions at NSF, which is causing considerable consternation among our members.

Placing this program on hiatus (twice in three years) is particularly worrisome in that the language used to explain the hiatus suggests that it is being targeted for replacement by "other programs," notably ADBC and PRFB—that, as the NSF blog announcing the hiatus stated, CSBR is "considered important" only insofar is it contributes "to the infrastructure that supports these activities." This line of thinking is puzzling because both of the programs slated for continuation are themselves largely if not entirely dependent on functional museum collections and an already-trained, skilled, and experienced collection user community, which, as is well known to BIO, has few other options for research funding. Programs such as the postdoctoral training program and the iDigBio can succeed only in the context of well-staffed, functional, active museums; in no sense are they adequate replacements for CSBR or even independent of the museum community supported by CSBR. It appears too that the CSBR evaluation is far too narrow in scope in that collections underpin a broad diversity of programs at NSF; many of NSF's recent funding initiatives require museum expertise and museum services, not only for identification but also for vouchering (a critical component of data management plans). The National Ecological Observatory Network (NEON, now managed by Battelle), e.g., is charged with national inventory of biodiversity and is poised to yield potentially thousands of specimens. The identification and long-term curation of these voucher specimens are critical museum functions. The ability of scientists to duplicate past studies and verify conclusions from NEON, iDigBio, PEET (Partnerships for Enhancing Expertise in Taxonomy), PBI (Planetary

Biodiversity Inventory), and other NSF-funded initiatives would be imperiled if specimens are put at risk by redirecting or eliminating funding for CSBR.

How NSF can continue to undertake enormous projects requiring extensive specimen management and vouchering at the same time it seriously considers ceasing the NSF funding which supports the infrastructure required for managing the collections that are repositories for these specimens is not at all clear.

Yet another reason that support of collections is critical well beyond ADBC and PRFB is that physical specimens provide data that cannot be captured or disseminated digitally. The transformative nature of digitized data has been abundantly illustrated by projects funded through Digitization TCN and other initiatives, documenting change over long timespans, including, among other things, the distribution and abundance of non-indigenous organisms in sensitive ecosystems, biological impacts of climate change, and causes and consequences of biodiversity shifts. Digital data associated with specimens, however, are by nature incomplete. In fact, digital data represent primarily meta-data, information on age, geographic distributions, and phenotypes of specimens; digitization is essentially a 21st century enhancement of 19th century data.

Entomologists in particular are acutely aware of the irreplaceable nature of physical specimens and the data they can yield with the advent of new technologies. For example, the small size, hyperdiversity, and extreme morphological convergence of many insect taxa have led to a reliance upon access to molecular data to recognize and catalogue species. NSF-funded research, e.g., revealed that morphology fails to differentiate tropical parasitoid wasps; barcoding of 171 morphological species collected from the Area de Conservacion Guanacaste of Costa Rica, e.g., uncovered an additional 142 provisional species, with one morphospecies shown to comprise 32 distinct species (NSF0809175 Americas Program: Exploring the Diversification of Microgastrine Wasps (Braconidae) from the Area de Conservacion Guanacaste (Costa Rica)). Refinements of molecular methods, in some cases developed by NSF-funded research, continue to amplify the ability of investigators to extract entirely new kinds of information from physical specimens; a case in point is DNA-based target enrichment of highly conserved genomic elements (ultraconserved elements) for use in phylogenomic analyses across insect taxa, identifying a suite of universal markers that can be used in museum specimens that have undergone minimal preservation (Faircloth et al. NSF DEB-1354739, DEB-1354996, DEB-1242260, EF-0431330).

Beyond DNA, physical specimens have yielded other forms of biological information that allows investigators to reconstruct past ecological interactions. My own NSF-funded research, supported by DEB and not CSBR (NSF DEB0235773), nonetheless depended on access to 150 years of herbarium specimens of the invasive weed wild parsnip in museum collections. Phytochemical analysis of seeds from specimens collected over a 152-year span in North America and Europe revealed phytochemical shifts in the USA coincident in time with the introduction of the parsnip webworm, a major herbivore; furanocoumarins were preserved in the oil glands of the seeds, and analyzing their content allowed us to document an increase in these defenses to levels comparable to those in Europe, where the interaction coevolved. ***Short of a time machine, there was no other way to acquire this information.*** Other investigators, in a project funded from sources other than NSF, nonetheless utilized physical specimens in herbaria to reconstruct the nutritional value of the pollen of *Solidago canadensis*, an important pollinator resource, between 1842 and 2014, documenting a significant correlation between increases in ambient carbon dioxide content and reductions in protein content of the pollen; combined with field data, this study highlights another potential stress factor for North American bees (Ziska et al. 2016, http://bit.ly/1T6CnyI). Other interactions that have been reconstructed with the use of museum specimens include host-parasite associations; in 1990, e.g., investigators screened 136

archival tick specimens and detected *Borrelia burgdorferi*, the pathogen causing Lyme disease, in ticks collected nearly a half-century ago, preceding by decades identification of the disease as a clinical entity (http://bit.ly/1OrMoVh). Digital data, as they exist today, could not have been used to establish that association.

According to the blogpost, the CSBR program "has provided funding: 1) for improvements to secure and organize collections that are significant to the NSF BIO-funded research community; 2) to secure collections-related data for sustained, accurate, and efficient accessibility to the biological research community; and 3) to transfer ownership of threatened collections." The NSF BIO-funded research community still needs access to secure and organized collections and the data they yield and, across the nation, economic stresses continue to threaten collections, particularly those associated with state institutions. It is difficult to grasp how a hiatus and review of the importance of securing, improving, and organizing collections and insuring their sustained and efficient accessibility might lead NSF to think otherwise.

The Entomological Society of America joins the Natural Science Collections Alliance, the Society for the Preservation of Natural History Collections, the American Institute of Biological Sciences, the American Phytopathological Society, and the US Culture Collection Network and its stakeholders in urging NSF BIO to reverse its hiatus and continue its vital support for America's invaluable and irreplaceable collections.

Sincerely,

May Berenbaum
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President, Entomological Society of America