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Announcing Big-Bee: An initiative to promote understanding of bees through image and trait digitization

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Introduction

Bees are critical to sustaining a large proportion of global food production, as well as pollinating both wild and cultivated plants. They are decreasing in both numbers and diversity and our understanding of the factors driving these declines is limited, in part, because we lack sufficient data on the distribution of bee species to predict changes in their geographic range under climate change scenarios. Additionally lacking is adequate data on the behavioral and anatomical traits that may make bees either vulnerable or resilient to human-induced environmental changes. Fortunately, a wealth of associated attributes can be extracted from the specimens deposited in natural history collections. [Extending Anthophilia Research Through Image and Trait Digitization \(Big-Bee\)](#) is a newly funded US National Science Foundation Advancing Digitization of Biodiversity Collections project. Big-Bee will advance research on bee ecology and taxonomy through the creation and standardization of open datasets for taxonomic and computational analysis. It will overcome challenges in bee identification and discovery by linking ecological and anatomical traits. The project will supply innovative methods for deep digitization of target taxa, including high-resolution imaging methods. These image data will enable the scoring of life-history traits and will facilitate identification from digitized specimens. Big-Bee will further revolutionize processes of insect specimen digitization by enabling global bee data to be integrated and linked. The project will produce important partnerships between researchers, industry, and government agencies.

The Big-Bee network of participating institutions includes thirteen US institutions and partnerships with US government agencies. We will develop novel mechanisms for sharing image datasets and datasets of bee traits that will be available through an open, [Symbiota-Light](#) data portal called the Bee Library. In addition, biotic interaction and species association data will be shared via [Global Biotic Interactions](#) (GloBI).

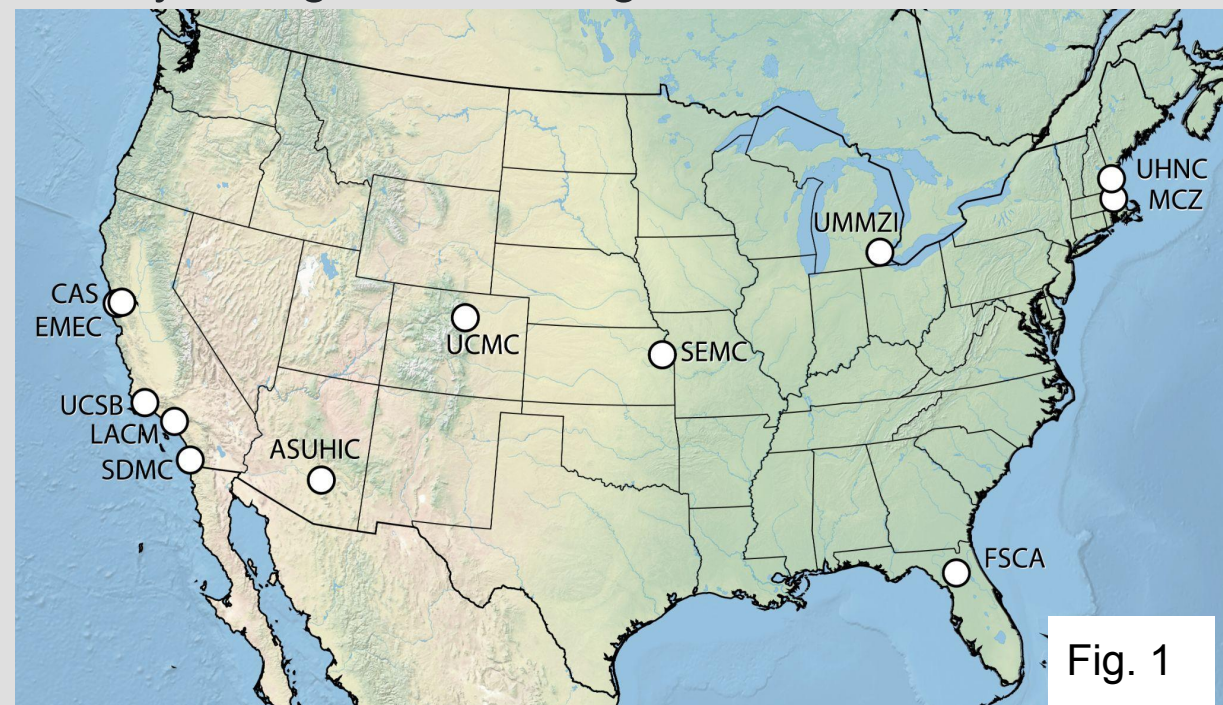


Fig. 1

The Big-Bee project will engage the public in research through community science via crowdsourcing trait measurements and data transcription from images using [Notes from Nature](#) (NfN).

Objectives

Over the course of three years, we will create over one million high-resolution 2D and 3D images of bee specimens representing over 5,500 worldwide bee species, including most of the major pollinating species. We will also develop tools to measure bee traits from images and generate comprehensive bee trait and image datasets to measure changes through time.

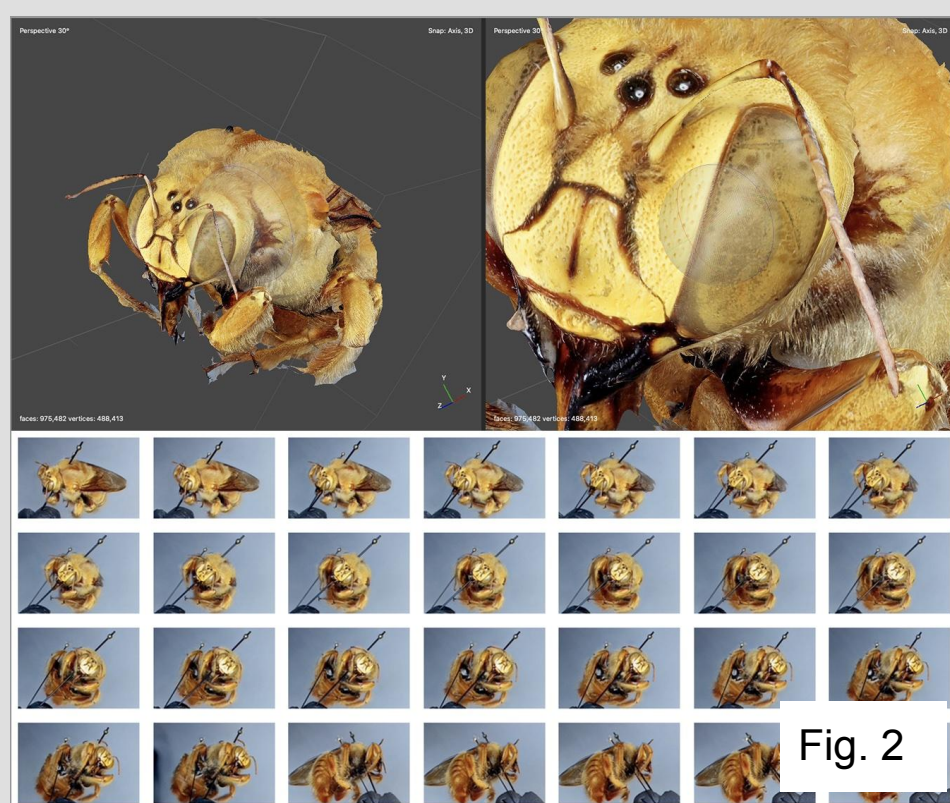


Fig. 2

Materials and Methods



Fig. 3

Using the Macropod Pro 3D imaging system we will create over 1M images of the focal bee species (Table 1). These images include habitus (Fig 3, B) details of morphological features (Fig. 3, C), 3D images (Fig. 2) and museum specimen label images (Fig. 3, A).

Family	Genus	Species in ITIS
Apidae	Bombus, Peponapis, Xenoglossa, Xylocopa	678
Megachilidae	Osmiini	1087
	Megachilini	1522
Melittidae	Dasypoda, Samba, Capicola, Eremaphanta, Hesperapis, Ceratonomia, Meganomia, Pseudophilanthus, Uromonia, Afrodasyopoda, Macropis, Promelitta, Melitta, Rediviva, Redivivoides	206
Andrenidae	Andrena	1556
Colletidae	Colletes	460
	Total species	5509

Table 1: Big-Bee focal taxa

The full proposal can be found at: Seltmann, K. C. (2021). Extending Anthophilia research through image and trait digitization (Big-Bee) proposal. UC Santa Barbara: Cheadle Center for Biodiversity and Ecological Restoration. Retrieved from <https://escholarship.org/uc/item/2vm761mv>

Results



Fig. 4

Although very early in the project we have significant results including the Notes from Nature (NfN) measurement tool under development (Fig. 4). With this tool, NfN users will calibrate a ruler using the included scale bar before measuring the body size of a bee.

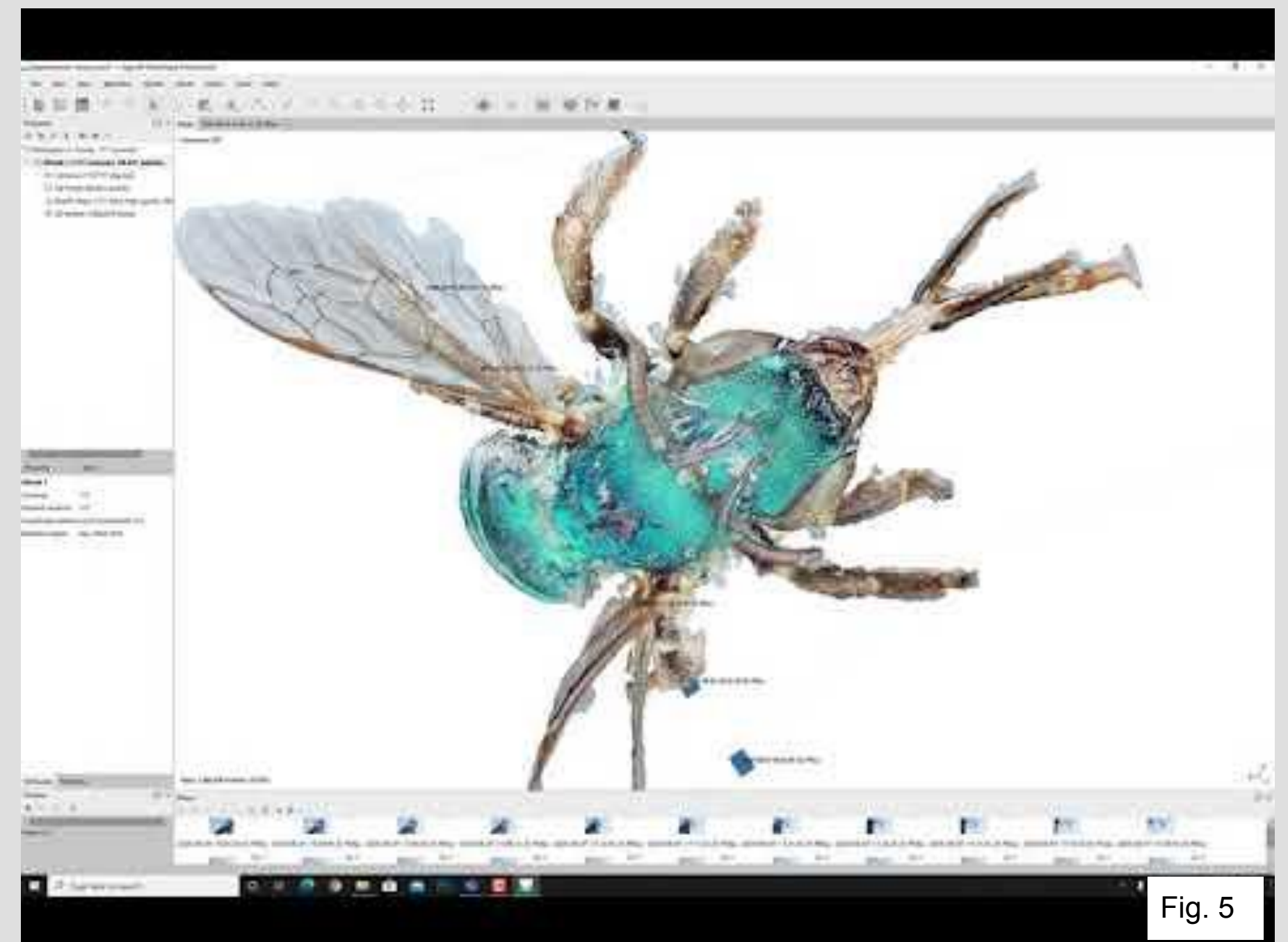


Fig. 5

Already available are the first image stacks for 3D image reconstruction (Fig. 5). Records and images from the Bee Library are also shared as citable data publications through the Internet Archive and Zenodo. These published archives have a digital identifier (DOI) and an identifier that verifiably identifies the archive content (hash). The archives includes metadata describing the origin of the specimen records and images, and the records and images themselves. Above video available at: https://youtu.be/5bey_9KVE1c

Cheadle Center for Biodiversity and Ecological Restoration, University of California Santa Barbara. (2021). UC Santa Barbara Invertebrate Zoology Collection (UCSB-IZC) Data Archive and Biodiversity Dataset Graph (0.1) [Data set]. Zenodo.

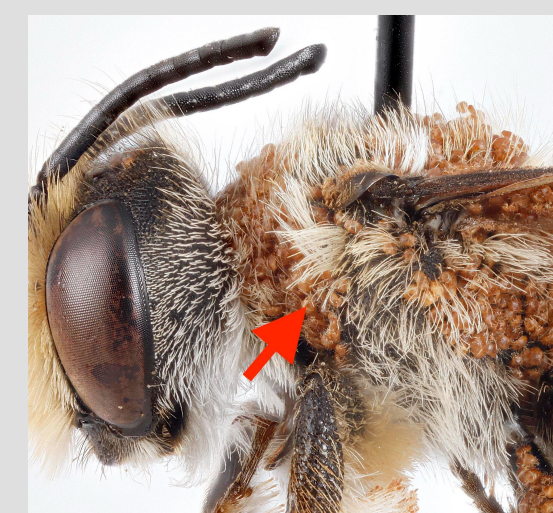
<https://doi.org/10.5281/zenodo.5557670>

<https://archive.org/details/preston-ucsb-izc>

hash://sha256/d5eb492d3e0304afadcc85f968de1e23042479ad670a5819cee00f2c2c277f36

Conclusions

The Big-Bee project provides a unique opportunity to study bees using images. What would you like to investigate using the Big-Bee image dataset?



Understanding seasonality of bee parasites?



Verification of sex via counting antennal segments?



Evolution of pollen collecting hairs?



Interspecific variation in tongue length?

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#bigbee

