IMLS Final Report

Narrative:

Project Title

Curation of the Randall Morgan Plant-Pollinator Collection

Project Partners:

- Symbiota Collections of Arthropods Network (SCAN): Dr. Neil Cobb at Northern Arizona University. Our SCAN partner helped set us up as a contributing institution to the SCAN online data repository. We received training and guidance in the use of the Symbiota platform for uploading museum specimen data.
- Randall Morgan at University of California Santa Cruz helped us with many questions about his collection as well as with identifying butterflies and moths in his collection.
- Dr. Robbin Thorp at University of California Davis, helped identify bee species in the Morgan collection
- Dr. Martin Hauser at California Dept. of Food and Agriculture, helped our graduate student sort and identify specimens in the syrphidae fly family.
- Dr. Michelle Trautwein, California Academy of Sciences, helped our graduate student sort and identify specimens in the bombyliidae fly family
- Dr. Max Klepikov took over for Randall Morgan and helped us identify all of our butterfly and moth specimens
- Dr. Maurius Wasbauer was a late volunteer add-on that helped us identify our spider wasp specimens
- Dr. Terry Griswold took over for Robbin Thorp and is still currently helping us identify species in the Megachiladae bee family.

Overview:

The Norris Center successfully re-housed, curated, and digitized specimens in the Randall Morgan Insect Collection. All ~72,200 specimens were re-housed in new cabinets and sorted into taxonomic groups. A final ~2,500 unlabeled specimens were individually labeled with collection metadata. Taxonomic identifications were completed for most specimens in important pollinator groups. Data from 27,189 of these specimens were digitized and uploaded to the Symbiota Collections of Arthropod Network (SCAN), an online database associated with the Integrated Digitized Biocollections (iDigBio) project. This project employed and trained 20 undergraduate and 1 graduate student while creating an accessible online resource for researchers worldwide. An established workflow has facilitated further data digitization beyond pollinator groups. A broader endowment fund, an accompanying website, museum exhibits, data analysis projects, field guide, and public presentations have and will continue to be used to disseminate important data from the Morgan Insect collection to the broader community.

Changes:

Personnel

- Randall Morgan: Unfortunately, Mr. Morgan passed away in Spring 2017 while we were in the midst of this project. We were able to find a lepidopterist, Dr. Max Klepikov, to help us curate and complete identifications for all the butterflies and moths in the Morgan collection.
- Robbin Thorp: Unfortunately, Dr. Thorp also passed away during our project. We were able to find another bee biologist, Terry Griswold, who agreed to help us make species identifications for bees in the Megachilidae family. Because of Mr. Thorp's protracted illness and difficulties with communicating with him, we weren't able to deliver specimens to Mr. Griswold until December 2018. A prolonged government shutdown and many other priorities has delayed his progress. Currently, we are still awaiting these identifications from approximately 1,500 specimens. Once we receive them, it will be straightforward to finish the data digitization process, as we now have a well-established workflow.

Budget Allocation

- We used the funding that was allocated to pay Mr. Morgan and Dr. Thorp, as well as some of the travel funds, to pay for additional salary for graduate student Andy Kulikowski and undergraduate students who worked on the collection. We also paid Dr. Max Klepikov for some of the hours he spent identifying lepidoptera.

Activities completed:

Proposed Activity	Proposed Quantity	Actual Quantity Completed	Explanation for any difference
Re-house Morgan Collection	~70,000 specimens	~72,200 specimens	
Sort specimens into broad taxonomic groups	All 72,200 specimens	All 72,200 specimens	
Label remaining unlabeled specimens	~3,000 specimens	~2,500 specimens	Proposed quantity was an approximation and some of Morgan's specimens were impossible to resolve
Bulk upload skeletal records to SCAN database	~70,000 records	72,200 specimens	This was successful and allows for future streamlined data digitization efforts.
Identify major pollinator groups to genus or species level	29,880 specimens	27,189 specimens	We didn't complete all the bees because our bee biologist passed away before he could finish
Digitize Collection Records for important pollinator groups and upload to SCAN database	29,880 specimens	27,189 specimens	We didn't complete all the bees because our bee biologist passed away before he could finish
Georeference uploaded specimen records	29,880 specimens	25,560 specimens	Some collection sites were not at Morgan's main 39 locations. They require further research and may be ultimately unknowable.

Proposed Activity	Proposed Quantity	Actual Quantity Completed	Explanation for any difference
Image pollinator species	~500 unique species	618 unique species	
A comprehensive list of pollinator species in the area	Unspecified in our proposal	813 total taxa (including subspecies and varieties), 78 families, 539 genera, 783 species	This is easily tallied using the SCAN database
Publish Collections metadata	29,880 specimens	27,189 specimens	
Develop web site as a guide to viewing collections data	1 companion website	1 companion website	We will add details to the website over time as we publicize and disseminate results from data analysis
Present results regionally and nationally to groups and at conferences	Unspecified	1 presentation to UCSC research community and 1 presentation to California Native Plant Society	We still need to present at conferences and to the local Land Trust
Train graduate and undergraduate students in curatorial skills	Unspecified	20 undergraduate students and 1 graduate student	We continue to train new students to work on other parts of Morgan's collection
Sponsor undergraduate projects that analyze data from Morgan Collections	Unspecified	5 undergraduate projects	
Proposed Activity	**Proposed Quantity**	**Actual Quantity**	**Explanation for any**

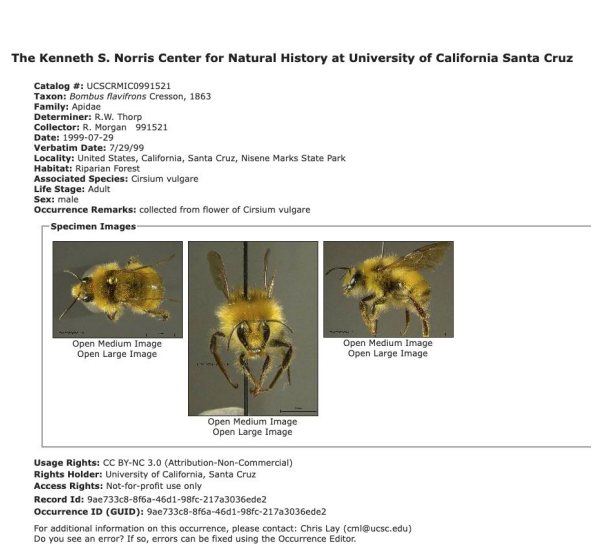
		Completed	difference
Share information about Morgan Collection to private landowners	Uspecified	2 private landowners	We plan to communicate with more in the coming year.
Collaborate with the Santa Cruz Museum of Natural History (SCMNH) and other museums to create curriculum and exhibit	Animal adaptations curriculum, pollinator exhibit at the California Academy of Sciences, and pollinator exhibit at Norris Center and SCMNH	Added to exhibit at Norris Center; sponsored pollinator-themed Art in Nature activities at SCMNH and California Academy of Sciences.	

Project Results:

Accomplishments

As listed in the above table, we largely succeeded in accomplishing the major tasks involved in re-housing, sorting, and digitizing the pollinator specimens within the Morgan Insect Collection. With the purchase of four new cabinets and associated drawers, the re-housing process was straightforward. Now, all of Morgan's collection are together in our collections room in tight-sealing drawers that are all the same drawer type. This has greatly improved our long-term stewardship of the collection and made it much easier to sort the collection as we continue to identify new taxonomic groups. The data digitization process took the most time out of any of the tasks associated with our project. We received timely guidance and feedback from our partners at Northern Arizona University who manage the SCAN database. Our 2-part specimen data upload process was successful and has allowed us to continue adding specimen records from other non-pollinator groups to the SCAN database in an efficient seamless manner. Our dissemination and publicity of Morgan's pollinator records involved sponsoring undergraduate projects, creating a companion website, giving public talks, and creating online resources about the Morgan Collection and local pollinator groups. Our intention is to continue sponsoring projects, add more resources about Morgan's collection and project results to our website, and to present our findings to more local stakeholder groups.

Images: Top left is a screenshot of one of our records on the SCAN database; top right is one of our new cabinets. Below are three of our undergraduates who helped with data transcription



The Kenneth S. Norris Center for Natural History at University of California Santa Cruz

Catalog #: UCSCRMIC0991521
Taxon: *Bombus flavifrons* Cresson, 1863
Family: Apidae
Determiner: R.W. Thorp
Collector: R. Morgan 991521
Date: 1999-07-29
Verbatim Date: 7/29/99
Locality: United States, California, Santa Cruz, Nisene Marks State Park
Habitat: Riparian Forest
Associated Species: Cirsium vulgare
Life Stage: Adult
Sex: male
Occurrence Remarks: collected from flower of Cirsium vulgare

Specimen Images

Open Medium Image
Open Large Image

Open Medium Image
Open Large Image

Open Medium Image
Open Large Image

Usage Rights: CC BY-NC 3.0 (Attribution-Non-Commercial)
Rights Holder: University of California, Santa Cruz
Access Rights: Not-for-profit use only
Record Id: 9ae733c8-8f6a-46d1-98fc-217a3036ede2
Occurrence ID (GUID): 9ae733c8-8f6a-46d1-98fc-217a3036ede2

For additional information on this occurrence, please contact: Chris Lay (cml@ucsc.edu)
Do you see an error? If so, errors can be fixed using the Occurrence Editor.

Unanticipated Circumstances

Our biggest challenges were losing two of our important taxonomic specialists during the grant period. Randall Morgan himself unfortunately was sick for much of the grant period and passed away in June 2017. Because we learned soon after the grant was awarded that he had a terminal illness, we spent considerable time before his death (often in the hospital) extracting as much additional information as we could from him. Despite this effort, there was some information that we were unable to get from him, either because we did not think to ask him or that we did not encounter until after his death. The main information we were unable to resolve centered around some of his collection locations and the exact collection date of specimens he collected during the first two years of his collecting effort. Fortunately, the number of specimens that we were unable to resolve was small relative to his entire collection. Morgan was also going to help with butterfly and moth identifications, but his illness prevented him from doing that. Fortunately, before he fell sick, he met a local lepidopterist, Max Klepikov, who helped us immensely. Through both paid and volunteer time, Dr. Klepikov identified nearly all of our lepidoptera specimens to the species level and took the time to sort,organize, and label them in our collection.

In addition, our bee expert Robbin Thorp also fell sick later in the grant period and eventually passed away in Fall 2018. Because we didn't know Robbin as well and because he lived in a different area, it was difficult to communicate with him. This led to a significant delay in getting

a number of our bee specimens identified. Many of those specimens are still unidentified and are currently with Dr. Terry Griswold at the USDA bee lab in Logan, Utah. We are hoping to get these bees back soon. Once we get them back, it will be very straightforward to add taxonomic information to each skeletal record that has already been uploaded to the SCAN database.

Lessons Learned

- We gained a sophisticated understanding of how Symbiota-based online databases work. We have been able to immediately apply this new familiarity toward continuing to digitize more insect data from Morgan's collection. We also were able to apply this knowledge to our plant collection, which is now also using a Symbiota-based online database.
- We learned how to provide a meaningful and successful internship experience for the many students that worked on this project. This included developing a "crash course" in insect taxonomy, empowering student teams to take on big tasks and solve problems as they arose, and enriching the student experience through participating in public outreach events (such as open houses and exhibits at other community museums).
- We were slightly too ambitious proposing outreach projects and collaborations that we could realistically complete within the timeframe of the grant. We have yet to create a primary-school field trip curriculum module focused on pollinators and create a full public exhibit about the Morgan Pollinator with the Santa Cruz Museum of Natural History. We still plan to give presentations to several more local conservation organizations, including the Land Trust of Santa Cruz County. In a future grant similar to this one, we would focus on fewer projects and collaborations and ensure that we communicate as early as possible with our stakeholders in order to ensure our ability to co-sponsor events.

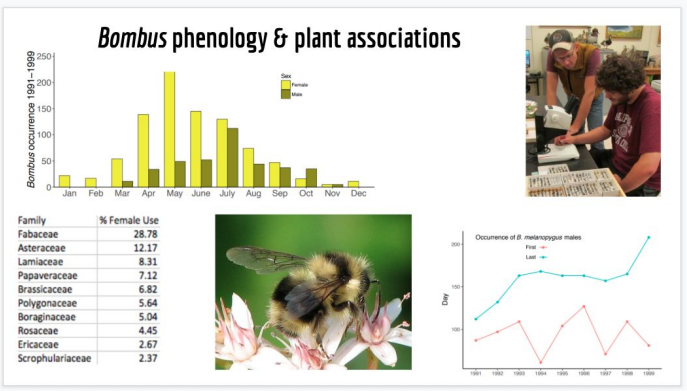
Outcomes

The Norris Center staff are now very familiar with the Symbiota database platforms and the iDigBio project. We have already translated that skill into helping manage our plant collections, which are now also managed on a Symbiota platform. It is very likely that we will soon do the same for our fungi collection. We are much more knowledgeable about pollinator taxonomy. The Norris Center Director was able to take the "Bee Course" in Arizona, which greatly facilitated his ability to identify bees to the generic level. Our graduate student, who was mainly focused on syrphid and bombyliid taxonomy, also trained and helped us sort out family and sub-genera of many other groups, including sphecid, vespid, and pompilid wasps; the skills he gained in insect taxonomy and student mentoring will benefit him in his future career. Finally, this project has catalyzed many other training opportunities for undergraduate students. These projects include ongoing specimen digitization, analysis of Morgan's data, and participating in insect re-surveys at some of Morgan's collection sites. Currently (Fall 2019 and Winter 2020), we have students working on other parts of Morgan's collections, including coleoptera (beetles) and odonata (dragonflies and damselflies), we have several students doing insect surveys, and have our sixth student starting a senior thesis on Morgan's collections.

Impact

The Norris Center is committed to long term stewardship, preservation, and access to its collections. Our collections are now widely accessible for research and teaching. This project has greatly helped demonstrate this commitment to our community both on and off campus. As a result, faculty and our upper administration are seeking us out more and supporting us as a growing resource on campus. In the broader community, more people and organizations have been giving us their collections for long-term preservation. Work on this grant helped spur our larger donor community to help us create the Morgan Initiative (see more on this below). Many presentations, projects, field guides, exhibits, and public events to engage broader community have and will continue to result from our work on Morgan's collections.

Images: Top: an exhibit about Randall Morgan that we added to during the grant period. Bottom-a slide from a presentation about bumblebee natural history based on data from Morgan's collection



What's Next: *describe any plans to continue work in this area and/or sustain the benefit of this project beyond this grant's end date*

This project helped catalyze a larger effort to create the Randall Morgan Initiative (RMI) at the Norris Center. The goals of the RMI are to honor, preserve, and build upon the legacy of Morgan's work as a local naturalist and conservationist. The RMI provides ongoing funding for long-term stewardship of Morgan's collections and affords UCSC students the opportunity to develop their natural history skills and participate in local species and habitat conservation efforts. Specific ongoing goals include specimen identifications (particularly of groups where little is known past the genus level, such as syrphidae), digitizing more of Morgan's collection and observational data, training students and researchers in collections stewardship and field survey methods, and promoting education and conservation of local species and ecosystems.

Grant products:

One tangible product that has resulted from this project is a new local field guide to common fly species in the syrphidae, an important and often overlooked pollinator group. This project was a collaborative effort that involved using the newly identified and digitized syrphid specimens completed as part of this project. In consultation with two local fly experts, our graduate student Andy Kulikowski successfully sorted and identified all 3,430 syrphid specimens in Morgan's collection. Our team of undergraduates imaged one representative specimen for each species and uploaded all specimen metadata to the SCAN database. Then, one of our enthusiastic undergraduate students, Jessica Correa, a first generation Latina student, focused her senior thesis project on creating a field guide to local syrphids found in the Santa Cruz area. Her project consisted of writing a literature review focused on the natural history of syrphid flies, creating a field guide to all common local syrphid genera, and presenting her findings to the local chapter of the California Native Plant Society. Due to the expertise Jessica developed working on this project, we later hired her to help curate other parts of the Morgan Insect Collection and supervise a team of students surveying the insects at one of our natural reserves. Although now graduated, Jessica still volunteers occasionally in the Norris Center, helping us with collecting and identifying insects and mentoring other students following in her footsteps, while she makes plans for attending graduate school. Like many other students we have mentored, we have developed a lasting connection with her. We look forward to advising her on future career and academic paths as well as relying on her as an alumni resource to help mentor our current students as they make the post-college transition.

Five additional students have already completed research projects using Morgan's collection. These include:

Michelle Pastor (Environmental Studies, 2018) wrote a biography about Morgan and created 4 illustrations that depict his contributions to Santa Cruz natural history and conservation.

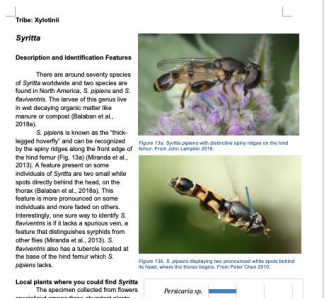
Daniel Simoni (Environmental Studies, 2018) studied emergence patterns and plant associations with various bumblebee species (Bombus spp.). Daniel was able to closely track the behavior (emergence, reproduction and feeding) of male and females of multiple bumblebee species using Randy's detailed data.

Jesse Laine (Ecology and Evolutionary Biology, 2018) examined bumblebee community dynamics over the 10 years that Randy sampled bumblebees in Santa Cruz County. He looked at temporal changes in bee richness as well as changes in the network of plants visited by these important pollinators.

Alexandra Ahmad (Environmental Studies, 2019) summarized how lycaenid butterfly diversity had changed over the 10 years that Morgan collected insects in Santa Cruz.

Jessica Correa (Environmental Studies, 2019) used the Morgan's collection to create a field guide to local species in the Syrphidae, an important fly pollinator family.

Images: Left- Jessica at her public presentation about syrphid flies; Right- a page from Jessica's field guide to syrphids in Santa Cruz.


Tribe: Xylotinii

Syritta

Description and Identification Features

There are around seventy species of *Syritta* worldwide and two species are found in North America, *S. pipiens* and *S. flaviventris*. The larvae of this genus live in wet decaying organic matter like manure or compost (Balaban et al., 2018a).

S. pipiens is known as the "thick-legged hoverfly" and can be recognized by the spiny ridges along the front edge of the hind femur (Fig. 13a) (Miranda et al., 2013). A feature present on some individuals of *Syritta* are two small white spots directly behind the head, on the thorax (Balaban et al., 2018a). This feature is more pronounced on some individuals and more faded on others. Interestingly, one sure way to identify *S. flaviventris* is if it lacks a spurious vein, a feature that distinguishes syrphids from other flies (Miranda et al., 2013). *S. flaviventris* also has a tubercle located at the base of the hind femur which *S. pipiens* lacks.

Figure 13a. *Syritta pipiens* with distinctive spiny ridges on the hind femur. From John Lamplish 2016.

Figure 13b. *S. pipiens* displaying two pronounced white spots behind its head, where the thorax begins. From Peter Chen 2015.

Local plants where you could find *Syritta*

The specimen collected from flowers

Persicaria sp.