CHALLENGES AND EMERGING SOLUTIONS TO BUILDING SCIENTIFIC CONTRIBUTIONS BASED ON DIGITIZATION OF FLOWER VISITOR COLLECTION DATA

HILARY SWAIN & MARK DEYRUP

Photo by Reed Bowman

ARCHBOLD BIOLOGICAL STATION

History behind the Collection at the Archbold Biological Station

Founder: Richard Archbold, with his 1920s-30s experience of organizing the Archbold Expeditions to Madagascar and New Guinea with the American Museum of Natural History, believed that long-term ecological investment in a site required continual survey of the local species and their natural history, and management of a reference collection. We would call this a biodiversity survey. This work began in the late 1940's after he established the Station

Multi-Taxon	Specimens	Species	Ecologist Curator	Databased	OnLine
Plants	**4,276**	1,388	**Eric Menges** Betsey Boughton	**4,276** (1,000 more TB added)	**4,276**
Bryophytes	**538**	200	**Eric Menges** Joannes A. Janssens	**80%**	
Pollen slides	**300**		Barbara Hansen	**100%**	
Arthropods	**258,000**	7,993	**Mark Deyrup**	**3.9%**	**~6,000**
Herptiles	**2,068**	100	**Betsie Rothermel** Butch Norden	**100%**	
Fishes	**2,248**	45	**Betsie Rothermel** Butch Norden	**90%**	
Birds	**2,007**	512	**Reed Bowman**	**100%**	
Mammals	**73**	30	**Reed Bowman**	**100%**	

270,000

The number of Florida plant, arthropod, bird, mammal, reptile, amphibian, and fish specimens in the Archbold Natural History Collection – one of the largest of any field station in the world.

Status of the ABS Collection is representative of many natural history collections reviewed by the Interagency Working Group on Scientific Collections (2009) and NSF (Skog et al. 2009)

- dearth of information available online
- limited interoperability of data with regional, (inter)national, collections.
- example of "dark data" by the collections community, i.e.
  - small institution without extensive IT expertise
  - no dedicated full-time curators (except entomology)
  - Lacking wherewithal to link their important regional collections to global networks (Billick et al. 2013, NRC 2014).

Digitizing the ABS Collection will enhance value……

I. **Reference:** Improve rapid on-site AND OFFSITE identification of plants & animals, including thousands of species of macroinvertebrates.

   A. **Enable community-level studies and other multi-taxon research.**

   B. Bypasses problem of decline in available taxonomic expertise

II. **Make Biodiversity documentation available**, record of on-site biodiversity.

   A. One of very few North American sites where on-site diversity of macroinvertebrates is known in detail. e.g. 1, 592 species of beetles.

   B. Biogeographic comparisons: e.g. bee fauna with far fewer species of *Andrena* than found in sites farther north.

   C. Track changes in biodiversity, arrival of new invasive species etc.

   D. Tie changes to other long-term environmental data

III. **Repository for voucher specimens for research** projects.

IV. Specimens often have **unexpected or novel uses beyond data on labels**.

   A. Genetic studies. (BUT challenges of linking to dispersed databases of blood and other tissue data collected at Archbold)

   B. U.V. patterns

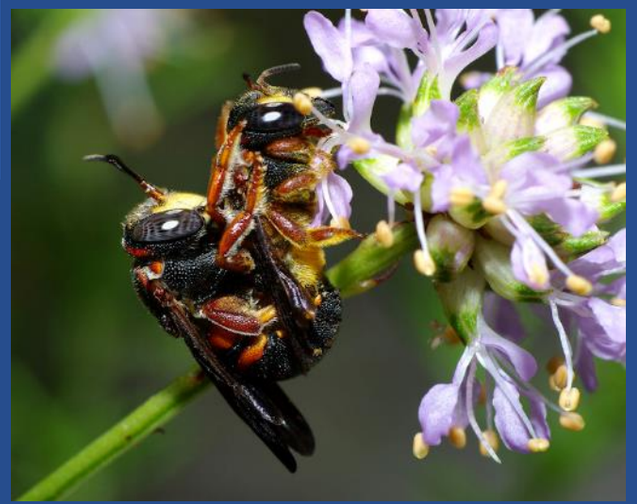
   C. Color, size, or structural polymorphisms, e.g. eumenine Vespidae

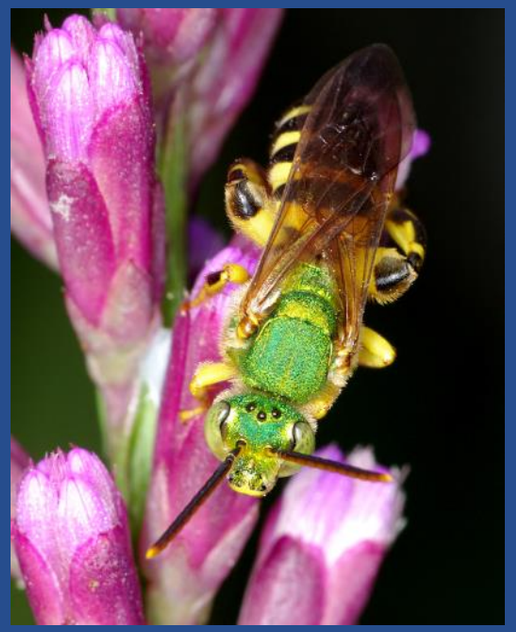
V. Not a teaching collection but use for **training research interns**







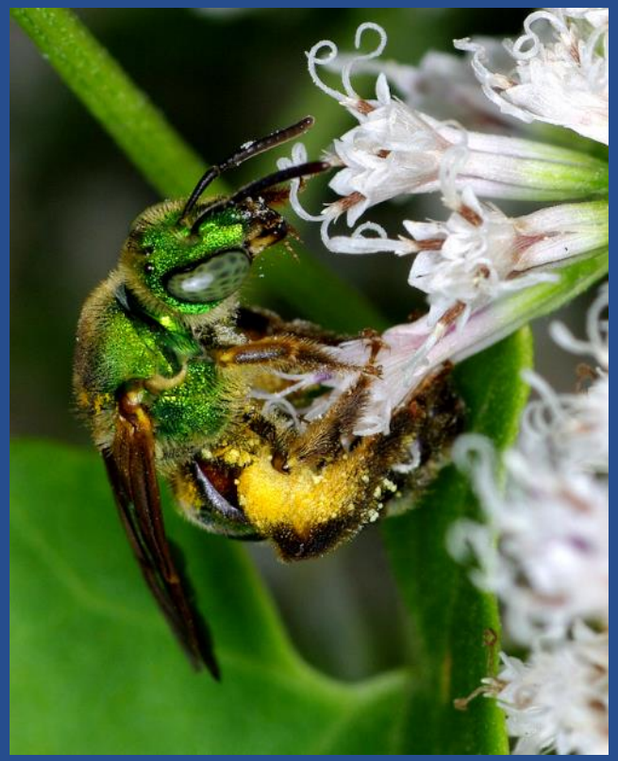












One Flower, Hundreds of Insects:
Saw Palmetto Flowers as an Ecological Nexus

Mark Deyrup and Leif D. Deyrup

Saw palmetto, *Serenoa repens*
common species, copious production of nectar and pollen should make it an important node in ecological network.

Goals:

1. **Document taxonomic diversity** of insects supported by nectar and pollen of saw palmetto at a single site.
2. Examine **how saw palmettos support invertebrate food webs**, including additional trophic roles (e.g. predator, parasite) by providing energy and nutrients.
3. **Characterize saw palmetto as a node in a flower-visitor network** by quantifying additional floral hosts.
4. Investigate **if there is a group of specialized insects dependent on saw palmetto flowers**, and if pollen-feeders (esp bees) more likely to belong to this group.

Saw Palmetto Flowers
Photo by Thomas Eisner

Who Is In the Network?

311 species of insects found visiting saw palmetto flowers at Archbold:

- **121 Hymenoptera**
- **117 Diptera**
- **52 Coleoptera**
- **21 Lepidoptera & miscellaneous orders**

Euphoria limbalis (Scarabaeidae).
Photo by P. Carmichael

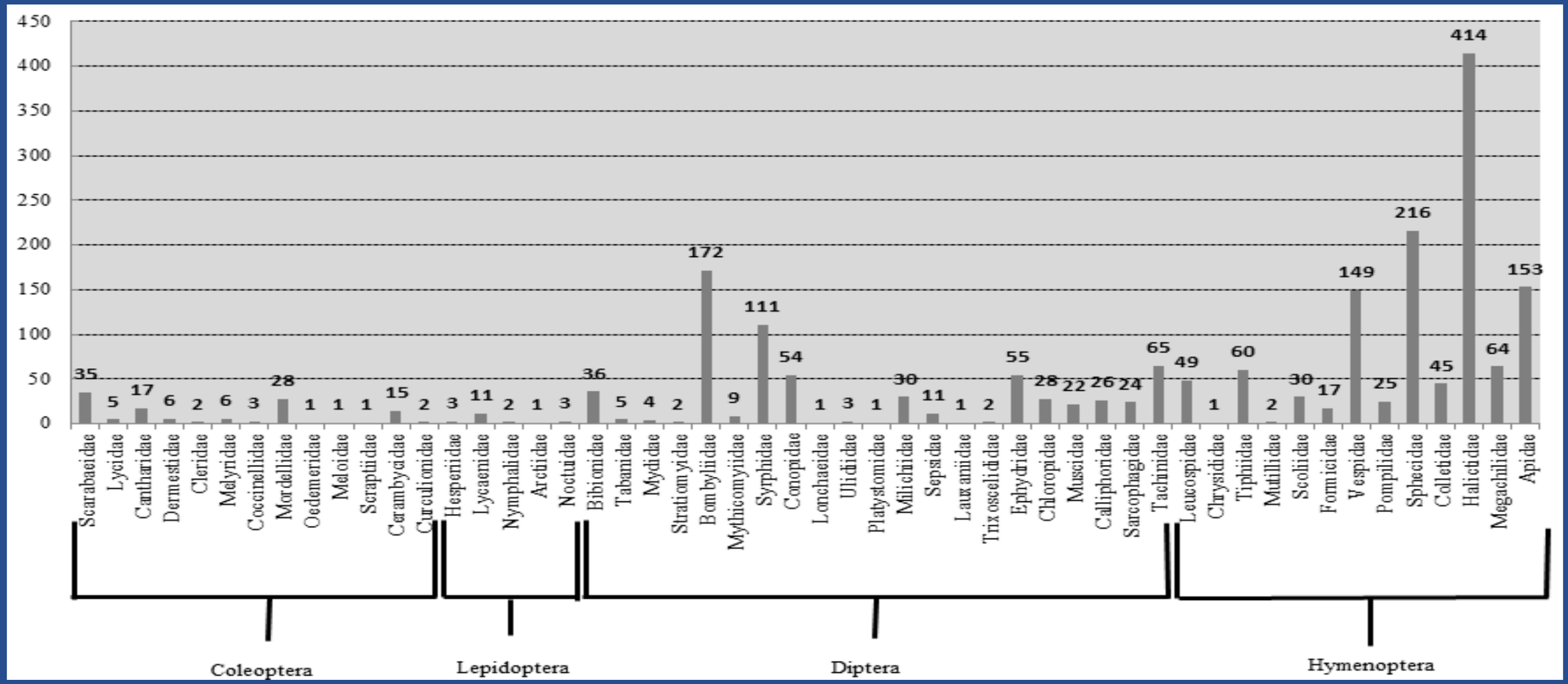
What Known Ecological Roles Are Fueled by Saw Palmetto Flowers at this Site?

- **158 predators**
- **47 phytophagous species**
- **52 decomposers**

Mydas maculiventris (Mydidae).
Photo by P. Carmichael

Interlocking Networks of Flower Visitors:

- Most of these insects visit flowers of other plant species at Archbold.
- Saw palmetto connected to other plants through its flower visitors
- Number of shared relationships of flower visitors involving saw palmetto is 2,029
- Might be competition for flower visitors, but certainly serendipitous relationship in mutual support of the flower visitor network. System resilient.



Conclusions

Insect Diversity:

Saw palmetto fosters insect diversity by providing resources to a minimum of 311 insect species.

Ecological Diversity:

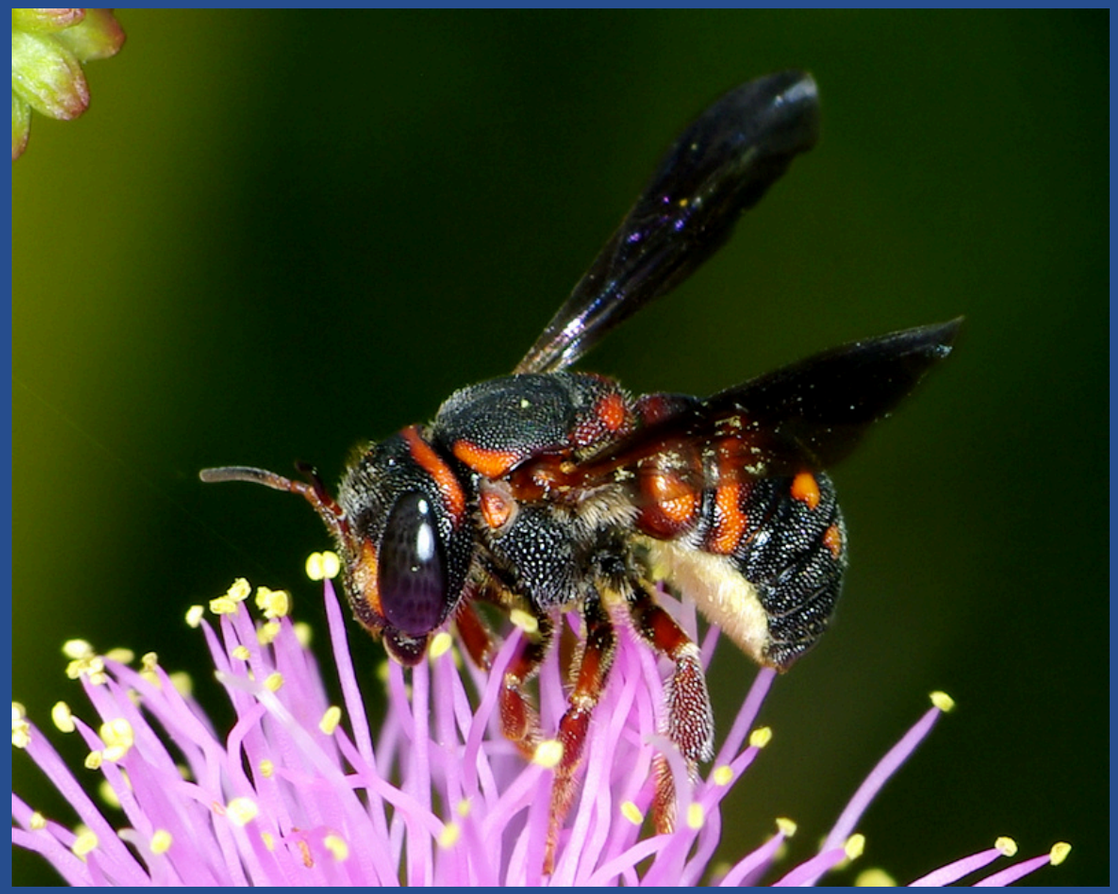
Saw palmetto fosters ecological diversity by fueling adult activities of an ecologically diverse group of insects.

A Glimpse of Normal Ecological Complexity:

Operational complexity of ecosystems can be accessed through study of specimens of flower visitors at a single site.

Further Analysis:

As this system becomes more accessible through digitization, it should be available for mathematical analysis.

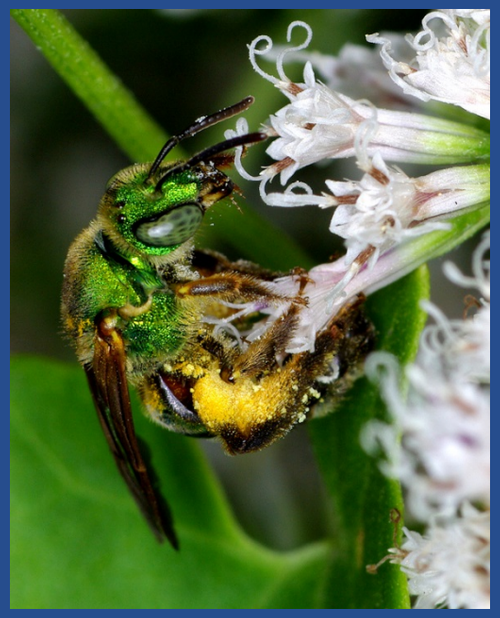


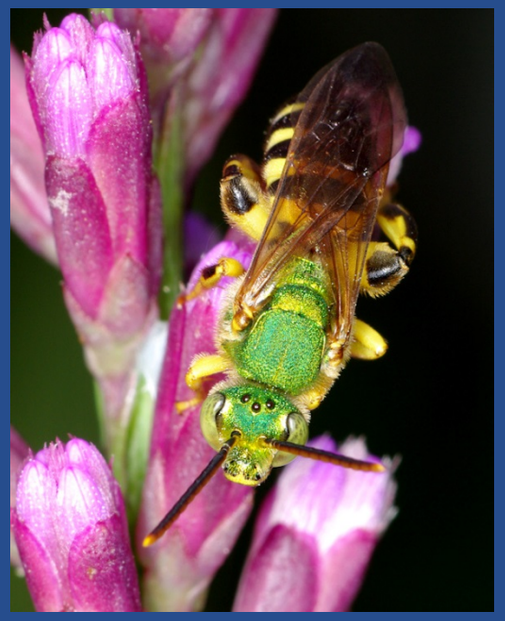
Flower Insect Visitors

Archbold collection has an estimated 10,000 insect specimens with flower visitor information on labels

Photos by Tim Lethbridge (Archbold Volunteer)

Challenges in Archbold's insect collection:





Agapostemon splendens
Photos by Tim Lethbridge (Archbold Volunteer)

OVERCOME

- Identified to species by experts
- Excellent curation (in taxonomic order in trays and Cornell cabinets)

REMAINING:

- <5% unique ID or barcode on specimens
- Few specimen label data digitized
- 272,000 specimens

~6,000 specimens with flower visitor data are currently entered in an excel file, 4,000 to go….

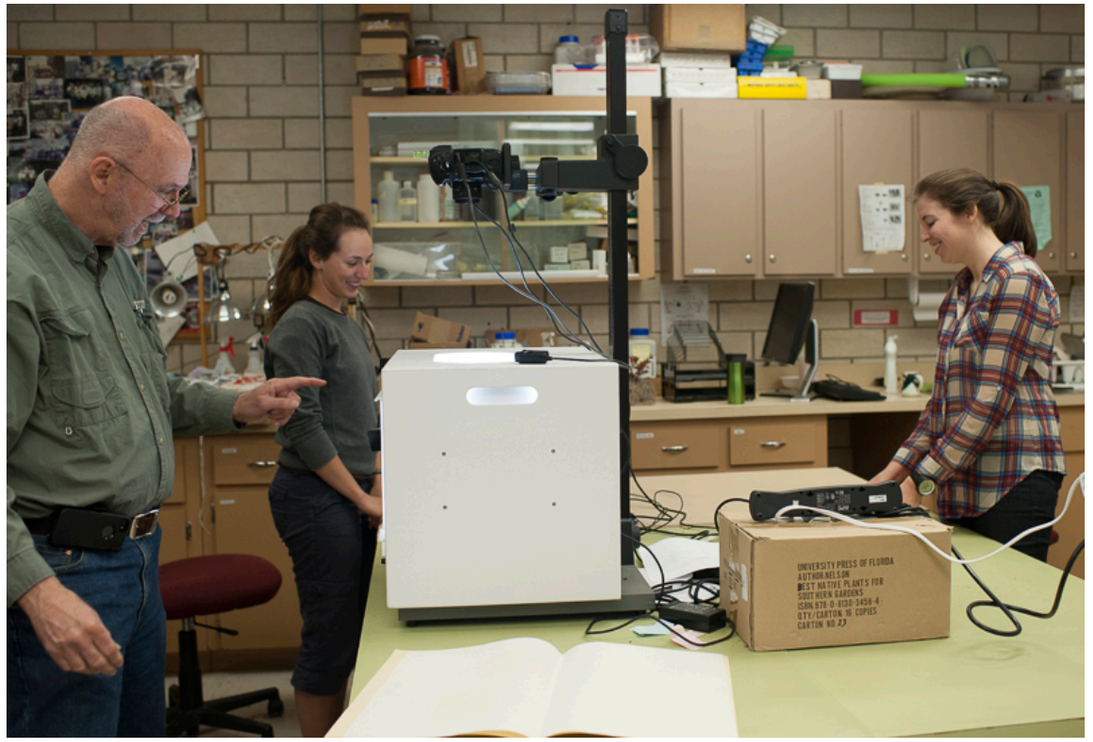
e.g. Bombyliidae visitors to *Bidens alba*

Bombyliidae	*Chrysanthrax*	*mira*	(Coquillett)	MD		*Bidens alba*	990826
Bombyliidae	*Exprosopa*	*fasciata*	Macquart	JC		*Bidens alba*	871009
Bombyliidae	*Exprosopa*	*fasciata*	Macquart	MD		*Bidens alba*	990826
Bombyliidae	*Exprosopa*	*fasciipennis*	(Say)	MD		*Bidens alba*	990826
Bombyliidae	*Geron*	*vitripennis*	Loew	MD		*Bidens alba*	990826
Bombyliidae	*Lepidophora*	*lepidocera*	(Wiedemann)	MD		*Bidens alba*	990902
Bombyliidae	*Poecilanthrax*	*lucifer*	(Fabricius)	AS		*Bidens alba*	830415
Bombyliidae	*Poecilanthrax*	*lucifer*	(Fabricius)	MD		*Bidens alba*	990903
Bombyliidae	*Poecilanthrax*	*lucifer*	(Fabricius)	MD		*Bidens alba*	20000317
Bombyliidae	*Poecilognathus*	*sp.*		AS		*Bidens alba*	830415
Bombyliidae	*Poecilognathus*	*sulphurea*	(Loew)	MD		*Bidens alba*	990903
Bombyliidae	*Systoechus*	*solitus*	(Walker)	MD		*Bidens alba*	990903

Photo by Tim Lethbridge

Calliphoridae	*Chrysomya*	*sp.*		MD		*Bidens alba*	*990902*
Conopidae	*Physocephala*	*sagittaria*	(Say)	MD		*Bidens alba*	*990902*
Conopidae	*Physoconops*	*bulbirostris*	(Loew)	MD		*Bidens alba*	*990918*
Conopidae	*Zodion*	*americanum*	Wiedemann	MD		*Bidens alba*	*990903*
Sarcophagidae	*Senotainia*	*trilineata*	(Wulp)	MD		*Bidens alba*	*20000317*
Syrphidae	*Copestylum*	*nigrum*	(Greene)	MD		*Bidens alba*	*830331*
Syrphidae	*Copestylum*	*nigrum*	(Greene)	AS		*Bidens alba*	*830418*
Syrphidae	*Copestylum*	*pusillum*	(Macquart)	AS		*Bidens alba*	*830420*
Syrphidae	*Copestylum*	*pusillum*	(Macquart)	MD		*Bidens alba*	*990826*
Syrphidae	*Palpada*	*furcata*	Wiedemann	MD		*Bidens alba*	*990907*
Syrphidae	*Palpada*	*furcata*	Wiedemann	MD		*Bidens alba*	*990918*
Syrphidae	*Palpada*	*pusilla*	(Macquart)	MD		*Bidens alba*	*990826*
Tachinidae	*Prosenoides*	*flavipes*	Coquillett	MD		*Bidens alba*	*990826*
Tachinidae	*Prosenoides*	*flavipes*	Coquillett	MD		*Bidens alba*	*20000626*

Other insect visitors to *Bidens alba*



iDigBio Weekend Digitization Blitz Yields 4,276 Specimen Images for Archbold Biological Station

http://nansh.org/portal/collections/index.php

Status of databasing: herbarium OnLine

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Photo by Tim Lethbridge

NEXT STEPS

Just awarded NSF funding: Collections in Support of Biological Research (CSBR):

Databasing and imaging specimens to make data internet-accessible with www-based portals.

- Emphasis will be on the arthropods:
  - Arthropod holdings list (8,000)
  - Flower-insect visitors (6,000 done, + 4,000)
  - Ants (database 50,000 of 120,000)
  - Scrub endemics (900 done, +~500)
  - Dead wood insects (~5-6,000)
- Vertebrates
  - Birds, mammals, herptiles, fishes
- Herbarium
  - Bryophytes

Partner with iDigBio to effectively database, image and migrate specimen data to the internet. Symbiota-linked portals will be linked to the ABS website. Specify for multi-taxon approach. New Assist. Curator position.

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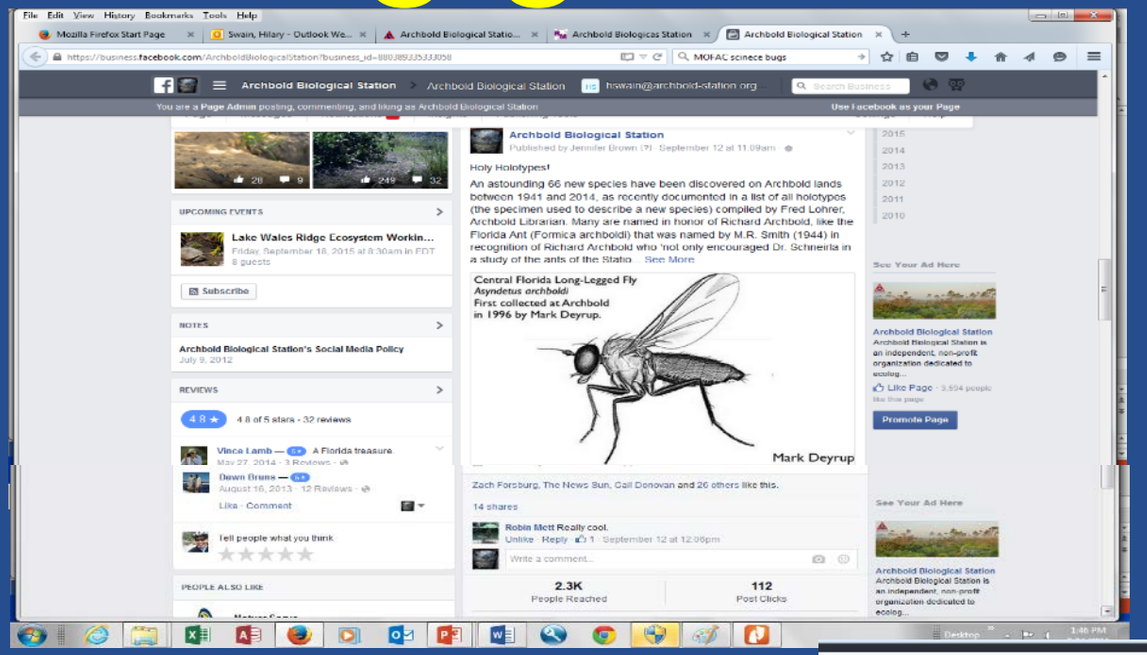
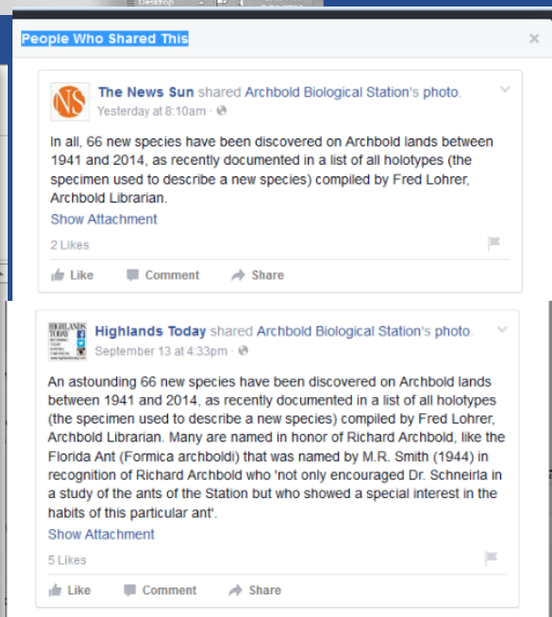
Challenges ahead we want to solve

- Imaging protocols for varied collection materials from eggs to boxes of bugs, to wet collection herptiles (today at workshop)
- Most taxa in Archbold collection will be straightforward to link to existing portals (herbarium, VertNet, etc) EXCEPT for the 252,000 arthropods, few to no obvious global portals
- We have a multi-taxon collection with some need for many-to-many linkages for ecological analyses
  - ✓ we don't want to maintain a web portal just linkages—hard work to make searchable, not that visible globally
  - ✓ even if there were global portals for all our taxa, global portals do not have many-to-many capacity
  - ✓ *Specify* can provide one on-site database, but they will need new queries for taxa to taxa linkages (per Jim Beach)
  - ✓ Just extract and create e.g. Access database for flower insect visitors and post it? How link specimen data back to this?
  - ✓ Can we also tag specimen data so users know ancillary environmental data may be available. More data exists!
- Realtime automated updating/entering new records w/portals

Outreach and public engagement….





closing thoughts …..

oto by Tim Lethbridge