March 2002

# The diversity and floral hosts of bees at the Archbold Biological Station, Florida (Hymenoptera: Apoidea)

Mark Deyrup
*Archbold Biological Station, Lake Placid, FL*

Jayanthi Edirisinghe
*Department of Zoology, University of Peradeniya, Peradeniya, Sri Lanka*

Beth Norden
*National Museum of Natural History, Smithsonian Institution, Washington, DC*

# The diversity and floral hosts of bees at the Archbold Biological Station, Florida (Hymenoptera: Apoidea)

Mark Deyrup
Archbold Biological Station
P.O. Box 2057
Lake Placid, FL 33862

Jayanthi Edirisinghe
Department of Zoology, University of Peradeniya
Peradeniya, Sri Lanka

Beth Norden
Department of Systematic Biology
Entomology Section, MRC – 188
National Museum of Natural History
Washington, D.C. 20560

**Abstract**. A list is provided of 113 species of bees and their 157 known floral hosts at the Archbold Biological Station(ABS), a 2105 ha site on the Lake Wales Ridge in Highlands County in south-central Florida. This is more species than might be expected at a single site so far south in Florida, based on previous studies in the Miami area and Everglades National Park, but fewer species than would be expected in an upland area of similar size with open habitats in north Florida, the mid-Atlantic states, or the upper Midwest. The small size of the fauna might be correlated with the absence of species that require a cold period in their life cycle, those that require clay or other heavy soils, those that require mesic woodlands and those that require abundant host plants in certain groups that are poorly represented on the ABS, such as Rosaceae. The natural history of southeastern bees is not known in enough detail to ascribe these causes to the individual species that are missing from the ABS fauna. In terms of bee taxa, the relatively small diversity at this site can be mainly attributed to a very poor representation of the genus *Andrena* (3 species), a poor representation of the genus *Lasioglossum* (13 species), and a poor representation of the entire family Apidae (22 species).

The bee fauna of the ABS is mostly composed of species that occur (or may be expected to occur) through much of the southeastern Coastal Plain, combined with species that are widely distributed in eastern North America. In addition to these elements, there appear to be at least a few species or populations that may be relics of the dry savannahs that stretched across southern North America in parts of the Pleistocene or in the late Pliocene. There is only one species that appears to have come up from tropical Florida or the West Indies.

There is no evidence that there are plants that are dependent on single bee species at the ABS, but certain buzz-pollinated plants may rely on only a few species of *Bombus*. A few species of bees appear to be oligolectic; their host plants, however, are visited by a wide variety of bees and other insects.

Bees at the ABS belong to four conspicuous mimetic complexes: metallic green; black with a red abdomen; black with red bands and spots; black with yellow bands and spots. Most ABS bees do not have any warning coloration that is conspicuous to human eyes.

There is only one exotic bee on the site, the European honey bee. This lack of a large exotic component in the fauna contrasts with the situation in the ants, of which about one fourth are introduced. Honey bees are often extremely abundant, and possibly dominate nectar and pollen resources in ways that are disruptive to native bees. Although it is easy to observe individual honey bees displacing individual native bees on flowers, there are no data on the ecological effects of honey bees on native pollinators at the ABS.

About one quarter of the bee species (26) are parasitic species that depend on other species to gather nectar and pollen. This proportion of parasitic species is similar to some other well-studied sites in temperate North America, and is higher than the proportion found in tropical areas.

## Introduction

To make a survey of bees at any site requires only dedication and a certain degree of knowledge. Published site surveys of bees, however, are rare: there are only a few other published attempts to list all the bees of a single site in North America. There are some good reasons for this. 1. Since every site differs in its ecology from every other site, a site list is site specific, and may not have much predictive

value for another site that has different habitats. 2. Site lists are an open-ended enterprise. Every site could have its own list of everything, but the effort that this would require would be impossible in a practical sense. When are site lists worth the effort? There is no rule for answering this question; it depends on the situation. 3. The production of site lists of insects is an old-fashioned activity, requiring little in the way of modern technology, and much in the way of characteristics that are in eclipse in modern science: a dedication to field natural history, the ability to identify large numbers of species, and a willingness to remain in one place for a series of field seasons. 4. It is difficult to decide when a survey is sufficiently complete for publication; more species continue to be found year after year, including common species that were overlooked until an understanding of their natural history made them easy to find.

There are, however, compensating factors that make it worth the effort and expense to produce and publish this list of bees from a single site. 1. Biological diversity is an abstract concept until it is seen operating in ecological communities. There are more than 700 species of bees in the eastern United States (Mitchell 1960, 1962), but many of these species never encounter each other. When more than 100 species are found in a single site, however, one is forced to consider whether all these bees have a multitude of different functional roles. 2. Site lists are useful for biogeographic analysis and comparative community ecology. Such studies help explain patterns of distribution and diversity, and can also help guide management in a world that is increasingly managed by our species. The scientific literature could, in theory, become overwhelmed by innumerable site lists for bees and other organisms, but such lists are rare, to the point that it is difficult to find site lists to compare for biogeographic analysis or for comparative community ecology. Since there are only a few site lists for bees in North America, our discussion and analysis of this list is largely speculative. The pioneer finds many novelties, but has few explanations. 3. Site lists, especially annotated site lists, add bits of natural history information to our knowledge of the species in the list, in this case, both bees and plants. 4. Site lists of various organisms serve as baseline studies in a world that is rapidly changing. Without these lists, it is difficult to track the comprehensive effects of destruction, degradation and fragmentation of remaining natural areas. Most sites in natural areas in temperate North America have many species of bees, so bees provide many data points. Bees are likely to be sensitive to changes in the physical habitat (e.g., whether a site is open or forested) as well as to presence or absence of certain plants and the prevalence and type of chemical insecticides. Bees are especially useful as an example of a group that is both diverse and resilient, judging by a recent inventory of bees in Carlinville, Illinois after an interval of 75 years (Marlin and LaBerge 2001). 6. It is relatively easy to work with bees. The bee fauna, especially in eastern North America, is relatively well known, and Mitchell (1960, 1962) has provided a manual for eastern bees that covers the great majority of species. Since almost all bees, even most of the parasitic species, visit flowers, it is relatively easy to collect bees, including some of the rarer species. 7. Since bees are important pollinators of certain flowers, bees are ecologically significant, not only as indicators, but in their own right.

## Methods and materials

The Archbold Biological Station (ABS) is a private institution with about 5000 acres (2100 hectares) of natural habitats. The soil is acidic and low in nutrients; it is almost pure sand except for organic matter in the form of partially broken down leaf litter in upland sites and muck sediments in seasonal ponds. All the habitats burn periodically, some more frequently than others. Many plants respond to burning by profuse flowering. Major habitats are: 1. Florida scrub, a shrub community dominated by dwarf oaks, Ericaceae and short palmettos, sometimes with an over story of pine. Scrub areas remain dry during the rainy season, and tend to burn at about 15 to 50 year intervals. 2. Pine flatwoods, open areas with short shrubs, palmettos, and many species of herbaceous plants; usually there is a sparse over-story of pines. Many flatwoods areas flood occasionally during the rainy season. They tend to burn at about 5 to 15 year intervals. 3. Seasonal ponds are open, with grasses, sedges, and various herbs. Shrubby St. John's Worts (*Hypericum* spp.) occur in many ponds. Seasonal ponds are highly flammable when dry, and can potentially burn every few years. 4. Sandhill has a sparse over-story of pines and a more or less dense ground cover of grasses and herbs, with scattered clumps of shrubs and palmettos. This habitat is maintained by fires at about 3 to 15 year intervals. 5. Bayheads occur in wet areas that have escaped burning for about 25 years or more, and are densely

shaded by large pines, several species of evergreen broadleaf trees and vines that have grown up into the canopy. 6. The fire lanes that cut through the various natural habitats are another habitat type. Their regular maintenance can provide elevated population levels of annual herbs that are more normally found in open patches of the various habitats that the fire lanes traverse. For more detailed descriptions of the habitats of the Archbold Biological Station see Abrahamson et al. (1984). Habitats that occur at the latitude of the Archbold Biological Station in Florida, but are not represented on the station include: cypress swamps, marshes, wet and dry prairie systems, flood plain and corridor forest, coastal beaches, mangroves and coastal subtropical forest.

The climate is transitional between warm temperate and subtropical. The temperature may drop below 0°C several times during the winter, but only for a few hours, and sheltered microhabitats are frost-free. Mean rainfall is 135.1 cm (53.2 in) annually, most of which falls between late May and mid-October. Summers are hot and wet, winters are cool and dry, with the dry season stretching through the spring, when drought stress is generally the greatest. Rapid percolation of water through the sand accentuates the severity of the drought conditions during the dry season. Many of the upland plants have drought adaptations, but flushes of growth and flowering are not usually directly dependent on recent rains, as they often are in desert regions of southwestern North America.

Collecting bees and records of floral hosts has been a long-term effort. Most specimens were collected on flowers or in Malaise traps. The survey took advantage of knowledge of the site and of the habits of particular bee species to collect as many bee species as possible. For example, a special effort was made to look for bees on *Nuphar lutea* (L.) (Small) because oligolectic bees are known to occur on this plant. The survey was not designed to be replicable by inexperienced investigators at other sites.

All records cited in this survey have associated voucher specimens. The great majority of the specimens are in the arthropod collection of the Archbold Biological Station, but some are in the Florida State Collection of Arthropods in Gainesville or the National Museum of Natural History in Washington, DC. Identifications are by the authors and a number of specialists who are listed in the acknowledgment section below. The outside identifiers are also included in the species accounts.

## Annotated list of bees

The following list treats families in the same order as they appear in Hurd (1979). Genera and species are alphabetical under the families. Nomenclature generally follows Hurd (1979). Nomenclature of genera of Halictidae follows Moure and Hurd (1987) in order to avoid confusion, as it is not always clear which species will be placed in which subgenera of *Lasioglossum*. Family classification follows Michener (2000). Records of flower associations do not always refer to pollen gathering. No attempt was made to match the pollen found on a bee with that of a particular plant. Letters (f, m) after the plant name refer to the sex of the bees found on that flower; numbers refer to the number of specimens. Plant nomenclature, English names of plants, and designation of plants as native or exotic in Florida follow Wunderlin (1998), except as noted. Author names of plants appear in the cross-reference list of plants.

## COLLETIDAE

*Caupolicana* sp.
**Flowers:** *Dalea feayi* (1m), *Dicerandra frutescens* (1f,1m), *Trichostema dichotomum* (1m). This species was seen robbing nectar by using the labrum to slit the corolla of *D. frutescens* and unopened buds of *T. dichotomum*. Many additional specimens were seen, but not collected, on flowers of *Dicerandra frutescens*, *Trichostema dichotomum*, and a few on *Seymeria pectinata*. This appears to be a rare species confined to Florida scrub habitat. It is a large, conspicuous species, active in both morning and evening, and the scarcity of specimens in collections indicates that it is truly a rare species (Deyrup 1994). Pollen hosts at the ABS are unknown, and the females we have collected were not carrying pollen. ABS records: Sept.

*Colletes banksi* Swenk
**Flowers:** *Ilex glabra* (21f, 21m), *Serenoa repens* (1f, 1m), *Lyonia fruticosa* (1m), *Persea borbonia* (1m). Most females on *Ilex* were carrying pollen; this is a probable pollen host. The female on *Serenoa* was not carrying pollen. One male was prey of *Mallaphorina clausicella* (Macquart) (Diptera: Asilidae). ABS records: Mar.– May.

*Colletes brimleyi* Mitchell
**Flowers:** *Ilex glabra* (1f), *Persea borbonia* (10f, 4m), *P. humilis* (1f), *Quercus laurifolia* (1f), *Q.*

*myrtifolia* (1f), *Quercus* sp. (1f), *Serenoa repens* (1f, 3m). No females with filled scopae were taken on any hosts. Females often occur on oak catkins, where they are presumably gathering pollen. The pollen of oaks is composed of small grains that do not clump easily, so it is possible that the scopae may shed their pollen when the bees are captured. ABS records: Feb. – May.

*Colletes distinctus* Cresson
**Flowers:** *Xyris elliottii* (1f). ABS records: Mar, June.

*Colletes latitarsis* Robertson
We know of only two ABS specimens (Malaise trap). ABS records: Apr.

*Colletes mandibularis* Smith
**Flowers:** *Aralia spinosa* (1m), *Baccharis halimifolia* (1f, 3m), *Eryngium cuneifolium* (4f, 12m), *Euthamia caroliniana* (1f, 2m), *Garberia heterophylla* (1f, 1m), *Hyptis verticillata* (1f), *Ilex glabra* (12f, 2m), *Melilotus albus* (1m), *Pityopsis graminifolia* (1f), *Polygonella basiramia* (2m), *P. gracilis* (1f, 4m), *P. polygama* (1f, 1m), *P. robusta* (1f, 3m), *Rhus copallina* (1f, 1m), *Serenoa repens* (5f), *Solidago fistulosa* (1m), *S. odora chapmanii* (2m), *Syngonanthus flavidulus* (6m). Many of the females taken on various hosts have full scopae; this is appears to be a polylectic species at the ABS. It flies in spring and fall; there are no records for June and July. A female in the ABS collection was identified by Roy R. Snelling. ABS records: Feb. – May, Aug. – Dec.

*Colletes nudus* Robertson
**Flowers:** *Hypericum fasciculatum* (1f), *Ilex glabra* (2f, 2m), *Parthenocissus quinquefolia* (4f, 2m), *Persea borbonia* (1f, 2m), *P. humilis* (2m), *Serenoa repens* (2m). No females have full scopae. A male in the ABS collection was identified by Charles Porter. ABS records: Apr. – June.

*Colletes productus* Robertson
Five specimens collected in Malaise traps. ABS records: May.

*Colletes simulans* Cresson
**Flowers:** *Baccharis halimifolia* (5m), *Euthamia caroliniana* (2m). ABS records: Sept. – Oct.

*Colletes thysanellae* Mitchell
**Flowers:** *Baccharis halimifolia* (7f, 13m), *Euthamia caroliniana* (13f, 9m), *Hyptis verticillata* (1m), *Palafoxia feayi* (1f), *Pityopsis graminifolia* (1f), *Polygonella gracilis* (3m), *Solidago fistulosa* (16m). Females with full scopae on *Euthamia, Baccharis,* and *Palafoxia.* At the ABS this is a fall species that is associated with Asteraceae. ABS records: Sept. – Oct.

*Colletes* sp. A
**Flowers:** *Eryngium cuneifolium* (1f), *Hypericum reductum* (1f), *Licania michauxii* (1f), *Lyonia fruticosa* (3m), *Polygonella robusta* (1f), *Serenoa repens* (3f). ABS records: Dec., Apr. – May, Sept.

*Colletes* sp. B
**Flowers:** *Bumelia tenax* (1f, 2m). ABS records: May.

*Hylaeus confluens* Smith
**Flowers:** *Agalinis filifolia* (1f), *Aralia spinosa* (1f), *Eriocaulon decangulare* (3m), *Euthamia caroliniana* (2f), *Hypericum edisonianum* (1f), *H. reductum* (3f), *Ilex cassine* (3f, 1m), *Parkinsonia aculeata* (1f), *Polygonella robusta* (3f, 2m), *Prunus angustifolia* (1f), staminate flowers of *Salix caroliniana* (7f, 1m), *Syngonanthus flavidulus* (1f, 1m). Specimens were taken at honeydew produced by *Cinara* sp. aphids on *Pinus clausa* (1f, 6m). A male was found collecting nectar at a flower of *Vaccinium myrsinites* from which the corolla had recently dehisced. ABS records: Jan. – Oct.

*Hylaeus graenicheri* Mitchell
**Flowers:** *Serenoa repens* (4f), *Mikania cordifolia* (1f). This is the only ABS species that is otherwise only known from specimens from tropical areas of south Florida. ABS records: Mar. – May, Nov.

*Hylaeus ornatus* Mitchell
Two specimens from Malaise traps, identified by Roy Snelling. ABS records: May – June.

*Hylaeus schwarzi* Cockerell
**Flowers:** *Hypericum edisonianum* (1m), *Mikania cordifolia* (1f), *Nuphar lutea* (2m), *Pontederia cordata* (1f, 1m). ABS records: Feb., Apr. – June, Nov.

*Hylaeus volusiensis* Mitchell
One specimen from Malaise trap. ABS record: Apr.

## ANDRENIDAE

*Andrena atlantica* Mitchell

Two specimens from Malaise trap. ABS records: Apr.

*Andrena dimorpha* Mitchell

Four specimens from Malaise traps. ABS records: Mar. – Apr.

*Andrena fulvipennis* Smith

**Flowers:** *Chrysopsis scabrella* (1m), *Euthamia caroliniana* (1f, 1m), *Heterotheca subaxillaris* (1f), *Pityopsis graminifolia* (19f, 7m). Observations of females indicate that *P. graminifolia* is a pollen host; the female on *H. subaxillaris* had full scopae. ABS records: Sept. – Nov.

*Perdita bequaerti* Viereck

**Flowers:** *Balduina angustifolia* (18f, 11m), *Palafoxia feayi* (1f, 2m). Prey of *Zelus longipes* (Linnaeus) (Reduviidae), 1 m. bee. Observations of females indicate that *B. angustifolia* and *Palafoxia feayi* are pollen hosts. This is a communal nesting species; details of nesting behavior are the subject of a current study at the ABS. Mating is often seen on flowers of *B. angustifolia*, and was also seen on *P. feayi*. A male and female in the ABS collection were identified by Bryan Danforth. ABS records: Sept. – Oct.

*Perdita blatchleyi* Timberlake

**Flowers:** *Pityopsis graminifolia* (5f, 6m). ABS records: Oct. – Nov.

*Perdita floridensis* Timberlake

**Flowers:** *Ilex glabra* (10f, 14m), *Lyonia fruticosa* (1f, 1m). Aggregations of solitary nests are in open sandy areas, including dry seasonal ponds; details of nesting behavior are the subject of a current study at the ABS by Beth Norden and colleagues. Parasite at ABS: *Sphecodes brachycephala*. A male and female in the ABS collection were identified by Karl Krombein. ABS records: Apr. – May.

*Perdita graenicheri* Timberlake

**Flowers:** *Heterotheca subaxillaris* (7f, 1m), *Pityopsis graminifolia* (18f, 13m), *Solidago odora* (2f, 1m). Females with full scopae were taken on all these hosts. This species was studied at the ABS by Norden et al. (1992). These researchers found that aggregations of solitary nests occur in sandy areas with sparse vegetation. The paper describes nest structure, lining of the nest and coating of the pollen ball, larval structure, variations in the head shape of the adult male and the occurrence of mating on flowers. The pollen host recorded was *H. subaxillaris*; bees were also taken on "*Chrysopsis microcephala*," probably referring to *Chrysopsis graminifolia* var. *microcephala* (Small) Cronquist, a synonym of *P. graminifolia*. A species of minute robber fly (Asilidae) was often seen perched next to the burrows at the ABS, and two females were seen to enter the burrows (Scarbrough et al. 1995). Possibly the fly larvae prey on the bee larvae or provisions, or it might be a way for the female fly to get her eggs into cooler and damper sand away from the surface. ABS records: Aug. – Nov.

*Perdita halictoides* Smith

One specimen from Malaise trap. ABS record: May.

*Perdita polygonellae* Timberlake

**Flowers:** *Polygonella basiramia* (1f), *P. gracilis* (3f, 2m). Females with full scopae were taken on *P. gracilis*. A female in the ABS collection was identified by Bryan Danforth. ABS records: Oct. – Nov.

## HALICTIDAE

*Agapostemon splendens* (Lepeletier)

**Flowers:** *Agalinis filifolia* (3f), *Baccharis halimifolia* (1f), *Balduina angustifolia* (2f, 5m), *Bejaria racemosa* (1f), *Bidens alba* (1f), *Calamintha ashei* (1m), *Callicarpa americana* (1f, 1m), *Chrysopsis scabrella* (1f, 2m), *Dalea feayi* (3m), *Erigeron strigosus* (1f), *Eupatorium mohrii* (1m), *Euthamia caroliniana* (2f, 3m),. *Garberia heterophylla* (4f, 1m), *Heterotheca subaxillaris* (1f), *Ilex glabra* (2f, 2m), *Lachnanthes caroliniana* (1f, 7m), *Lantana camara* (1f), *Liatris tenuifolia* (1m), *Licania michauxii* (1m), *Ludwigia peruviana* (1f, 1m), *Mimosa quadrivalvis* (1f), *Opuntia humifusa* (6f), *Palafoxia feayi* (1f, 3m), *Piloblephis rigida* (1m), *Pityopsis graminifolia* (2f, 1m), *Polygonella basiramia* (1f, 1m), *Richardia scabra* (1m), *Sabal etonia* (4f, 1m), *Serenoa repens* (2f,2m), *Solidago odora* (1m), *Syngonanthus flavidulus* (1f), *Urena lobata* (2f), *Vaccinium darrowii* (1m), *Vitis rotundifolia* (2f), *Ximenia americana* (1m). Males (conspicuously different from females) were often seen patrolling patches of flowers. Two females and two males in the ABS collection were identified by Karl Krombein. ABS records: Feb. – Nov.

*Augochlora pura* Say
**Flowers:** *Aralia spinosa* (1f), *Balduina angustifolia* (1f), *Bidens alba* (1f), *Callicarpa americana* (2f), *Chamaecrista fasciculata* (1f), *Elephantopus elatus* (1m), *Eryngium cuneifolium* (2f), *Garberia heterophylla* (2f, 2m), *Hyptis mutabilis* (2m), *Ilex cassine* (1f), *Ilex glabra* (2f, 8m), *Ludwigia peruviana* (2f), *Persia borbonia* (1f), *P. humilis* (1f), *Phytolacca americana* (1m), *Pityopsis graminifolia* (1m), *Polygonella robusta* (1f), *Rhus copallina* (1f, 1m), *Sabal etonia* (1f), *Serenoa repens* (2f, 2m), *Smilax auriculata* (3f). Prey of spider *Peucetia viridans* (Hentz) (1f bee). ABS records: Mar. – Oct.

*Augochlorella aurata* (Smith)
**Flowers:** *Agalinis filifolia* (2f), *Baccharis halimifolia* (3f), *Balduina angustifolia* (4f), *Bejaria racemosa* (2f), *Bidens alba* (1f), *Calamintha ashei* (3f), *Carphephorus odoratissimus* (1f), *Chapmannia floridana* (2f), *Dalea feayi* (6f), *Dicerandra frutescens* (2f), *Elephantopus elatus* (2f), *Erigeron strigosus* (2f), *Eryngium cuneifolium* (2f), *Euthamia caroliniana* (1m), *Galactia regularis* (8f), *Garberia heterophylla* (3f), *Gaylussacia dumosa* (2f), *Heterotheca subaxillaris* (1f), *Hypericum reductum* (2f), *H. tetrapetalum* (2f), *Hyptis verticillata* (1f), *Liatris laevigata* (1f, 1m), *L. tenuifolia* (2f), *Licania michauxii* (1f, 1m), *Ludwigia peruviana* (3f), *Lygodesmia aphylla* (1f), *Mikania cordifolia* (8f), *Mimosa quadrivalvis* (13f), *Momordica charantia* (1f), *Opuntia humifusa* (4f), *Palafoxia feayi* (1f), *Persea humilis* (1f), *Piloblephis rigida* (2f), *Piriqueta caroliniana* (2f), *Pityopsis graminifolia* (9f), *Polygonella polygamma* (2f), *P. robusta* (1m), *Quercus myrtifolia* (4f), *Rhus copallina* (1f), *Sabal etonia* (1f), *Sabatia grandiflora* (1f), *Sabal etonia* (1f), *Serenoa repens* (4f, 1m), *Seymeria pectinata* (5f), *Solidago odora* (2f), *Vaccinium darrowii* (1f), *V. myrsinites* (1f), *Warea carteri* (2f). The rarity of males (5 were collected) on flowers is so striking that it seems likely that mating must occur elsewhere. Two females and one male in the ABS collection were identified by George Eickwort. ABS records: Mar. – Nov.

*Augochlorella gratiosa* (Smith)
**Flowers:** *Agalinis filifolia* (3f), *Bejaria racemosa* (2f), *Bidens alba* (1f, 1m), *Cirsium horridulum* (1f), *Gaylussacia dumosa* (1f), *Hypericum reductum* (1f), *Ilex cassine* (1f), *Lagerstroemia indica* (1f), *Lepidium virginicum* (1f), *Pectis linearifolia* (1f), *Polygonella basiramia* (1f), *Rosa bracteata* (2f), *Sida acuta* (3f), *Solidago fistulosa* (1f), *Syngonanthus flavidulus* (1f), *Vaccinium corymbosum* (3f, taking nectar through holes gnawed by some other insect), *Vaccinium darrowii* (1f), *Vaccinium myrsinites* (1f). Only one male was found. In addition to being much rarer than *A. aurata*, *A. gratiosa* also seems to be more closely dependent on disturbed areas; most specimens were found near the ABS buildings, or near the railroad that runs through part of the ABS. One female in the ABS collection was identified by George Eickwort. ABS records: Feb. – June, Sept. – Nov.

*Augochlorella striata* (Provancher)
Fifteen specimens from blue bowl traps and a malaise trap in dry swamp forest by Lake Annie. ABS records: Feb. – Apr.

*Augochloropsis anonyma* (Cockerell)
**Flowers:** *Agalinis filifolia* (2f), *Hypericum reductum* (1f), *Ilex glabra* (1f), *Polygonella basiramia* (1f), *P. gracilis* (1m), *P. polygamma* (2f), *P. robusta* (2f), *Chamaecrista nictitans* (1f), *Heterotheca subaxillaris* (1f), *Lagerstroemia indica* (f), *Mikania cordifolia* (1f), *Sabal etonia* (3f), *Rhexia mariana*, *Vaccinium corymbosum* (1f, taking nectar through holes gnawed by some other insect.), *V. myrsinites* (1f), *Vitis rotundifolia* (1f). ABS records: Feb. – June, Sept. – Dec.

*Augochloropsis metallica* (Fabricius)
**Flowers:** *Asclepias curassavica* (1m), *Baccharis halimifolia* (1f), *Bidens alba* (1f), *Bumelia tenax* (1m), *Chamaecrista fasciculata* (2f), *C. nictitans* (1f), *Chapmannia floridana* (1f), *Commelina erecta* (1f), *Elephantopus elatus* (1f), *Eriogonum longifolium* (4f, 6m), *Galactia regularis* (1f), *Garberia heterophylla* (1f, 1m), *Heterotheca subaxillaris* (2f), *Hypericum reductum* (1f), *Hyptis verticillata* (2f), *Ilex glabra* (1f, 1m), *Lachnanthes caroliniana* (4f), *Lagerstroemia indica* (1f), *Licania michauxii* (3f, 5m), *Mikania cordifolia* 3f, 1m), *Parthenocissus quinquefolia* (4f), *Piriqueta caroliniana* (2f), *Persea borbonia* (2f), *P. humilis* (1f, 2m), *Phytolacca americana* (1f), *Pityopsis graminifolia* (2f), *Polanisia tenuifolia* (1f), *Polygonella gracilis* (1f), *P. polygama* (2f, 1m), *Quercus chapmanii* (1f), *Sabal etonia* (4f), *Serenoa repens* (4f, 1m), *Solidago odora* (1f). Prey of *Peucetia viridans* (Hentz) on *Balduina angustifolia* (1f). Two females in the ABS collection were identified by Karl Krombein, one male by Charles Porter. ABS records: Mar. – Nov.

*Augochloropsis sumptuosa* (Smith)
**Flowers:** *Balduina angustifolia* (2f, 4m), *Bejaria racemosa* 5f, 2m), *Calamintha ashei* (1f), *Chamaecrista fasciculata* (4f), *Commelina erecta* (1f), *Dalea feayi* (4f, 1m), *Diodia teres* (1f), *Eriogonum longifolium* (1f, 2m), *Eryngium cuneifolium* (1f), *Galactia regularis* (2f), *Heterotheca subaxillaris* (1f), *Hieracium gronovii* (1f), *Hypericum cumulicola* (3f), *H. edisonianum* (1f), *H. reductum* (3f), *Ilex opaca arenicola* (1f), *Lachnanthes caroliniana* (2f, 1m), *Liatris laevigata* (2m), *L. tenuifolia* (1f, 1m), *Licania michauxii* (4m), *Ludwigia peruviana* (1m), *Lyonia fruticosa* (1m), *Mikania cordifolia* (1f, 2m), *Mimosa quadrivalvis* (1f), *Opuntia humifusa* (4f), *Palafoxia feayi* (2f, 2m), *Phytolacca americana* (1m). *Pityopsis graminifolia* (1f), *Polygonella gracilis* (1m), *P. robusta* (1f), *Rhus copallina* (1f), *Richardia scabra* (2f), *Sabal etonia* (1f), *Serenoa repens* (1f), *Seymeria pectinata* (1f), *Solidago odora* (3f, 2m), *Vaccinium corymbosum* (1f), *V. myrsinites* (1f), *Vitis rotundifolia* (1f), *Ximenia americana* (1f, 1m), *Xyris elliottii* (1f). Two females in the ABS collection were identified by Karl Krombein. ABS records: Feb. – Dec.

*Dialictus coreopsis* (Robertson)
**Flowers:** *Agalinis filifolia* (2f), *Balduina angustifolia* (1m), *Chamaecrista fasciculata* (1f), *Croton michauxii* (1f), *Eriocaulon decangulare* (3f), *Hieracium gronovii* (1f), *Hypericum tetrapetalum* (1f), *Ilex glabra* (2f), *Lachnanthes caroliniana* (2f), *Liatris laevigata* (1f), *Polygonella gracilis* (1f), *Rosa bracteata* (1f), *Sabal etonia* (1f), *Sabatia grandiflora* (2f), *Solidago odora* (1f), *Syngonanthus flavidulus* (2f), *Sisyrinchium nashii* (2f), *Xyris brevifolia* (1f), *X. elliottii* (1f). A female in the ABS collection was identified as *D. longiceps* by George Eickwort, who seemed to believe that the species known as *longiceps* should be removed from synonymy with *coreopsis*. In a letter dated 5 Feb., 1991, he writes: "My identifications of *Dialictus tegularis, tamiamensis,* and *longiceps* in your collection are correct. Please recall that the synonymy of *longiceps* with *robertsonellus* (previously considered a junior synonym of *coreopsis*) has not been published." This seems to imply that Eickwort thought that *robertsonellus* Mitchener, a southeastern species described as *Halictus longiceps* Robertson (this name is a junior homonym, according to Michener 1951) is a different species from the more widespread *coreopsis*. Thus, *robertsonellus* may eventually become the valid name for the ABS species. ABS records: Feb. – Mar.

*Dialictus miniatulus* Mitchell
**Flowers:** *Agalinis filifolia* (4f), *Baccharis halimifolia* (2f), *Balduina angustifolia* (4f), *Chamaecrista fasciculata* (1f), *Chrysopsis scabrella* (1f), *Eryngium cuneifolium* (3f), *Garberia heterophylla* (2f), *Hypericum cumulicola* (3f), *H. edisonianum* (4f), *H. reductum* (12f), *H. tetrapetalum* (1f), *Ilex glabra* (3f), *Mikania cordifolia* (1f), *Mimosa quadrivalvis* (2f), *Paronychia chartacea* (1f), *Phytolacca americana* (1m), *Piloblephis rigida* (2f), *Pityopsis graminifolia* (1f), *Polygonella basiramia* (1f), *P. gracilis* (1f), *P. robusta* (1f), *Sabal etonia* (11f), *Serenoa repens* (2m). A female in the ABS collection was identified by George Eickwort. ABS records: Mar., May – Nov.

*Dialictus nymphalis* (Smith)
**Flowers:** *Asclepias curtissii* (1f), *Agalinis filifolia* (5f), *Asimina reticulata* (1f), *Baccharis halimifolia* (1f), *Balduina angustifolia* (2f, 1m), *Calamintha ashei* (2f), *Chapmannia floridana* (1f), *Chrysopsis scabrella* (1f), *Cirsium horridulum* (2f), *Commelina erecta* (2f), *Croton michauxii* (2f), *Dalea feayi* (3f), *Eriogonum longifolium* (2f), *Eryngium cuneifolium* (7f), *Eupatorium leptophyllum* (2f), *Euthamia caroliniana* (1f), *Garberia heterophylla* (1f), *Helianthemum corymbosum* (4f), *Heterotheca subaxillaris* (4f), *Hypericum cumulicola* (19f), *H. edisonianum* (1f), *H. reductum* (3f), *Hypoxis juncea* (2f), *Ilex glabra* (6f), *Lagerstroemia indica* (1f), *Liatris ohlingerae* (1f), *Licania michauxii* (2f, 1m), *Linaria floridana* (1f), *Ludwigia peruviana* (1f), *Mikania cordifolia* (1f), *Opuntia humifusa* (6f), *Paronychia americana* (1f), *P. chartacea* (35f, 3m), *P. herniarioides* (4f, 9m), *Pectis linearifolia* (1f), *Phytolacca americana* (4f, 2m), *Piloblephis rigida* (1f), *Pityopsis graminifolia* (8f), *Pluchea odorata* (2f), *Polanisia tenuifolia* (1f), *Polygonella basiramia* (6f, 4m), *P. gracilis* (7f, 2m), *P. polygama* (1f), *P. robusta* (1f), *Polypremum procumbens* (1f), *Sabal etonia* (9f, 6m), *Sabatia brevifolia* (1f), *S. grandiflora* (3f), *Serenoa repens* (6f), *Sisyrinchium xerophyllum* (1f), *Solidago odora* (6f, 1m), *Stipulicida setacea* (3f), *Syngonanthus flavidulus* (16f), *Tradescantia roseolens* (1f), *Xyris brevifolia* (1f), *X. elliottii* (1f). Two males in the ABS collection were identified by George Eickwort. ABS records: Jan. – Nov.

*Dialictus placidensis* Mitchell
**Flowers:** *Agalinis filifolia* (1f), *Balduina angustifolia* (1f), *Callicarpa americana* (1f), *Chamaecrista fasciculata* (1f, on extra-floral nectaries), *Chap-*

*mannia floridana* (2f), *Commelina erecta* (2f), *Croton michauxii* (2f), *Dicerandra frutescens* (1f), *Erigeron strigosus* (2f), *Eryngium aromaticum* (1f), *E. cuneifolium* (1f), *Eupatorium leptophyllum* (4f), *Euthamia caroliniana* (1f), *Garberia heterophylla* (9f), *Hypericum edisonianum* (1f), *H. reductum* (2f), *Ilex cassine* (3f), *I. glabra* (11f), *Indigofera caroliniana* (1m), *Lagerstroemia indica* (4f), *Ludwigia peruviana* (3f), *Lyonia lucida* (1f), *Mimosa quadrivalvis* (13f), *Palafoxia feayi* (3f), *Paronychia americana* (1f), *P. chartacea* (1f), *Phytolacca americana* (2f, 1m), *Piriqueta caroliniana* (1f), *Pityopsis graminifolia* (1f), *Polygonella gracilis* (4f, 1m), *P. myriophylla* (1f), *P. polygama* (1f), *P. robusta* (1f), *Prunus angustifolia* (1f), *Quercus myrtifolia* (1f), *Rhus copallina* (6f), *Rubus trivialis* (3f), *Sabal etonia* (4f), staminate flowers of *Salix caroliniana* (1f), *Serenoa repens* (7f, 7m), *Seymeria pectinata* (2f), *Sisyrinchium xerophyllum* (1f), *Solidago odora* (6f), *Tradescantia roseolens* (2f), *Trichostema dichotomum* (1f), *Vaccinium corymbosum* (1f), *Vitis rotundifolia* (1f), *Warea carteri* (1f), *Ximenia americana* (1f). A female in the ABS collection was identified by George Eickwort. At the time of this identification (1991), the female of *placidensis* was officially unknown. In a letter dated 5 Feb., 1991, George Eickwort explained the situation: "*Dialictus placidensis* Mitchell is the male of *Dialictus tarponensis* Mitchell. The synonymy has not been published; I shall probably elect to call *tarponensis* the senior name, as females are much more frequently collected and studied. This is actually a frequently collected and widespread species, and there are previous records from Archbold." As far as we know, this taxonomic change was not published before George Eickwort's sudden death. The use of the name *D. placidensis* in our paper is not intended as a change in nomenclature or usage; we use this name because it is the name on the identified specimen. ABS records: every month of year.

*Dialictus tamiamensis* Mitchell
**Flowers:** *Eriocaulon decangulare* (4f), *Heterotheca subaxillaris* (1f), *Lachnanthes caroliniana* (1f), *Portulaca pilosa* (1f), *Syngonanthus flavidulus* (12f, 1m), *Xyris brevifolia* (1f). A female in the ABS collection was identified by George Eickwort. ABS records: Jan. – Apr., June – Aug., Nov. – Dec.

*Dialictus tegularis* (Robertson)
**Flowers:** *Abrus precatorius* (1f), *Agalinis filifolia* (1f), *Argemone mexicana* (1f), *Balduina angustifolia* (1f), *Calamintha ashei* (1f), *Euthamia caroliniana* (1f), *Heterotheca subaxillaris* (1f), *Hypericum reductum* (1f), *Ilex glabra* (1f), *Linaria floridana* (1f), *Opuntia humifusa* (5f), *Pectis linearifolia* (6f), *Phytolacca americana* (1f), *Rubus trivialis* (3f), *Sabatia grandiflora* (1f), staminate flowers of *Salix caroliniana* (3f), *Serenoa repens* (2f), *Syngonanthus flavidulus* (6f), *Tradescantia roseolens* (1f). A female in the ABS collection was identified by George Eickwort. ABS records: Jan. – June, Sept. – Oct.

*Evylaeus pectoralis* (Smith)
**Flowers:** *Balduina angustifolia* (3f), *Bidens alba* (2f, 1m), *Cirsium horridulum* (1f), *Lepidium virginicum* (1f), *Linaria floridana* (2f), *Momordica charantia* (1f), *Persea borbonia* (1f), *Phytolacca americana* (1m), *Prunus angustifolia* (1f) staminate flowers of *Salix caroliniana* (12 f), *Serenoa repens* (1f). A male in the ABS collection was identified by George Eickwort. ABS records: Jan. – Nov.

*Evylaeus nelumbonis* (Robertson)
**Flowers:** *Nuphar lutea* (11f, 8m). ABS records: Mar. – June, Sept.

*Evylaeus* sp.
An unidentified species, known from a single specimen taken in a yellow bowl trap. It does not fit the description of any species known from eastern North America, but there is always the possibility that this is one of the many species known from the Southwest. Xeric habitats in Florida are already known to contain a number of southwestern arthropods, or close relatives of southwestern species (Deyrup 1990).

*Halictus ligatus* Say
**Flowers:** *Argemone mexicana* (1f), *Asclepias curtissii* (1f), *Baccharis halimifolia* (1f), *Balduina angustifolia* (10f, 6m), *Bidens alba* (16f, 1m), *Callicarpa americana* (1f, 1m), *Carphephorus corymbosus* (1f, 1m), *Cirsium horridulum* (2f), *Erigeron strigosus* (1f), *Eriocaulon decangulare* (1f), *Eupatorium mohrii* (2f), *Euthamia caroliniana* (1fm 2m), *Galactia elliottii* (1f), *Heterotheca subaxillaris* (5f), *Hieracium gronovii* (1f), *Lactuca graminifolia* (1f), *Ludwigia peruviana* (1f), *Melilotus albus* (2f), *Opuntia humifusa* (7 f), *Palafoxia feayi* (9f, 1m), *Pityopsis graminifolia* (4f, 3m), *Pluchea odorata* (3f), *Polygonella polygama* (1f), *Rosa bracteata* (3f), *Sabal etonia* (1f), *Sabatia grandiflora* (1f), *Serenoa repens* (2f), *Solidago fistulosa* (1f, 1m), *S. odora* (5f, 1m), *Syngonanthus flavidulus* (1f), *Urena lobata*

(1f), *Vigna luteola* (1f), *Wedelia trilobata* (1f). ABS records: Mar. – Oct.

*Nomia heteropoda* (Say)
**Flowers:** *Balduina angustifolia* (4f, 3m), *Bidens alba* (1f). ABS records: Sept. – Oct.

*Nomia maneei* Cockerell
**Flowers:** *Galactia elliottii* (1f), *G. regularis* (1f). ABS records: May – Sept.

*Sphecodes atlantis* Mitchell
**Flowers:** *Stipulicida setacea* (1f). Twenty-eight specimens were taken in Malaise traps. ABS records: Mar. – Jul., Oct. – Dec.

*Sphecodes banksii* Lovell
**Flowers:** *Hyptis verticillata* (1m); only specimen taken at ABS. ABS record: Oct.

*Sphecodes brachycephalus* Mitchell
**Flowers:** *Ilex glabra* (1f). Females seen entering burrows of *Perdita floridensis*. ABS records: Apr. – May.

*Sphecodes fattigi* Mitchell.
Twelve specimens were taken in Malaise traps. ABS records: Apr. – June, Sept.

*Sphecodes heraclei* Robertson
**Flowers:** *Baccharis halimifolia* (1f), *Eriogonum longifolium* (1m), *Eryngium cuneifolium* (1f), *Euthamia caroliniana* (2f, 2m), *Ilex cassine* (1f), *I. glabra* (1m), *Licania michauxii* (2f, 2 m), *Polygonella gracilis* (4f), *P. polygama* (2m), *P. robusta* (2f), *Serenoa repens* (3f, 2m), *Solidago fistulosa* (1f, 1m), *S. odora* (2m) *Syngonanthus flavidulus* (6f). This is the only species of *Sphecodes* regularly seen on flowers at the ABS. ABS records: Mar. – Oct., Dec.

*Sphecodes stygius* Robertson
Twenty-seven specimens were taken in Malaise traps. ABS records: Oct.

## MEGACHILIDAE

*Anthidiellum notatum rufimaculatum* Schwarz
**Flowers:** *Balduina angustifolia* (2m), *Bidens alba* (1m), *Calamintha ashei* (1f), *Crotalaria pallida* (1f), *Galactia regularis* (1f, 1m), *Garberia heterophylla* (1f, 1m), *Ilex glabra* (1f, 3m), *Indigofera hirsuta* (1f), *Linaria floridana* (2f, 2m), *Lupinus diffusus* (1f), *Melilotus albus* (1f), *Momordica charantia* (1m), *Parkinsonia aculeata* (1m), *Pityopsis graminifolia* (2f, 4m), *Polygala grandiflora* (1m), *Richardia scabra* (1f, 1m), *Seymeria pectinata* (1m), *Stipulicida setacea* (1f). ABS records: Feb., Apr. – Nov.

*Anthidiellum perplexum* (Smith)
**Flowers:** *Balduina angustifolia* (1m), *Bejaria racemosa* (2f, 1m), *Bidens alba* (1f, 2m), *Calamintha ashei* (1f, 1m), *Dalea feayi* (1f, 1m), *Elephantopus elatus* (1m), *Erechtites hieracifolia* (1f), *Eryngium cuneifolium* (1f), *Euthamia caroliniana* (2f, 1m), *Galactia regularis* (3m), *Hieracium gronovii* (1f, 1m), *Hypericum edisonianum* (1f), *H. reductum* (1f), *Ilex glabra* (2f, 3m), *Indigofera hirsuta* (1f, 2m), *Lachnanthes caroliniana* (2f), *Lupinus diffusus* (1m), *Mimosa quadrivalvis* (1m)*Palafoxia feayi* (1f), *Parkinsonia aculeata* (4m), *Persea humilis* (1m), *Pityopsis graminifolia* (2f, 2m), *Polygonella robusta* (1f, 2m), *Seymeria pectinata* (1m), *Sisyrinchium xerophyllum* (1m), *Syngonanthus flavidulus* (1f), *Vigna lutea* (1f). ABS records: Mar. – Nov.

*Anthidium maculifrons* Smith
**Flowers:** *Agalinis filifolia* (1m), *Bejaria racemosa* (1m), *Bidens alba* (1f), *Crotalaria pallida* (1f), *Galactia regularis* (1f), *Hieracium gronovii* (1f), *Ilex glabra* (1m), *Lachnanthes caroliniana* (1f, 1m), *Palafoxia feayi* (1f), *Parkinsonia aculeata* (1f, 1m), *Pluchea odorata* (1m), *Vigna luteola* (1f). A female was collected that was gathering hairs from *Pityopsis graminifolia*. ABS records: Feb. – Sept.

*Coelioxys boharti* Mitchell
Two specimens collected in Malaise traps at the ABS are in the Florida State Collection of Arthropods.

*Coelioxys dolichos* Fox
**Flowers:** *Aralia spinosa* (1m), *Balduina angustifolia* (f), *Bidens alba* (3m), *Euthamia caroliniana* (1m), *Hyptis verticillata* (1f), *Lachnanthes caroliniana* (1f), *Smilax auriculata* (1m). A female in the ABS collection was identified by T. Griswold. *Megachile xylocopoides* is “almost certainly” a host at the ABS (Krombein 1967). ABS records: Mar. – Apr., June, Sept. – Oct.

*Coelioxys galactiae* Mitchell
Two specimens collected in Malaise traps at the ABS are in the Florida State Collection of Arthropods.

*Coelioxys germana* Cresson
**Flowers:** *Balduina angustifolia* (1f, 2m), *Bidens alba* (1f), *Calamintha ashei* (1m), *Galactia regularis* (1m), *Parkinsonia aculeata* (1m), *Pluchea odorata* (1f, 1m), *Ximenia americana* (1m). ABS records: Apr., June, Aug. – Oct.

*Coelioxys mexicana* Cresson
**Flowers:** *Balduina angustifolia* (5f, 6m), *Eryngium cuneifolium* (1f), *Eupatorium mohrii* (1f, 1m), *Garberia heterophylla* (1m), *Heterotheca subaxillaris* (1m), *Lachnanthes caroliniana* (2f, 3m), *Liatris tenuifolia* (1m), *Ludwigia peruviana* (1f), *Mikania cordifolia* (1m). A female in the ABS collection was identified by T. Griswold. ABS records: May – Oct.

*Coelioxys modesta* Smith
**Flowers:** *Bidens alba* (1f), *Ludwigia peruviana* (1m). Karl Krombein reared this species from *Megachile campanulae* and *M. georgica* at the ABS (Krombein1967). ABS records: Jul. – Sept.

*Coelioxys octodentata* Say
**Flowers:** *Bidens alba* (1f, 1m), *Carphephorus odoratissimus* (1m), *Euthamia caroliniana* (1f), *Lachnanthes caroliniana* (1f, 2m), *Pityopsis graminifolia* (1f), *Polygonella robusta* (1f). A male was reared from a single cell of molded leaves and flower petals situated in the base of an inflorescence of *Lachnanthes caroliniana* in a dry seasonal pond. A specimen of *Megachile brevis pseudobrevis* was reared from a similar cell. ABS records: June – Jul., Sept. – Oct.

*Coelioxys sayi* Robertson
**Flowers:** *Balduina angustifolia* (32f, 41m), *Bidens alba* (6f, 9m), *Carphephorus odoratissimus* (2f), *Eryngium cuneifolium* (3f, 1m), *Euthamia caroliniana* (3f, 1m), *Galactia regularis* (2f), *Garberia heterophylla* (1m), *Hypericum fasciculatum* (1f), *Ilex glabra* (4f, 2m), *Lachnanthes caroliniana* (4m), *Ludwigia peruviana* (1f, 1m), *Mikania cordifolia* (2f, 1m), *Parkinsonia aculeata* (2m), *Pityopsis graminifolia* (3f, 4m), *Polygonella robusta* (1f, 1m), *Serenoa repens* (1m), *Seymeria pectinata* (1f), *Vaccinium myrsinites* (1f), *Vigna luteola* (1f). *Coelioxys sayi* was reared by Karl Krombein from nests of *Megachile mendica* in trap nests at the ABS (Krombein 1967). Andrew Schreffler also reared *C. sayi* from trap nests containing *M. mendica* at the ABS. According to Schreffler's labels on specimens in the ABS collection, two *C. sayi* emerged first and second respectively from a nest that then produced one *M. mendica*; one *C. sayi* emerged first from another nest that then produced four *M. mendica*. Both Krombein (1967) and Schreffler found that the parasites and the host bees emerged on the same day or within 2 days of each other. ABS records: Mar. – Nov.

*Coelioxys slossoni* Viereck
A single specimen in the ABS collection was collected in a Malaise trap, and identified by T. Griswold. ABS records: Aug.

*Coelioxys texana* Cresson
**Flowers:** *Aralia spinosa* (1m), *Balduina angustifolia* (1f, 3m), *Parkinsonia aculeata* (4m), *Pityopsis graminifolia* (1m). ABS records: Mar. – Apr., Sept. – Oct.

*Dianthidium floridiense* Schwarz
**Flowers:** *Stylisma villosa* (1f), *Calamintha ashei* (1m), *Carphephorus odoratissimus* (1f, 1m), *Eriogonum longifolium* (1f), *Eupatorium mohrii* (1m), *Ilex glabra* (1f), *Lactuca graminifolia* (1f), *Melilotus albus* (1f), *Opuntia humifusa* (1m), *Palafoxia feayi* (1f), *Parkinsonia aculeata* (2f, 1m), *Pityopsis graminifolia* (1m), *Pontederia cordata* (1f), *Serenoa repens* (1m), *Solidago odora* (1f), *Urena lobata* (1f), *Vigna luteola*. ABS records: Apr. – Aug., Oct.

*Dolichostelis louisae* (Cockerell)
**Flowers:** *Balduina angustifolia* (1m), *Bidens alba* (1m), *Parkinsonia aculeata* (1f). Mar. - Apr., June, Sept. – Oct.

*Heriades leavitti* Crawford
**Flowers:** *Bidens alba* (1f), *Hyptis verticillata* (2m) *Parkinsonia aculeata* (3f). Karl Krombein, who reared this species from trap nests at the ABS, suggested that this species has a single annual generation at the ABS (Krombein 1967). ABS records: Apr. – May, Oct.

*Hoplitis truncata* (Cresson)
**Flowers:** *Calamintha ashei* (1f), *Syngonanthus flavidulus* (1m). ABS records: Mar. – Apr.

*Lithurgus gibbosus* Smith
**Flowers:** *Calamintha ashei* (1m), *Cirsium horridulum* (1m), *Opuntia humifusa* (5f, 7m). Four males in the ABS collection were identified by P. D. Hurd, Jr. Nests at the ABS were described by Vincent Brach (1978); he discovered that at least some of the tunnels interconnected, and bees might enter by

one hole and come out by another. ABS records: Mar. – Apr.

*Megachile albitarsis* Cresson
**Flowers:** *Agalinis filifolia* (2f), *Balduina angustifolia* (28f, 3m), *Bidens alba* (4f, 4m), *Carphephorus odoratissimus* (2f), *Elephantopus elatus* (1f), *Erechtites hieracifolia* (1m), *Eriocaulon decangulare* (2m), *Eryngium cuneifolium* (1m), *Eupatorium mohrii* (2f, 3m), *Euthamia caroliniana* (1f, 1m), *Galactia regularis* (2f), *Heterotheca subaxillaris* (5f, 3m), *Ilex glabra* (1m), *Indigofera hirsuta* (2f), *Lachnanthes caroliniana* (4f, 4m), *Liatris tenuifolia* (2f, 1m), *Palafoxia feayi* (9f), *Pityopsis graminifolia* (1f), *Pluchea rosea* (1f, 1m), *Polygonella robusta* (1f), *Sabal etonia* (1f), *Scoparia dulcis* (1f), *Solidago odora* (2f), *Wedelia trilobata* (1f). ABS records: Mar. – Apr., June – Nov.

*Megachile brevis pseudobrevis* Mitchell
**Flowers:** *Agalinis filifolia* (10f, 6m), *Asimina reticulata* (1f), *Balduina angustifolia* (14f, 7m), *Bejaria racemosa* (1f), *Bidens alba* (2f, 1m), *Calamintha ashei* (1f, 1m), *Callicarpa americana* (1f), *Chamaecrista fasciculata* (1f), *Chrysopsis scabrella* (1f, 1m), *Cirsium horridulum* (1f) *Commelina erecta* (2f), *Crotalaria pallida* (1f), *C. rotundifolia* (1m), *Dalea feayi* (2f, 3m), *Elephantopus elatus* (1f), *Eryngium cuneifolium* (2f, 2m), *Galactia regularis* (5f, 1m), *Gaylussacia dumosa* (1m), *Heterotheca subaxillaris* (4f), *Hieracium gronovii* (1f), *Hypericum edisonianum* (1f), *H. reductum* (4f), *Ilex glabra* (4f, 1m), *Lachnanthes caroliniana* (3f, 2m), *Liatris laevigata* (2f, 2m), *L. tenuifolia* (1f, 3m), *Licania michauxii* (1m), *Ludwigia peruviana* (1f), *Opuntia humifusa* (4f), *Palafoxia feayi* (3f), *Parkinsonia aculeata* (4m), *Piloblephis rigida* (1m), *Pityopsis graminifolia* (11f, 5m), *Polygala cymosa* (1f), *Polygonella basiramia* (2f), *Sabal etonia* (2f, 1m), *Seymeria pectinata* (1f, 1m), *Sisyrinchium xerophyllum* (4f), *Vigna luteola* (2f), *Vitis rotundifolia* (1f), *Xyris brevifolia* (1f), *X. elliottii* (2f). One female emerged from a cell of leaf and petal fragments inside curled leaf of *Quercus inopina.* A male *Coelioxys octodentata* was reared from a similar cell. A female in the ABS collection was identified by T. Griswold; a male identified by K. V. Krombein. ABS records: Feb. – Nov.

*Megachile brimleyi* Mitchell
**Flowers:** *Liatris tenuifolia* (1f), *Galactia regularis* (1f). ABS records: Aug. – Sept.

*Megachile campanulae* (Robertson)
**Flowers:** *Crotalaria pallida* (1f). A male in the ABS collection was identified by R. R. Snelling. Karl Krombein reared this species from trap nests at the ABS; he suggests that the species has one generation per year in Florida; he reared *Coelioxys modesta* from 11 of the 20 cells in his trap nests (Krombein 1967). ABS records: Mar. – Apr., Oct.

*Megachile deflexa* Cresson
**Flowers:** *Dalea feayi* (1f, 1m), *Galactia regularis* (1f). A male in the ABS collection was identified by R. R. Snelling. ABS records: Apr. – May, Aug. – Sept.

*Megachile exilis parexilis* Mitchell
**Flowers:** *Abrus precatorius* (2f), *Bidens alba* (2m), *Calamintha ashei* (3f, 3m), *Crotalaria pallida* (3f, 1m), *Dalea feayi* (1m), *Galactia elliottii* (5f, 4m), *G. regularis* (1f, 3m), *Ilex glabra* (1f, 2m), *Ludwigia peruviana* (2f, 1m), *Lupinus diffusus* (1f), *Parkinsonia aculeata* (1f, 3m), *Vigna luteola* (2m). A female in the ABS collection was identified by P. D. Hurd. Galleries of this species in trap nests at the ABS were described by Karl Krombein (1967). ABS records: Mar. – June, Aug. – Oct.

*Megachile frugalis* Cresson
**Flowers:** *Parkinsonia aculeata* (2m). One male in the ABS collection was identified by T. Griswold. ABS records: Apr. – June.

*Megachile georgica* Cresson
**Flowers:** *Balduina angustifolia* (1f, 5m), *Calamintha ashei* (7f, 2m), *Crotalaria pallida* (1f, 1m), *Galactia elliottii* (5f, 6m), *G. regularis* (7f, 2m), *Hieracium gronovii* (1f), *Hypericum reductum* (1f), *Lachnanthes caroliniana* (1m), *Linaria floridana* (2m), *Ludwigia peruviana* (1f, 1m), *Melilotus albus* (1f), *Palafoxia feayi* (1m), *Parkinsonia aculeata* (6f, 2m), *Pityopsis graminifolia* (1f, 2m), *Syngonanthus flavidulus* (1m), *Tephrosia chrysophylla* (1f). A female in the ABS collection was identified by R. R. Snelling, another by K. V. Krombein. Nest structure from trap nests at the ABS are described by K. V. Krombein (1967). At the ABS this species is parasitized by *Coelioxys modesta* and *Leucospis affinis floridana* Cresson (Krombein 1967). ABS records: Feb. – Nov.

*Megachile inimica* Cresson
**Flowers:** *Balduina angustifolia* (12f, 7m), *Bidens pilosa* (2f), *Carphephorus odoratissimus* (1m), *Het-*

*erotheca subaxillaris* (1m), *Ludwigia peruviana* (1m), *Palafoxia feayi* (5f, 6m), *Parkinsonia aculeata* (3m), *Pityopsis graminifolia* (1f). One male in the ABS collection was identified by T. Griswold. ABS records: Mar., Aug. – Sept.

*Megachile integra* Cresson
**Flowers:** *Centrosema arenicola* (1f), *Galactia regularis* (4f, 1m), *Parkinsonia aculeata* (1m). ABS records: Mar., Aug. – Sept.

*Megachile integrella* Mitchell
**Flowers:** *Gaylussacia dumosa* (1f). A female in the ABS collection was identified by R. R. Snelling. ABS records: May – June.

*Megachile mendica* Cresson
**Flowers:** *Abrus precatorius* (3f), *Agalinis filifolia* (7f, 2m), *Aralia spinosa* (1m), *Balduina angustifolia* (3f, 10m), *Bejaria racemosa* (1f, 2m), *Bidens alba* (6m), *Centrosema arenicola* (1f), *Chamaecrista fasciculata* (1f), *Chrysopsis scabrella* (1f), *Eryngium cuneifolium* (2m), *Euthamia caroliniana* (1f, 1m), *Galactia elliottii* (1f), *G. regularis* (2f, 1m), *Garberia heterophylla* (2f), *Hypericum edisonianum* (2f), *Ilex glabra* (9f, 2m), *Lachnanthes caroliniana* (7f, 6m), *Liatris laevigata* (2m), *Ludwigia peruviana* (2m), *Momordica charantia* (1f), *Palafoxia feayi* (2f), *Parkinsoniana aculeata* (1f), *Parthenocissus quinquefolia* (1f), *Pityopsis graminifolia* (4f), *Richardia scabra* (1m), *Sabal etonia* (1m), *Seymeria pectinata* (1f), *Smilax auriculata* (5f), *Solidago odora* (1m), *Vigna luteola* (1f), *Vitis rotundifolia* (4f, 1m), *Ximenia americana* (1f, 1m). A female in the ABS collection was identified by T. Griswold, a male by K. V. Krombein. A. Schreffler and K. V. Krombein reared *M. mendica* from trap nests at the ABS; gallery structure was described by K. V. Krombein (1967). At the ABS *M. mendica* breeds more or less continuously through the year; it is parasitized by *Coelioxys sayi* and an unidentified species of *Anthrax* (Bombyliidae) (Krombein 1967). ABS records: Feb. – Nov.

*Megachile petulans* Cresson
**Flowers:** *Abrus precatorius* (1f), *Agalinis filifolia* (3f, 2m), *Balduina angustifolia* (5f, 14m), *Bejaria racemosa* (1m), *Bidens alba* (1f), *Calamintha ashei* (4m), *Clitoria fragrans* (1f), *Crotalaria pallida* (1f), *Dalea feayi* (1m), *Dicerandra frutescens* (1m), *Galactia elliottii* (1f), *G. regularis* (7f, 1m), *Hypericum edisonianum* (1f, 1m), *Ilex glabra* (4f, 7m), *I. opaca* (1m), *Lachnanthes caroliniana* (1f, 5m), *Liatris tenuifolia* (1m), *Palafoxia feayi* (1m), *Parkinsonia aculeata* (2m), *Pityopsis graminifolia* (3m), *Seymeria pectinata* (1f), *Vitis rotundifolia* (1f). Prey of spider *Peucetia viridans* (Hentz) (1m. bee). A female in the ABS collection was identified by T. Griswold. ABS records: Mar. – Nov.

*Megachile policaris* Say
**Flowers:** *Balduina angustifolia* (3f, 1m), *Ilex glabra* (1f), *Opuntia humifusa* (1m), *Palafoxia feayi* (1m), *Parkinsonia aculeata* (1m), *Serenoa repens* (m). A female in the ABS collection was identified by T. Griswold, a male by R. R. Snelling. A trap nest from the ABS is described by K. V. Krombein (1967); A. Schreffler also reared 3 males and 2 females from a trap nest at the ABS. ABS records: Apr. – Oct.

*Megachile pruina* Smith
**Flowers:** *Balduina angustifolia* (1f, 4m), *Garberia heterophylla* (1f), *Ludwigia peruviana*(1m), *Pityopsis graminifolia* (1f). ABS records: Sept. – Nov.

*Megachile rugifrons* (Smith)
**Flowers:** *Bidens alba* (1m), *Calamintha ashei* (1f), *Ilex glabra* (2f), *Parkinsonia aculeata* (2f, 2m). ABS records: Apr. – May.

*Megachile texana* Cresson
**Flowers:** *Agalinis filifolia* (1f), *Asclepias* sp. (1f), *Balduina angustifolia* (1f), *Calamintha ashei* (1m), *Eryngium cuneifolium* (2f), *Ilex glabra* (1f), *Lachnanthes caroliniana* (5f, 1m), *Opuntia humifusa* (1m), *Palafoxia feayi* (2m), *Parkinsonia aculeata* (1f), *Richardia scabra* (1f), *Solidago odora* (1f). ABS records: Apr. – Oct.

*Megachile xylocopoides* Smith
**Flowers:** *Aralia spinosa* (1m), *Balduina angustifolia* (4f), *Bidens alba* (1f, 4m), *Elephantopus elatus* (1f), *Garberia heterophylla* (1f), *Heterotheca subaxillaris* (1f), *Ilex glabra* (1f), *Lachnanthes caroliniana* (2f), *Ludwigia leptocarpa,* (1m), *Mikania cordifolia* (1m), *Palafoxia feayi* (2f), *Serenoa repens* (2m), *Smilax auriculata* (1m). A female and a male in the ABS collection were identified by K. V. Krombein, a male by T. Griswold. Krombein (1967) described galleries of *M. xylocopoides* from trap nests at the ABS, and suggested that there are several generations annually at the ABS; he reared *Coelioxys dolichos* from nests of *M. xylocopoides* at the ABS. ABS records: Mar. – Apr., June – Nov.

*Osmia sandhouseae* Mitchell
**Flowers:** *Calamintha ashei* (1f), *Linaria floridana* (1m), *Vaccinium corymbosum* (1f). ABS records: Mar. Three ABS specimens were identified by T. Griswold.

*Osmia* sp.
**Flowers:** *Calamintha ashei* (10f, 2m), *Lupinus diffusus* (1f). ABS records: Mar. – Apr. This species appears to be undescribed. Specimens were sent to T. Griswold for inclusion in a revision of North American *Osmia*.

*Trachusa fontemvitae* (Schwarz)
Two copulating pairs and one female were collected from *Balduina angustifolia*. A male in the ABS collection was identified by L. Stange. ABS records: Oct.

## APIDAE

*Epeolus bifasciatus* Cresson
Four specimens were taken in Malaise traps, none on flowers. ABS records: May – June.

*Epeolus carolinus* Mitchell
**Flowers:** *Conyza canadensis* (1f), *Euthamia caroliniana* (1f, 1m), *Garberia heterophylla* (1f), *Pityopsis graminifolia* (1f, 1m). ABS records: Oct. – Nov.

*Epeolus erigeronis* Mitchell
**Flowers:** *Calamintha ashei* (1m), *Ilex glabra* (1m), *Serenoa repens* (1f). ABS records: Mar. – May.

*Epeolus floridensis* Mitchell
Thirteen specimens were taken in Malaise traps, none on flowers. ABS records: Apr. – June.

*Epeolus glabratus* Cresson
**Flowers:** *Bidens alba* (1m), *Ilex glabra* (2f, 7 m), *Serenoa repens* (3f). A male was seen apparently scent marking by rubbing gaster on a small, low leaflet of *Serenoa repens*. ABS records: Apr. – June.

*Epeolus pusillus* Cresson
**Flowers:** *Ilex glabra* (1f). A female in the ABS collection was identified by R. R. Snelling. ABS records: Apr. – May.

*Epeolus zonatus* Smith
**Flowers:** *Aralia spinosa* (1f), *Bidens alba* (3m), *Calamintha ashei* (1m), *Ilex glabra* (3f, 4m), *Licania michauxii* (1m), *Persea borbonia* (1m), *Prunus angustifolia, Serenoa repens* (2m), *Vigna luteola* (1m). ABS records: Feb. – May.

*Habropoda laboriosa* (Fabricius)
**Flowers:** *Gelsemium sempervirens* (2f, 2m), *Vaccinium corymbosum* (1f). ABS records: Feb. – Mar.

*Melissodes communis* Cresson
**Flowers:** *Bidens alba* (1m), *Lachnanthes caroliniana* (2f, 3m), *Opuntia humifusa* (f), *Polygala rugelii* (1m), *Ximenia americana* (1m). One specimen in the ABS collection was identified by W. E. LaBerge. ABS records: Apr. – Aug.

*Melissodes comptoides* Cresson
**Flowers:** *Bidens alba* (1m). ABS record: Sept.

*Nomada fervida* Smith
**Flowers:** *Balduina angustifolia* (1m), *Bidens alba* (1m), *Pityopsis graminifolia* (6f, 1m). The host for this species in the fall at the ABS is almost certainly *Andrena fulvipennis*, the only *Andrena* species known to occur at the ABS in fall. In spring there must be some other host. ABS records: Apr. – July, Oct. – Nov.

*Svastra aegis* (LaBerge)
**Flowers:** *Balduina angustifolia* (1f, 3m). ABS records: Oct.

*Svastra atripes* (Cresson)
**Flowers:** *Galactia regularis* (1f). ABS records: Aug.

*Apis mellifera* Linnaeus
**Flowers** (all records are of worker bees): *Agalinis filifolia* (1), *Argemone mexicana* (1), *Baccharis halimifolia* (1), *Balduina angustifolia* (1), *Bidens alba* (2), *Calamintha ashei* (1), *Callicarpa americana* (1), *Carya floridana* (3), *Cirsium horridulum* (1), *Crotalaria pallida* (2), *Dicerandra frutescens* (1), *Eupatorium mohrii* (1), *Euthamia caroliniana* (1), *Galactia regularis* (4), *Gaylussacia dumosa* (1), *Hypericum edisonianum* (2), *H. fasciculatum* (1), *H. reductum* (2), *Hyptis verticillata* (1), *Ilex glabra* (20), *Lachnanthes caroliniana* (3), *Licania michauxii* (1), *Ludwigia leptocarpa* (1), *L. peruviana* (1), *Nolina brittoniana* (4), *Nuphar lutea* (1), *Opuntia humifusa* (1), *Palafoxia feayi* (1), *Parkinsonia aculeata* (2), *Parthenocissus quinquefolia* (2), *Persea borbonia* (1), *Polygonella robusta* (1), *Pontederia cordata* (3), *Quercus chapmanii* (1), *Q. lau-*

*rifolia* (1), *Q. myrtifolia* (2), *Q. nigra* (1), *Richardia scabra* (1), *Sabal etonia* (5), *Salix caroliniana* (1), *Serenoa repens* (5), *Smilax auriculata* (2), *Solidago fistulosa* (1), *S. odora* (1), *Vaccinium corymbosum* (1), *V. darrowii* (1), *Vitis rotundifolia* (2), *Ximenia americana* (1), *Xyris elliottii* (3). ABS records: every month.

*Bombus fraternis* (F. Smith)
Known at the ABS from two queens, one male, one worker; no flower records. Two queens in the ABS collection were identified by G. Heinrich. ABS records: Apr., July – Aug.

*Bombus griseocollis* (De Geer)
**Flowers:** *Gelsemium sempervirens* (1q), *Lupinus diffusus* (1q). One queen, one worker in the ABS collection were identified by G. Heinrich. ABS records: Feb. – Mar., Nov.

*Bombus impatiens* Cresson
**Flowers:** *Abrus precatorius* (1w), *Agalinis filifolia* (4w), *Azalea* sp. (cultivated) (1q), *Balduina angustifolia* (6w, 2m), *Bejaria racemosa* (7w), *Bidens alba* (2w), *Calamintha ashei* (1w), *Chamaecrista fasciculata* (2w), *Chapmannia floridana* (2w), *Chrysopsis scabrella* (1w, 1m), *Crotalaria pallida* (2w), *Dalea feayi* (4w, 1m), *Dicerandra frutescens* (3w), *Eupatorium mohrii* (1w), *Euthamia caroliniana* (3w, 1m), *Galactia regularis* (4w), *Garberia heterophylla* (4w, 1m), *Gaylussacia dumosa* (1w), *Gelsemium sempervirens* (1q), *Heterotheca subaxillaris* (1w), *Hypericum edisonianum* (1q, 8w), *H. fasciculatum* (2w), *Hyptis mutabilis* (1w), *H. verticillata* (1w), *Ilex glabra* (2w, 1m), *Lachnanthes caroliniana* (2w, 1m), *Liatris laevigata* (1w, 1m), *L. tenuifolia* (1m), *Ludwigia leptocarpa* (1w), *L. peruviana* (3w), *Lyonia ferruginea* (1w), *L. fruticosa* (1w), *L. lucida* (3w), *Mikania cordifolia* (3w, 5m), *Opuntia humifusa* (1w), *Palafoxia feayi* (1w), *Persea borbonia* (3w), *Phytolacca americana* (1w), *Pityopsis graminifolia* (2m), *Polygonella robusta* (1m), *Rhexia mariana* (2w), *Sabal etonia* (1w), *Serenoa repens* (3w), *Seymeria pectinata* (1w), *Vaccinium corymbosum* (1q), *Vitis rotundifolia* (2w), *Xyris elliottii* (1w). Prey of *Peucetia viridans* (Hentz) on *Balduina angustifolia* (5w, 2m). Three queens in the ABS collection were identified by R. W. Dawson. ABS records: Feb. – Nov.

*Bombus pennsylvanicus* De Geer
**Flowers:** *Abrus precatorius* (1w), *Agalinis filifolia* (1w), *Balduina angustifolia* (1w), *Bejaria racemosa* (3w), *Carphephorus odoratissimus* (1w), *Centrosema arenicola* (1w), *Dicerandra frutescens* (1w), *Eryngium cuneifolium* (1w), *Hypericum edisonianum* (1w), *Lachnanthes caroliniana* (1w), *Lantana camara* (1w), *Liatris tenuifolia* (1q), *Opuntia humifusa* (2q, 2w), *Richardia scabra* (2w), *Rosa bracteata* (1w), *Sabal etonia* (1w), *Serenoa repens* (1q), *Stachytarpheta jamaicensis* (1w). Two queens in the ABS collection were identified by G. Heinrich. ABS records: Mar. – May, July, Sept. – Nov.

*Bombus variabilis* (Cresson)
One female was taken in a Malaise trap. ABS record: Oct.

*Ceratina dupla floridana* Mitchell
**Flowers:** *Bidens alba* (1f), *Pontederia cordata* (1f), *Solidago fistulosa* (2f), *Syngonanthus flavidulus* (1f). ABS records: Mar. – Apr., Oct.

*Xylocopa micans* Lepeletier
**Flowers:** *Balduina angustifolia* (2f), *Bidens alba* (1f), *Chamaecrista fasciculata* (2f), *Euthamia caroliniana* (1f), *Hypericum fasciculatum* (1f), *Ilex glabra* (1f), *Lachnanthes caroliniana* (3f), *Ludwigia leptocarpa* (1f), *Lyonia fruticosa* (1m), *Parkinsonia aculeata* (2f, 1m), *Pontederia cordata* (1f, 2m), *Smilax auriculata* (2f). One female in the ABS collection was identified by K. V. Krombein. ABS records: Jan., Mar. – Apr., June – Aug., Oct.

*Xylocopa virginica krombeini* Hurd
**Flowers:** *Balduina angustifolia* (2f, 3m), *Garberia heterophylla* (1f, 1m), *Gelsemium sempervirens* (1m), *Ilex glabra* (1f), *I. opaca arenicola* (1f), *Lachnanthes caroliniana* (1m), *Lagerstroemia indica* (1f), *Ludwigia peruviana* (1f, 1m), *Opuntia humifusa* (1f), *Pityopsis graminifolia* (1f, 1m), *Serenoa repens* (2m) *Smilax auriculata* (1m). Two males in the ABS collection were identified by G. Heinrich. ABS records: Feb. – May, Aug., Oct. – Nov.

## List of flower species visited

*Abrus precatorius* L. Rosary Pea. Fabiaceae. Old World tropical exotic. Genus lacks native FL species. **Bees:** *Dialictus tegularis, Megachile exilis parexilis, M. mendica, M. petulans, Bombus impatiens, B. pennsylvanicus*

*Agalinis filifolia* (Nutt.) Raf. Seminole False Foxglove. Scrophulariaceae. Native. Flowers at ABS open in morning, close in early afternoon. **Bees:** *Hylaeus confluens, Agapostemon splen-*

*dens, Augochlorella aurata, A. gratiosa, Augochloropsis anonyma, Dialictus coreopsis, D. miniatulus, D. nymphalis, D. placidensis, D. tegularis, Anthidium maculifrons, Megachile albitarsis, M. brevis pseudobrevis, M. mendica, M. petulans, M. texana, Apis mellifera, Bombus impatiens, B. pennsylvanicus*

*Aralia spinosa* L. Devil's Walkingstick. Araliaceae. Native to FL, but planted at ABS. **Bees:** *Colletes mandibularis, Hylaeus confluens, Augochlora pura, Coelioxys dolichos, C. texana, Megachile mendica, M. xylocopoides, Epeolus zonatus*

*Argemone mexicana* L. Prickly Poppy. Papaveraceae. Native. **Bees:** *Apis mellifera, Dialictus tegularis, Halictus ligatus*

*Asclepias curassavica* L. Scarlet Milkweed. Asclepiadaceae. Neotropical exotic. Genus with native FL species. **Bees:** *Augochloropsis metallica*

*Asclepias curtissii* A. Gray. Curtiss' Milkweed. Asclepiadaceae. Native. **Bees:** *Dialictus nymphalis, Halictus ligatus*

*Asimina reticulata* Chapm. Pawpaw. Annonaceae. Native. **Bees:** *Dialictus nymphalis, Megachile brevis*

*Azalea* sp. Azalea. Ericaceae. Old World temperate exotic. Genus with native FL species. **Bees:** *Bombus impatiens*

*Baccharis halimifolia* L. Groundsel Tree. Asteraceae. Native. **Bees:** *Colletes mandibularis, C. simulans, C. thysanellae, Agapostemon splendens, Augochlorella aurata, Augochloropsis metallica, Dialictus miniatulus, D. nymphalis, Halictus ligatus, Sphecodes heraclei, Apis mellifera*

*Balduina angustifolia* (Pursh) B. L. Rob. Coastal Plain Honeycomb-Head. Asteraceae. Native. **Bees:** *Perdita bequaerti, Agapostemon splendens, Augochlora pura, Augochlorella aurata, Augochloropsis sumptuosa, Dialictus coreopsis, D. miniatulus, D. nymphalis, D. placidensis, D. tegularis, Evylaeus pectoralis, Halictus ligatus, Nomia heteropoda, Anthidiellum notatum rufimaculatum, A. perplexum, Coelioxys dolichos, C. germana, C. mexicana, C. sayi, C. texana, Megachile albitarsis, M. brevis pseudobrevis, M georgica, M. inimica, M. mendica, M. petulans, M. policaris, M. pruina, M. texana, M. xylocopoides, Dolichostelis louisae, Trachusa fontemvitae, Nomada fervida, Svastra aegis, Apis mellifera, Bombus impatiens, B. pennsylvanicus, Xylocopa micans, X. virginica krombeini*

*Bejaria racemosa* Ventenant. Tarflower. Ericaceae. Native. **Bees:** *Agapostemon splendens, Augochlorella aurata, A. gratiosa, Augochloropsis sumptuosa, Anthidiellum perplexum, Anthidium maculifrons, Megachile brevis pseudobrevis, M. mendica, M. petulans, Bombus impatiens, B. pennsylvanicus*

*Bidens alba* (L.) D.C. Beggar-Ticks. Asteraceae. Native. At ABS only in disturbed sites. **Bees:** *Agapostemon splendens, Augochlora pura, Augochlorella aurata, A. gratiosa, Augochloropsis metallica, Evylaeus pectoralis, Halictus ligatus, Nomia heteropoda, Anthidiellum notatum rufimaculatum, A. perplexum, Anthidium maculifrons, Coelioxys dolichos, C. germana, C. modesta, C. octodentata, C. sayi, Heriades leavitti, Megachile albitarsis, M. brevis pseudobrevis, M. exilis parexilis, M. inimica, M. mendica, M. petulans, M. rugifrons, M. xylocopoides, Dolichostelis louisae, Ceratina dupla floridana, Epeolus glabratus, E. zonatus, Melissodes communis, M. comptoides, Nomada fervida, Apis mellifera, Bombus impatiens, Xylocopa micans*

*Bumelia tenax* L. Tough Bully. Sapotaceae. Native. **Bees:** *Colletes* sp. B, *Augochloropsis metallica*

*Calamintha ashei* (Weath.) Shinners. Ashe's Calamint. Lamiaceae. Native. **Bees:** *Agapostemon splendens, Augochlorella aurata, Augochloropsis sumptuosa, Dialictus nymphalis, D. tegularis, Anthidiellum notatum rufimaculatum, A. perplexum, Dianthidium floridiense, Epeolus erigeronis, E. zonatus, Hoplitis truncata, Coelioxys germana, Lithurgus gibbosus, Megachile brevis pseudobrevis, M. exilis parexilis, M. georgica, M. petulans, M. rugifrons, M. texana, Osmia sandhouseae, Osmia* sp, *Apis mellifera, Bombus impatiens*

*Callicarpa americana* L. American Beauty Berry. Verbenaceae. Native. **Bees:** *Agapostemon splendens, Augochlora pura, Dialictus placidensis, Halictus ligatus, Megachile brevis pseudobrevis, Apis mellifera*

*Carphephorus corymbosus* (Nutt.) Torr. & A. Gray. Florida Paintbrush. Asteraceae. Native. **Bees:** *Halictus ligatus*

*Carphephorus odoratissimus* (J. F. Gmel.) H. Herbert. Vanilla-Leaf. Asteraceae. Native. **Bees:** *Augochlorella aurata, Dianthidium floridiense, Coelioxys octodentata, C. sayi, Megachile albitarsis, M. inimica, Bombus pennsylvanicus*

*Carya floridana* Sarg. Scrub Hickory. Juglandaceae. Native. **Bees:** *Apis mellifera*

*Centrosema arenicola* (Small) F. J. Herm. Pineland Butterfly Pea. Native. **Bees:** *Megachile integra, M. mendica, Bombus pennsylvanicus*

*Chamaecrista fasciculata* (Michx.) Greene. Partridge Pea. Fabaceae. Native. Flowers at ABS open in mornings only. Buzz pollinated. **Bees:** *Augochlora pura, Augochloropsis metallica, A. sumptuosa, Dialictus coreopsis, D. miniatulus, Megachile brevis pseudobrevis, M mendica, Bombus impatiens, Xylocopa micans*

*Chamaecrista nictitans* (L.) Moench. Sensitive Pea. Fabaceae. Native. **Bees:** *Augochloropsis anonyma, A. metallica*

*Chapmannia floridana* Torr. & A. Gray. Alicia. Fabaceae. Native. Flowers at ABS open before dawn, close before 11:00 AM. **Bees:** *Augochlorella aurata, Augochloropsis metallica, Dialictus nymphalis, D. placidensis, Bombus impatiens*

*Chrysopsis* cf. *scabrella* T. & G. (may be an undescribed species). Goldenaster. Asteraceae. Native. **Bees:** *Andrena fulvipennis, Agapostemon splendens, Dialictus miniatulus, D. nymphalis, Megachile brevis pseudobrevis, M. mendica, Bombus impatiens*

*Cirsium horridulum* Michx. Thistle. Asteraceae. Native. **Bees:** *Augochlorella gratiosa, Dialictus nymphalis, Evylaeus pectoralis, Halictus ligatus, Lithurgus gibbosus, Megachile brevis pseudobrevis, Apis mellifera*

*Clitoria fragrans* Small. Sweetscented Pigeonwings. Fabaceae. Native. **Bees:** *Megachile petulans*

*Commelina erecta* L. Whitemouth Dayflower. Commelinaceae. Native. **Bees:** *Augochloropsis metallica, A. sumptuosa, Dialictus nymphalis, D. placidensis, Megachile brevis pseudobrevis*

*Conyza canadensis* (L.) Cronq. Canadian Horseweed. Asteraceae. Native. **Bees:** *Epeolus carolinus*

*Crotalaria pallida* Aiton. Smooth Rattlebox. Fabaceae. African exotic. Genus with native FL species.
**Bees:** *Anthidiellum notatum rufimaculatum, Anthidium maculifrons, Megachile brevis pseudobrevis, M. campanulae, M. exilis parexilis, M. georgica, M. petulans, Apis mellifera, Bombus impatiens*

*Crotalaria rotundifolia* J. F. Gmel. Rabbit-Bells. Fabaceae. Native. **Bees:** *Megachile brevis pseudobrevis*

*Croton michauxii* G. L. Webster. Rushfoil. Euphorbiaceae. Native. **Bees:** *Dialictus coreopsis, D. nymphalis, D. placidensis*

*Dalea feayi* (Chapm.) Barneby. Feay's Prairieclover. Fabaceae. Native. **Bees:** *Caupolicana electa, Agapostemon splendens, Augochlorella aurata, Augochloropsis sumptuosa, Dialictus nymphalis, Anthidiellum perplexum, Megachile brevis pseudobrevis, M. deflexa, M. exilis parexilis, M. petulans, Bombus impatiens*

*Dicerandra frutescens* Shinners. Scrub Balm. Native. **Bees:** *Caupolicana electa, Augochlorella aurata, Dialictus placidensis, Megachile petulans, Apis mellifera, Bombus impatiens, B. pennsylvanicus*

*Diodia teres* Walter. Poor Joe. Rubiaceae. Native. **Bees:** *Augochloropsis sumptuosa*

*Elephantopus elatus* Bertol. Fall Elephant's-foot. Asteraceae. Native. **Bees:** *Augochlora pura, Augochlorella aurata, Augochloropsis metallica, Anthidiellum perplexum, Megachile albitarsis, M. brevis pseudobrevis, M. xylocopoides*

*Erechtites hieracifolia* (L.) Raf. ex DC. American Burnweed. Asteraceae. Native. **Bees:** *Anthidiellum perplexum, Megachile albitarsis*

*Erigeron strigosus* Muhl. ex Willd. Prairie Fleabane. Asteraceae. Native. **Bees:** *Agapostemon splendens, Augochlorella aurata, Dialictus placidensis, Halictus ligatus*

*Eriocaulon decangulare* L. Ten angle Pipewort. Eriocaulaceae. Native. **Bees:** *Hylaeus confluens, Dialictus coreopsis, D. tamiamensis, Halictus ligatus, Megachile albitarsis*

*Eriogonum longifolium* Nutt. var. *gnaphifolium* Gand. Longleaf Wild Buckwheat. Polygonaceae. Native. **Bees:** *Augochloropsis metallica, A. sumptuosa, Dialictus nymphalis, Sphecodes heraclei, Dianthidium floridiense*

*Eryngium aromaticum* Baldwin. Baldwin's Eryngo. Apiaceae. Native. **Bees:** *Dialictus placidensis*

*Eryngium cuneifolium* Small. Wedgeleaf Eryngo. Apiaceae. Native. **Bees:** *Colletes mandibularis, C.* sp. A, *Augochlora pura, Augochlorella aurata, Augochloropsis sumptuosa, Dialictus miniatulus, D. nymphalis, D. placidensis, Sphecodes heraclei, Anthidiellum perplexum, Coelioxys mexicana, C. sayi, Megachile albitarsis, M. brevis pseudobrevis, M. mendica, M. texana, Bombus pennsylvanicus*

*Eupatorium leptophyllum* DC. False fennel. Asteraceae. Native. **Bees:** *Dialictus nymphalis, D. placidensis*

*Eupatorium mohrii* Greene. Mohr's Thoroughwort. Asteraceae. Native. **Bees:** *Agapostemon splendens, Halictus ligatus, Coelioxys mexicana, Dianthidium floridiense, Megachile albitarsis, Apis mellifera, Bombus impatiens*

*Euthamia caroliniana* (L.) Greene ex Porter & Britton. Slender Goldenrod. Asteraceae. Native. **Bees:** *Colletes mandibularis, C. simulans, C. thysanellae, Hylaeus confluens, Andrena fulvipennis,*
*Agapostemon splendens, Augochlorella aurata, Dialictus nymphalis, D. placidensis, D. tegularis, Halictus ligatus, Sphecodes heraclei, Anthidiellum perplexum, Coelioxys dolichos, C. octodentata, C. sayi, Megachile albitarsis, M. mendica, Epeolus carolinus, Apis mellifera, Bombus impatiens*

*Galactia elliottii* Nutt. Elliott's Milk Pea. Fabaceae. Native. **Bees:** *Halictus ligatus, Nomia maneei, Megachile exilis parexilis, M. georgica, M. mendica, M. petulans*

*Galactia regularis* (L.) Britton et al. Eastern Milk Pea. Fabaceae. Native. **Bees:** *Augochlorella aurata, Augochloropsis metallica, A. sumptuosa, Nomia maneei, Anthidiellum notatum rufimaculatum, A. perplexum, Anthidium maculifrons, Coelioxys germana, C. sayi, Megachile albitarsis, M. brevis pseudobrevis, M. brimleyi, M. deflexa, M. exilis parexilis, M. georgica, M. integra, M. mendica, M. petulans, Svastra atripes, Apis mellifera, Bombus impatiens*

*Garberia heterophylla* (W. Bartram) Merr. & F. Harper. Garberia. Asteraceae. Native. **Bees:** *Colletes mandibularis, Agapostemon splendens, Augochlora pura, Augochlorella aurata, Augochloropsis metallica, Dialictus miniatulus, D. nymphalis, D. placidensis, Anthidiellum notatum rufimaculatum, Coelioxys mexicana, C. sayi, Megachile mendica, M. pruina, M. xylocopoides, Epeolus carolinus, Bombus impatiens, Xylocopa virginica krombeini*

*Gaylussacia dumosa* (Andrews) Torr. & A. Gray. Dwarf Huckleberry. Ericaceae. Native. **Bees:** *Augochlorella aurata, A. gratiosa, Megachile brevis pseudobrevis, M. integrella, Apis mellifera, Bombus impatiens*

*Gelsemium sempervirens* (L.) W. T. Aiton. Carolina Jessamine. Loganiaceae. Native. **Bees:** *Habropoda laboriosa, Bombus griseocollis, B. impatiens, Xylocopa virginica krombeini*

*Helianthemum corymbosum* Michx. Pine Barren Frost-Weed. Cistaceae. Native. **Bees:** *Dialictus nymphalis*

*Heterotheca subaxillaris* (Lam.) Britton & Rushby. Camphorweed. Asteraceae. Native. **Bees:** *Andrena fulvipennis, Perdita graenicheri, Agapostemon splendens, Augochlorella aurata, Augochloropsis anonyma, A. metallica, A. sumptuosa, Dialictus nymphalis, D. tamiamensis, D. tegularis, Halictus ligatus, Coelioxys mexicana, Megachile albitarsis, M. brevis pseudobrevis, M. inimica, M. xylocopoides, Bombus impatiens*

*Hieracium gronovii* L. Queen-Devil. Asteraceae. Native. **Bees:** *Augochloropsis sumptuosa, Dialictus coreopsis, Halictus ligatus, Anthidiellum perplexum, Anthidium maculifrons, Megachile brevis pseudobrevis, M. georgica*

*Hypericum cumulicola* (Small) W. P. Adams. Highlands Scrub St. John's-Wort. Clusiaceae. Native. **Bees:** *Augochloropsis sumptuosa, Dialictus miniatulus, D. nymphalis*

*Hypericum edisonianum* (Small) W. P. Adams & N. Robson. Edison's St. John's-Wort. Clusiaceae. Native. **Bees:** *Hylaeus confluens, H. schwarzi, Augochloropsis sumptuosa, Dialictus miniatulus, D. nymphalis, D. placidensis, Anthidiellum perplexum, Megachile brevis pseudobrevis, M. mendica, M. petulans, Apis mellifera, Bombus impatiens, B. pennsylvanicus*

*Hypericum fasciculatum* Lam. Sand Weed. Clusiaceae. Native. **Bees:** *Colletes nudus, Coelioxys sayi, Apis mellifera, Bombus impatiens, Xylocopa micans*

*Hypericum reductum* W. P. Adams. Atlantic St. John's-Wort. Clusiaceae. Native. **Bees:** *Colletes* sp. A, *Hylaeus confluens, Augochlorella aurata, A. gratiosa, Augochloropsis anonyma, A. metallica, A. sumptuosa, Dialictus miniatulus, D. nymphalis, D. placidensis, D. tegularis, Anthidiellum perplexum, Megachile brevis pseudobrevis, M. georgica, Apis mellifera*

*Hypericum tetrapetalum* Lam. Four-Petal St. John's-Wort. Clusiaceae. Native. **Bees:** *Augochlorella aurata, Dialictus coreopsis, D. miniatulus*

*Hypoxis juncea* Sm. Fringed Yellow Star-Grass. Hypoxidaceae. Native. **Bees:** *Dialictus nymphalis*

*Hyptis mutabilis* ( Rich.) Briq. Tropical Bush Mint. Lamiaceae. Neotropical exotic. Genus with native Florida species. **Bees:** *Augochlora pura, Bombus impatiens*

*Hyptis verticillata* Jacq. English name: John Charles. Lamiaceae. Neotropical exotic. Genus with native Florida species. **Bees:** *Colletes*

*mandibularis, C. thysanellae, Augochlorella aurata, Augochloropsis metallica, Sphecodes banksii, Coelioxys dolichos, Heriades leavitti, Apis mellifera, Bombus impatiens*

*Ilex cassine* L. Dahoon Holly. Aquifoliaceae. Native. **Bees:** *Hylaeus confluens, Augochlora pura, Augochlorella gratiosa, Dialictus placidensis, Sphecodes heraclei*

*Ilex glabra* (L.) A. Gray. Gallberry. Aquifoliaceae. Native. Dioecious. **Bees:** *Colletes banksi, C. brimleyi, C. mandibularis, C. nudus, Perdita floridensis, Agapostemon splendens, Augochlora pura, Augochloropsis anonyma, A. metallica, Dialictus coreopsis, D. miniatulus, D. nymphalis, D. placidensis, D. tegularis, Sphecodes brachycephalus, S. heraclei, Anthidiellum notatum rufimaculatum, A. perplexum, Anthidium maculifrons, Coelioxys sayi, Dianthidium floridiense, Megachile albitarsis, M. brevis pseudobrevis, M. exilis parexilis, M. mendica, M. petulans, M. policaris, M. rugifrons, M. texana, M. xylocopoides, Epeolus erigeronis, E. glabratus, E. pusillus, E. zonatus, Apis mellifera, Bombus impatiens, Xylocopa micans, X. virginica krombeini*

*Ilex opaca arenicola* (Ashe) Ashe. Scrub Holly. Aquifoliaceae. Native. Dioecious. **Bees:** *Augochloropsis sumptuosa, Megachile petulans, Xylocopa virginica krombeini*

*Indigofera caroliniana* Mill. Carolina Indigo. Fabaceae. Native. **Bees:** *Dialictus placidensis*

*Indigofera hirsuta* L. Hairy Indigo. Fabaceae. African exotic. Genus with native FL species. **Bees:** *Anthidiellum notatum rufimaculatum, A. perplexum, Megachile albitarsis*

*Lachnanthes caroliniana* (Lam.) Dandy. Carolina Redroot. Haemodoraceae. Native. **Bees:** *Agapostemon splendens, Augochloropsis metallica, A. sumptuosa, Dialictus coreopsis, D. tamiamensis, Anthidiellum perplexum, Anthidium maculifrons, Coelioxys dolichos, C. mexicana, C. octodentata, C. sayi, Megachile albitarsis, M. brevis pseudobrevis, M. georgica, M. mendica, M. petulans, M. texana, M. xylocopoides, Melissodes communis, Apis mellifera, Bombus impatiens, B. pennsylvanicus, Xylocopa micans, X. virginica krombeini*

*Lactuca graminifolia* Michx. Grass-Leaf Lettuce. Asteraceae. Native. **Bees:** *Halictus ligatus, Dianthidium floridiense,*

*Lagerstroemia indica* L. Crepe Myrtle. Lythraceae. Asian exotic. Genus lacks native FL species. **Bees:** *Augochlorella gratiosa, Augochloropsis anonyma, A. metallica, Dialictus nymphalis, D. placidensis, Xylocopa virginica krombeini*

*Lantana camara* L. Lantana. Verbenaceae. West Indian exotic. Genus with native FL species. **Bees:** *Agapostemon splendens, Bombus pennsylvanicus*

*Lepidium virginicum* L. Virginia Pepper Weed. Brassicaceae. Native. **Bees:** *Augochlorella gratiosa, Evylaeus pectoralis*

*Liatris laevigata* Nutt. (variance from Wunderlin 1998). Gayfeather. Asteraceae. Native. **Bees:** *Augochlorella aurata, Augochloropsis sumptuosa, Dialictus coreopsis, Megachile brevis pseudobrevis, M. mendica, Bombus impatiens*

*Liatris ohlingerae* (S. F. Blake) B.L. Rob. Florida Gayfeather. Asteraceae. Native. **Bees.** *Dialictus nymphalis*

*Liatris tenuifolia* Nutt. (Variance from Wunderlin 1998). Shortleaf Gayfeather. Asteraceae. Native. **Bees:** *Agapostemon splendens, Augochlorella aurata, Augochloropsis sumptuosa, Coelioxys mexicana, Megachile albitarsis, M. brevis pseudobrevis, M. brimleyi, M. petulans, Bombus impatiens, B. pennsylvanicus*

*Licania michauxii* Prance. Gopher Apple. Chrysobalanaceae. Native. **Bees:** *Colletes* sp. A, *Agapostemon splendens, Augochlorella aurata, Augochloropsis metallica, A. sumptuosa, Dialictus nymphalis, Sphecodes heraclei, Megachile brevis pseudobrevis, Epeolus zonatus, Apis mellifera*

*Linaria floridana* Chapm. Apalachicola Toadflax. Scrophulariaceae. Native. **Bees:** *Dialictus nymphalis, D. tegularis, Evylaeus pectoralis, Anthidiellum notatum, Osmia sandhouseae, Megachile georgica*

*Ludwigia leptocarpa* (Nutt.) H. Hara. Angle-Stem Primrose-Willow. Onagraceae. Native. **Bees:** *Megachile xylocopoides, Bombus impatiens, Apis mellifera, Xylocopa micans*

*Ludwigia peruviana* (L.) H. Hara. Peruvian Primrose Willow. Onagraceae. Neotropical exotic. Genus with native FL species. **Bees:** *Agapostemon splendens, Augochlora pura, Augochlorella aurata, Augochloropsis sumptuosa, Dialictus nymphalis, D. placidensis, Halictus ligatus, Coelioxys mexicana, C. modesta, C. sayi, Megachile brevis pseudobrevis, M. exilis parexilis, M. georgica, M. inimica, M. mendica, M. pruina, Apis mellifera, Bombus impatiens, Xylocopa virginica krombeini*

*Lupinus diffusus* Nutt. Sky-blue Lupine. Fabaceae. Native. **Bees:** *Anthidiellum notatum rufi-*

*maculatum, A. perplexum, Megachile exilis parexilis, Osmia* sp., *Bombus griseocollis*

*Lygodesmia aphylla* (Nutt.) DC. Rose Rush. Asteraceae. Native. **Bees:** *Augochlorella aurata*

*Lyonia ferruginea* (Walt.) Nutt. Rusty Staggerbush. Ericaceae. Native. **Bees:** *Bombus impatiens*

*Lyonia fruticosa* (Michx.) G. S. Torr. Coastal Plain Staggerbush. Ericaceae. Native. **Bees:** *Colletes banksi, C.* sp. A, *Perdita floridensis, Augochloropsis sumptuosa, Bombus impatiens, Xylocopa micans*

*Lyonia lucida* (Lam.) K. Koch. Fetterbush. Ericaceae. Native. **Bees:** *Dialictus placidensis, Bombus impatiens*

*Melilotus albus* Medik. White Sweet Clover. Fabaceae. Exotic from Eurasia. Genus lacks native FL species. **Bees:** *Colletes mandibularis, Halictus ligatus, Anthidiellum notatum rufimaculatum, Dianthidium floridiense, Megachile georgica*

*Mikania cordifolia* (L. f.) Willd. Florida Keys Hemp-Vine. Asteraceae. Native. **Bees:** *Hylaeus graenicheri, H. schwarzi, Augochlorella aurata, Augochloropsis anonyma, A. metallica, A. sumptuosa, Dialictus miniatulus, D. nymphalis, Coelioxys mexicana, C. sayi, Bombus impatiens*

*Mimosa quadrivalvis* L. Sensitive Briar. Fabaceae. Native. **Bees:** *Agapostemon splendens, Augochlorella aurata, Augochloropsis sumptuosa, Dialictus miniatulus, D. placidensis, Anthidiellum perplexum*

*Momordica charantia* L. Balsam Pear. Cucurbitaceae. Old World tropical exotic. Genus lacks native FL species. **Bees:** *Augochlorella aurata, Evylaeus pectoralis, Anthidiellum notatum rufimaculatum, Megachile mendica*

*Nolina brittoniana* Nash. Britton's Bear Grass. Agavaceae. Native. **Bees:** *Apis mellifera*

*Nuphar lutea* (L.) Sm. Spatterdock. Nymphaeaceae. Native. **Bees:** *Hylaeus schwarzi, Evylaeus nelumbonis, Apis mellifera*

*Opuntia humifusa* (Raf.) Raf. Prickly Pear. Cactaceae. Native. **Bees:** *Agapostemon splendens, Augochlorella aurata, Augochloropsis sumptuosa, Dialictus nymphalis, D. tegularis, Halictus ligatus, Dianthidium floridiense, Lithurgus gibbosus, Megachile brevis pseudobrevis, M. policaris, M. texana, Melissodes communis, Apis mellifera, Bombus impatiens, B. pennsylvanicus, Xylocopa virginica krombeini*

*Palafoxia feayi* Gray. Feay's Palafox. Asteraceae. Native. **Bees:** *Colletes thysanellae, Perdita bequaerti, Agapostemon splendens, Augochlorella aurata, Augochloropsis sumptuosa, Dialictus placidensis, Halictus ligatus, Anthidiellum perplexum, Anthidium maculifrons, Dianthidium floridiense, Megachile albitarsis, M. brevis pseudobrevis, M. georgica, M. inimica, M. mendica, M. petulans, M. policaris, M. texana, M. xylocopoides, Apis mellifera, Bombus impatiens*

*Parkinsonia aculeata* L. Mexican Palo Verde. Fabaceae. Exotic from w. N. America. Genus lacks native FL species. **Bees:** *Hylaeus confluens, Anthidiellum notatum rufimaculatum, A. perplexum, Anthidium maculifrons, Coelioxys germana, C. sayi, C. texana, Dianthidium floridiense, Heriades leavitti, Megachile brevis pseudobrevis, M. exilis parexilis, M. frugalis, M. georgica, M. inimica, M. integra, M. mendica, M. petulans, M. policaris, M. rugifrons, Dolichostelis louisae, Xylocopa micans, Apis mellifera.*

*Paronychia americana* (Nutt.) Fenzl ex Walp. American Nailwort. Caryophyllaceae. Native. **Bees:** *Dialictus nymphalis, D. placidensis*

*Paronychia chartacea* Fern. Paper Nailwort. Caryophyllaceae. Native. **Bees:** *Dialictus miniatulus, D. nymphalis, D. placidensis*

*Paronychia herniarioides* (Michx.) Nutt. Coastal Plain Nailwort. Caryophyllaceae. Native. **Bees:** *Dialictus nymphalis*

*Parthenocissus quinquefolia* (L.) Planch. Virginia Creeper. Vitaceae. Native. **Bees:** *Colletes nudus, Augochloropsis metallica, Megachile mendica, Apis mellifera*

*Pectis linearifolia* Urban. Florida Chinchweed. Asteraceae. Native. **Bees:** *Augochlorella gratiosa, Dialictus nymphalis, D. tegularis*

*Persea borbonia* (L.) Spreng. Red Bay. Lauraceae. Native. **Bees:** *Colletes banksi, C. brimleyi, C. nudus, Augochloropsis metallica, Evylaeus pectoralis, Epeolus zonatus, Apis mellifera, Bombus impatiens*

*Persea humilis* Nash. Silk Bay. Lauraceae. Native. **Bees:** *Colletes brimleyi, C. nudus, Augochlora pura, Augochlorella aurata, Augochloropsis metallica, Anthidiellum perplexum*

*Phytolacca americana* L. American Pokeweed. Phytolaccaceae. Native. **Bees:** *Augochlora pura, Augochloropsis metallica, A. sumptuosa, Dialictus miniatulus, D. nymphalis, D. placidensis, D. tegularis, Evylaeus pectoralis, Bombus impatiens*

*Piloblephis rigida* (W. Bartram ex Benth.) Raf. Wild Pennyroyal. Lamiaceae. Native. **Bees:**

*Agapostemon splendens, Augochlorella aurata, Dialictus miniatulus, D. nymphalis, Megachile brevis pseudobrevis*

*Piriqueta caroliniana* (Walt.) Urban. Piriqueta. Turneraceae. Native. **Bees:** *Augochlorella aurata, Augochloropsis metallica, Dialictus placidensis*

*Pityopsis graminifolia* (Michx.) Nutt. Narrow-Leaf Silkgrass. Asteraceae. Native. **Bees:** *Colletes mandibularis, C. thysanellae, Andrena fulvipennis, Perdita blatchleyi, P. graenicheri, Agapostemon splendens, Augochlora pura, Augochlorella aurata, Augochloropsis metallica, A. sumptuosa, Dialictus miniatulus, D. nymphalis, D. placidensis, Halictus ligatus, Anthidiellum notatum rufimaculatum, A. perplexum, Coelioxys octodentata, C. sayi, C. texana, Dianthidium floridiense, Megachile albitarsis, M. brevis pseudobrevis, M. georgica, M. inimica, M. mendica, M. petulans, M. pruina, Epeolus carolinus, Nomada fervida, Bombus impatiens, Xylocopa virginica krombeini*

*Pluchea odorata* (L.) Cass. Camphorweed. Asteraceae. Native. **Bees:** *Halictus ligatus, Dialictus nymphalis, Anthidium maculifrons, Coelioxys germana*

*Pluchea rosea* R. K. Godfrey. Rosy Camphorweed. Asteraceae. Native. **Bees:** *Megachile albitarsis*

*Polanisia tenuifolia* Torr. & A. Gray. Slender-Leaf Clammyweed. Capparaceae. Native. **Bees:** *Augochloropsis metallica, Dialictus nymphalis*

*Polygala cymosa* Walter. Tall Pine Barren Milkwort. Polygalaceae. Native. **Bees:** *Megachile brevis pseudobrevis*

*Polygala grandiflora* Walt. Large-Flowered Milkwort. Polygalaceae. Native. **Bees:** *Anthidiellum notatum rufimaculatum*

*Polygala rugelii* Shuttlew. Yellow Bachelor's Button. Polygalaceae. Native. **Bees:** *Melissodes communis*

*Polygonella basiramia* (Small) G. L. Nesom & V. M. Bates. Florida Jointweed. Polygonaceae. Native. **Bees:** *Colletes mandibularis, Perdita polygonellae, Agapostemon splendens, Augochlorella gratiosa, Augochloropsis anonyma, Dialictus miniatulus, D. nymphalis, Megachile brevis pseudobrevis*

*Polygonella gracilis* (Nutt.) Meisn. Tall Jointweed. Polygonaceae. Native. **Bees:** *Colletes mandibularis, C. thysanellae, Perdita polygonellae, Augochloropsis anonyma, A. metallica, Augochloropsis sumptuosa, Dialictus coreopsis, D. miniatulus, D. nymphalis, D. placidensis*

*Polygonella myriophylla* (Small) Horton. Small's Jointweed. Polygonaceae. Native. **Bees:** *Dialictus placidensis*

*Polygonella polygama* (Vent.) Engelm. & A. Gray. October Flower. Polygonaceae. Native. **Bees:** *Colletes mandibularis, Augochlorella aurata, Augochloropsis anonyma, A. metallica, Dialictus nymphalis, D. placidensis, Halictus ligatus, Sphecodes heraclei*

*Polygonella robusta* (Small) G. L. Nesom & V. M. Bates. Sandhill Wireweed. Polygonaceae. Native. **Bees:** *Colletes mandibularis, C. thysanellae, Colletes* sp. A, *Hylaeus confluens, Augochlora pura, Augochlorella aurata, Augochloropsis anonyma, A. sumptuosa, Dialictus miniatulus, D. nymphalis, D. placidensis, Sphecodes heraclei, Anthidiellum perplexum, Coelioxys sayi, C. octodentata, Megachile albitarsis, Apis mellifera, Bombus impatiens*

*Polypremum procumbens* Linnaeus. Rust Weed. Loganiaceae. Native. **Bees:** *Dialictus nymphalis*

*Pontederia cordata* L. Pickerelweed. Pontederiaceae. Native. **Bees:** *Hylaeus schwarzi, Dianthidium floridiense, Ceratina dupla floridana, Apis mellifera, Xylocopa micans*

*Portulaca pilosa* L. Pink Purslane. Portulacaceae. Native. **Bees:** *Dialictus tamiamensis*

*Prunus angustifolia* Marsh. Chickasaw Plum. Rosaceae. Native. **Bees:** *Dialictus placidensis, Hylaeus confluens, Evylaeus pectoralis, Epeolus zonatus*

*Quercus chapmanii* Sarg. Chapman's Oak. Fagaceae. Native. **Bees:** *Augochloropsis metallica, Apis mellifera*

*Quercus laurifolia* Michx. Laurel Oak. Fagaceae. Native. **Bees:** *Colletes brimleyi, Apis mellifera*

*Quercus myrtifolia* Willd. Myrtle Oak. Fagaceae. Native. **Bees:** *Colletes brimleyi, Augochlorella aurata, Dialictus placidensis, Apis mellifera*

*Quercus nigra* L. Water Oak. Fagaceae. Native. **Bees:** *Apis mellifera*

*Quercus* sp. Oak. Fagaceae. Native. **Bees:** *Colletes brimleyi*

*Rhexia mariana* L. Pale Meadow-Beauty. Melastomaceae. Native. **Bees:** *Augochloropsis anonyma, Bombus impatiens*

*Rhus copallina* L. Winged Sumac. Anacardiaceae. Native. **Bees:** *Colletes mandibularis, Augochlora pura, Augochlorella aurata, Augochloropsis sumptuosa, Dialictus placidensis*

*Richardia scabra* L. Rough Mexican Clover. Rubiaceae. Neotropical exotic. Genus lacks native FL species. **Bees:** *Agapostemon splendens, Augochloropsis sumptuosa, Anthidiellum maculatum rufimaculatum, Megachile mendica, M. texana, Apis mellifera, Bombus pennsylvanicus*

*Rosa bracteata* J. C. Wendl. Macartney Rose. Rosaceae. Chinese exotic. Genus with native FL species. **Bees:** *Augochlorella gratiosa, Dialictus coreopsis, Halictus ligatus, Bombus pennsylvanicus*

*Rubus trivialis* Michx. Southern Dewberry. Rosaceae. Native. **Bees:** *Dialictus placidensis, D. tegularis*

*Sabal etonia* Swingle ex Nash. Scrub Palmetto. Arecaceae. Native. **Bees:** *Agapostemon splendens, Augochlorella aurata, Augochloropsis anonyma, A. metallica, A. sumptuosa, Dialictus coreopsis, D. miniatulus, D. nymphalis, D. placidensis, Halictus ligatus, Megachile albitarsis, M. brevis pseudobrevis, M. mendica, Apis mellifera, Bombus impatiens, B. pennsylvanicus*

*Sabatia brevifolia* Raf. Short-Leaf Rose-Gentian. Gentianaceae. Native. **Bees:** *Dialictus nymphalis, D. tegularis*

*Sabatia grandiflora* (A. Gray) Small. Large-Flower Rose-Gentian. Native. **Bees:** *Augochlorella aurata, Dialictus coreopsis, D. nymphalis, D. tegularis, Halictus ligatus*

*Salix caroliniana* Michx. Carolina Willow. Salicaceae. Native. **Bees:** *Hylaeus confluens, Dialictus placidensis, D. tegularis, Evylaeus pectoralis, Apis mellifera*

*Scoparia dulcis* L. Sweetbroom. Scrophulariaceae. Native. **Bees:** *Megachile albitarsis*

*Serenoa repens* (W. Bartram) Small. Saw Palmetto. Arecaceae. Native. **Bees:** *Colletes banksi, C. brimleyi, C. mandibularis, C. nudus, Colletes* sp. A, *Hylaeus graenicheri, Agapostemon splendens, Augochlora pura, Augochlorella aurata, Augochloropsis metallica, A. sumptuosa, Dialictus miniatulus, D. nymphalis, D. placidensis, D. tegularis, Evylaeus pectoralis, Halictus ligatus, Sphecodes heraclei, Coelioxys sayi, Dianthidium floridiense, Megachile policaris, M. xylocopoides, Epeolus erigeronis, E. glabratus, E. zonatus, Apis mellifera, Bombus impatiens, B. pennsylvanicus, Xylocopa virginica krombeini*

*Seymeria pectinata* Pursh. Piedmont Black Senna. Scrophulariaceae. Native. **Bees:** *Augochlorella aurata, Augochloropsis sumptuosa, Dialictus placidensis, Anthidiellum notatum rufimaculatum, A. perplexum, Coelioxys sayi, Megachile brevis pseudobrevis, M. mendica, M. petulans, Bombus impatiens*

*Sida acuta* Burm. f. Common Fan-Petals. Malvaceae. Native. **Bees:** *Augochlorella gratiosa*

*Sisyrinchium nashii* E. P. Bicknell. Nash's Blue-Eyed Grass. Iridaceae. Native. **Bees:** *Dialictus coreopsis*

*Sisyrinchium xerophyllum* Greene. Jeweled Blue-Eyed Grass. Iridaceae. Native. **Bees:** *Dialictus nymphalis, D. placidensis, Anthidiellum perplexum, Megachile brevis pseudobrevis*

*Smilax auriculata* Walter. Ear-Leaf Greenbrier. Smilacaceae. Native. **Bees:** *Augochlora pura, Coelioxys dolichos, Megachile mendica, M. xylocopoides, Apis mellifera, Xylocopa micans, X. virginica krombeini*

*Solidago fistulosa* Mill. Pine-Barren Goldenrod. Asteraceae. Native. **Bees:** *Colletes mandibularis, C. thysanellae, Augochlorella gratiosa, Halictus ligatus, Sphecodes heraclei, Ceratina dupla floridana, Apis mellifera*

*Solidago odora* var. *chapmanii* (Torr. & A. Gray) Cronquist. Chapman's Goldenrod. Asteraceae. Native. **Bees:** *Colletes mandibularis, Perdita graenicheri, Agapostemon splendens, Augochlorella aurata, Augochloropsis metallica, A. sumptuosa, Dialictus coreopsis, D. nymphalis, D. placidensis, Halictus ligatus, Sphecodes heraclei, Dianthidium floridiense, Megachile albitarsis, M. mendica, M. texana, Apis mellifera*

*Stachytarpheta jamaicensis* (L.) Vahl. Blue Porterweed. Verbenaceae. Native. **Bees:** *Bombus pennsylvanicus*

*Stipulicida setacea* Michx. Pineland Scaly-Pink. Caryophyllaceae. Native. **Bees:** *Dialictus nymphalis, Sphecodes atlantis, Anthidiellum notatum rufimaculatum*

*Stylisma villosa* (Nash) House. Hairy Dawn-Flower. Convolvulaceae. Native. **Bees:** *Dianthidium floridiense*

*Syngonanthus flavidulus* (Michx.) Ruhland. Yellow Hat-Pins. Eriocaulaceae. Native. **Bees:** *Colletes mandibularis, Agapostemon splendens, Augochlorella gratiosa, Ceratina dupla, Dialictus coreopsis, D. nymphalis, D. tamiamensis, D. tegularis, Halictus ligatus, Hoplitis truncata, Hylaeus confluens, Sphecodes heraclei, Anthidiellum perplexum, Megachile georgica*

*Tephrosia chrysophylla* Pursh. Scrub Hoary-Pea. Fabaceae. Native. **Bees:** *Megachile georgica*

*Tradescantia roseolens* Small. Long-Leaf Spiderwort. Commelinaceae. Native. **Bees:** *Dialictus nymphalis, D. placidensis, D. tegularis*

*Trichostema dichotomum* L. Forked Blue-Curls. Lamiaceae. Native. **Bees:** *Caupolicana electa, Dialictus placidensis*

*Urena lobata* L. Caesarweed. Malvaceae. Native. **Bees:** *Agapostemon splendens, Halictus ligatus, Dianthidium floridiense*

*Vaccinium corymbosum* L. Highbush Blueberry. Ericaceae. Native. **Bees:** *Augochloropsis sumptuosa, Dialictus placidensis, Osmia sandhouseae, Habropoda laboriosa, Apis mellifera, Bombus impatiens*

*Vaccinium darrowii* Camp. Darrow's Blueberry. Ericaceae. Native. **Bees:** *Agapostemon splendens, Augochlorella aurata, A. gratiosa, Apis mellifera*

*Vaccinium myrsinites* Lam. Shiny Blueberry. Ericaceae. Native. **Bees:** *Augochlorella aurata, A. gratiosa, Augochloropsis anonyma, A. sumptuosa, Coelioxys sayi*

*Vigna luteola* (Jacq.) Benth. Hairy-Pod Cow-Pea. Fabaceae. Native. **Bees:** *Halictus ligatus, Anthidiellum perplexum, Anthidium maculifrons, Coelioxys sayi, Dianthidium floridiense, Megachile brevis pseudobrevis, Megachile exilis parexilis, M. mendica, Epeolus zonatus*

*Vitis rotundifolia* Michx. Muscadine. Vitaceae. Native. **Bees:** *Agapostemon splendens, Augochloropsis anonyma, A. sumptuosa, Dialictus placidensis, Megachile brevis pseudobrevis, M. mendica, M. petulans, Apis mellifera, Bombus impatiens*

*Warea carteri* Small. Carter's Pineland Cress. Brassicaceae. Native. **Bees:** *Augochlorella aurata, Dialictus placidensis*

*Wedelia trilobata* (L.) Hitchcock. Creeping Ox-Eye. Asteraceae. West Indian Exotic. Genus lacks native FL species. **Bees:** *Halictus ligatus, Megachile albitarsis*

*Ximenia americana* L. Hog Plum. Olacaceae. Native. **Bees:** *Agapostemon splendens, Augochloropsis sumptuosa, Dialictus placidensis, Coelioxys germana, Megachile mendica, Melissodes communis, Apis mellifera*

*Xyris brevifolia* Michx. Short-Leaf Yellow-Eyed Grass. Xyridaceae. Native. **Bees:** *Dialictus coreopsis, D. nymphalis, D. tamiamensis, Megachile brevis pseudobrevis*

*Xyris elliottii* Chapm. Elliott's Yellow-Eyed Grass. Xyridaceae. Native. **Bees:** *Colletes distinctus, Augochloropsis sumptuosa, Dialictus coreopsis, D. nymphalis, Megachile brevis pseudobrevis, Apis mellifera, Bombus impatiens*

### Summary of the ABS Bee Survey

Currently 113 species of bees, 112 of them native, are known from the ABS. Two questions immediately arise: Is this survey complete? How effective were the survey methods?

**Is the survey complete?** There are probably additional species to be found, based on the following kinds of information. 1) A 2100 ha. site probably has some habitat types that have not been adequately sampled. An example of this on the ABS is a small area of swamp forest where two additional species were found in spring of 2001. 2) A 2100 ha. acre site probably has species that are patchily distributed due to microbiogeography, and some of these species may have been missed because the whole site was not covered in a uniform manner. 3) A number of species are currently represented in collections by only a few specimens. There are 14 such species: 7 species represented by one specimen, 5 by 2 specimens, 2 by 3 specimens. This indicates that there are probably more species to be discovered. To look at this another way, if only a few specimens were ever found, it would have been relatively easy to miss those specimens, and there are likely to be other species that are similarly scarce that were missed altogether.

On the other hand, we do not believe that the number of species yet to be found is very large. We would expect no more than 20 additional species, almost all of them rare in the sense of being sparsely distributed, or highly localized, or only active for a short period, or some combination of these. We base this assumption on our species accumulation, which shows only a small increase in species during 2000-2001, when there was intensive bee collecting.

In contrast to the survey for bees, the survey of bee-flower relationships is undoubtedly far from complete. There seems to be an element of luck in obtaining the some associations, perhaps because many species of bees are rare or localized at the ABS and because the many species of generalist bees may spend most of their time and effort visiting those species of flowers that are commonest and provide the best resources. It is common to find a large patch of flowers that is not being visited by bees, or visited by only a few individuals. It may take years before one comes upon a patch of flowers

of a particular type that is being visited with any intensity. The first records of bees on *Smilax auriculata*, for example, a common species with conspicuous flowers, were not obtained until 2002, in spite of at least casual attention to this species for several years.

**The effectiveness of survey methods**. The principal survey methods were collecting bees as they visited flowers, and collecting with small Malaise traps. The great majority of bee species known from the ABS have been found at least once on a floral host. It would be satisfying to report that this is an adequate method for sampling bee diversity, since it is always preferable to collect specimens with some associated natural history information beyond date and habitat. Unfortunately, even after years of effort to document insect-flower relationships, there are still 20 bee species known only from traps, and additional species known primarily from traps, with only one or two flower records. All species frequently taken on flowers were also frequently collected in Malaise traps. Six species were taken only on flowers, never in traps. We made no attempt, however, to check the effectiveness of traps by setting up traps in the places where these bees had been found.

A new technique that we did not try until the winter of 2001 was the use of blue or white plastic bowls filled with water and a few drops of detergent. In February of 2001, 6 blue plastic bowls were deployed near a Malaise trap in a dry swamp forest. The bowls caught many more bees (almost all halictids) than the Malaise trap. The effectiveness of bowls and Malaise traps depends on their exact placement relative to the flight paths of insects, so the main value of this comparison is to indicate that the bowls can be useful for sampling some bees.

The general lesson from the work with flower collecting and Malaise traps is that traps remain indispensable for survey work. They are particularly useful for surveying parasitic bees of the 20 species caught only in traps, 8 are parasitic.

## General biogeography of Florida bees

**Large-scale patterns.** Some consideration of the biogeography of Florida bees is useful for putting in perspective the ABS fauna. There is no publication dealing specifically with the biogeography of Florida bees, but the subject may be approached through the biogeographic analyses of C. D. Michener (1979, 2000), combined with the state records in T. B. Mitchell's manual of Eastern bees (1960, 1962) and the specimen records in the Florida State Collection of Arthropods, where there is a large collection of bees, curated by Lionel Stange and James Wiley.

Most groups of plant-eating insects have their greatest diversity in the moist tropics, where the diversity of plants reaches its peak. There are some big exceptions to this rule: sawflies and the vegetarian anthomyiid flies, for example, are concentrated in the cool temperate regions of the Northern Hemisphere. Bees are another exception: their diversity does not climax where there is the greatest diversity of flowering plants, but rather in semi-arid warm temperate areas (Michener 1979). California, for example, has almost 2000 species of bees (more than twice the number of species found in eastern North America), and most of these species live in arid and semi-arid parts of the state. Michener suggests (1979, 2000) several reasons that might account for the failure of bee diversity to match plant diversity in the wet tropics: poor storage conditions for nectar and pollen; domination of the fauna by generalist social bees (*Apis* and meliponines), possibly greater abundance of generalist predators, such as ants. A Mediterranean climate (cool, moist winters, warm dry summers) seems to lead to a high diversity of bees wherever such a climate occurs. This climate provides a pronounced seasonality that allows bees to easily synchronize their life cycles with those of host plants, and a warm dry summer that is ideal for hymenopteran flight activity. Southwestern North America probably also benefits from the fact that the rich Madrotertiary fauna could have been locally displaced southward during the glacial episodes of the Pleistocene, but would not have been trapped against any major geographic barriers.

Florida, with its relatively warm climate, pronounced wet and dry seasons and easily excavated sandy soils, might seem ideal for bees, but Florida's bee diversity is relatively low, about 260 recorded species (Mitchell, 1960, 1962). As the bee fauna of Florida becomes better known, this number will probably rise to around 300-320 species, but is unlikely to reach the 520 species known from Mitchell's well-surveyed home state of North Carolina. Florida's apparent advantages in climate and soil cannot match the ecological diversity of North Carolina, with its varied climates, soils and topography, and its remarkable plant diversity, making it a meeting place for boreal, Appalachian, and coastal plain species.

The warm climate and sandy soils may actually be mixed blessings for bees in Florida. The climate is the reverse of Mediterranean: instead of wet winters and dry summers, Florida has dry winters and wet summers. This makes for warm, humid conditions for pollen and nectar storage during the developmental period of the egg and larva. This promotes growth of fungi and bacteria that spoil the provisions (Batra et al. 1973). Burrowing bees are in damp sand, with successive layers of saturation moving down through the soil column following rains. These same bees are exposed to great numbers of predatory insects, from subterranean ants to bee-flies, that can move easily through the sand.

Most upland habitats in Florida evolved with periodic fires, and the most profuse flowering of herbaceous perennials is correlated not with seasonality, but with fires that temporarily reduce vegetation cover and make room for seedlings. It would probably not be practical for bees to have life cycles synchronized with these episodes of intense flowering because the fires are too infrequent. This is not to say that most species bloom only after a fire, but the number of plants blooming and the number of flowers per plant may be greatly influenced by fire. Eastern milk pea (*Galactia regularis*), for example, can be found in bloom every year, but heavy blooming only occurs one or two years after a fire. This species is heavily patronized by megachilids. Chapman's Goldenrod (*Solidago odora*) is another plant that has only a few scattered blooming individuals in a normal year and massive flowering following a fire. Some plants, such as gallberry (*Ilex glabra*), if burned before flowering in the spring, do not produce flowers that year, so bees dependent on that plant lack hosts in the burned area for a year. One might expect fire-controlled ecosystems to produce assemblages of nomadic bees; this hypothesis has not yet been considered or tested. Ecological systems in which plants invest heavily in flowers every year would seem to be more favorable to bees than systems in which plants invest heavily in flowers at 5 to 50 year intervals.

In summary, a combination of ecological factors helps explain why Florida has fewer bees than states to the north, and far fewer than southwestern states. Only about 260 species are known for the entire state of Florida, and one would expect a small fraction of that number in a single 2100 ha. site with habitats and plant diversity representing only a small fraction of that found in the state. From this perspective, the fauna of the ABS, with its 113 species, is surprisingly diverse.

A simplified account of the historical biogeography of eastern bees can be assembled from the distribution, seasonal, and flower records in Mitchell (1960, 1962), Hurd (1979), and Moure and Hurd (1987). There is a group of woodland bees, many of them spring-flyers, that is centered in the Appalachians; there is a small secondary center of woodland bee diversity in the boreal forest. There is a group of open-site bees associated with the fire-maintained pinelands of the Coastal Plain. There is another group of open-site bees derived from the large fauna of the Great Plains, where its species still occur in natural and semi-natural areas. There might at one time been a series of narrowly distributed open-site endemics confined to edges and chronically disturbed sites, such as shores of lakes, marshes and seacoast, stream courses with sporadically occurring beaver meadows, and slopes and sandy soils with frequent wind-throw of large trees. Many of the open-site species must have increased in numbers and range over the last few hundred years with the reduction in forests and the increase in fields and the open site corridors provided by roads.

One might expect Florida to be populated largely by bees whose center of distribution is the southern Coastal Plain, but this does not seem to be the case. The majority of Florida species are widespread east of the Rocky Mountains; some of these are from the Appalachian fauna, and some might represent an eastern extension of the Great Plains fauna, which in turn owes much to the Madrotertiary fauna surviving in southwestern North America. It is likely that southeastern populations of some widespread species came directly from the Southwest. During the late Pliocene through the mid-Pleistocene a band of arid climate extended across southern North America, connecting the Southeast directly with elements of the Madrotertiary fauna and flora (Webb 1990), though the Mississippi and its associated low forests and marshes probably continued to act as a barrier or ecological filter impeding wholesale migration. There are some examples of species that have a southern distributions that seem divided by the Mississippi lowlands, for example *Coelioxys slossoni* and *C. texana*. It is likely that some of the Florida species of *Perdita* have their closest relatives in the Southwest rather than in the Northeast or the Mid-Atlantic states. One of the interesting projects for students of Florida bees will be to figure out which

species and populations are ancient vestiges of the transcontinental dry savannahs of the late Pliocene through mid-Pleistocene.

### Special Features of the Florida Bee Fauna

**Patterns from north to south in the Peninsula.** As one moves south in the Florida peninsula the bee fauna seems to become smaller, probably reflecting a decrease in plant diversity as the soils become more sterile and sandy, the topography less varied, and seasonality less pronounced. Most of south Florida is lowlands that are regularly flooded part of the year, while the uplands are rapidly-draining sands that are subject to regular severe droughts in the spring when the temperature is high and water stress in plants is increased by dry winds. The flora of the 5000-acre Archbold Biological Station in south-central Florida includes about 535 species of vascular plants, while San Felasco State Park in north Florida (Alachua Co.) has more than twice as many species, including far more species in a number of families favored by bees, such as Rosaceae, Asteraceae, and Fabaceae. In addition to the effects of a reduction in diversity of potential host plants, certain bees are likely to be excluded from south Florida by other factors: the reduction of duration and intensity of the cold season for temperate-climate species that require cold to break dormancy; the challenge of frequent inundations for ground-nesting species; a lack of compacting soils for species that require firm substrates for their burrows; poorly developed topography for species that require slopes and banks; frequent fires that affect species that live in dead twigs, stems and wood.

In certain groups of insects, such as the Formicidae and Cerambycidae, as one approaches the tropical tip of Florida the fauna is augmented by a rich West Indian fauna, disjunct populations of species that also occur in the Bahamas and Cuba. Four such species among Florida bees are *Centris versicolor* (Fabricius), *Megachile bahamensis* Mitchell, *Exomalopsis pulchella* Cresson and *E. similis* Cresson. In addition, species that are known only from tropical Florida, such as *Hylaeus metopii* Mitchell and *Dialictus tahitensis* Mitchell, could easily turn out to be West Indian species. In general, however, there is only a small influx of West Indian species of bees into Florida, compared to many other groups of insects. This is probably due to two factors. The first is the relatively small bee fauna of the West Indies (Eickwort 1988). The second is the general life history strategy of solitary bees, which is not suited to casual long-distance colonization. Individual females produce only a few offspring, which may easily become separated if there is any dispersal by adults.

**Exotic bees in Florida.** The only exotic bees reported from Florida are *Apis mellifera*, *Megachile lanata* (Fabricius) and *M. concinna* Smith, from the Old World. Mitchell (1962) was uncertain whether *M. lanata* was established in Florida, but we have seen recently collected specimens from South Florida. Recent collections of *M. concinna* were reported by Pascarella et al. (1999). This lack of exotic bee species (about 1% of Florida species) contrasts with some other groups, such as ants, with 52 exotic species (about 24% of Florida species) known from Florida (Deyrup et al., 2000). The small reproductive potential of a female solitary bee transported to a new area may be partly responsible for this lack of exotic species. Ground-nesting species are unlikely to occur in soil of imported pots of plants. Bees such as *M. lanata* and *M. concinna* that nest in dead wood or in structures are more likely to be imported, but this may be less likely for species originating in the tropics or subtropics, as bees that attempt to forage during transport are liable to being left behind. There are more exotic bees in northern states; in Tompkins County, New York, there are ten species of accidentally introduced bees, all of which are thought to have arrived in North America as diapausing groups (Ascher, 2001). All but one of the seventeen species of bees accidentally imported and established in North America live in hollow plant stems or other preformed cavities (Ascher, 2001).

**Bees known only from Florida.** When Mitchell produced his volumes on the bees of eastern North America (1960, 1962), 23 species were listed as known only from Florida. Some of these probably occur in Georgia and Alabama as well; there are several species of bees that are listed from Florida, with the next nearest record from considerably farther north (usually North Carolina), suggesting that at the time of Mitchell's work the fauna of Georgia and Alabama were not as well investigated as that of Florida. A few species are likely to be lumped with more widespread species once the variation within these species is better known; this might, for example, reduce the number (6) of *Dialictus* known only from Florida. On the other hand, there is a good possibility that additional species will be found that occur only in Florida, especially in areas where there seem to be concentrations of

Florida endemics belonging to other groups of organisms. Areas to search would be the major inland sand ridges, the wetlands adjacent to these ridges, and various areas of the Panhandle, especially the ravines and bluffs of the Apalachicola River, the coastal scrubs, and the sandhills and ravines of the western Panhandle. *Perdita*, which already has 4 species known only from Florida, is the genus most likely to have additional species that are restricted to Florida, as its representatives are often closely associated with sandy areas in warm climates, have specialized host plant requirements and short flight seasons. Members of this genus often escape notice because of their small size, inconspicuous nests (some species "swim" to and from their cryptic nest entrances through a layer of loose sand), and rapid, wavering flight.

## The bee fauna of the Archbold Biological Station

**Diversity and biogeography.** There are 113 species of bees known from the ABS. They are distributed by family as follows: Colletidae: 17 (14%); Andrenidae: 9 (8%); Halictidae: 26 (23%); Megachilidae: 39 (35%); Apidae 22 (20%). For so large a site, 113 species is not an impressively large number. Francis Evans (1986), for example, found 134 species of bees during a two year period in a single 7.7 ha abandoned field in Michigan. The relatively small ABS fauna is probably an expression of the reduced bee fauna of south Florida, discussed above.

To an entomologist from Georgia or the Carolinas, the most conspicuous deficiency in a single genus would be in the Holarctic genus *Andrena*. There are 3 species of *Andrena* known from the ABS, compared to 13 species found in northern Florida, which is depauperate compared with Georgia, with 60 species (numbers compiled from Mitchell 1960). There are no *Andrena* known only from Florida. Additional species of *Andrena* may be found in the Florida Panhandle, but the total number of species will remain low compared to that of Georgia. Species in the genus *Colletes* are quite similar to *Andrena*, being medium-sized groundnesters that are often strongly seasonal in their activity. *Colletes*, however, shows relatively little reduction through the Southeast, with the same number (16) in Georgia and Florida, and a relatively robust fauna (10 species) at the ABS. Parasitic bees associated with these two genera reflect the diversity of their hosts: at the ABS there is one species of *Nomada*, primarily parasites of *Andrena*, and seven species of *Epeolus*, primarily parasites of *Colletes*.

The other genus of Andrenidae represented at the ABS is *Perdita*, with 6 species. This may equal or exceed the number of species that occur in other sites in eastern North America. This genus, which is highly speciose in the Southwest, has its best eastern development in Florida (17 species), where there are even more species known than in North Carolina (14 species), the center of Mitchell's 38 years of collecting.

The Megachilidae is the most diverse bee family at the ABS (39 species). Most of these (18) are in the genus *Megachile*, or in the genus *Coelioxys* (10 species), parasites of *Megachile*. The records in Mitchell (1962) do not suggest that these genera diminish as one moves into Florida. There are 39 species of *Megachile* reported from Florida, 33 from Georgia; 17 Florida *Coelioxys*, 10 in Georgia. The larger number of species in Florida may reflect disproportionate collecting. Howard Weems, who set up Malaise traps in several areas of Florida and accompanied Mitchell on his collection trips to Florida, probably added enough additional species to single-handedly emphasize the bee fauna of Florida relative to that of adjacent states. *Megachile* also includes many species that nest in holes in dead wood or hollow twigs, and are therefore less affected by the lack of edaphic diversity and the problem of flooding that inhibit ground-nesting bees in the southern Peninsula.

There is larger-scale study of the bees of the Miami area (Graenicher 1930). This area has several habitats not found on the ABS, including pine rocklands, tropical hammocks, marl prairies, and coastal habitats. Graenicher was an experienced bee collector whose Miami work spanned 12 years. He supplemented his own considerable taxonomic expertise with consultation with various other specialists, including Mitchell, who updated Graenicher's 1930 names in the eastern bee manual (1960, 1962). As Graenicher noted, "The bee fauna of the Miami area is surprisingly poor, both in numbers of species and individuals." He found 60 species, distributed by family as follows: Colletidae: 6 (10%); Andrenidae: 2 (3%); Halictidae: 12 (20%); Megachilidae: 25 (42%); Apidae: 15 (25%). Of these species only 13 do not occur at the ABS: 4 halictids, 5 megachilids and 4 apids. There are 66 species that occur at the ABS but were not found in Graenicher's study: 11 colletids, 16 halictids, 7 andrenids, 19 megachilids, 12 apids. It should be noted that

Graenicher's collection notes imply that he collected almost all his specimens individually on flowers, and did not use traps. As mentioned above, traps seem to be indispensable for obtaining an exhaustive site list of bees. Even if, however, Graenicher's list omits as many as 20 or 30 of the species actually present in the Miami area, it would still show the decrease in bee diversity that occurs in south Florida.

More recently, Pascarella et al. (1999) published lists for four sites in Everglades National Park. A two-year study produced 33 species in the Flamingo area, 51 at Long Pine Key, 38 at Chekika, and 22 at Shark Valley. Pascarella et al. suggest that a lack of well-drained, sandy nesting sites may help explain the depauperate fauna in these areas. Shark Valley, for example, is almost entirely marsh with small islands of tropical hammock. The tram road provides the only elevated open area. The larger bee fauna at Long Pine Key may be due to its higher elevation above the water table and richer flora. The proportions of bees in the four families found in the Everglades are similar to those at the ABS: Colletidae: 6 (10%); Halictidae 13 (21%); Megachilidae: 28 (44%); Apidae 16 (25%). In the Everglades fauna of 63 species, 14 species are not known from the ABS; the ABS has 62 species not known from the Everglades.

### Habitat changes at the ABS that might affect bees

**Natural habitats.** Most of the ABS is composed of various habitats that are believed to be in relatively natural states. These habitats are described above in the section on "site description and methods." This does not mean that the ABS is exactly the way it was a thousand years ago. When the area that was to become part of the ABS was embedded in a much larger landscape of natural habitats, some parts of the site were wetter because there were no drainage ditches cutting across watersheds, and the north end of the site was adjacent to a large seasonally flooded forest. The biggest difference was probably in the scale of the fires that swept across the area, unimpeded by the roads, firelanes, citrus groves and housing developments that now occupy much of Highlands County. As the ABS is increasingly becoming an island of natural habitats surrounded by man-made habitats, it is not practical or advisable to simultaneously burn the whole property, or even a large percentage of it. To do so could severely affect populations of species that must recolonize recently burned areas, or eliminate species that are only in recently burned areas. The ABS is managed like a microcosm of a larger landscape, with, for example, small acreages of recently burned flatwoods adjacent to small areas of flatwoods that burned four years ago. Since more habitat variations are compressed into a smaller area, there could be a greater diversity of species of bees than would have occurred on the site at any one time in the past.

**Disturbed habitats.** Although most of the ABS is in natural habitats, there are disturbed areas that have weedy plants that are rare or absent in natural habitats. These are not always exotic species; *Heterotheca subaxillaris* (17 species of bees recorded from ABS) and *Bidens alba* (35 species recorded from the ABS) are both native, disturbed-site species (Wunderlin 1998). There are other examples of native, weedy species that are visited by bees, as well as exotic, disturbed-site species such as *Hyptis verticillata* (9 species of bees recorded from ABS). Since these disturbed habitats are concentrated around the buildings and roads of the ABS, bees on these weedy plants are particularly likely to be collected.

### Special features of the ABS fauna

**Endemism in the local fauna.** Several groups of insects show local endemism associated with Florida scrub habitat on the Lake Wales Ridge, where the ABS is situated (Deyrup 1900). There are no bees that clearly show this pattern. At the ABS there is one species of *Colletes* and one species of *Osmia* that appear to be undescribed. Although these may be local endemics, it is also possible that they are more widely distributed in sandy uplands of Florida.

**Proportions of parasitic species.** In 1987 Wcislo published a paper that includes a discussion of the percentage of parasitic bees as a function of latitude, showing that there tends to be a higher proportion of parasitic species in the fauna of temperate areas in both the Old and New World (excluding Australia). The ABS fauna known at the time (74 species) was included in this analysis: there were 20 known parasitic species, or 27%, a somewhat higher percentage than expected. Currently there are 26 parasitic species known from the ABS, and the percentage has fallen to 23 %, similar to that of two other intensively collected sites listed by Wcislo: Carlinville, Illinois (24%), and the George Reserve, Michigan (24 %). The well-

collected state of North Carolina (thanks to Mitchell) also has a 24% parasitic bee fauna (numbers derived from Mitchell 1960, 1962). The ABS, therefore, in spite of its southern location, has the pattern of parasitism of other well-known sites in the East and Midwest, and at the community level, as well as the taxonomic level, shows no affinity to the fauna of the tropics and subtropics. Data on the percent of parasitic bees in the fauna can be influenced by the intensity and methods of collecting. Parasitic species usually spend little time on flowers, compared to non-parasitic species, but may be readily collected in traps. The reduction in the known percentage of parasitism at the ABS between 1987 and the present probably reflects an increased emphasis on collecting on flowers, and a decreased emphasis on collecting with Malaise traps.

**Specificity in relationships between bees and plants at the ABS.** Specialized mutualistic relationships might seem more efficient than general mutualistic relationships because they allow precise co-evolution of floral structures and bees, and seasonal synchronization of life cycles. Such relationships, however, come at the expense of a reduction in the number of possible relationships. In the compilation of 113 species of bees and 153 floral hosts at the ABS there is no clear indication of an exclusive relationship: there is no plant with a series of visitation records of only one species of bee that is only found on that one species (or group of related species) of plant. Most species of plants at the ABS that are visited by bees do not have an exclusive relationship with bees as a group. When bees are collected from flowers at the ABS there is a simultaneous attempt to sample other flower visitors, especially flies and wasps. In many cases, bees account for only a small proportion of the diversity of the visitors. *Serenoa repens* is an extreme example: it is visited by 27 species of bees at the ABS, and by over 200 species of insects in other groups.

The specificity between species of bees and species of flowers at the ABS often seems to be asymmetrical: one member of the partnership is much more dependent than the other. The various kinds of asymmetries can give some insight into the structure of pollinator systems within communities. Unfortunately, it is usually difficult to be sure of the relative strengths of relationships without doing a tricky quantitative study of individual species pairs. Showing, for example, that, at the ABS, *Colletes banksi* is much more dependent on gallberry (*Ilex glabra*) for food (high level of specialization) than *I. glabra* is dependent on *C. banksi* for pollination (low level of specialization) would require much effort. It would be necessary to intercept *C. banksi* approaching some patches of female flowers and not others, and later count seed set, in order to measure the dependence of the plant on the insect. There is the additional problem that the number of bees is likely to vary from patch to patch of gallberry, depending on the location of nesting sites, and there are also likely to be annual fluctuations in bee abundance and flower production. It would also be necessary to collect and identify the pollen from *C. banksi* returning to their burrows in areas where gallberry is present, as well as in areas where gallberry is absent, if *C. banksi* can be found in such areas. Sometimes, however, one can make a reasonable qualitative estimation of the relative strengths of relationships by simple examination of flower structure and general observations of flower visitors and their behavior.

At the ABS, the buzz-pollinated legume *Chapmannia floridana* appears to be strongly dependent on only a few species of pollinators: *Bombus impatiens*, and metallic green halictids, especially *Augochloropsis metallica* (Mayfield 1998). These same bees seem to be the primary visitors at the ABS of *Chamaecrista fasciculata*, another buzz-pollinated flower. No detailed work has been done on this plant at the ABS, but in Oklahoma the primary pollinators are bees of the genera *Bombus*, *Xylocopa*, and *Svastra* (Thorp and Estes 1975). *Chamaecrista fasciculata* is specialized for pollination by large bees: an asymmetrical arrangement of petals guides large bees to a landing site where they buzz to vibrate out pollen from ten anthers, two of these are elongated and positioned to apply pollen to the sides of the bee where, the pollen will come into contact with the deflexed stigma of another flower (Wolfe and Estes 1992). Green halictids visit the flowers and vibrate out the pollen by buzzing, but they are too small to contact the stigma, and should be considered as pollen robbers (Thorp and Estes 1975). The bees that visit these plants at the ABS visit flowers of many other species of plants, have flight periods months longer than these flowers are available, and occur on parts of the ABS where the plants are rare or absent. Clearly, these two plants have a much more specific dependency than do their pollinators. Both *Chapmannia floridana* and *Chamaecrista fasciculata* have one-day flowers that open before sunrise and fade early, *Chapmannia* usually fades before 9:00 AM, *Chamaecrista* before noon. Bumble bees, in particular,

appear before sunrise to take advantage of the newly presented pollen.

These two buzz-pollinated plants have generalist insects that act as specialists, a common strategy for insect-pollinated plants. The various mechanisms include special timing of presentation of nectar and pollen, special handling techniques that the gatherer must learn, and a distinctive (yet clearly floral) shape, color or odor that form a unique search image for visiting insects. While co-dependent relationships are strong and efficient, it is much safer for plants to have common and widespread insects to act as specialists through flower constancy than it is to develop a co-dependency with a single species. At the ABS there are major perturbations in natural communities, caused by floods, fires, droughts, and severe freezes. Communities with major perturbations should not favor co-dependent relationships between species pairs of insects and flowers. Having common and widespread insects as specialist pollinators is an example of how complex and flexible solutions to problems may be favored in unstable biological systems.

*Nuphar lutea* is another plant that may be dependent on only a few species of insects for pollination at the ABS, especially *Evylaeus nelumbonis*, but this is not well documented, since several species of flies and beetles also occur in the flowers. The flowers of *N. lutea* have only a narrow opening through which insects enter and exit, and we have the impression that male *E. nelumbonis* may lie in wait in the flowers for females, which cannot easily escape through the opening. *Nuphar lutea* and its insect visitors would make an interesting study.

At the ABS there appear to be several asymmetrical relationships in which a species of bee is heavily dependent on one or two plant species that are visited by many other insects (including other species of bees). *Lithurgus gibbosus* is dependent on pollen from *Opuntia* cactus (Hurd 1979), and all ABS records of pollen-carrying females are from *O. humifusa*, the only cactus on the ABS. *Andrena fulvipennis* at the ABS occurs almost exclusively on the abundant *Pityopsis graminifolia*; there are records from the closely related genus *Heterotheca*, but this genus occurs in only a few places on the ABS. *Andrena fulvipennis* seems to specialize on yellow-flowered Asteraceae throughout its range (Hurd 1979). *Perdita bequaerti* seems strongly dependent on *Balduina angustifolia* and *Palafoxia feayi*; both species are in the Asteraceae, but they are not closely related or similar in appearance. *Balduina angustifolia* is a biennial and facultative annual that is abundant some years at the ABS, scarce in other years; *P. feayi* is more dependable. The range of *P. bequaerti* extends north beyond the range of these two plants, and it is known to visit other plant species (Hurd 1979). *Perdita floridensis* and *Colletes banksi* may be dependent on *Ilex glabra* at the ABS; both species are known to also visit *Vaccinium arboreum* Marsh (Ericaceae) elsewhere (Mitchell 1960). Several other species in the genera *Perdita*, *Andrena*, and *Colletes* may also prove to be oligolectic at the ABS. As far as we know, the southern Lake Wales Ridge does not have any endemic bees, but it is nevertheless the kind of area in which speciation in bees might occur, since it is peripheral to the main ranges of a number of species, and the reduced number of available hosts might lead to irreversible specialization in foraging, seasonal synchronization, habitat preference, and mating sites.

At the community level, future studies might show that many species of bees in areas with a low diversity of plants that offer nectar and pollen are forced to be serially oligolectic. Although this seems a logical outcome of reduced floral diversity, the research involved would be difficult, involving simultaneous studies of pollen collection and the seasonality of both plants and bees. Bees that are serially oligolectic would be more vulnerable to local extirpation than one might suppose from examination of a list of their floral hosts.

**Bees that do not significantly benefit their floral hosts at the ABS.** A number of species of bees at the ABS do not always function as pollinators. This is certainly true of bees that collect pollen from the catkins of oaks (*Quercus* spp.), which are wind pollinated. These bees do not visit the female flowers, so there is unlikely to be any incidental pollination. Oak pollen is collected at the ABS by species of colletids and halictids, and also by bumble bees and honey bees. It is not clear how important oak pollen is to native bees. We have relatively few records, but there are so many oaks blooming at once in spring that the foraging bees may be diluted rather than uncommon. It is unlikely that these native bees are numerous enough to depress acorn production. Honey bees, however, often aggregate in the thousands on flowering oaks, especially on individual trees that bloom early, appearing day after day during the short blooming period of the tree. It seems possible that honey bees depress acorn production on early-blooming oaks at the ABS. It reveals something about the persistence of

opportunistic ecological relationships that an exploitative, probably primitive type of relationship between bees and wind-pollinated plants can be found today in modern communities that also have great numbers of plants and insects whose pollination ecology is strongly mutualistic.

Some bees collect nectar or pollen without transferring pollen to the stigma. This often happens when small bees visit large flowers, as in the case of *Chamaecrista fasciculata*, mentioned above. *Dicerandra frutescens* at the ABS provides a documented case of a species that seems to benefit little from the visits of bees. It is regularly visited by a number of bees, including the nectar-robbing *Caupolicana electa*. A study of the pollination ecology of this plant, however, shows that bees do not seem to be significant pollinators, and a single species of large fly in the family Bombyliidae accomplishes most of the pollination (Deyrup and Menges 1997). The fly visits a large number of different hosts and occurs in many areas where *Dicerandra frutescens* does not occur. This is a fly-based pollination system that involves training a generalist species to act as a specialist, as in the bee-based systems of *Chapmannia* and *Chamaecrista*.

*Perdita floridensis*, which is usually found on the shrub *Ilex glabra*, may be an example that shows how specialization in a bee species may have little to do with pollination of a flower. The population of *Ilex glabra* that occurs on the ABS is dioecious, and the *Perdita* seem to concentrate on the male plants, where they can collect both nectar and pollen. It seems logical that these bees would have little incentive to visit the female plants, and it may well turn out that this locally specialized bee should be considered a pollen and nectar robber, rather than a mutualistic partner of the plant. *Ilex glabra* is visited by many other species of insects, and it is unlikely that seed set is significantly affected by the activities of the tiny *Perdita floridensis*, which does not seem to be an abundant species in most areas of the ABS.

Dioecious, insect-pollinated plants may face special difficulties with a tendency among bees to visit only male plants. Another probable example at the ABS is *Paronychia chartacea*, which, as can be seen from the list above, is visited by species of *Dialictus*. These visit only male plants, and, as this plant produces no nectar, female plants are not attractive even to male bees (pollination seems to be accomplished by small flies, which visit both sexes of plants for unknown reasons). An ideally adapted, bee-dependent dioecious plant might produce pollen on male plants, nectar on female plants, but there seem to be no examples of this on the ABS. It might be a revealing exercise at the ABS to concentrate bee collecting on a few dioecious plants, such as *Rhus copallina*, *Smilax auriculata* and the two species mentioned above to quantify any difference in visitation rates on male and female plants.

**Indications of ABS plants that produce deficient or unattractive pollen.** Although several bees at the ABS collect pollen from oaks, there are no records of bees collecting pollen from several other abundant wind-pollinated plants. These include *Pinus* spp., *Ceratiola ericoides*, and common grasses in the genera *Aristida*, *Panicum*, and *Andropogon*. Perhaps the pollen of these species is too dry to gather and collect, or perhaps it is deficient or repellent. The pollen of oak may itself be deficient in some way, as there are no bees at the ABS that seem to depend exclusively on oak pollen. Although individual oak trees have a short blooming period, perhaps about two weeks, both within species and between species there is great variation at the ABS in time of blooming of oaks, so that oak pollen would be available for at least two months, from mid- to late February to mid- to late April. Oak pollen is an enormous pollen resource at the ABS, and throughout much of North America. There are a number of published records of native bees, most in the genus *Andrena*, that collect oak pollen (Hurd 1979), but all these species, like the oak-visiting bees of the ABS, are generalists that visit a large variety of plants in other genera and families.

A possible example of another ABS plant with pollen that may have deficiencies or repellents is saw palmetto, *Serenoa repens*. Honey bees and a few halictids gather pollen of saw palmetto at the ABS, but most of the native bees on flowers of this plant are taking nectar only. Scrub palmetto (*Sabal etonia*), which begins to bloom toward the end of the blooming period of saw palmetto at the ABS, is visited much more intensively by pollen-gathering bees. Adjacent flowering plants of these two species may show obvious differences in bee activity. This contrast has not been studied, nor is there anything known about saw palmetto pollen that would make it unattractive to most bees. Investigating the pollen quality of such a dominant Florida plant would make an rewarding project for a student with an interest in pollination ecology.

**Native bees on exotic plants at the ABS.** The flexibility of many bees is demonstrated by their ready acceptance of flowers of a number of

exotic plants, as documented by Evans (1986), who found that several of his "principle resource" plants were exotics. The preceding list of 153 plants includes 16 exotic species that are visited by bees at the ABS. Seven of these plants belong to genera that lack any native Florida species. Two exotic plants have more records of bee visitors at the ABS than most native species: *Ludwigia peruviana* (19 species) and *Parkinsonia aculeata* (22 species). There is one bee, the parasitic *Sphecodes banksii,* that is known at the ABS from one specimen collected on an exotic plant, but there are no pollen-gathering species known only from exotics.

**Honey bees at the ABS.** The European honey bee is the only exotic bee known from the ABS. Colonies are no longer kept on the grounds, and feral colonies seem to have become scarce since tracheal and varroa mites became established in the area. In winter and spring large numbers of hives are positioned just outside the ABS borders, providing honey bees with total access to the ABS. In late April and May most of these hives are usually removed, but smaller numbers of honey bees occur throughout the year. Honey bees are recorded from over 40 species of hosts at the ABS. The records of numbers of individuals taken on a host are minimal because there is no need to collect specimens in order to identify them, as, for example, in the case of most species of *Megachile.* It would be easy to collect hundreds of honey bees in a single morning on some plants, such as *Ilex glabra.* Early in the year, honey bees dominate any large source of nectar or pollen, such as *Vaccinium* spp., *Quercus* spp., *Ilex glabra* and *I. cassine*, *Serenoa repens* and *Sabal etonia.*

Native bees and some other flower-visiting insects are often wary of other insects, especially those as large as a honey bee, and honey bees may displace other insects on flowers. The effect of honey bees on populations of other flower-visiting insects at the ABS is unknown, and this subject could not easily be studied. It is likely that populations of many species of flower-visiting insects are limited by factors other than competition for nectar and pollen. Such factors might include scarce nesting sites, natural enemies, and the amount of time and effort that it takes to construct and provision the nest. It is difficult, however, to imagine any way in which honey bees could benefit native bees at the ABS.

The effects of honey bees on the plants at the ABS is likewise unknown. Because of their large numbers and their heavy requirement for pollen, and almost unlimited requirement for nectar (which is periodically removed as honey from the hive by beekeepers), honey bees are among the most persistent foragers for both nectar and pollen. It is difficult to believe that such a large number of insects methodically visiting such a large number of flowers has no effect. Even if honey bees were shown to increase seed set of certain native plants, they would still be changing the balance of natural pollinator systems. Therefore, they would still be unwelcome at a site such as the ABS where a primary goal is preservation of natural ecosystems.

**Bees and mimetic complexes at the ABS.** Mimetic complexes are community-based phenomena: a local group of potential prey is communicating with a local group of potential predators. Mimetic complexes can vary from one area to another, perhaps depending on the prevalence and relative potency of particular defended species that serve as models, and the type and perceptions of potential predators. Natural selection presumably operates most readily on characters that are already variable, and easily modified without affecting the basic design of the organism; this may be why mimetic complexes are often based on such features as amount and color of pilosity, color patterns of the integument, and behavior. Most complexes that include bees at the ABS are widespread. The metallic green halictids are an example of such a complex, which occurs throughout North America and into the tropics. At the ABS, chrysidid wasps, several calliphorid flies, and the male green halictids are possible Batesian mimics of female green halictids. Bees of the genera *Bombus*, *Xylocopa*, *Svastra* and *Habropoda* form a small local complex, with *Mallophora* asilids as Batesian or Mullerian mimics. There is a large group of ABS insects that are black with a red abdomen. This includes several species of *Sphecodes* (females only), *Hylaeus volusiensis* and *H. graenicheri*, and perhaps the orange-tinted species *Dialictus nymphalis* and *Perdita polygonellae.* This complex includes about 90 additional species at the ABS; with the exception of *D. nymphalis*, the bees in this complex at the ABS are uncommon and probably of little importance as models. There is another complex, centered on the eumenine wasps, that involves dark red bands and spots on a black background, including markings on both the thorax and abdomen. Most of the insects involved sting, so this may be generally considered a 50% Mullerian system, with the males Batesian. A special feature of this complex is that in northeastern North America many of the species

are yellow and black (or there are closely related yellow and black species), with orange tones appearing in the Southeast, and a red and black pattern in Florida. Examples of this in the bees are *Dolichostelis louisae* and *Anthidiellum notatum*, both of which have Florida subspecies based largely on color. *Dianthidium floridense* and *Anthidiellum perplexum* are examples of Florida red and black species that have northern yellow and black relatives. The familiar and widespread pattern of a black abdomen with yellow bands (usually with yellow markings on the thorax) occurs in some ABS bees, including four species of *Perdita*, *Anthidium maculifrons*, and the male of *Agapostemon splendens* (which has a metallic green thorax). This pattern also occurs in other insect groups at the ABS, although it is less common than the variations on red and black. A more detailed study on mimetic complexes at the ABS is in preparation.

Most individuals and species of bees at the ABS show no warning coloration that is obvious to human eyes. Most species are blackish, usually with some pale pilosity on the mesonotum, and narrow white or silvery bands on the abdomen. Many sphecid wasps at the ABS are similarly marked. Perhaps there are conspicuous, ultraviolet-reflecting patterns that we do not perceive as conspicuous, or perhaps these species rely on behavioral cues to warn potential predators. It is also likely that these insects have a suite of residual predators that are undeterred by stings or other defenses. Anybody who has collected bees and wasps on flowers has discovered that most species of bees and wasps are wary and take flight readily. The modest black and pale coloration might be a compromise between no warning coloration and excessive conspicuousness.

**General abundance of bees at the ABS.** We hope that this paper will encourage more entomologists and botanists to study bees at the ABS, and we will be happy to provide advice to anybody who wishes to work at this site. It would be an excellent site to study in detail some species of bees and some bee-flower relationships. It should be admitted, however, that a perusal of the lists of bees and flower relationships should not be lightly used to plan a research program that requires hundreds of different bee-flower relationships, perhaps in some complex study of competition between plant species for pollinators. Bees are often difficult to find on the ABS in large numbers or diversity, a phenomenon that has struck several visiting specialists, as well as the authors themselves. Large patches of flowers can be found that are not being visited by bees, or are visited by only a few bees, even though the cumulative list of bee species known to visit those flowers on the ABS may include fifteen or twenty species. We have not thought of any easy way to compare the overall abundance of bees on the ABS with any other site, but our impression is that the abundance of bees is relatively low compared with sites where we have collected in the Northeast, the Mid-Atlantic States, and the Southwest.

## Acknowledgements

We are grateful to Karl Krombein for collecting, identifying, and providing biological information on ABS bees; to Terry Griswold, Wallace LaBerge, George Eickwort, Paul Hurd, Jr., Roy Snelling, Brian Danforth, Lionel Stange, James Wiley, and R. W. Dawson for identification of specimens; to Andrew Schreffler, James Cronin, Robert Shumate, Byron Alexander and Thomas Pliske for collecting and depositing specimens in the ABS collection; to Howard Weems, Jr., for organizing the Malaise trap study in 1973, to Sylvia Halkin, Cathy Harris, Thomas Webber and Lisa Klein for collecting and preparing specimens from this trap, and to James Wiley for sending out specimens for identification and returning them to the ABS; to Suzanne Batra, John Ascher and Hilary Swain for suggestions on the manuscript. Jayanthi Edirisinghe's work at the ABS was supported by a Fulbright Scholar Program Research Award.

## Literature cited

**Abrahamson, W. G., A. F. Johnson, J. N. Layne, and P. A. Peroni.** 1984. Vegetation of the Archbold Biological Station, Florida: an example of the southern Lake Wales Ridge. Florida Scientist 47: 209-250.

**Ascher, J. S.** 2001. *Hylaeus hyalinatus* Smith, a European bee new to North America, with notes on other adventive bees (Hymenoptera: Apoidea). Proceedings of the Entomological Society of Washington 103: 184-190.

**Batra, L. R., S. W. T. Batra and G. E. Bohart.** 1973. The mycoflora of domesticated and wild bees (Apoidea). Mycopathologia et Mycologia Applicata 49: 13-44.

**Brach, V.** 1978. Notes on the biology of *Lithurgus gibbosus* Smith in Florida (Hymenoptera: Megachilidae). Bulletin of the Southern California Academy of Sciences 77: 144-147.

**Deyrup, M.** 1990. Arthropod footprints in the sands of time. Florida Entomologist 73: 529-538.

**Deyrup, M.** 1994. Ants, Bees and Wasps. Pp. 713-734 *in* M. Deyrup and R. Franz, eds. Rare and endangered biota of Florida. IV. Invertebrates. University Presses of Florida, Gainesville, FL. xxx + 798 pp.

**Deyrup, M., L. Davis, and S. Cover.** 2000. Exotic ants in Florida. Transactions of the American Entomological Society 126: 293-326.

**Deyrup, M., and E. S. Menges.** 1997. Pollination ecology of the rare scrub mint *Dicerandra frutescens* (Lamiaceae). Florida Scientist 60: 143-157.

**Eickwort, G. C.** 1988. Distribution patterns and biology of West Indian sweat bees (Hymenoptera: Halictidae). Pp. 231-253 *in* Liebherr, J. K., ed., Zoogeography of Caribbean insects. Cornell University Press, Ithaca, NY. 285+ix pp.

**Evans, F. C.** 1986. Bee-flower interactions on an old field in southeastern Michigan. Pp. 103-109 *in* Clambey, G. K., and R. H. Pemble, eds. The Prairie: past, present and future. Proceedings of the Ninth North American Prairie Conference. Tri-College University Center for Environmental Studies. Fargo, NC, Moorhead, MN.

**Graenicher, S.** 1930. Bee-fauna and vegetation of the Miami region of Florida. Annals of the Entomological Society of America 23: 153-174.

**Hurd, P. D., Jr.** 1979. Superfamily Apoidea. Pp. 1741-2209 *in* K. V. Krombein, P. D. Hurd, Jr., D. R. Smith, and B. D. Burks, eds., Catalog of Hymenoptera in America north of Mexico. Vol. 2. Smithsonian Press, Washington, D.C.

**Krombein, K. V.** 1967. Trap-nesting wasps and bees: life histories, nests, and associates. Smithsonian Press, Washington, D.C. 570 pp.

**Krombein, K. V., and B. B. Norden.** 1995. Notes on the behavior and taxonomy of *Megachile (Xeromegachile) brimleyi* Mitchell and its probable cleptoparasite, *Coelioxys (Xerocoelioxys) galactiae* Mitchell. (Hymenoptera: Megachilidae). Proceedings of the Entomological Society of Washington 97: 86-89.

**Krombein, K.V., and H. K. Townes.** 1951. Hymenoptera of North America, Synoptic Catalog. USDA Agricultural Monograph 2. 1420 pp.

**Marlin, J. C., and W. E. LaBerge.** 2001. The native bee fauna of Carlinville, Illinois, revisited after 75 years: a case for persistence. Conservation Ecology 5: 9. (online) URL: http://www.consecol.org/vol5/iss1/art9

**Mayfield, M. M.** 1998. Pollinators of *Chapmannia floridana* (Fabaceae) and their foraging preferences. Florida Entomologist 81: 489-496.

**Michener, C. D.** 1951. Family Halictidae. Pp. 1104-1134 *in* Meusebeck, C. F. W., K. V.

**Michener, C. D.** 1979. Biogeography of the bees. Annals of the Missouri Botanical Garden 66: 277-347.

**Michener, C. D.** 2000. The Bees of the World. John Hopkins University Press, Baltimore. xiv + 913pp.

**Mitchell, T. B.** 1960. Bees of the Eastern United States. Vol. 1. North Carolina Agricultural Experiment Station Technical Bulletin. 141: 538pp.

**Mitchell, T. B.** 1962. Bees of the Eastern United States. Vol. 2. North Carolina Agricultural Experiment Station Technical Bulletin 152: 557pp.

**Moure, J. S., and P. D. Hurd, Jr.** 1987. An annotated catalog of the halictid bees of the Western Hemisphere. Smithsonian Press, Washington, D.C. vii+405 pp.

**Norden, B. B., K. V. Krombein, and B. N. Danforth.** 1992. Taxonomic and bionomic observations on a Floridian panurgine bee, *Perdita (Hexaperdita) graenicheri* Timberlake (Hymenoptera: Andrenidae). Journal of Hymenoptera Research 1: 107-118.

**Pascarella, J. B., K. D. Waddington, and P. R. Neal.** 1999. The bee fauna (Hymenoptera: Apoidea) of Everglades National Park, Florida and adjacent areas: distribution, phenology, and bigeography. Journal of the Kansas Entomological Society 72: 32-45.

**Scarbrough, A. G., B. D. Norden, and K. V. Krombein.** 1995. A new species of *Townsendia* Williston (Diptera: Asilidae) from Florida with notes on its association with *Perdita graenicheri* Timberlake (Hymenoptera: Andrenidae). Proceedings of the Entomological Society of Washington 97: 689-694.

**Thorp, R. W., and J. R. Estes.** 1975. Intrafloral behavior of bees on flowers of *Cassia fasciculata*. Journal of the Kansas Entomological Society 48: 175-184.

**Wcislo, W. T.** 1987. The roles of seasonality, host synchrony, and behavior in the evolutions and distributions of nest parasites in Hymenoptera (Insecta), with special reference to bees (Apoidea). Biological Review 62: 515-543.

**Webb, S. D.** 1990. Historical Biogeography. Pp. 70-100 *in* Myers, R. L., and T. T. Ewel, eds. Ecosystems of Florida. University of Central Florida Press, Orlando. 765 pp.

**Wolfe, A. D., and J. R. Estes.** 1992. Pollination and the function of floral parts in *Chamaecrista fasciculata* (Fabaceae). American Journal of Botany 79: 314-317.

**Wunderlin, R. P.** 1998. Guide to the vascular plants of Florida. University Press of Florida, Gainesville. x + 806 pp.