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Authors: Hall, H. Glenn, and Ascher, John S.

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SURVEYS OF BEES (HYMENOPTERA: APOIDEA: ANTHOPHILA) IN NATURAL AREAS OF ALACHUA COUNTY IN NORTH-CENTRAL FLORIDA

H. GLENN HALL[1] AND JOHN S. ASCHER[2]
[1]Department of Entomology and Nematology, University of Florida, Gainesville, FL 32611-0620
E-mail; hgh@ufl.edu

[2]Division of Invertebrate Zoology, American Museum of Natural History, New York, NY 10024-5192
E-mail; ascher@amnh.org

ABSTRACT

Bee surveys were conducted in Alachua County, Florida, at 1 to 6 sites within each of 4 natural areas including 2 large state preserves. Bees were collected passively with colored cups and actively with nets. A total of 2,590 bees were captured belonging to 34 genera and 111 species. Of the 5 bee families found, Apidae was represented by the most species, whereas the 6 most numerous species were Halictidae. Six species are new state records for Florida. Males of the rarely-collected Florida endemic bee *Stelis ater* Mitchell were discovered, and this species is reported for the first time as a cleptoparasite of *Osmia chalybea* Smith, confirmed by rearing from trap nests. Other potential new host-parasite associations are discussed. Bee species lists and ecological patterns are compared with those from previous surveys in southern Florida. Distinctive characteristics of the north-central Florida bee fauna are discussed including the presence of both northern and peninsular species, subspecies, and populations.

Key Words: native bees, bee bowls, trap nests, cleptoparasitic bees

RESUMEN

Información acerca de la diversidad de abejas nativas en áreas naturales de la región Nor-Central del estado de Florida es limitada. Con el objetivo de disminuir este vacío, se llevó a cabo muestreos de abejas en 1 a 6 sitios dentro de cuatro áreas naturales, incluyendo dos reservas estatales, localizadas en el condado de Alachua. Se utilizó un método pasivo de colecta con contenedores plásticos de colores y un método activo con redes entomológicas. Se capturaron 2590 abejas en total, pertenecientes a 34 géneros y 111 especies. De las 5 familias documentadas, la familia Apidae fue la más especiosa, mientras que las seis especies más abundantes pertenecieron a la familia Halictidae. De las especies atrapadas seis no han sido reportadas anteriormente en el estado de Florida. Además, fueron descubiertos machos de la especie endémica y raramente colectada *Stelis ater* Mitchell. Por primera vez se reporta a esta especie como cleptoraparásito de *Osmia chalybea* Smith; hallazgo verificado a través de su crianza en trampas nido. Se enumeran en esta publicación otras asociaciones parásito-hospedero, las cuales podrían ser nuevas. Las listas de especies de abejas y sus rangos de distribución son comparados con muestreos previos realizados en el sur de Florida. Las características distintivas de las especies del área Nor-Central de Florida son discutidas, incluyendo la presencia de especies norteñas y peninsulares, subespecies, y poblaciones.

Translation provided by the authors.

To understand ecosystems, the biodiversity responsible for their function must be documented. Pollinators are an essential component of terrestrial ecosystems and of agricultural production. They are needed for the reproduction of three-quarters of the world's flowering plants, which includes a large proportion of the food for wild vertebrates and two-thirds of the crop species (Committee on the Status of Pollinators in North America 2007). Because bees collect pollen as their source of protein, they are overall the most efficient and important pollinators (Michener 2007). Agricultural crops that require pollination are largely dependent on the honey bee *Apis mellifera* L. Beyond their vital importance in natural communities, native bees contribute significantly to agricultural pollination (Hurd & Linsley 1964; Cane & Payne 1988; Thorp 2003; Torchio 2003; Pascarella 2007; Winfree et al. 2008). Native bees can be diverse in agricultural systems (Tuell et al. 2009) and can potentially have a much greater role in crop pollination, especially in light of recent honey bee losses (Winfree et al. 2007).

Natural bee populations and even species, especially endemic species, are threatened by several factors. The major threat is the loss of natural habitat, including nesting sites and floral resources, due to land development and agricultural intensification (Buchmann & Nabhan 1996; Allen-Wardell et al. 1998; Kearns et al. 1998; Kremen et al. 2002; Klein et al. 2007; Goulson et al. 2008). The expansion of large-scale industrial agriculture eliminates natural areas, along with the associated bee diversity responsible for pollination services that provide stability for the human food supply. Thus, conservation and restoration are "crucial to the preservation of pollinator populations and diversity" (Committee on the Status of Pollinators in North America, 2007).

More than 19,500 described species of bees are known world-wide, about 3,500 of which occur in the United States and Canada (Ascher & Pickering 2010). Much remains to be learned about bee taxonomy, distribution, species richness, abundance, natural history, and floral hosts. The need and importance of thorough systematic surveys to increase our knowledge of bee faunas has been emphasized (Committee on the Status of Pollinators in North America 2007). Existing natural areas, restored natural areas, farms, and other anthropogenic landscapes are all relevant sites for such studies. Ongoing monitoring is required to detect changes over time, including decline or loss of species, which might occur as a consequence of environmental disturbances and land use changes (Deyrup et al. 2002). Given the ability of bees to disperse and occupy newly available habitats, bee communities may serve as quality bioindicators when comparing restored natural land with established natural areas.

Florida is a unique place for biological studies, being a large peninsular extension of the eastern United States that extends from temperate into subtropical climates. Florida has a large diversity of natural plant communities and a major agricultural industry. The state has had an increasing human population and intense development, which have slowed recently but will likely resume in the future. Thus, there is urgency to document and preserve biodiversity in its remaining natural areas. About 320 described and several undescribed bee species have been recorded from Florida (Mitchell 1960, 1962; Deyrup et al. 2002; updated by Pascarella 2008; additional state records and updated nomenclature in Ascher & Pickering 2010). The state list for Florida is relatively well documented, but county records are fragmentary (Pascarella 2008), and only a few systematic site surveys of the bee fauna have been conducted. Graenicher (1930) studied the bees along the Atlantic coast of southeastern Florida, mainly the Miami area, extending north to Jupiter, south to Homestead, and southwest to the former Royal Palm State Park on the eastern side of what is now Everglades National Park. Pascarella et al. (2000) conducted a broader survey of bees at 4 regions within the Everglades. Their report contains a summary of bee species from the Everglades and from Dade and Monroe counties outside the park including those found by Graenicher, those listed in other published records, and present in regional museum collections. Deyrup et al. (2002) list the bee species and their floral hosts found at Archbold Biological Station on the Lake Wales Ridge, Highlands County, south-central Florida, and discuss the Florida bee fauna. Unpublished surveys at the Tall Timbers Land Conservancy (TTLC) Research Station and the St. Marks National Wildlife Refuge, north and south of Tallahassee, respectively, and the Osceola National Forest, west of Jacksonville, have been done by John Pascarella (Georgia Southern University, personal communication). Despite these multiple surveys, the bees of large areas of Florida, including major regions such as north-central Florida, have not been studied adequately.

This report documents 111 bee species in 34 genera captured in natural areas of Alachua County in the north-central region of peninsular Florida. This survey represents the first in a series that will include additional areas and different plant communities in northern Florida. Bees move between natural and cultivated areas (Kremen et al. 2002, 2004; Kohler et al. 2008; Winfree et al. 2008), so both types of landscapes are being studied.

MATERIALS AND METHODS

Collecting Methods and Preparation

Most bees were caught in colored cups filled with soapy water after being attracted to the color and drowned in the water. Translucent plastic 3.25 oz soufflé cups (Solo, Highland Park, Illinois) were used, painted either white, fluorescent yellow, or fluorescent blue as described in the "Handy Bee Manual" (Droege 2008), with several modifications. Spray paint was used (yellow and blue, respectively, Krylon® 3104 and 3107 or Ace® Brand, made by Krylon, I17052A00 and I19716A00; white, Krylon® Fusion 2320) (the inside bottom rim was first lined with a water-based paint to prevent dissolving it with the spray paint) for cups used in 2007 and later, rather than the non-spray paint recommended in the manual. The cups were hung 10 to 20 cm above the ground vegetation on custom hand-bent wires stuck into the ground. Organic-based dishwashing soap was used, (Seventh Generation™, Free and Clear, Burlington, Vermont), 2 tablespoons per gallon of water. The cups were placed about 5 m apart along curved or straight lines, alternating 4-cup groups of each color. For each collection, 24 to 48 cups were placed at a site for about 30 h. Bees were also collected by net in flight, usually while foraging on flowers, or caught with a hand-held vacuum (http://tech.groups.yahoo.com/group/bee-monitoring/files/). Collected bees were frozen, washed, and dried later as described in the "Handy Bee Manual" with minor modifications. The bees were washed by vigorous shaking in a large capped tube with soapy water for 2 min, followed by shaking in 95% ethanol for 2 min. After brief blotting of the ethanol, the bees were placed in a large small-mesh tea strainer, with a fashioned metal lid, and vigorously shaken for 1.5 min over a hair-dryer at a low heat setting.

Trap nests were either bundles of blocks (3/4" square 6" long) with drilled holes ranging in diameter from 1/8" to 3/8" or commercially available 14-hole, 5/16" diameter, "Binderboard®" nests (www.pollinatorparadise.com/).

Collection Areas and Sites

This study surveyed bees in 4 natural areas of Alachua County, Florida: Kanapaha Prairie (3 sites), Paynes Prairie Preserve State Park (6 sites), San Felasco Hammock Preserve State Park (6 sites), and the University of Florida Natural Area Teaching Lab (1 site). Generally, most of the sites were sampled once a month from May through Oct, 2006, and Mar and Apr, 2007. Some sites were sampled late Feb and mid Nov. A few other sites were determined to be less favorable and sampled only once or twice. Table 1 lists the sites within the areas, their abbreviations, their geographical coordinates (from Google Earth), and the months and numbers of times when sampled. The areas and sites therein are described below as the natural communities defined by the Florida Natural Areas Inventory (www.fnai.org/natcomguide_update.cfm). In the following descriptions, "adjacent" means within 50 m; "near" or "nearby" means within 500 m.

Kanapaha Prairie (KP) is about a 300-ha basin marsh largely owned by the Conservation Fund. It is surrounded by mesic hammock dominated by large Live Oaks (*Quercus virginiana* Mill.) in which there are homesites of 5 to 10 ha. Portions of the prairie periodically flood. Much of the prairie had been pasture of imported Bahia Grass (*Paspalum notatum* Flüggé) and is still used for cattle grazing. Site W (West) is along the higher and drier elevations of the prairie adjacent to the hammock, distant from the cattle grazing area, and that has largely returned to a natural state. Site R (Road) is deeper within the basin marsh along a road and ditch between the grazed and a more natural part of the prairie. Site S (South) is along a road south and outside of the prairie, adjacent to the mesic hammock and former pasture. Ruderal areas and some homesites are nearby.

NATL (The University of Florida Natural Area Teaching Laboratory, http://natl.ifas.ufl.edu/) is a 24-ha area at the southwest corner of the main Gainesville campus. Major roads and building complexes border 2 sides of the lab area. Collections were in an area of about 2 ha of open field of herbaceous and woody vegetation. Half-hectare plots represent different succession time periods between prescribed burns and cutting. Adjacent are upland mixed forest, upland pine forest, and a retention basin.

Paynes Prairie Preserve State Park (PP) is a 8,500-ha area, predominantly a large basin marsh which periodically floods and drains through Alachua Sink. Two sites on the south side, TW and BB (Tower and Bolen Bluff), are on the wet prairie margin between the lower basin marsh and the upland mixed forest. Site NE (Northeast) on the north side and site LT (Lake Trail) on the south side, both about 2 km from the basin boundary, are former pasture, cleared from what was originally sandhill and upland pine forest, adjacent to existing upland mixed forest and upland pine forest, respectively. Site PW (Pine Woods) is within mesic flatwoods. Site RS (Restored), about 3 km from the south edge of the basin marsh, is being restored to its former sandhill community and is adjacent to upland pine forest, floodplain forest, and mesic flatwoods and near upland mixed forest, baygall, and a small basin marsh.

San Felasco Hammock Preserve State park (SF) is about a 2,800-ha, mostly forested, natural area. Sites SH (Sandhill) and PL (Pine Land) are in sandhill communities, adjacent to surrounding upland pine forest and near upland mixed forest beyond. Sites NS and EW are along clearings for powerlines running north-south and southeast-northwest, respectively, through upland mixed forest. Site EW is adjacent to upland pine forest. Site NS is on a slope descending to a nearby lower basin swamp and bottomland forest to the north and near site PL to the west. Site BA (Old Barn) is in a former pasture and ruderal area being restored as a long-leaf pine forest, adjacent to upland mixed forest. Site IB (Itchy Bottom Lake) is in former pasture adjacent to upland mixed forest, upland pine forest, and near a floodplain marsh.

Results

In this study, a total of 2,590 bees were captured in the Alachua County natural areas, belonging to 34 genera and 111 species, 1 of which is believed to be undescribed. Six percent of the species were in the family Colletidae, 15% in Andrenidae, 23% in Halictidae, 25% in Megachilidae, and 31% in Apidae. Eighty-eight percent of individuals were female; 12% male. The list of the species, including the earliest and latest dates when captured, the areas and sites where captured (abbreviations from Table 1), and the numbers of females and males captured in cups and on each of the plant species (names and abbrevia-

TABLE 1. BEE COLLECTION AREAS AND SITES.

Area-Site Abbreviation	Area Site Name	Geographical Coordinates	Collections Months (# from bee bowls—# from flowers)/ Year[1]
KP-W	Kanapaha Prairie West	29°33'13"N 82°26'10"W	5, 4, 8 (0-2), 9, 10 (0-2), 11 (0-1)/ 06 3, 4 (1-1), 6 (1-1), 10 (0-1)/ 07 4 (0-1), 7 (0-1), 9 (0-1)/ 08
KP-R	Kanapaha Prairie Road	29°33'07"N 82°25'42"W	11 (0-1)/06, 10 (0-1)/ 07 3 (0-1), 4 (0-1), 5 (0-1)/ 08, 9 (0-1), 11 (0-2) / 09
KP-S	Kanapaha Prairie South	29°32'03"N 82°26'08"W	5 (0-2), 6 (0-1), 9 (0-1)/ 08, 9 (0-1)/ 09
NATL	UF Natural Area Teaching Lab	29°38'02"N 82°22'08"W	4, 5, 6, 9, 10 (2-1)/ 06 2 (1-1), 3, 4/ 07, 10 (0-1)/ 09
PP-BB	Paynes Prairie Bolen Bluff	29°33'36"N 82°19'34"W	5/ 06
PP-LT	Paynes Prairie Lake Trail	29°32'20"N 82°17'39"W	4, 8/ 06
PP-NE	Paynes Prairie Northeast	29°36'32"N 82°17'03"W	6, 9 (1-1), 10 (2-3)/ 06 3, 5/ 07, 10 (0-1)/ 09
PP-PW	Paynes Prairie Pine Woods	29°31'58"N 82°17'08"W	9/ 06
PP-RS	Paynes Prairie Restored Area	29°31'18"N 82°17'19"W	4, 8, 9, 11 (1-1)/ 06, 3 (2), 5, 6/ 07, 11 (0-1)/08, 3 (0-1)/ 09
PP-TW	Paynes Prairie Tower	29°33'00"N 82°17'30"W	10/ 06 3, 5, 6/ 07
SF-BA	San Felasco Old Barn	29°45'28"N 82°27'40"W	4/ 06 3, 4/ 07
SF-EW	San Felasco East-West Powerline	29°43'36"N 82°26'01"W	5, 6, 8, 9, 10/ 06 3, 4/ 07
SF-IB	San Felasco Itchy Bottom Lake	29°45'59"N 82°27'02"W	4 (1-1), 6/ 06 4/ 07
SF-NS	San Felasco North-South Powerline	29°44'35"N 82°27'19"W	5, 6, 8, 9, 10/ 06 3, 4/ 07
SF-PL	San Felasco Pine Land	29°44'34"N 82°27'41"W	5/ 06
SF-SH	San Felasco Sandhill	29°42'56"N 82°27'28"W	5, 6, 8, 9, 10/ 06 3, 4/ 07

[1]Parentheses indicate months when either more than 1 collection was made, or when collections were made also, or only, from flowers.

tions in Table 2), is in Table 3. Eight species were captured over a span of 6 months but were far more abundant during a segment of that time. For these species, the 2 or 3 months and the percentage of bees caught during that period that exceed 70% of the total are indicated in the "Remarks" column. The species found in the county previously or reported to be found throughout Florida, according to Pascarella (2008), are indicated by an "AC" in the "Remarks" column. In organic farms of Alachua County, we have captured about 25 bee species not found in this study, which will be reported in a forthcoming article.

From the spring of 2006 to the spring of 2007, bee collecting was most consistently and systematically done with colored cups, which were particularly useful at locations and at times with little herbaceous flowering. Eighty percent of the bees were caught in cups. As others have found (Cane et al. 2000; Roulston et al. 2007; Wilson et al. 2008), bees caught in the cups were not fully representative of the resident fauna. Some bee

TABLE 2. PLANTS FROM WHICH BEES WERE COLLECTED.

Ba	—	*Bidens alba* (L.) DC.
Bl	—	*Bidens laevis* (L.) Britton et al.
Ca	—	*Cirsium altissimum* (L.) Spreng.
Cd	—	*Croptilon divaricatum* (Nutt.) Raf.
Ch	—	*Cirsium horridulum* Michx.
Io	—	*Ilex opaca* Aiton
Ec	—	*Euthamia caroliniana* (L.) Ex Porter and Britton
Em	—	*Eupatorium mikaniodes* Chapm.
Eq	—	*Erigeron quercifolius* Poir.
Hf	—	*Helianthus floridanus* A. Gray ex Chapm.
Hs	—	*Heterotheca subaxillaris* (Lam.) Britton and Rusby
Pg	—	*Pityopsis graminifolia* (Michx.) Nutt.
Rc	—	*Rhus copallinum* L.
Rr	—	*Raphanus raphanistrum* L. Not native.
Sd	—	*Symphotrichum dumosum* (L.) G. L. Nesom
Ss	—	*Solidago* spp. L.
Vac	—	*Vitex agnus-castus* L. Not native.
Vb	—	*Verbena brasiliensis* Vell. Not native.
Vg	—	*Vernonia gigantea* (Walter) Trel. ex Branner and Coville

Authorities from Wunderlin & Hansen (2003).

species were seen on flowers but not in cups placed nearby. Although the species are not equally attracted to the colored cups, for each species that is caught, the cups provide an objective measure of their abundance at different locations. From 2006 through 2009, bees also were captured in flight over flowers or nests, but this collecting was opportunistic, inconsistent, and done mainly in the fall, when herbaceous flowers were most abundant. The plants on which bees were caught are listed in Table 2 (plant authorities from Wunderlin & Hansen 2003). Most of the sampling sites were open areas near the edges of mixed pine-hardwood forests and wetlands, at boundaries between or near 2 or more natural communities. Thus, the different collections of bees from the sites are not necessarily characteristic of single plant communities.

Six species are new state records for Florida: *Andrena* (*Callandrena s.l.*) *asteroides* Mitchell, *Andrena* (*Iomelissa*) *violae* Robertson, *Xenoglossa* (*Eoxenoglossa*) *kansensis* Cockerell (discovery reported by Hall (2010) included specimens from this study), *Sphecodes antennariae* Robertson, *Osmia* (*Melanosmia*) *collinsiae* Robertson, and *Nomada annulata* Smith. The last 3 had been found previously only as far south as North Carolina (Mitchell 1960, 1962). Three species and 1 subspecies are Florida endemics: *Lasioglossum* (*Dialictus*) *robertsonellum* Michener, *Stelis* (*Stelis*) *ater* Mitchell, *Epeolus floridensis* Mitchell, and *Ceratina* (*Zadontomerus*) *dupla floridana* Mitchell. The specimens listed as *Lasioglossum* (*Dialictus*) aff. *raleighense* (Crawford) are believed to be a new, undescribed, species (Jason Gibbs, personal communication). The bee species previously recorded from Alachua County together with those listed as "throughout Florida" (Pascarella 2008) include 73 species found in this study and 67 not found. Thirty-seven additional species found in this study are new county records, including the 6 new state records. Thus, a total of 177 bee species are now reported from Alachua County, which does not include those among the additional species found in organic farms, mentioned above.

In descending order, the following species were the most abundant, the first 6 of which were Halictidae: *Lasioglossum* (*Dialictus*) *reticulatum* (Robertson) (527F 1M); *Augochlorella aurata* (Smith) (268F 1M); *Lasioglossum* (*Dialictus*) *puteulanum* Gibbs (180F 1M); *Lasioglossum* (*Dialictus*) *apopkense* (Robertson) (146F); *Agapostemon* (*Agapostemon*) *splendens* (Lepeletier) (114F 11M); *Halictus poeyi* (109F 11M); *Melissodes* (*Melissodes*) *communis communis* Cresson (78F 25M); *Melissodes* (*Melissodes*) *bimaculata bimaculata* (Lepeletier) (78F 17M); *Lasioglossum* (*Dialictus*) *nymphale* (Smith) (80F 1M); *Lasioglossum* (*Dialictus*) *pectorale* (Smith) (53F 5M).

Two *Megachile* Latreille species were caught emerging from or flying over ground nests. *Megachile* (*Megachiloides*) *rubi* Mitchell had clustered, but well-separated, nests. A single female of *M.* (*Acentron*) *albitarsis* Cresson came from an isolated nest opening (see images by Tim Lethbridge of a similar nest believed to be of this species from Archbold Biological Station, bugguide.net/node/view/375132).

Traps nests were located at Kanapaha and Paynes Prairies primarily for a separate study, but the bee species that occupied the nests are mentioned here. *Osmia* (*Helicosmia*) *chalybea* Smith was the main bee species to construct cells in the nests (the 5/16" and 3/8" diameter holes). For the first time, this species was confirmed as a host of *Stelis ater* which parasitized about a third of the cells. Both species are univoltine and emerge in the spring. The first males of *S. ater* were discovered earlier in this survey, captured in cups. More detail about these species' nests, immature stages, and other aspects of their association will be discussed in a separate report (Rozen & Hall, in preparation). *Megachile* (*Litomegachile*) *mendica mendica* Cresson constructed cells in 1 to 2 burrows of about 10% of the trap nests. From 1 nest that had been placed in an emergence cage while the cells were still sealed, the first brood emerged within about 2 months after cell construction began (timing was not closely monitored). Bee cleptoparasites emerged from the same nest, viz. 2 females of *Coelioxys* (*Boreocoelioxys*) *sayi* Robertson (established hosts *Megachile* (*Litomegachile*) *brevis* Say and *M. mendica*) and 2 males of *C.* (*Acrocoelioxys*) *doli-*

TABLE 3. BEES CAUGHT IN NATURAL AREAS OF ALACHUA COUNTY, FLORIDA, 2006-2009.

	Species[1]	Early date of collection	Late date of collection	Areas - Sites[2]																Individuals collected				Remarks[4,5]
																				In cups		On flowers[3]		
				KP-W	KP-R	KP-S	NATL	PP-BB	PP-LT	PP-NE	PP-PW	PP-RS	PP-TW	SF-BA	SF-EW	SF-IB	SF-NS	SF-PL	SF-SH	Females	Males	Females	Males	
1	*Colletes brimleyi* Mitchell	13-IV	13-IV	●																			1Io	AC
2	*Colletes mandibularis* Smith	6-VI	11-XI	●	●					●		●					●	●		3		2Ba 1Ec 1Hs 1Pg 20Sd	1Cd 1Em 2Ec 1Hs 1Sd	AC; 88% X-XI
3	*Colletes simulans miamensis* Mitchell	10-X	11-XI	●	●	●	●			●		●			●							1Ec 1Pg 23Sd 1Ss	1Em 4Ec 3Sd 4Ss	AC
4	*Colletes thysanellae* Mitchell	19-X	11-XI	●	●		●			●		●			●							10Em 8Pg 6Sd 7Ss	4Em 3Ec 2Sd 14Ss	AC
5	*Hylaeus* (*Paraprosopis*) *georgicus* (Cockerell)	12-III	12-III																●	1				
6	*Hylaeus* (*Prosopis*) *modestus modestus* Say	13-IV	13-IV	●																			1Io	
7	*Hylaeus* (*Prosopis*) *schwarzii* Cockerell	7-III	1-VI					●				●	●							8	2			AC
8	*Dieunomia* (*Dieunomia*) *heteropoda heteropoda* (Say)	11-X	11-X				●															1Ba	1Ba	AC
9	*Augochlora* (*Augochlora*) *pura pura* (Say)	8-III	7-XI									●			●				●	9	1	10Pg	4Pg	
10	*Augochlorella aurata* (Smith)	8-III	7-XI	●	●		●	●	●	●		●	●	●	●	●	●	●		264		1Ca 2 Pg 1Sd	1Pg	AC

[1]Species are listed in phylogenetic sequence by family-group, genus-group taxa, and alphabetically within the least inclusive applicable genus-group taxon.
[2]Area and site abbreviations in Table 1.
[3]Abbreviations for plant species in Table 2.
[4]AC—previous Alachua County records or found "throughout" Florida according to Pascarella (2008).
[5] Indicated are the percentages of bees caught during a 2- or 3- month period that exceed 70% of the total.
[6]*Stelis ater*—first report of males of this species and host association with *Osmia chalybea*; see text.
[7]Also emerged from trap nests, see text.
[8]Potential new host association, see text.
[9]*Xylocopa virginica virginica*—many were seen at KP-W in the spring, but were not captured.
[10]*Xenoglossa kansensis*—new Florida record reported previously (Hall 2010).
[11]*Apis mellifera*—caught in several areas, not collected or counted.

TABLE 3. (CONTINUED) BEES CAUGHT IN NATURAL AREAS OF ALACHUA COUNTY, FLORIDA, 2006-2009.

	Species[1]	Early date of collection	Late date of collection	Areas - Sites[2]																Individuals collected				Remarks[4,5]
																				In cups		On flowers[3]		
				KP-W	KP-R	KP-S	NATL	PP-BB	PP-LT	PP-NE	PP-PW	PP-RS	PP-TW	SF-BA	SF-EW	SF-IB	SF-NS	SF-PL	SF-SH	Females	Males	Females	Males	
11	*Augochlorella gratiosa* (Smith)	27-IX	27-IX									●								9				AC
12	*Augochloropsis* (*Paraugochloropsis*) *anonyma* (Cockerell)	10-III	16-IX	●						●		●								10	1			AC
13	*Augochloropsis* (*Paraugochloropsis*) *metallica* (Fabricius)	12-III	4-XI	●	●	●	●			●		●				●	●		●	22		1Io 2Rc 2Sd 1Vb		AC
14	*Augochloropsis* (*Paraugochloropsis*) *sumptuosa* (Smith)	15-V	16-IX							●										4	1			AC
15	*Agapostemon* (*Agapostemon*) *splendens* (Lepeletier)	23-II	11-XI	●	●	●	●	●		●		●	●		●		●		●	108	2	2Pg 1Rc 1Rr 2Vac	2Ca 1Pg 1Sd 3Vac 1Vb 1Vg	AC
16	*Sphecodes atlantis* Mitchell	6-V	6-V														●			1				AC
17	*Sphecodes antennariae* Robertson	14-IV	14-IV																●	1				New Florida record
18	*Sphecodes brachycephalus* Mitchell	14-IV	6-V						●										●	3	3			AC
19	*Sphecodes heraclei ignitus* Cockerell	14-IV	1-XI		●											●			●	1		1Rc	1Sd	AC

[1]Species are listed in phylogenetic sequence by family-group, genus-group taxa, and alphabetically within the least inclusive applicable genus-group taxon.
[2]Area and site abbreviations in Table 1.
[3]Abbreviations for plant species in Table 2.
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	Species[1]	Early date of collection	Late date of collection	Areas - Sites[2]																Individuals collected: In cups		Individuals collected: On flowers[3]		Remarks[4,5]
				KP-W	KP-R	KP-S	NATL	PP-BB	PP-LT	PP-NE	PP-PW	PP-RS	PP-TW	SF-BA	SF-EW	SF-IB	SF-NS	SF-PL	SF-SH	Females	Males	Females	Males	
20	*Halictus* (*Odontalictus*) *poeyi* Lepeletier	9-III	11-XI	●	●	●	●	●		●		●	●	●	●	●	●			86	2	3Ba 1Ca 2Eq 1Pg 7Sd 2Vb 6Vg 1 over ground	2Ba 1Ec 2Pg 3Sd 1Vb	AC
21	*Lasioglossum* (*Dialictus*) *apopkense* (Robertson)	14-IV	31-X				●								●		●		●	146				AC; 86% IX-X
22	*Lasioglossum* (*Dialictus*) *creberrimum* (Smith)	7-III	22-IX	●			●					●			●				●	20	1			AC; 95% III-V
23	*Lasioglossum* (*Dialictus*) *leviense* (Mitchell)	8-III	27-IX									●			●					3				AC
24	*Lasioglossum* (*Dialictus*) *macoupinense* (Robertson)	14-VIII	22-IX												●		●			2				AC
25	*Lasioglossum* (*Dialictus*) *nymphale* (Smith)	8-III	2-XI	●		●				●		●		●	●		●		●	79	1	1Vac		AC; 81% III-V
26	*Lasioglossum* (*Dialictus*) *pectorale* (Smith)	8-III	8-VI	●			●					●	●	●	●	●	●	●	●	53	5			AC
27	*Lasioglossum* (*Dialictus*) *puteulanum* Gibbs	7-III	2-XI	●			●			●		●		●	●	●	●	●	●	180	1			90% III-V
28	*Lasioglossum* (*Dialictus*) aff. *raleighense* (Crawford)	14-IV	27-X									●		●	●	●	●		●	11	1			83% IV-V
29	*Lasioglossum* (*Dialictus*) *reticulatum* (Robertson)	23-II	2-XI	●	●		●		●	●	●	●	●	●	●	●	●		●	523	1		1Bl 3Rc	AC

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				KP-W	KP-R	KP-S	NATL	PP-BB	PP-LT	PP-NE	PP-PW	PP-RS	PP-TW	SF-BA	SF-EW	SF-IB	SF-NS	SF-PL	SF-SH	Females	Males	Females	Males	
30	*Lasioglossum* (*Dialictus*) *robertsonellum* Michener	6-V	27-X												●		●			2				AC
31	*Lasioglossum* (*Dialictus*) *tarponense* (Mitchell)	12-III	2-XI				●					●			●	●	●	●	●	47		1Rc		AC
32	*Lasioglossum* (*Evylaeus*) *nelumbonis* (Robertson)	8-III	11-XI	●	●		●	●		●		●	●							36		10Bl		AC
33	*Andrena* (*Archiandrena*) *banksi* Malloch	9-III	9-III										●							1				AC
34	*Andrena* (*Callandrena s.l.*) *asteroides* Mitchell	27-X	11-XI		●										●							2Pg 26Sd		New Florida record
35	*Andrena* (*Callandrena s.l.*) *fulvipennis* Smith	22-X	7-XI							●		●			●							1Hs 13Pg	1Hs 1Pg	AC
36	*Andrena* (*Callandrena s.l.*) *krigiana* Robertson	12-III	12-III														●				1			AC
37	*Andrena* (*Holandrena*) *cressonii cressonii* Robertson	8-III	27-III									●								1	1			AC
38	*Andrena* (*Iomelissa*) *violae* Robertson	12-III	12-III											●						1				New Florida record
39	*Andrena* (*Larandrena*) *miserabilis* Cresson	23-II	23-II				●													2	1			AC
40	*Andrena* (*Leucandrena*) *macra* Mitchell	28-III	28-III										●							1				AC

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																				In cups		On flowers[3]		
				KP-W	KP-R	KP-S	NATL	PP-BB	PP-LT	PP-NE	PP-PW	PP-RS	PP-TW	SF-BA	SF-EW	SF-IB	SF-NS	SF-PL	SF-SH	Females	Males	Females	Males	
41	*Andrena* (*Melandrena*) *barbara* Bouseman and LaBerge	30-III	30-III				●													2				
42	*Andrena* (*Melandrena*) *confederata* Viereck	29-IV	29-IV	●																1				AC
43	*Andrena* (*Scrapteropsis*) *atlantica* Mitchell	13-IV	14-IV	●											●					1		1Io	3Io	AC
44	*Andrena* (*Scrapteropsis*) *imitatrix* Cresson	6-IV	6-IV	●																		1Io		AC
45	*Pseudopanurgus nebrascensis muesebecki* Michener	27-X	27-X												●		●				2	2Pg		
46	*Perdita* (*Alloperdita*) *bradleyi* Viereck	6-V	6-V																●	1				
47	*Perdita* (*Hexaperdita*) *bishoppi bishoppi* Cockerell	21-X	27-X							●					●							28Hs 1Pg	14Hs	AC
48	*Perdita* (*Hexaperdita*) *nubila* Timberlake	14-IV	29-IV	●											●					1	1			AC
49	*Perdita* (*Perdita*) *gerardiae* Crawford	27-X	27-X												●					2				
50	*Lithurgus* (*Lithurgopsis*) *gibbosus* Smith	19-IV	8-VI	●	●				●	●		●								2	4	1Ch	2Ch	

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51	*Anthidiellum* (*Loyolanthidium*) *perplexum* (Smith)	29-V	2-XI			●						●										1Vac	1Pg 1Vac	
52	*Stelis* (*Dolichostelis*) *louisae* Cockerell	27-X	27-X												●							1Pg		AC
53	*Stelis* (*Stelis*) *ater* Mitchell	9-III	9-III										●								2			6,7
54	*Heriades* (*Neotrypetes*) *leavitti* Crawford	1-XI	1-XI									●											1Pg	AC
55	*Hoplitis* (*Alcidamea*) *pilosifrons* (Cresson)	12-III	15-IV											●						1	3			AC
56	*Osmia* (*Helicosmia*) *chalybea* Smith	7-III	10-IV	●	●							●	●							3	15	2Ch	1Ch	AC; 7
57	*Osmia* (*Melanosmia*) *atriventris* Cresson	14-IV	14-IV											●						2				
58	*Osmia* (*Melanosmia*) *collinsiae* Robertson	7-III	28-III									●	●								2			New Florida record
59	*Osmia* (*Melanosmia*) *sandhouseae* Mitchell	23-II	6-V				●			●		●	●	●			●		●	36	7			
60	*Megachile* (*Acentron*) *albitarsis* Cresson	14-VIII	4-XI	●	●	●	●		●	●		●					●			4		1Cd 2Ec 3Hs 3Vb 6Vg 1 from ground nest	1Sd 1Vb	AC

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				KP-W	KP-R	KP-S	NATL	PP-BB	PP-LT	PP-NE	PP-PW	PP-RS	PP-TW	SF-BA	SF-EW	SF-IB	SF-NS	SF-PL	SF-SH	Females	Males	Females	Males	
61	*Megachile* (*Callomegachile*) *sculpturalis* Smith	2-VI	2-VI			●																2Vac	1Vac	
62	*Megachile* (*Chelostomoides*) *campanulae* (Robertson)	6-V	3-IX			●											●			2	1		1Vac	
63	*Megachile* (*Chelostomoides*) *georgica* Cresson	2-VI	2-XI			●						●					●		●	2	2	6Vac		AC
64	*Megachile* (*Eutricharaea*) *concinna* Smith	8-VI	8-VI				●													1				
65	*Megachile* (*Leptorachis*) *petulans* Cresson	6-V	11-XI		●					●							●				1	1 flying over ground	1Bl, 1 flying over ground	AC
66	*Megachile* (*Litomegachile*) *brevis pseudobrevis* Say	7-III	2-XI	●		●	●		●	●		●	●	●	●		●			24	5		1Pg 1Vac	
67	*Megachile* (*Litomegachile*) *mendica mendica* Cresson	30-III	11-XI	●	●	●	●			●		●		●	●		●		●	1	5	2Ba 1Cd 5Rc 4Sd 1Vac 5Vg	4Ba 2Bl 1Pg 1Sd 16Vac 2Vb 1Vg	7
68	*Megachile* (*Litomegachile*) *texana* Cresson	18-V	27-IX	●		●		●				●								1	1	1Vac 1Vg	1Rc 4Vac	AC
69	*Megachile* (*Megachiloides*) *rubi* Mitchell	28-III	23-IV										●			●					2	4 flying over ground nest		AC
70	*Megachile* (*Melanosarus*) *xylocopoides* Smith	18-V	7-X	●				●														1Ca 2Rc 1Vg	1Ba 1Vg	

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																				In cups		On flowers[3]		
				KP-W	KP-R	KP-S	NATL	PP-BB	PP-LT	PP-NE	PP-PW	PP-RS	PP-TW	SF-BA	SF-EW	SF-IB	SF-NS	SF-PL	SF-SH	Females	Males	Females	Males	
71	*Megachile* (*Sayapis*) *policaris* Say	22-IX	22-IX																●	1				AC
72	*Megachile* (*Xanthosarus*) *addenda* Cresson	14-IV	15-V	●						●		●		●	●					10				AC
73	*Coelioxys* (*Acrocoelioxys*) *dolichos* Fox	2-VI	2-VI			●																1Vac		7,8
74	*Coelioxys* (*Boreocoelioxys*) *sayi* Robertson	29-V	2-XI			●	●					●								2		1Vac	1Vac	AC
75	*Coelioxys* (*Coelioxys*) *mitchelli* Baker	13-IV	13-IV													●						2 from over *Megachile rubi* nests		8
76	*Coelioxys* (*Haplocoelioxys*) *mexicana* Cresson	2-VI	2-IX		●	●																1Vac 1Vb		
77	*Coelioxys* (*Xerocoelioxys*) *galactiae* Mitchell	13-IV	23-IV													●						3 from over *Megachile rubi* nests		8
78	*Xylocopa* (*Schonnherria*) *micans* Lepeletier	30-X	30-X				●															1Ba		AC
79	*Xylocopa* (*Xylocopoides*) *virginica virginica* L.	30-X	4-XI		●		●																2Ba 1Sd	AC; 7,9
80	*Ceratina* (*Ceratinula*) *cockerelli* Smith	6-V	6-V												●					1				AC

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				Areas - Sites[2]																Individuals collected				
																				In cups		On flowers[3]		
	Species[1]	Early date of collection	Late date of collection	KP-W	KP-R	KP-S	NATL	PP-BB	PP-LT	PP-NE	PP-PW	PP-RS	PP-TW	SF-BA	SF-EW	SF-IB	SF-NS	SF-PL	SF-SH	Females	Males	Females	Males	Remarks[4,5]
81	*Ceratina* (*Zadontomerus*) *dupla floridana* Mitchell	7-III	11-XI	●	●		●	●		●		●	●		●	●	●			25	4	1Sd		AC
82	*Nomada annulata* Smith	14-IV	14-IV														●				1			New Florida record
83	*Nomada australis* Mitchell	24-IV	24-IV	●																		1 flying over ground		AC
84	*Nomada fervida* Smith	2-VI	1-XI	●	●	●																1Vac 1Vg	2Sd 1Vac	AC
85	*Nomada texana* Cresson	4-XI	4-XI		●																	1Sd		
86	*Triepeolus georgicus* Mitchell	25-X	1-XI	●	●																	2Sd	1Ec	AC
87	*Triepeolus quadrifasciatus atlanticus* Mitchell	2-IX	2-IX		●																	1Vb		AC; [8]
88	*Triepeolus rugosus* Mitchell	4-V	18-V					●					●							1		2 flying over ground		
89	*Epeolus australis* Mitchell	14-IV	14-IV														●			1				
90	*Epeolus bifasciatus* Cresson	2-VI	2-VI			●																1Vb		
91	*Epeolus carolinus* Mitchell	22-X	2-XI							●		●			●		●			2	4	6Pg	1Hs 1Pg	AC
92	*Epeolus floridensis* Mitchell	27-X	11-XI		●												●			1		1Sd	1Bl	
93	*Epeolus glabratus* Cresson	30-V	2-VI			●																	9Vb	

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94	*Epeolus pusillus* Cresson	6-V	6-V														●				1			
95	*Melitoma taurea* (Say)	8-VI	8-VI	●																1				AC
96	*Florilegus* (*Florilegus*) *condignus* (Cresson)	19-V	19-V				●														1			AC
97	*Melissodes* (*Apomelissodes*) *apicata* Lovell and Cockerell	19-IV	1-VI						●				●							1	1			AC
98	*Melissodes* (*Eumelissodes*) *boltoniae* Robertson	22-IX	11-XI		●		●			●		●			●		●			3	1	3Ba 6Hs 3Pg 6Sd	3Hs 1Pg	AC
99	*Melissodes* (*Melissodes*) *bimaculata bimaculata* (Lepeletier)	23-II	7-XI			●	●			●		●			●	●	●		●	77	16	1Pg	1Vac	AC; 71% IX-X
100	*Melissodes* (*Melissodes*) *communis communis* Cresson	7-III	1-XI	●	●	●	●			●		●	●		●	●		●	●	69	15	8Vac 1Vg	7Vac 3Vb	AC; 92% IV-VI
101	*Melissodes* (*Melissodes*) *comptoides* Robertson	14-VIII	16-IV							●					●		●			2	1			AC
102	*Melissodes* (*Melissodes*) *tepaneca* Cresson	14-IV	31-X				●								●					2			1Vb	
103	*Svastra* (*Epimelissodes*) *aegis* (LaBerge)	30-VII	3-IX	●																		2Vg	1Hf	
104	*Svastra* (*Epimelissodes*) *atripes georgica* (Cresson)	14-IV	3-IX	●	●	●								●						1		2Vac 4Vg	5Vb	AC

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																			In cups		On flowers[3]		
			KP-W	KP-R	KP-S	NATL	PP-BB	PP-LT	PP-NE	PP-PW	PP-RS	PP-TW	SF-BA	SF-EW	SF-IB	SF-NS	SF-PL	SF-SH	Females	Males	Females	Males	
105 *Xenoglossa* (*Eoxenoglossa*) *kansensis* Cockerell	19-V	22-VI				●										●			2				New Florida record[10]
106 *Habropoda laboriosa* (Fabricius)	23-II	23-II				●															5Rr		AC
107 *Bombus* (*Cullumanobombus*) *griseocollis* (DeGeer)	12-III	12-III												●					1				AC
108 *Bombus* (*Pyrobombus*) *bimaculatus* Cresson	28-IV	28-IX					●			●	●								2			1Ca	AC
109 *Bombus* (*Pyrobombus*) *impatiens* Cresson	27-V	2-XI	●						●		●			●		●			6	1			AC
110 *Bombus* (*Thoracobombus*) *pen-sylvanicus* (DeGeer)	27-V	27-V	●																1				AC
111 *Apis* (*Apis*) *mellifera* L.																							AC; [11]
112 *Eucera* (*Synhalonia*) *rosae* (Robertson) caught on 14-IV-07 at SF-BA was missed. The totals for the study are 35 genera and 112 species.																							

[1]Species are listed in phylogenetic sequence by family-group, genus-group taxa, and alphabetically within the least inclusive applicable genus-group taxon.
[2]Area and site abbreviations in Table 1.
[3]Abbreviations for plant species in Table 2.
[4]AC—previous Alachua County records or found "throughout" Florida according to Pascarella (2008).
[5] Indicated are the percentages of bees caught during a 2- or 3- month period that exceed 70% of the total.
[6]*Stelis ater*—first report of males of this species and host association with *Osmia chalybea*; see text.
[7]Also emerged from trap nests, see text.
[8]Potential new host association, see text.
[9]*Xylocopa virginica virginica*—many were seen at KP-W in the spring, but were not captured.
[10]*Xenoglossa kansensis*—new Florida record reported previously (Hall 2010).
[11]*Apis mellifera*—caught in several areas, not collected or counted.

chos Fox. Most of the leaf-cutter bee cells were heavily infested by tiny parasitic eulophid wasps, *Melittobia digitata* Dahms (the biology of this genus was reviewed by Matthews et al. 2009). Remnants of a female and a male *M. m. mendica* and 2 male *C. dolichos* were found in the destroyed cells along 1 burrow. There was no evidence of *M.* (*Melanosarus*) *xylocopoides* Smith, the recognized host of *C. dolichos*. Although these results suggest that *M. m. mendica* may be an **a**lternate host of *C. dolichos*, the possible prior presence of *M. xylocopoides*, which might have been destroyed by the *Melittobia*, cannot be ruled out. *Xylocopa* (*Xylocopoides*) *virginica virginica* L. occupied and widened the burrows of a few trap nests of a different design, with U-shaped burrows with a plexiglass side. Offspring began to emerge in late Jun. The bee species that emerged from trap nests are footnoted on our list (Table 3), but the number of individuals is not included in the total bee count.

The 25 cleptoparasitic bees species found in this study included 4 *Sphecodes* Latreille, 5 *Coelioxys* Latreille, 2 *Stelis* Panzer, 5 *Nomada* Scopoli, 6 *Epeolus* Latreille, and 3 *Triepeolus* Robertson. *Coelioxys* (*Coelioxys*) *mitchelli* Baker were captured flying over *Megachile rubi* nests, suggesting a potential new host association for this species. *Coelioxys* (*Xerocoelioxys*) *galactiae* Mitchell were also flying over *M. rubi* nests. The latter new potential host association is not without precedent, as another species of *Xerocoelioxys*, *C. soledadensis* Cockerell, is reported as a possible parasite of *Megachile* (*Megachiloides*) *soledadensis* Cockerell (Hurd 1979), which like *M. rubi* belonged to the former subgenus *Xeromegachile* (included in an expanded subgenus *Megachiloides* by Michener 2007). In the Kanapaha Prairie area, we found several *Svastra* (*Epimelissodes*) *atripes georgica* (Cresson) and *Triepeolus quadrifasciatus atlanticus* Mitchell, suggesting a new host-parasite association. Rightmyer (2008) reported 3 specimens of this *Triepeolus* cleptoparasite from a nesting site of *S. atripes atrimitra* (LaBerge), and Cane (1995) observed adults inspecting and entering host nests. Both of these *S. atripes* subspecies are recorded from Alachua County (Pascarella 2008).

Only 3 non-native species, *Megachile* (*Eutricharaea*) *concinna* Smith, *Megachile* (*Callomegachile*) *sculpturalis* Smith, and *Apis mellifera* L. were caught. Honey bees were seen consistently in the cups, but only in small numbers, even at a location (KP-W) where managed colonies were located nearby. They were not collected or counted.

Both previously reported and new associations were found between bee species and the sites or floral resources therein. *Hylaeus schwarzii* Cockerell, a species associated with wetlands (Graenicher 1930) was found in the wet prairie community of Paynes Prairie. Most of the *Colletes* Latreille and associated cleptoparasitic *Epeolus*, *Andrena* F., and *Perdita* Smith were found either in the spring or fall, as has been well-documented previously (Mitchell 1960, 1962). *Colletes* were captured almost exclusively on Asteraceae flowers. *Lithurgus gibbosus* Smith was found at the sites with abundant *Opuntia humifusa* (Raf.) Raf., reflecting an oligolectic association with that plant genus (Hurd 1979). Only 2 females of *Xenoglossa kansensis*, an oligolege of *Cucurbita* L. and an important squash pollinator, were found in the natural areas, in contrast to large numbers found during this survey period in squash-growing organic farms in Alachua County (Hall 2010). In this survey, only 5 females of the southeastern blueberry bee *Habropoda laboriosa* (Fabricius) were captured from non-native wild radish *Raphanus raphanistrum* L. However, this bee species is probably more abundant in natural areas than indicated here, as we have captured this bee along roadsides and other locations from several native plants, such as Eastern Redbud, *Cercis canadensis* L., and Carolina Jessamine, *Gelsemium sempervirens* (L.) (Pascarella 2007) that are also found in the natural areas. *Osmia chalybea* was found foraging on *Cirsium* Mill. in Alachua County, but we also captured this species along with both sexes of *Stelis ater* on *Cirsium* in Highlands County (4 miles SW of Old Venus on 1 Apr 2009 by J. S. Ascher and D. Webber; specimens deposited in the American Museum of Natural History), which further reinforces their association.

Discussion

Previously published Florida bee surveys were from southern Florida. Pascarella et al. (2000) recorded species they had captured in the Everglades National Park along with those that Graenicher (1930) and others had found in the Everglades and in Dade and Monroe Counties outside the Park. In total, Pascarella listed 99 species and, for each of 5 of these, 1 additional subspecies. Graenicher had found 61 of these species. Two species, *Augochlorella gratiosa* (Smith) and *Coelioxys mexicana* Cresson and 1 additional subspecies of *Megachile brevis* (Say) were incorrectly attributed to Graenicher. Deyrup et al. (2002) found 107 described and 5 undescribed species at Archbold Biological Station, not counting *Augochlorella striata* (Provancher) now placed in synonymy with *A. aurata* (Smith) (Coelho 2004). The morphospecies referred to as *Caupolicana* sp. has since been described as *C.* (*Caupolicana*) *floridana* (Michener & Deyrup 2004). Pascarella and Deyrup together reported a total of 142 species, 69 of which were shared, and which included 15 of Florida's 20 endemic bee species and 7 of the 9 endemic subspecies. In Alachua County natural areas, we captured 49 of the species shared between these 2 studies, plus 6 species listed only in the Pascarella report and 12 only in the Deyrup report. Thus, of the 142 total species in the 2 reports, we found 67. Two of the 3 endemic species and the 1 endemic subspecies that we found were in either or both of the 2 reports. Of these endemic taxa, absence of *Stelis ater* from the Archbold list is noteworthy, especially in light of our subsequent collections of this species elsewhere in Highlands County and in Alachua County. The paucity of *Andrena* and *Nomada*, a cleptoparasitic genus of *Andrena,* in southern Florida and Archbold was noted in the earlier reports, compared with greater numbers in the northern part of the state, and especially in states to the north. Only 3 *Andrena* species were found at Archbold, none at all in the collections from southern Florida, and only 1 species of *Nomada* (*N. fervida* Smith, a cleptoparasite of *Agapostemon splendens* (Lepeletier) rather than of *Andrena*) from both areas. By contrast, we captured 13 *Andrena* and 5 *Nomada* species. Sixteen percent of the species from southern Florida were cleptoparasitic and 27% from Archbold, compared with 23% we found in Alachua County. In comparing our study with the others, we updated species identities as described below.

Compared with southwestern states such as California and Arizona, and to a lesser degree Atlantic coastal states to the north such as North Carolina, Florida has a relatively low bee diversity (Mitchell 1960, 1962; Michener 1979; Ascher & Pickering 2010) which decreases further in the southern part of the state (Graenicher 1930). Deyrup et al. (2002) and Pascarella et al. (2000) discuss possible reasons which include the abundant rainfall flooding ground nests, to which at least 1 Florida bee species has become adapted (Norden et al. 2003), frequent fires characteristic of some plant communities, spoilage of pollen stores because of the high summer heat and humidity, reduced land topography thereby lacking vertical banks available for ground nests, absence of many temperate plant species in the subtropical region, and a peninsular effect (Schwartz 1988).

Although Florida does not have an especially large bee fauna relative to other states, it is a unique area, evident from the endemic bee species and regional specialties present in the fauna. Because Florida extends as a peninsula as the southern-most region of the eastern United States, almost all of the bee species are derived from farther north on the Atlantic coastal plain or from the west along the Gulf Coast. A relatively high diversity and abundance of *Colletes* and associated *Epeolus*, *Lasioglossum* (*Dialictus*) and associated *Sphecodes*, *Perdita*, Megachilinae especially Megachilini, and Eucerini and associated *Triepeolus* is characteristic of the Florida bee fauna as a whole. Alachua County is an interface between the peninsular-Floridian fauna and northern elements and between Atlantic and Gulf Coast elements. Compared with subtropical southern Florida, temperate Alachua County is notably enriched in *Andrena* and associated *Nomada*, *Osmia* Panzer, and *Bombus* Latreille. On the other hand, Florida's endemic bee species and subspecies are concentrated toward the southern end of the peninsula. A few species in southern Florida have West Indian affinities and also are found in the Bahamas and Cuba (Deyrup et al. 2002; Pascarella et al. 2000), but none of these is present in north-central Florida. Thus, the entire Alachua County bee fauna can be considered continental. Some species best known from the southwestern United States also are present as disjunct populations in Florida. One of the most distinctive, *Centris lanosa* Cresson, was not found in this survey but has been reported from Alachua County (Pascarella 2008), and we found it recently in adjacent Putnam County. The new state records resulting from this study indicate that more remains to be learned about state-level distribution of bee species, even in a relatively well-known Eastern state.

Alachua County has a long native bee flight season but with a short hiatus in Dec and Jan, unlike the Keys, Everglades, and other subtropical areas of the state where native bees fly year-round. Conspicuous flowering in natural areas is concentrated in the spring (initially of woody plants followed by herbaceous plants) and especially the fall (largely Asteraceae). At these times, large numbers of bees, including specialists such as various *Andrena*, *Colletes*, Eucerini, and their cleptoparasites can be net-collected on flowers. Bees are present in significant numbers in natural areas even at times and places where flowering is inconspicuous. In such situations, bees are most efficiently collected with the colored cups and consist largely of rather cryptic, generalist, halictids. The numerical dominance of certain halictine species may be a function of their eusociality, their small size, and their use of a variety of sparse, scattered, floral food resources. Significant crop pollinators such as *Habropoda* and *Xenoglossa* are present in the natural areas of Alachua County, but not in great numbers. Nonetheless, these natural areas can be viewed as potential sources of such bees for colonization of new acreage of relevant crops, possibly even across large dispersal distances.

The bee fauna of Alachua County includes taxa characteristic of the southeastern coastal plain that have recently changed status, or soon will, as a result of modern revisionary studies. Southeastern populations of *Halictus ligatus* Say, including all present in Florida, are now considered a separate, cryptic species *Halictus poeyi* (Packer 1999). Many Florida specimens identified as *Lasioglossum* (*Dialictus*) *coreopsis* (Robertson) pertain to *L. robertsonellum*. From recent integrative studies of DNA and morphology, *Lasioglossum* (*Dialictus*) *tegulare* (Robertson) has been divided into 5 species, 2 of which, *L. puteulanum* and *L. lepidii* (Graenicher), are in Florida (Gibbs 2009, 2010). The subspecies *Ceratina dupla floridana* is now thought to be deserving of specific rank, as DNA analyses readily separate it from typical *Ceratina dupla* Say (Cory Sheffield, personal communication). *Lasioglossum puteulanum* and *C. dupla floridana* are widely distributed in Florida and occur north to North Carolina. Other subspecies present in Alachua County such as *Colletes simulans miamiensis* Mitchell, *Sphecodes heraclei ignitus* Cockerell, and *Megachile* (*Litomegachile*) *brevis pseudobrevis* Say are distinctive southeastern elements that may prove to be phylogenetic species and are therefore deserving of further taxonomic study.

Diagnostic features of Florida's cryptic species, putative subspecies, and visually distinctive regional populations lacking formal taxonomic status, include geographic color patterns. *Augochlora pura pura* (Say) is green in Alachua County, but the southern Florida subspecies *A. p. mosieri* Cockerell is blue or even purple in the Keys (Mitchell 1960; Pascarella 2008). Likewise, *Augochloropsis anonyma* (Cockerell) is green in the northern part of the state and blue or purple farther south (Pascarella 2008). *Ceratina dupla dupla* and *Lasioglossum tegulare* north of Florida are dark green, whereas in Florida *C. d. floridana* is blue (Michell 1962) and *L. puteulanum* is blue-black (Gibbs 2009, 2010). In Alachua County, species such as *Stelis lousiae* Cockerell and *Anthidiellum notatum* (Latreille) have maculae that include more red than in bees north of Florida, in which the maculae are almost entirely yellow. However, they are not as extensively red as bees farther south in Archbold Biological Station where the red mimicry pattern characteristic of southern Florida Hymenoptera is particularly well developed (Mitchell 1962; Deyrup & Eisner 2003).

This study has provided basic knowledge about Florida's bee fauna, thereby contributing to the documentation of the state's biodiversity. Furthermore, discoveries were made regarding bee distribution, taxonomy, and life history, including habitat, floral, and host-parasite associations. Thus, these findings are an example of how such inventories contribute to our understanding of basic bee biology at several levels, and provide information that can inform management for these pollinators, both locally and throughout their range.

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