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FLIGHT ACTIVITY AND RELATIVE ABUNDANCE OF PHYTOPHAGOUS SCARABS (COLEOPTERA: SCARABAEOIDEA) FROM TWO LOCATIONS IN FLORIDA

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ABSTRACT

The seasonal abundance of phytophagous scarabs in Gainesville and Fort Lauderdale, Florida, was documented with ultraviolet blacklight traps operated from April 2002 to November 2004. Over 44,000 adult scarabs were trapped and identified, including 30 species from 14 genera. *Hybosorus illigeri* Reiche was the most abundant species trapped (n = 12,306 or 27.9% of total trap catches). *Phyllophaga* was the most diverse genus with ten species collected. *Tomarus cuniculus* (F.) and *Dyscinetus morator* (F.) adults were trapped every month of the year. *Anomala innuba* (F.), *Cyclocephala lurida* (Bland), *C. parallela* Casey, *H. illigeri*, and *Phyllophaga bruneri* Chapin exhibited bimodal flight patterns. Adults of these five species combined represented 49.1, 56.5, and 64.6% of the collections in 2002, 2003, and 2004, respectively. Species that occurred in both locations tended to be active earlier in Fort Lauderdale than in Gainesville. The flight activity and species composition of potential scarab pests in Florida appears to be different from those in the midwestern and northern U.S., suggesting that turfgrass and ornamental plant managers need to adjust their management strategies accordingly.

Key Words: Scarabaeoidea, flight activity, blacklight trapping

RESUMEN

La abundancia estacional de las especies fitofagas de escarabajos (Familia Scarabaeidae) en Gainesville y Fort Lauderdale, Florida, fue documentada usando trampas de luz negra ultra violeta operadas de abril 2002 hasta noviembre del 2004. Mas de 44,000 adultos fueron capturados e identificados, incluyendo 30 especies en 14 géneros. *Hybosorus illigeri* Reiche fue la especie mas abundante capturada (n = 12,306 o 27.9% del total de las especies capturadas en la trampa). *Phyllophaga* fue el género mas diverso con diez especies recolectadas. Adultos de *Tomarus cuniculus* (F.) y *Dyscinetus morator* (F.) fueron capturados en cada mes del año. *Anomala innuba* (F.), *Cyclocephala lurida* (Bland), *C. parallela* Casey, *H. illigeri* y *Phyllophaga bruneri* Chapin mostraron un patrón bimodal de vuelo. Los adultos de estas cinco especies juntas representaron 49.1, 56.5, y 64.6% de las colecciones en 2002, 2003 y 2004, respectivemente. Las especies presentes en estos dos lugares tienden a ser tempranamente mas activas en Fort Lauderdale que en Gainesville. La actividad de vuelo y la composición de especies de Scarabaeiidae que son plagas potenciales en Florida parece ser diferentes que las en la región central y norte de los Estados Unidos, esto sugiere que los de negocios de césped y de plantas ornamentales deben ajustar sus estrategias del manejo según el caso.

Through their root feeding, some immature scarab beetles (Coleoptera: Scarabaeoidea) or white grubs, are economic pests of turfgrasses, corn, sorghum, grains, vegetables, conifers, and ornamental plants (Forschler & Gardner 1990; Vittum et al. 1999). Some adult scarabs do not feed, while others partially or completely defoliate hardwood trees and shrubs (Habeck & Wolfenbarger 1968), make mounds while ovipositing in the soil, or are nuisances by being abundant and active on golf course greens and tees. In addition, birds, raccoons, moles, armadillos, and other animals can cause extensive damage when digging to find white grub prey (Potter 1998).

White grubs were considered minor pests in Florida while several chlorinated hydrocarbon and organophosphate insecticides were available for use on turfgrass (Ralph White, pers. comm.). Most of these compounds are no longer available, and white grub populations have increased and become locally damaging along the Gulf and Atlantic Coasts. Several lawn care firms have reported poor control of several scarab species that are uncommon or do not exist in other states (pers. obs.). Although lists of scarabs collected in other states and their adult phenologies have been published (see Forschler & Gardner 1991), such data are incomplete in Florida. Thus, the following blacklight study was conducted to describe the seasonality of phytophagous scarabs in Florida. This information will be used to develop an integrated pest management program for white grubs on urban turfgrasses.

Materials and Methods

The blacklight traps (BioQuip, Rancho Dominguez, CA) used in this study were AC-powered, had a 22-watt Circline bulb, and were operated day and night for the duration of the study. Traps contained an insecticidal strip (dichlorvos, Hot Shot No-Pest Strip®) to kill insects caught in the bucket. The strip was replaced monthly or as needed. A hole in the bottom and side of the bucket allowed rain water to drain. All traps were suspended ca. 2 m from the ground from a metal hook.

One trap was located at the Gainesville Golf and Country Club in Gainesville (Alachua Co.), FL. The primary turfgrass on the golf course was bermudagrass (*Cynodon dactylon* [L.] Pers.) varieties 419, Ormond, and GN1. The soil was classified as Blichton-Urban land complex (loamy, siliceous, hyperthermic Arenic Plinthic Paleaquults). The trap was operated from 4 April 2002 until 22 November 2004. Scarabs were collected once or twice a week and frozen.

The second trap was located at the Fort Lauderdale Research and Educational Center (Broward Co.), FL. It was placed near bermudagrass and St. Augustinegrass (*Stenotaphrum secundatum* [Walt.] Kuntze.) turfgrass research plots. The soil was Margate fine sand (siliceous, hyperthermic Mollic Psamnaquent). Specimens were collected once or twice a week from 30 April 2002 until 15 November 2004, and frozen.

Scarab beetles were sorted, counted, and stored in 70% ethyl alcohol (EtOH). *Hybosorus illigeri* Reiche (Coleoptera: Scarabaeoidea: Hybosoridae) was also included because the adults are nuisance pests on golf courses in Florida (pers. obs.), but the larvae may not be phytophagous (Woodruff 1973; Ocampo 2002). The genitalia of *Cyclocephala* spp. and *Phyllophaga* spp. were extracted for species and gender determination. Identifications were based on comparisons with specimens at the Florida Collection of Arthropods and keys (Gordon & Anderson 1981; Woodruff & Beck 1989; Arnett et al. 2002). Identifications were confirmed by M. Thomas and P. Skelley, and voucher specimens were deposited at the Florida Collection of Arthropods at the Division of Plant Industry, Gainesville, FL.

Results and Discussion

During this study, >44,000 adult scarabs were trapped and identified, including 30 species from 14 genera. The total number of scarabs caught in traps (Tables 1 and 2) varied somewhat each year at both sites (11,334 beetles in 2002, 16,916 beetles in 2003, and 15,791 beetles in 2004). The number of species and genera also varied over time (22 species and ten genera in 2002, 28 species and 14 genera in 2003, and 26 species and 12 genera in 2004). The trapped scarabs were more diverse at the Gainesville site (25 species) than at the Fort Lauderdale site (14 species). However, species that occurred in both locations tended to be active earlier in Fort Lauderdale than in Gainesville. The most abundant species captured in the light traps in 2002 was *Dyscinetus morator* (F.) (n = 4,550), but *H. illigeri* was the predominant species collected in 2003 (n = 4,942) and 2004 (n = 5,155). The species composition of phytophagous scarabs in Florida had some slight overlap with other southeastern states (Forschler & Gardner 1991; Flanders et al. 2000; Harpootlian 2001).

Three species of *Anomala*, *A. innuba* (F.), *A. marginata* (F.), and *A. undulata* Melsheimer, were collected, which represented 13.5% of the total catch during this study (n = 5,964). This was the most abundant genus in 2003 and 2004. *Anomala innuba* exhibited bimodal flight activity at both locations (Fig. 1), with peak activity from late April to mid-May and early August to mid-September in Gainesville and from early April to mid-May and late August to mid-October in Fort Lauderdale. It had one flight peak in Alabama and Kansas (Hayes 1925; Flanders et al. 2000). The number of *A. innuba* collected in the Fort Lauderdale trap appeared to be increasing each year, which might indicate a growing pest problem there. Although not detected in this study, Hall (1987) observed a bimodal flight pattern of *A. marginata* in a sugarcane field in south-central Florida. This species has a unimodal flight pattern in Kentucky and North Carolina (Brimley 1938; Ritcher 1966). *Anomala* spp. larvae attack grass roots (Hayes 1925).

Cyclocephala spp. represented 13.0% of the total catch (n = 5,720). Several *Cyclocephala* spp. have been considered among of the most damaging white grub pests of sugarcane and turfgrass in Florida (Reinert 1979; Hall 1987). The southern masked chafer *C. lurida* (Bland.) had two flight peaks each year in Gainesville (Fig. 2), which has not been previously documented, and the species was not collected in Fort Lauderdale. In other unpublished research, third instars were collected in July, pupation occurred in late July and early August, and the adults were identified (pers. obs.). Its peak adult activity occurred from early May to mid-June for the first generation and early August to late September for the second generation. Peak flight periods for *C. lurida* typically occur in June and July in other states (Flanders et al. 2000). *Cyclocephala parallela* Casey had one flight peak in Gainesville but had a bimodal flight pattern in Fort Lauderdale (Fig. 3). Peak adult activity for *C. parallela* was in early June in Gainesville, and from late April to early June and mid-August to late September in Fort Lauderdale. However, in a study conducted in a south-central Florida sugarcane field, peak *C. parallela* adult

TABLE 1. PHYTOPHAGOUS SCARAB BEETLES COLLECTED WITH BLACKLIGHT TRAPS IN GAINESVILLE, FL, FROM 2002 TO 2004.

Species	Year	*n*	Flight period	Peak activity
Anomala innuba (F.)	2002	168	Apr. 12-Sep. 26	Apr. 25-May 9 Aug. 1-8
	2003	68	Apr. 21-Oct. 6	May 5-12 Aug. 21-Sep. 11
	2004	73	Apr. 29-Sep. 21	May 10-17 Aug. 13-30
Anomala marginata (F.)	2002	33	May 2-July 18	June 3-17
	2003	58	Apr. 10-July 17	June 2-19
	2004	143	May 20-Aug. 19	June 10-28
Anomala undulata Melsheimer	2002	88	Apr. 8-May 2	Apr. 12-May 2
	2003	178	Feb. 25-June 9	Mar. 3-Apr. 8
	2004	22	Mar. 1-May 17	Mar. 8-Apr. 12
Aphonus variolosus (LeConte)	2003	1	June 9	—
Cyclocephala lurida (Bland.)	2002	1,579	Apr. 12-Dec. 5	May 2-June 17 Aug. 8-Sep. 26
	2003	955	Apr. 24-Nov. 17	May 5-June 16 Aug. 14-Sep. 29
	2004	1,075	Apr. 26-Nov. 1	May 20-June 21
Cyclocephala parallela Casey	2002	39	May 20-July 15	May 30-June 17
	2003	20	May 22-June 26	May 27-June 9
	2004	16	June 10-July 12	June 14-21
Cyclocephala seditiosa LeConte	2003	1	June 5	—
Diplotaxis punctatorugosa Blanchard	2002	8	Apr. 15-June 6	—
	2003	5	May 29-Aug. 14	—
	2004	1	Apr. 26	—
Dyscinetus morator (F.)	2002	4,217	Apr. 8-Nov. 14	Apr. 12-May 20
	2003	3,386	Feb. 10-Dec. 8	Feb. 25-Apr. 8
	2004	1,761	Jan. 5-Nov. 22	Mar. 8-Apr. 12
Euetheola humilis rugiceps (LeConte)	2002	50	Apr. 8-Nov. 7	Apr. 18-May 4
	2003	96	Mar. 13-Nov. 13	Mar. 17-Apr. 8
	2004	39	Mar. 8-Oct. 4	Mar. 29-Apr.19
Hybosorus illigeri Reiche	2002	587	Apr. 25-Oct. 7	May 2-June 17 Sep. 2-13
	2003	292	Apr. 8-Oct. 30	May 19-June 9 Aug. 14-Sep. 8
	2004	533	May 3-Oct. 22	May 24-June 28 Sep. 13-21
Pelidnota punctata (L.)	2002	29	May 2-July 8	May 20-30
	2003	34	May 8-Aug. 14	June 2-9
	2004	72	May 10-Aug. 30	June 7-24
Phyllophaga crenulata (Froelich)	2002	3	Apr. 8-May 9	—
	2003	5	Mar. 20-June 9	—
	2004	10	Mar. 15-May 6	—
Phyllophaga debilis (LeConte)	2002	1	May 30	—
	2004	1	May 24	—
Phyllophaga glaberrima (Blanchard)	2002	39	May 9-Aug. 26	June 6-17
	2003	63	June 2-Aug. 25	June 9-30
	2004	66	May 24-Aug. 26	June 14-24

TABLE 1. (CONTINUED) PHYTOPHAGOUS SCARAB BEETLES COLLECTED WITH BLACKLIGHT TRAPS IN GAINESVILLE, FL, FROM 2002 TO 2004.

Species	Year	*n*	Flight period	Peak activity
Phyllophaga latifrons (LeConte)	2002	109	May 2-July 11	May 30-June 17
	2003	75	May 12-Aug. 14	June 2-12
	2004	28	May 27-Aug. 2	June 14-July 6
Phyllophaga parvidens (LeConte)	2004	1	May 3	—
Phyllophaga prununculina (Burmeister)	2002	25	May 16-July 4	—
	2003	32	June 2-July 14	—
	2004	30	June 14-Aug. 2	—
Phyllophaga quercus (Knoch)	2002	121	May 30-Aug. 1	June 6-July 4
	2003	115	May 27-Aug. 21	June 19-July 7
	2004	204	June 7-Aug. 13	June 14-July 12
Phyllophaga tecta Cartwright	2003	22	Mar. 20-June 9	—
	2004	9	Mar. 29-June 14	—
Phyllophaga uniformis (Blanchard)	2002	393	May 2-July 11	May 30-June 17
	2003	568	May 8-Aug. 14	May 27-June 30
	2004	852	May 10-July 29	June 7-28
Polyphylla occidendentalis (L.)	2002	3	Apr. 15-May 2	—
	2003	5	Apr. 28-May 22	—
	2004	2	May 10-June 17	—
Serica sericea (Illiger)	2003	3	Mar. 20-Apr. 10	—
Strategus antaeus (Drury)	2003	2	Aug. 14-Sep. 2	—
	2004	1	June 28	—
Tomarus gibbosus DeGeer	2002	8	Apr. 25-May 20	—
	2003	27	Apr. 21-Sep. 18	—
	2004	21	Apr. 29-Sep. 28	—

activity only occurred from mid-April to mid-May (Hall 1987). Trap catches contained primarily male *C. lurida* (91.7%) and *C. parallela* (90.4%), but only 43.5% of *C. miamiensis* (Howden and Endrodi) were male. Just one male *C. seditiosa* LeConte was collected in this study.

The rice beetle, *Dyscinetus morator* (F.), was abundantly collected (*n* = 9,493 or 21.6% of the total catch) nearly every month of the year, with peak flight occurring between February and May in Gainesville. Its peak flight period occurred in May and June in Alabama and Georgia (Flanders et al. 2000), but a second generation may occur in August and September in Georgia (Forschler & Gardner 1991). Woodruff (1970) also suggested that *D. morator* was bivoltine in southern Florida, based on the occurrence of greater adult activity in the spring and fall and Smyth's (1915) data indicating that other *Dyscinetus* spp. could go from egg to adult in ≤144 days in Puerto Rico. However, only one peak of adult activity was detected each of the three years of this Florida study. It is known to inhabit wet soils, marsh areas (Buckingham & Bennet 1989), and compost (Ritcher 1966). Larvae feed on rice, pangola grass pastures, crabgrass, water hyacinth, caladium bulbs, and azaleas (Staines 1990).

Phyllophaga spp. represented 12.8% of the total catch during this study (*n* = 5,643). Fifty-four species of *Phyllophaga* occur in Florida (Woodruff & Beck 1989), but only nine species were collected in Gainesville, compared to the three species collected in Fort Lauderdale. Only *P. glaberrima* (Blanchard) and *P. latifrons* (LeConte) occurred at both sites in this study, and are known to have a statewide distribution (Woodruff & Beck 1989). The most abundant species was *P. bruneri* Chapin (*n* = 2,240), which was only collected in Fort Lauderdale (Fig. 4) and is unique within this genus by exhibiting a bimodal flight pattern (Fig. 4), representing two distinct generations, and is active every month of the year in southern Florida (Habeck & Wolfenbarger 1968). The earliest flight activity in the year consistently began with *P. crenulata* (Froelich) and *P. tecta* Cartwright in March in Gainesville and *P. glaberrima* and *P. latifrons* in Fort Lauderdale. Species that were active from May to August included *P. glaberrima*, *P. latifrons*, and *P. quercus* (Knoch), which have similar flights in Alabama (Flanders et al. 2000)

TABLE 2. PHYTOPHAGOUS SCARAB BEETLES COLLECTED WITH A BLACKLIGHT TRAP IN FT. LAUDERDALE, FL, FROM 2002 TO 2004.

Species	Year	*n*	Flight period	Peak activity
Anomala innuba (F.)	2002	493	Apr. 30-Dec. 31	Apr. 30-May 14 Sep. 3-Oct. 8
	2003	1,952	Jan. 3-Dec. 26	Apr. 1-May 8 Aug. 26-Oct. 21
	2004	2,468	Jan. 6-Nov. 11	Apr. 9-May 4 Aug. 31-Oct. 16
Anomala marginata (F.)	2002	69	Apr. 30-Dec. 31	—
	2003	80	Jan. 3-Dec. 26	—
	2004	71	Jan. 6-Nov. 15	—
Cyclocephala miamiensis (Howden & Endrodi)	2002	4	Apr. 30-May 10	—
	2003	133	Apr. 22-May 16	—
	2004	35	Apr. 27-June 15	—
Cyclocephala parallela Casey	2002	312	Apr. 30-Dec. 13	May 10-28 Aug. 13-Sep. 28
	2003	1,004	Mar. 14-Nov. 21	Apr. 4-May 20 Aug. 19-Sep. 30
	2004	547	Feb. 24-Oct. 25	May 4-June 12 Aug. 31-Oct. 1
Dyscinetus morator (F.)	2002	33	Aug. 6-Dec. 27	—
	2003	59	Feb. 4-Dec. 30	—
	2004	37	Jan. 9-Oct. 18	—
Euphoria sepulcralis (F.)	2003	10	Feb. 28-July 8	—
	2004	22	Feb. 17-Aug. 10	—
Euetheola humilis rugiceps (LeConte)	2004	1	Jan. 20	—
Hybosorus illigeri Reiche	2002	1,622	Apr. 30-Dec. 27	May 6-June 6 Aug. 6-Sep. 17
	2003	4,650	Feb. 11-Dec. 5	May 6-June 3 July 22-Sep. 5
	2004	4,622	Apr. 27-Nov. 4	May 25-June 29 Aug. 10-Sep. 17
Pelidnota punctata (L.)	2002	2	Apr. 30-May 10	—
	2003	38	Apr. 1-May 13	—
	2004	16	Mar. 23-July 9	—
Phyllophaga bruneri Chapin	2002	760	Apr. 30-Dec. 24	Apr. 30-May 28 July 26-Aug. 20
	2003	617	Feb. 25-Dec. 26	Apr. 22-May 13 Aug. 19-Sep. 23
	2004	863	Jan. 2-Oct. 21	Apr. 23-June 1 Aug. 17-Sep. 17
Phyllophaga glaberrima (Blanchard)	2002	4	May 10-Dec. 10	—
	2003	66	Mar. 25-Sep. 2	—
	2004	68	Mar. 19-Aug. 24	—
Phyllophaga latifrons (LeConte)	2002	31	Apr. 30-July 18	—
	2003	222	Mar. 21-July 18	Apr. 29-May 13
	2004	240	Mar. 23-Aug. 24	May 25-June 12
Tomarus cuniculus (F.)	2002	501	Apr. 30-Dec. 31	—
	2003	2,076	Jan. 3-Dec. 30	—
	2004	1,841	Jan. 28-Nov. 18	—
Tomarus subtropicus (Blatchley)	2003	1	July 1	—

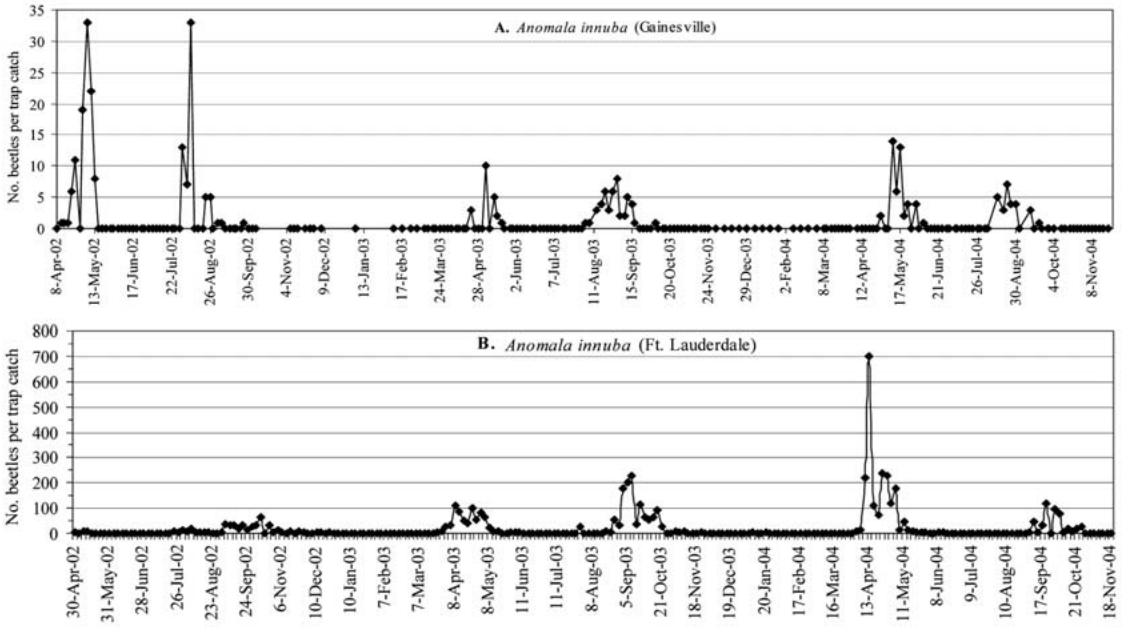

Fig. 1. Flight activity of *A. innuba* at blacklight traps located in Gainesville (A) and Fort Lauderdale, FL (B).

and are probably univoltine (Luginbill & Painter 1953; Flanders et al. 2000). Genders for all adult *Phyllophaga* spp. trapped from 2002 to 2004 were identified. Species that had more males than females collected in traps, averaged over the three years, included *P. crenulata* (93.3% male), *P. glaberrima* (94.1%), *P. latifrons* (64.4%), *P. parvidens* (LeConte) (100%), *P. prununculina* (Burmeister) (92.3%), *P. quercus* (91.6%), *P. tecta* (85.4%), and *P. uniformis* (Blanchard) (59.5%). Only *P. bruneri* (47.0% male) and *P. debilis* (LeConte) (50%) had more of a female bias. Nearly all of these species can damage ornamental plant foliage as adults, and many of the larvae infest nursery stock or turfgrass (Woodruff & Beck 1989).

Tomarus spp. (formerly *Bothynus* and *Ligyrus*) represented 10.2% of the total catch (n = 4,475). The carrot beetle, *T. gibbosus* (DeGeer), which is a pest of various vegetable crops (Hayes 1917), was collected only in Gainesville. *Tomarus cuniculus* (F.), only collected in Fort Lauderdale, is an invasive species that can cause significant turfgrass damage along the Atlantic Coast of Florida. Adults were abundantly collected in the Fort Lauderdale trap nearly every month of the year without a distinct peak period of activity. Only one

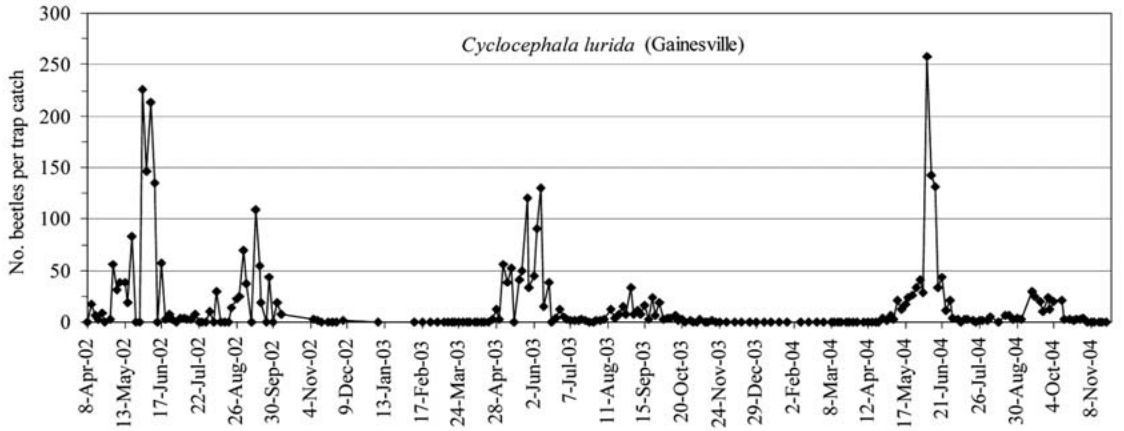

Fig. 2. Flight activity of the southern masked chafer, *C. lurida*, in Gainesville, FL.

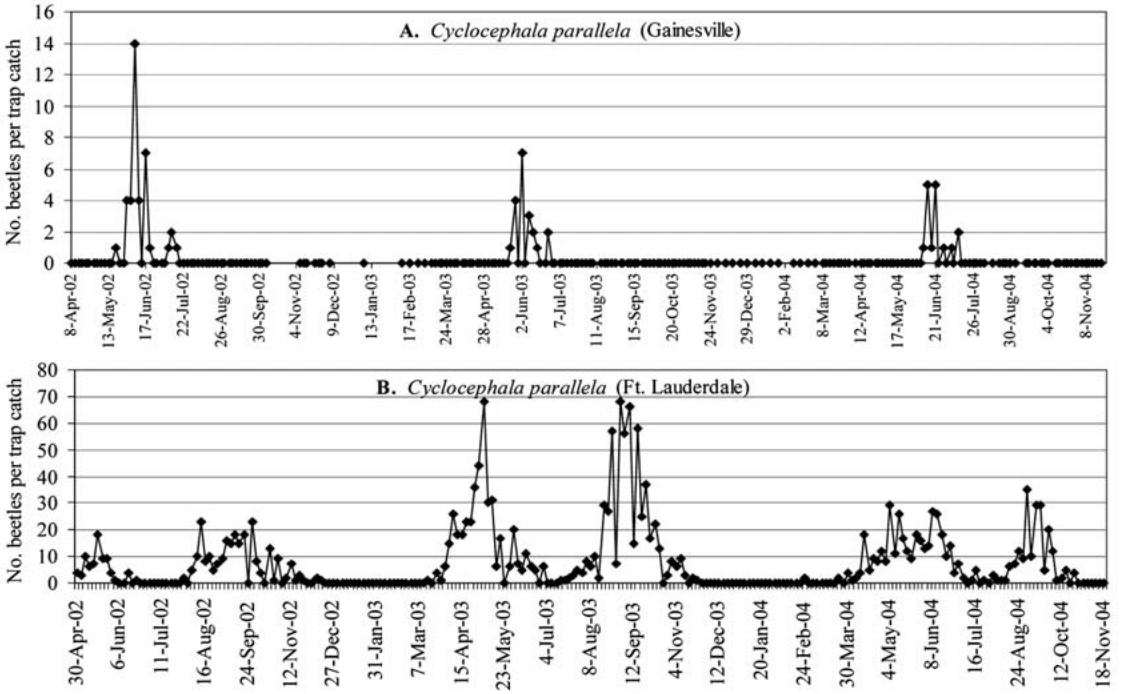

Fig. 3. Flight activity of *C. parallela* at blacklight traps located in Gainesville (A) and Fort Lauderdale, FL (B).

T. subtropicus (Blatchley) flew to a black light trap. This species tends to be more abundant along the Gulf Coast in St. Augustinegrass (pers. obs.) and is considered a primary pest of sugarcane (Gordon & Anderson 1981). Adult *T. subtropicus* are active from April to July in sugarcane in south-central Florida (Cherry 1985).

Hybosorus illigeri was collected at the light traps from April to October in Gainesville and nearly all year in Fort Lauderdale (n = 12,306 beetles from both sites, or 27.9% of the total catch). Although Woodruff (1973) considered *H. illigeri* to be univoltine, two peaks of activity (May to June, August to September) were consistently observed in this study at both locations (Fig. 5). The smaller second flight peak suggests that not all individuals fully complete a second generation. Little is known about its biology (Woodruff 1973; Ocampo 2002), but it has been collected at light, in dung, in carrion, and has been observed feeding on other scarabs (see Ocampo 2002). The abundance of adults and the small mounds that they make on golf course tees and greens are annoying to golfers and golf course superintendents,

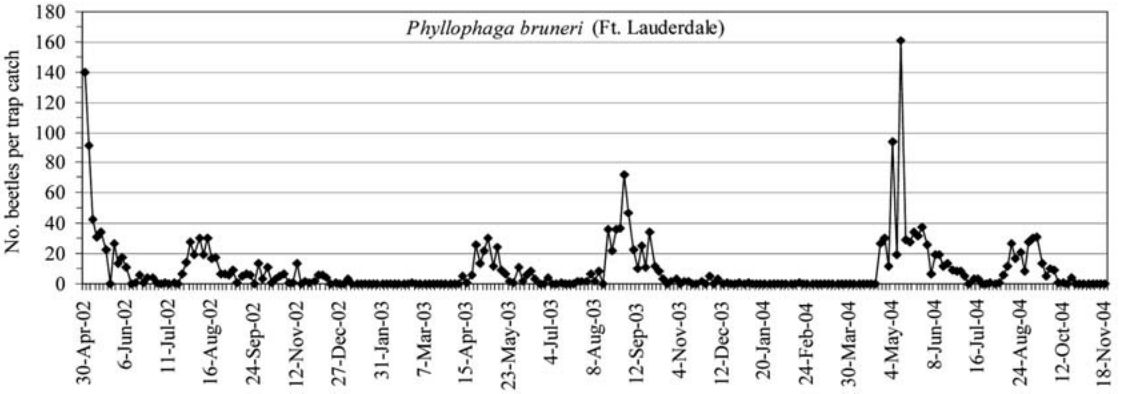

Fig. 4. Flight activity of the Cuban May beetle, *P. bruneri*, in Fort Lauderdale, FL.

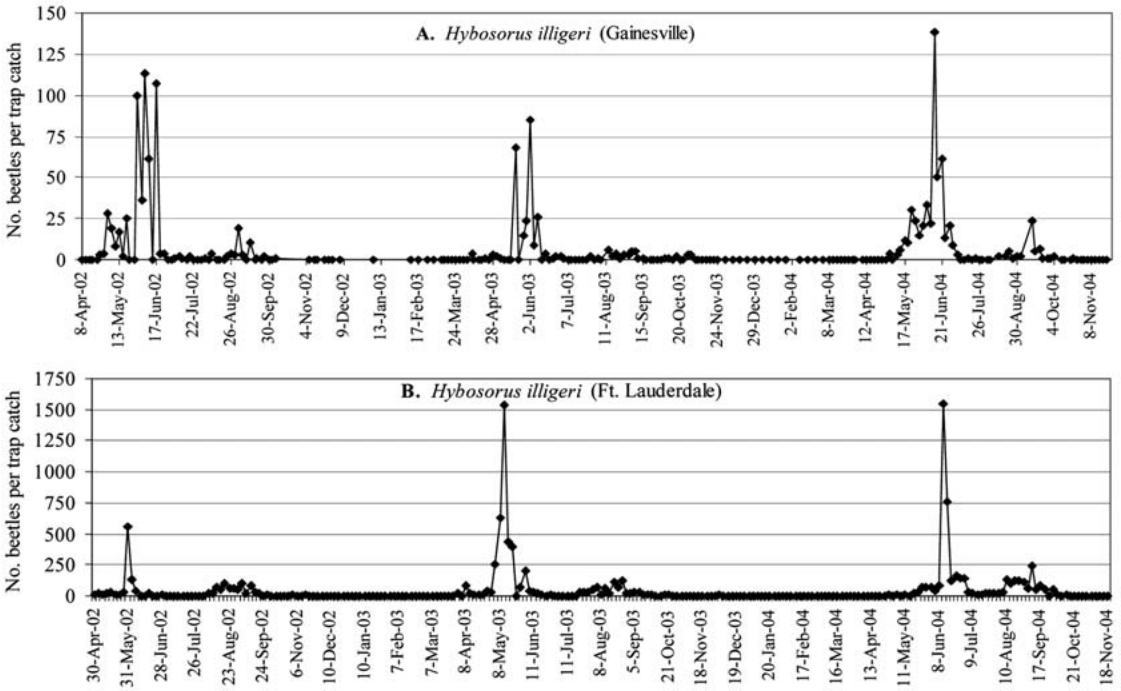

Fig. 5. Flight activity of *H. illigeri* at blacklight traps located in Gainesville (A) and Fort Lauderdale, FL (B).

but turf damage is not apparent even where densities are high (pers. obs.).

The existence of a bimodal flight pattern for several scarab species in Florida could be the result of several factors, which might be resolved by collecting adults and rearing the subsequent generation(s) under controlled conditions. It is possible that two similar species or an undescribed invasive species might coincide in an area, but adults may not have been taxonomically separated. Especially with individuals beginning their flights early in the year, egg and/or larval development might be at least initially slower due to cooler and drier conditions (Gaylor & Frankie 1979; Potter 1981) than those individuals that fly and lay eggs during the warmer and more humid Florida summer. However, because some individuals are simply active earlier, one generation may have time to complete development and allow at least a partial second generation to occur later in the year. Turfgrass is an available and consistent food source for grubs throughout the year in southern Florida, but warm season grasses decline in the fall and transition back in the spring in northern Florida. Insect development time also may be affected by changes in fertilization and watering practices in winter months compared to summer months. In addition, individuals or populations could diapause during adverse conditions. A second flight peak of several scarab species may not have been detected in studies specifically done on sugarcane fields if flooding during the summer or early fall was done to control grub populations (Cherry 1984), if cane height reduced black light visibility, or if the crop had been harvested.

More information is needed on the biology, damage potential, and management of these key scarabs. White grub populations are increasing in importance in Florida turfgrass production and maintenance industries. Older, broad-spectrum insecticides, which may have kept white grub numbers below damaging levels, have been replaced with products which lack efficacy against root-feeding scarabs (e.g., pyrethroids, fipronil). Management strategies based on application timing determined in more northern states have not provided satisfactory results in Florida. According to the data in this study, most scarab adults are active from April to June, which may be the most appropriate timing for preventive insecticide applications against young white grubs, if needed.

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