RELATIVE ABUNDANCE OF WHITE GRUBS (COLEOPTERA: SCARABAEIDAE) IN FLORIDA SUGARCANE ON SAND AND MUCK SOILS

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ABSTRACT

Sugarcane fields in Florida on sand or organic (muck) soils were sampled to determine the abundance of white grub species (Coleoptera: Scarabaeidae). Adult flight activity was monitored with light traps and larval populations were estimated by soil samples. Both methods revealed similar patterns: more *Ligyrus subtropicus* (Blatchley) were found on muck, while more *Phyllophaga latifrons* (LeConte) and Anomala marginata (F.) were found on sand. *Cyclocephala parallela* Casey was more evenly distributed over soil types although they tended to favor sand. A practical implication of these results is that the most damaging species, *L. subtropicus,* is rare or absent on sand soils.

INTRODUCTION

In the earliest report of white grubs (Coleoptera: Scarabaeidae) as pests in Florida sugarcane, Ingram et al. (10) wrote of damaging infestations of *Phyllophaga latifrons* (LeConte) and *Cyclocephala immaculata* Olivier on sand. The latter was probably *C. parallela* Casey, the species reported by Gordon and Anderson (8). More recently, *Ligyrus subtropicus* (Blatchley) has been recognized as the grub pest of greatest economic importance in Florida sugarcane (Gordon and Anderson, 8), capable of reducing yields 39% at high infestation levels (Sosa, 16). The pest status of a fourth species commonly found in sugarcane, *Anomala marginata* (F.), has not been determined.

Gordon and Anderson (8) noted that *L subtropicus* was most common on highly organic muck soils, while *C. parallela* Casey and *P. latifrons* predominated on sand-muck mixtures. Hall (9) provided information on the flight activity of scarab species in Florida sugarcane. However, these authors did not provide data on the abundance of white grub species with respect to soil type, nor did they report collecting from cane grown on sand soils. The relative abundance of white grubs is known to be correlated with soil texture in Australian sugarcane (Cherry and Allsopp, 6). Our objective was to compare the abundance of white grub species in muck and sand soils in Florida sugarcane.

MATERIALS AND METHODS

Light trap samples

General purpose blacklight traps with 15 W lamps were set adjacent to 6 commercial sugarcane fields in southern Florida. The fields were surrounded by large sugarcane acreage so that most adult

Scarabaeidae came from sugarcane fields. Three of the traps were located in fields on muck soil approximately 7.5 km ssw of South Bay and 13 km from the closest sand soil location (McCollum et al., 11). The other three fields were located on sand soil 5 km sw of Clewiston and about 5 km from muck soils (Belz et al., 2). One light trap was placed at the edge of each field for one night near the 15th of each month from August 1982 to August 1985. Captured insects were frozen for later identification. Total numbers collected on each soil type were analyzed for significant deviations from expected means using a Chi-square analysis (Sokal and Rohlf, 15).

Soil Samples

Thirty commercial sugarcane fields were sampled throughout the sugarcane growing region of southern Florida. Half the fields chosen were on muck soils (organic matter > 55%) and the other half on sand soils (organic matter < 12%). Fields were 5.2 to 16.2 ha in size and were sampled after harvest during December 1991 through March 1992. Sugarcane plants in the sampled fields were 2 or more years old (ratoon crops) and were selected because higher numbers of white grubs have been reported to occur in ratoon plantings compared to newly planted sugarcane fields (Cherry, 5).

Twenty-five soil samples were taken randomly within each field. Each sample was centered on a sugarcane stool and consisted of a 40x40x20 cm volume of soil and roots. Most larvae of *L subtropicus* and *C. parallels* in sugarcane fields are known to be found within these confines (Cherry, 3). Each sample was visually searched in the field for 10 minutes. A preliminary study showed that an efficiency> 95% for 3rd instars could be achieved with this method for each of the 4 grub species in both sand and muck soil. Grubs from each sample were preserved in 70% EtOH for later identification based on a key by Gordon and Anderson (8). Significant differences in mean numbers of grubs between soil types were identified with Student's t-Test (SAS Institute, 14).

A composite soil sample from each site was analyzed for organic matter and mineral nutrient content according to procedures outlined by Sanchez (13). Mean organic matter content of the muck soils sampled was 76.6% (Standard error of the mean (SE) = 2.95) while sand soils was 3.8% (S.E. = 0.84). Correlations between numbers of grub larvae and percent organic matter content were determined using the "PR0C CORR" program which determined the correlation coefficients (R) and the probability that these were not equal to zero (SAS Institute, 14).

RESULTS

Adults

Adults of all four scarab species were collected in light traps located on both soil types (Table 1). Over 2.5 times more beetles were trapped on sand than on muck. The most abundant species was *C. parallels,* followed by *P. latifrons, A. marginata,* and finally *L subtropicus.* However, *L subtropicus* was more abundant on muck than all other species except for *C. parallels.*

Total numbers of each species caught on the two soil types deviated significantly from the expected 1:1 ratio by Chi-square analysis ($P < 0.001$). *L. subtropicus* adults were 3 to 4 times more abundant on muck than on sand. In contrast, many more *A. marginata* and *P. latifrons* were caught on sand than on muck. *C. paral/e/a* was the most evenly distributed grub species over the two soil types.

Table 1. Total number of adult Scarabaeidae caught in Florida sugarcane fields on two soil types using three blacklight traps one night per month from August 1982 through August 1985.

Soil type	L subtropicus	P latifrons	C. parallela	A. maroinata	Total
Sand	36	633	750	366	1785
Muck	132	78	411	48	699
Total	168	711	1161	414	2454
X^2	109.7[4]	866.5	198.0	488.5	408.2[b]

* Chi-square for null hypothesis numbers of each species were equal between soil types (df = 1, *P* < 0.0001 for all).

[b] Chi-square for null hypothesis that adults were randomly distributed among soil types over all 4 species (df = 3, *P* < 0.0001).

Seasonal flight activity was unimodal except for *A. marginata* which was bimodal (Table 2). Most adults of *L subtropicus* were caught in June while numbers of the other species peaked in May. *A. marginata* had a second peak in August. These results agreed with a previously reported study carried out in a Florida sugarcane field characterized by soil of 76% organic matter (Hall, 9).

Table 2. Mean number per trap per night of 4 scarab species captured in six blacklight traps in Florida sugarcane fields during months of maximum catch.

Species	Flight Distribution	Months of Maximum Catch	Mean (SD) per Trap per Night
L. subtropicus	Unimodal	June	9.0(4.1)
C. parallela	Unimodal	May	62.1(21.9)
P. latifrons	Unimodal	May	33.6(14.3)
A. marginata	Bimodal	May	11.1(6.3)
		August	4.8 (3.6)

Larvae

Large, easily visible third instars of *L subtropicus* and *C. parallela* were the predominant life stage observed and third instars of the two other species were also the most common stage. Cherry, (4) also observed predominantly 3rd instar grubs during these months. Abundance patterns of grubs followed patterns seen for adults. Mean numbers of larvae per sample differed significantly between the two soil types for 3 grub species, *L subtropicus., P. latifrons* and *A. marginata* {Table 3). *P. latifrons* and *A. marginata* were more abundant on sand and their numbers were negatively correlated with percent organic matter content (R = -0.36 and -0.32 respectively, $P < 0.05$, N = 30). More *C. parallela* were also found on sand than muck although the difference and correlation with organic matter content were not significant. In contrast to the other three species, *L subtropicus* was found only in muck soils. The lack of a significant correlation between the abundance of *L subtropicus* and soil organic matter was probably due to the limited distribution of this species (33% of the muck fields sampled).

There were more grubs over all species on sand than on muck. *A. marginata* had the highest mean numbers in sand samples but were exceeded in maximum numbers by *P. latifrons* and *C. parallela* (Table 3). *A. marginata* occurred in more fields on sand than any other species. On muck, *C. parallela* was the most abundant species and occurred in the greatest number of fields, followed by *A. marginata* and *L. subtropicus.* However, the maximum number of *A marginata* in muck was the greatest of any species on this soil type.

Table 3. Mean(SE) and maximum number of 3rd instar grubs per field by soil type and percent of fields infested.

	Soil Type*					
	Sand			Muck		
Species	Mean(SE)	Max	%	Mean(SE)	Max	%
L. subtropicus'[b]	0.0(0.0)	0	0	1.8(1.0)	12	23
P. latifrons"	7.8(3.7)	58	38	0.1(0.1)	1	1
C. parallela[NS]	3.8(2.5)	38	19	3.3(1.2)	15	42
A. marginata"	8.9(2.7)	27	43	2.7(1.5)	20	34

[1] Fifteen fields for each soil type, 25 samples 40x40x20 cm from each field.
[b] Results of t-test for H_0 = no difference in abundance of larvae between soil types: * $P < 0.1$, ** $P < 0.05$, NSP>> 0.1.

DISCUSSION

Our results show that the distributions of three of the four principle grub species found in Florida sugarcane are correlated with organic matter content of the soil. *A. marginata* and especially *P. latifrons* were more abundant on sand soils while *L subtropicus* was absent from this soil type, occurring exclusively on muck. On the other hand, the abundance of *C. parallels* appeared to be less dependant on soil organic matter content although a trend toward more on sand soils was seen for both adults and larvae.

Biological factors responsible for the observed dependence of grub distribution on soil types remain unknown. However, soil parameters including soil texture are reported to affect egg and larval survival (Gaylor & Frankie, 7) and oviposition {Potter (12), Allsopp et al., 1) in other species of Scarabaeidae. Preliminary results indicate a preference by *L subtropicus* females to oviposit in muck versus sand soil (R. Cherry, unpublished data).

One practical implication of our results is that growers of Florida sugarcane on sand need be less concerned with the threat of grub damage than for cane grown on muck. This is because *L subtropicus,* the most economically important grub species, is wholly or largely absent on sand soils. On the other hand, the historical occurrence of damaging *C. parallela* and *P. latifrons* populations on sand was substantiated by our finding that large numbers of these two species are occasionally found in this soil type.

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