DUNG BEETLES (COLEOPTERA: SCARABAEIDAE) ACTIVE IN PATCHY FOREST AND PASTURE HABITATS IN SANTA CRUZ PROVINCE, BOLIVIA,DURING SPRING

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ABSTRACT

The abundance, habitat preferences and flight periods of dung beetles (Coleoptera: Scarabaeidae) in spring was obtained by using cattle dung baited pitfall traps at 4 sites in patchy forest and pasture habitats in Santa Cruz Province, Bolivia. Nine species were trapped in the forest habitat and 4 in the pasture habitat. One species, *Onthophagus ptox* was trapped in forest and pasture habitats, the other species were stenotopic, found only in forest or only in pasture. Twice as many beetles were attracted to the forest traps but their mean dry weight (biomass/beetle) was 3 times less than the mean dry weight of pasture species. The most important beetles (in terms of biomass) in the forest, *Eurysternus caribeus* and *Ontherus appendiculatus* were similar in size and had the same flight periods but their dung utilization methods were different. The most important beetles in the pasture habitat had different flight activities, *Gromphas aeruginosa* flying during the day and *Ontherus sulcator* during the night. When forest is cleared, stenotopic forest dung beetles will disappear resulting in reduced species richness. The effect of reduced dung beetle activity in patchy forest could impact on soil structure fertility and water retention making it difficult for reestablishment of the forest.

KEY WORDS: Bolivia, patchy forest, pastures, dung beetles, Scarabaeidae

RESUMEN

Se obtuvieron datos sobre la abundancia, la preferencia de hábitat y los períodos de vuelo durante la primavera para los escarabajos estercoleros, utilizando trampas de pozo cebadas con estiércol bovino, en cuatro sitios con manchones de bosque y pastizales en la Provincia de Santa Cruz, Bolivia. En el habitat boscoso fueron capturadas nueve especies y en el pastizal se obtuvieron solo cuatro especies. *Onthophagus ptox* se colectó en los dos habitat, en tanto que las otras especies se consideran como estenotópicas del bosque o del pastizal. Casi el doble de escarabajos fueron atraídos a las trampas situadas en el bosque, pero su promedio en peso seco (biomasa/ escarabajo) fue tres veces menor que el promedio obtenido en las especies del pastizal.

Las especies más importantes (en términos de biomasa) en el bosque *Eurysternus caribeus* y *Ontherus appendiculatus* tienen una talla similar y los mismos períodos de vuelo, pero el método para emplear el estiércol es diferente. Las especies más importantes del pastizal tienen diferente período de vuelo, *Gromphas aeruginosa* vuela durante el día y *Ontherus sulcator* durante la noche.

En los sitios donde el bosque es clareado, los coprófagos forestales estenotópicos desaparecen, produciendo una reducción en la riqueza específica. La reducción de la actividad de los escarabajos en los manchones de bosque tiene un impacto en la estructura del suelo, su fertilidad y su capacidad para retener agua, por lo cual es difícil el reestablecimiento del bosque.

PALABRAS CLAVE: Bolivia, manchones de bosque, pastizal, escarabajos estercoleros, Scarabaeidae.

INTRODUCTION

Dung beetles (Coleoptera: Scarabaeidae) are important in the ecology of pastures, especially where large amounts of dung are deposited by livestock. The activities of dung beetles help maintain soil structure fertility and water retention. The Neotropical dung beetle fauna is very diverse (Bornemissza, pers. comm.; Halffter, 1964, 1974) and has been widely studied especially in Mexico, (Halffter & Matthews, 1966; Halffter, 1974; Kohlmann & Colon, 1984; Morón, *et al.*, 1985); in Ecuador, (Peck & Forsyth, 1982); in Colombia (Howden & Nealis, 1975); in Argentina (Martínez, 1959) and Panama, (Peck & Howden, 1984). A rich fauna of stenotopic dung beetle species making up distinct forest and pasture guilds in the Neotropical zone has been described by Halffter & Matthews (1966) and Howden & Nealis (1975). However no work has been carried out on the dung beetle fauna of small patches of forest left after widescale clearing.

The following work was carried out in the Santa Cruz region of Bolivia which is being deforested and where there is no information about the dung beetle faunas of pastures or forest. Cattle dung baited pitfall traps were used over a 5 week period in spring to gather data on the numbers, size and flight activity of dung beetles in forest patches and cleared areas.

METHODS

General Collections

In addition to trapping with dung baited traps, dung beetles were collected from dung and fruit at 14 localities in the Santa Cruz Province of Bolivia.

Sites

The regular trapping sites were at the CIAT (Bolivia) Field Station at Saavedra, Lat. 17°14 S; Long. 63° 10 W at 320 m altitude, 70 km north east of Santa Cruz Bolivia. In addition occasional trapping sites were at San Ramon and San Pedro on the Brazilian shield north east of Santa Cruz and Montero 15 km south of Saavedra.

Mean annual rainfall at Saavedra is about 1200 m with highest rainfall (about 44% of annual total) in summer, and lowest (about 12% of annual total) in winter, however there is rain at all times of the year. Mean annual

temperature is 24° C with means of 26° C in the summer months and 20.3° C in the winter months. Soils are heavy silty loams. The terrain is flat with forested patches surrounded by cattle rearing pastures. Both pastures and forested patches were fenced off; there was no access to forested areas for cattle. The forested area used at Saavedra was about 3 ha in area, separated from other forested areas by improved pasture land.

Trapping in 1987

Three traps were set 25 m apart inside thick evergreen forest and three 25 m apart in a field containing cattle. Each trap consisted of a plastic jar buried to its rim in the soil. Each jar contained water, detergent and a small amount of 70% ethanol. A 200 ml fresh cattle dung bait wrapped in fine gauze was placed on a chicken wire mesh above each jar.

Twenty four hour traps were set at 1630 each day and their contents removed 24 h later. Flight activity was studied by baiting traps at 0800 and removing contents at 1630 for day fliers and baiting traps at 1630 and removing contents at 0830 the following day for night fliers. One trap was set in forest and one in pasture at each of the 3 occasional sites and left for 24 h before removing the contents.

Biomass (dry weight)

Beetles were dried in an oven at 60° c for 3 days and then weighed on an electronic balance. At least 5 examples of each species were dried unless fewer were trapped when all adults were dried.

RESULTS

General collecting

Thirthy one species were trapped and collected from herbivore dung (on one occasion, fruit) in the Santa Cruz Province during September, October and November 1987 (Appendix 1). *Onthophagus ptox* Erichson was the most widespread followed by *Ontherus sulcator* (F.) and *Dichotomius nisus* Olivier) (Appendix 1).

Trapping 1987 and biomass (dry weight)

Over a 5 week period at Saavedra 12 species were trapped, 8 only in the forest, 3 only in the pastures and 1, *O. ptox*, in both habitats. The most

common forest species were *Ontherus appendiculatus* (Mannerheim), *O. ptox* and *Eurysternus caribaeus* (Herbst.). *Gromphas aeruginosa* (Perty) and *O. sulcator* were the most common in pasture. (Table 1).

At Saavedra 112 beetles were trapped in the forest and 51 in the pasture but more than half the total beetle dry weight, 7279 mg consisted of pasture species. The mean dry weight/ forest beetle was 51 mg and the mean dry weight/ pasture beetle was 143 mg. The dry weight of *O. appendiculatus* / trap exceeded that of the total dry weight of all other species trapped in the forest. *E. caribaeus* had a substantial average dry weight/trap. The dry weights of *G. aeruginosa* and *O. sulcator*/ trap were 98% of the total dry weight in the pasture (Table 1).

In the pasture *O. sulcator* made up 98% of beetle dry weight during the night and *G. aeruginosa* 97% of beetle dry weight during the day (Table 1). In the forest there was not such a marked difference in flight activity. Sixty one percent of beetle dry weight was made up by *O. appendiculatus*, 36% by *E. caribaeus* during the night and the same species were most abundant during the day, *O. appendiculatus* 44% and *E. caribaeus* 43% (Table 1).

The results of 24 h trapping at St Ramon, St Pedro and Montero followed the same pattern as at Saavedra. 119 beetles were trapped in the forest and 76 in the pastures. Total beetle dry weight was twice as great in the pastures, 9949 mg compared to 4604 mg in the forest. *O. appendiculatus* 79% and *E. caribaeus* 15% were the most common forest beetles and *G. aeruginosa* 31%, *O. sulcator* 14% and *D. nisus* 53% the most common pasture species. The mean dry weight/beetle in the forest traps was 4 times less (61 mg) than the mean dry weight/beetle in the pasture traps (231 mg).

DISCUSSION

Sloths and monkeys were the largest mammals present in the forest and fruit and fungi were observed. Food resources for dung beetles in the forest were therefore small in size, sporadically produced and transient.

The activity periods and body weights of the 2 largest forest beetles *O. appendiculatus* and *E. caribaeus* were similar. Their dung removal methods are different however (Halffter & Edmonds, 1982).

Table 1: Number of beetles / trap and beetle dry weight/ trap at Saavedra.

Tribe and species	FOREST			PASTURE	
	No. beetles /trap (se)	Dry wt mg/trap		No. beetles /trap (se)	Dry wt mg/trap
Coprini					
O. appendiculatus	0.9(0.2)	91	*O. sulcator*	0.3(0.2)	107
Eurysternini					
E. caribaeus	0.7(0.2)	61	----	----	----
E. hirtellus	0.03(0.003)	1	----	----	----
E. plebejus	0.03(0.003)	1	----	----	----
Onitini					
---	---	--	*G. aeruginosa*	0.4(0.2)	88
Onthophagini					
O. ptox	1.1(02)	8	*O. ptox*	0.7(0.1)	55
Scarabaeinae					
S. imitans	0.1(0.4)	4	----	----	----
S. sp.	0.4(0.2)	13	----	----	----
Aphodiidae					
Ataenius sp. 1	0.3(0.2)		*A.pseudolividus*	0.6(0.3)	2
Ataenius sp. 2					
Flight activity					
Night	29	2141		18	3619
Mean dry wt/beetle (mg)		74			201
Day	71	2994		24	2740
Mean dry wt/beetle (mg)		42			114

O. appendiculatus forms brood balls in isolated chambers whilst *E. caribaeus* forms its definitive nest in a shallow crater under or near the dung source (Halffter, *et. al.*, 1980; Morón, *et. al.*, 1985).

Dung resources were large and abundant in the fenced off pastures. The largest beetles trapped in the pastures, *G. aeruginosa* and *O. sulcator* were 2 to 3 times as large as the largest forest species. *O. sulcator* was considerably bigger than *G. aeruginosa* but these species utilized the dung resource differently, *O. sulcator* flying during the night, *G. aeruginosa* during the day. The smaller size of the forest species is advantageous because they can manoeuver more easily in dense vegetation and can utilize the smaller dung resources available (Nealis, 1977). A disadvantage is that they are stenotopic and when tropical forest is cleared these species will disappear, as observed by Peck & Forsyth (1982) in Ecuador, and Howden & Nealis (1975) in Colombia. The number and diversity of species adapted to tropical forest in the Neotropical zone is large in comparison to the number of species adapted to pastures (Howden & Nealis, 1975; Halffter & Matthews, 1966).

It is surprising to note the small number of forest species trapped here. This may have been because; cattle dung only was used as a bait (for practical reasons this was the most convenient bait), omnivore dung would probably have trapped more species; the forest fragments surveyed were small in size and consequently species richness was lower. It would be interesting to survey as many forest patches as possible using many different bait types. Such information would indicate species loss compared to species number in undisturbed forest, and would be useful in the conservation of the dung beetle fauna.

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Appendix 1

Localities and habitats where dung beetles were collected in Santa Cruz Province, Bolivia (September, October, November, 1987). Taxonomic lay out based on Halffter & Edmonds (1982), Onitini based on Zunino, 1985. Abbreviations: F = forest; O = open; C = Cattle dung; H = Horse dung; M= Mule dung.

Species	Length (mm)	Dry wt (mg)	Localities, Dates, Habitat, Dung type
Coprini			
(Dichotomiina)			
Ateuchus sp. 1	5	-	Mennonite colony, 1/9, O,C
Ateuchus sp. 2	6	9	Guapamocito, 17/9,O,C; Montero, 13/10,O,C; Equipetrol, 9/11,O,C.
Canthidium sp. 1	8	-	San Ramon, 18/9,O, Fruit
Canthidium sp. 2	6	-	Equipetrol, 10/11, F,C
Canthidium sp. 3	6		Equipetrol, 10/11, F.C
Canthidium sp. 4	6	-	Abapo-Izozog, 15/10, O,H.
Dichotomius nisus (Olivier)	23	590	Okinawa 2,3/9,O,C; San Pedro, 9/9,O,C; Angostura,10/9,O,C; Montero, 3/10,O,C; Abapo-Izozog, 15/10,O,C; Equipetrol, 9/11, O,C.
Ontherus appendiculatus (Mannerheim)	14	101	San Pedro, 9/9, F,C; Buena Vista, 23/9,F,C; Montero,3/10,F,C; Saavedra, 9,14,15,22,29/9,12/10,F.C.
O. sulcator (F.)	18	356	Okinawa 2,3/9,O,C; Abapo-Izozog, 15/10,O,C; Equipetrol, 9/11,O,C: Saavedra, 12,13/10,O,C.
Eurysternini			
Eurysternus caribaeus (Herbst.)	13	87	San Pedro, 9/9,F,C; San Ramon,14/9,F,C; Montero, 3/10,F,C; Equipetrol, 9/11,F,C; Saavedra, 4,5,9,22,29,30/9,12/10,F,C.
E. hirtellus Dalman	5	7	Saavedra, 30/9,F,C.
E. plebejus Harold	9	2	Saavedra, 12/10,F,C.
Onitini			
(Gromphina)			
Bolbites onitoides Harold	20	-	Abapo-Izozog, 15/10,O,H.
Gromphas aeruginosa (Perty)	16	221	Los Troncos, 3/9,O,H; San Pedro, 9/9,O,C; Buena Vista, 23/9,O,C; Pari River, 23/9,O,C; Saavedra, 4,5,7,11,22,/9,O,C.

Onthophagini			
Onthophagus ophion Erichson	7	-	Equipetrol, 10/11,F,C.
O. ptox Erichson	7	8	Okinawa 2,3/9,O,M; Los Troncos, 3/9,O,C; Mennonite Colony, 1/9,O,C; Angostura, 10/9,O,C; Guapamocito, 15/9,O,C; Buena Vista, 23/9,O,H; San Pedro, 9/9,O,F,C; San Ramon, 14/9,O,F,C; Montero, 3/10, O,C; Cotoca, 2/11,O,C; Equipetrol,O,F,C; Saipina, 7/11,O,C; Saavedra,4,5,7,9,14,15,22,29,30,/9,12/10,O,F,C.
Scarabaeini (Canthonina)			
Anisocanthon villosus (Harold)	7	--	Equipetrol, 10/11, F,C.
Canthon lituratus (Germar)	6	--	Cotoca, 2/11,O,C.
C. quinquemaculatus Laporte	9	36	Saavedra, 4,5,9,22/8,F,C.
C. mutabilis Lucas	6	--	Mennonite Colony, 1/9,O,C.
Malagoniella astyanax (Olivier)	12	--	Guapamocito, 17/9,O,H.
Sybalocanthon imitans (Harold)	9	36	Saavedra, 4,5,9,22/9,F,C.
Sylvicanthon sp.	8	33	Buena Vista, 23/9,F,C; Guapamocito, 17/9,F,C; Saavedra, 4,5,9,22/9,F,C.
Aphodiidae			
Aphodius brasiliensis Lap.			San Ramon, 14/9,F,C; Buena Vista, 23/9,O,H.
A. pseudolividus Balth.			Los Troncos, 3/9,O,C; San Ramon, 13/9,O,H; Saavedra, 28/9,O,C.
Ataenius sp.			Saavedra, 26/9,O,C.
Ataenius sp. 1			Mennonite Colony, 1/9,O,C; San Pedro, 8/9,O,C.
Ataenius sp. 2			Saavedra, 28/9,F,C.
Ataenius sp. 3			Okinawa 2, 3/9,O,C.
Cartwrightia cartwrighti Cartw.			San Ramon, 14/9,F,C.
Didactylia infuscatopennis (Schm.)			Los Troncos, 3/9,O,H; San Ramon,14/9,O,C.