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SHORT COMMUNICATION

Dung beetles (Coleoptera, Scarabaeinae) attracted to sheep dung in exotic pastures

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ABSTRACT. Dung beetles (Coleoptera, Scarabaeinae) attracted to sheep dung in exotic pastures. In this study we provide data on the abundance and richness of dung beetles (Coleoptera, Scarabaeidae, Scarabaeinae) attracted to sheep dung in exotic pastures (*Brachiaria* spp.). In four areas of exotic pasture pitfall traps were installed and baited with fresh sheep dung for sampling of dung beetles. A total of 2,290 individuals were captured belonging to 16 species, 10 genera and five tribes of Scarabaeinae beetles. *Trichillum externepunctatum* Preudhomme de Borre, 1886 and *Dichotomius bos* (Blanchard, 1843) were dominant. The guild of dwellers was the most abundant in pastures. We demonstrate that dung beetles are attracted to sheep dung. Since the production of both cattle and sheep in the same area is common in tropical pasturelands, results obtained here highlight the need to investigate the actual role of dung sharing (cattle dung + sheep dung) by dung beetles. It is also suggested that experiments be performed for evaluation of the ecological functions performed by dung beetles using sheep dung.

KEYWORDS. Agro-pastoral landscape; coprophagous beetles; ecological functions; Insecta.

Sheep farming is present in all continents. The worldwide sheep flock consists of approximately 1,034 billion animals (FAO 2007) and Brazil has a flock of about 14 million (IBGE 2006). The growing demand for sheep products (meat, milk, and skin) has stimulated an increase in pasture areas for sheep farming in Brazil (Silva *et al.* 1998). Thus, locations initially used for grazing of cattle and horses and later replaced by sheep farming may cause a change in community structure of detritivore insects (*e.g.*, Lobo *et al.* 2006).

Brachiaria spp. occupies about 80% of all cultivated pastures in Brazil (Pereira *et al.* 2005). This grass, originally from Africa, was introduced in Brazil more than two centuries ago. Because it presents excellent adaptation to climate and good nutritional value, it is widely used for the creation of herbivores such as cattle, horses, goats and sheep, and the excrements of these animals have been used as a food source by dung beetles (Coleoptera, Scarabaeinae). Thus, by burying dung for nesting, feeding and offspring, dung beetles increase the rate of nutrient recycling, improving fertility and soil aeration, contribute to the reduction of helminthes and parasitic flies of human and domestic animals, assist in the growth and development of pasture and also increasing the grazing area when incorporating the fecal mass (Nichols *et al.* 2008, and references therein).

Availability of vertebrate feces to dung beetles varies greatly with respect to time and space, and may be important for stabilization or fluctuations in populations of these insects (Hernández & Vaz-de-Mello 2009). The attractiveness of this trophic resource to dung beetles can also vary depending on the feeding habits of these animals (omnivore, carnivore and herbivore), and it has been observed that they are more attracted to the dung of omnivorous mammals (*e.g.*, Martín-Piera & Lobo 1996; Filgueiras *et al.* 2009). Trophic selection may play an important role in the coexistence of species and the subsequent sharing of resources (Martín-Piera & Lobo 1996), where most of the species utilize a large variety of feces, which reduces interspecific competition (Halffter 1991; Estrada *et al.* 1993; Sowig & Wassmer 1994). In contrast to cattle dung, which develops a compact crust on its surface, sheep dung are able to rehydrate with dew or rain and therefore remain attractive to dung beetles for a longer period (*e.g.*, Lumaret & Kirk 1987; Wassmer 1995). Additionally, the physical and chemical composition of the herbivore dung often varies with the species and also with pasture quality (Martín-Piera & Lobo 1996).

In Brazil, most surveys on dung beetles species in pastures were performed using cow dung as bait (see list in Louzada & Carvalho e Silva 2009), but there are works with the dung of horses (Louzada & Carvalho e Silva 2009) and pigs (Flechtmann *et al.* 2009). Knowledge on the dung beetles assemblage that utilized sheep dung as a resource is scarce through the world; this lack of information is even more pro-

nounced for the Neotropical region (*e.g.*, Brazil: Stumpf 1986; Uruguay: Morelli *et al.* 1997, 2002). Due to the small amount of information on the dung beetles associated with sheep dung in Brazil, we provide data on the abundance and diversity of dung beetles attracted to this trophic resource in exotic pastures.

Samples were collected in exotic pastures (*Brachiaria* spp.) in a transition area between the Cerrado and Pantanal ecosystems in Aquidauana, Mato Grosso do Sul, Brazil (20°28'15"S; 55°47'13" W). Climate of the region, according to the Köppen classification, is Tropical Hot – Wet (Aw) (Peel *et al.* 2007) with annual rainfall between 1,200 to 1,300 mm and average annual temperature of 26°C. Two areas were selected with the constant presence of cattle (average of 0.7 adult cattle·ha^{-1}), and two other areas were selected without these animals for about five months before the collection of beetles. Regions surrounding the sampling sites are dominated by extensive exotic pastures and patches of native vegetation (Brazilian savanna).

All sampling was conducted during the middle of the rainy season, in January 2011. The rainy season is recognized as the best period of the year to sample dung beetles in Brazilian pastures (*e.g.*, Abot *et al.* 2012). All traps were baited with fresh sheep dung collected from breeding facilities near the areas studied. Sheep are bred extensively in the area feeding just on the exotic grasses (*Brachiaria* spp.).

In each pasture a linear transect was installed with 10 pitfall traps (1000 mL) separated by 20 m. Fresh sheep dung (50 mL) were placed in plastic containers in the center of each trap with a wire. The traps contained approximately 250 mL of a 1.5% liquid detergent solution and remained installed in the field for a period of 48 hours in each pasture. Traps were covered with a plastic lid in order to reduce desiccation of the bait and avoid damage caused by potential rainfall.

The beetles captured were sent to the Universidade Federal de Mato Grosso (UFMT, Cuiabá, Mato Grosso, Brazil) where they were identified by Dr. Fernando Z. Vaz-de-Mello. Voucher specimens are deposited in the Entomology Section of the Zoological Collection of the UFMT, as well in the collection of the Laboratory of Systematics and Biology of Coleoptera (Universidade Federal de Viçosa – UFV, Viçosa, Minas Gerais, Brazil).

Rarefaction analysis based on the number of individuals captured was used to compare patterns of species richness (Sobs Mao Tau) and sampling effort. In order to obtain estimates of sample richness, the richness' estimators of ACE, Chao 1, and Jackknife 1 were calculated. This was performed using the software EstimateS 7.5, with 500 randomizations (Colwell 2005).

A total of 2,290 individuals were captured belonging to 16 species, 10 genera and five tribes of Scarabaeinae: Ateuchini (three genera and four species), Coprini (three genera and eight species), Deltochilini (one species), Onthophagini (two genera and two species) and Phanaeini (one species) (Table I). The richness estimate (ACE, Chao 1, and Jackknife 1) indicated a maximum of 17 species (Fig. 1). The average of these estimates and observed richness indicates that sampling efficiency was roughly 95.29%. Curve produced using the number of individuals (Sobs) tended towards an asymptote (Fig. 1).

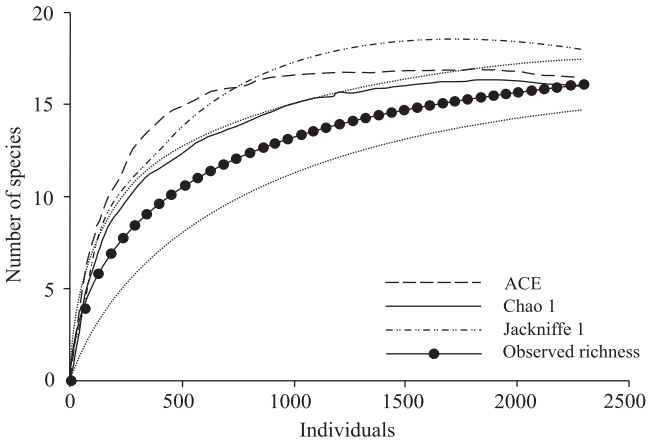

Fig. 1. Richness estimates of dung beetles (Coleoptera, Scarabaeinae) attracted to sheep dung in exotic pastures (*Brachiaria* spp.), in Aquidauana, Mato Grosso do Sul, Brazil. The dotted lines are ± 95% Confidence Interval.

The majority of species were represented by few individuals, with large numbers of singleton and doubleton species. *Trichillum externepunctatum* Preudhomme de Borre, 1886 and *Dichotomius bos* (Blanchard, 1843) were most abundant, representing respectively 43.58 and 31.40% of the individuals captured (Table I).

Dweller beetles accounted for 58.25% of all individuals collected, whereas burrowers and rollers accounted for 41.57 and 0.17% of the sampled individuals, respectively (Table I). Burrower beetles represented 68.75% of the species collected, and dwellers and rollers accounted for 25.00 and 6.25% of sampled species, respectively (Table I).

We demonstrated that dung beetles are attracted to sheep dung in exotic pastures. In addition, we provide the first report of the attraction of 16 species of Scarabaeinae beetles to sheep dung in Brazil, increasing the knowledge of the number of dung beetles that can potentially utilize this resource. In Brazil, prior to the present study, five species of dung beetles had been sampled in areas of sheep breeding (Stumpf 1986), none of which were sampled in our study.

Our study of the dung beetles assemblage in exotic pastures confirmed the occurrence of dung beetles species common to open areas, such as exotic pastures (*e.g.*, Flechtmann *et al.* 1995; Aidar *et al.* 2000; Koller *et al.* 2007; Abot *et al.* 2012). It also contributes to the understanding of local diversity of these beetles and increases knowledge on their distribution. Despite the small sampling effort, sampling efficiency was high, although we believe that considering the taxonomic richness of Scarabaeinae in the Neotropical region, possibly many other species may also be associated with the dung of sheeps.

Table I. Richness and abundance of the dung beetles (Coleoptera, Scarabaeinae) attracted to sheep dung in exotic pastures (*Brachiaria* spp.), in Aquidauana, Mato Grosso do Sul, Brazil. Each functional guild was determined via the classification proposed by Halffter & Matthews (1966).

Taxon	Abundance		Guild
	N	(%)	
Ateuchini			
Ateuchus sp.	2	0.09	Dweller
Ateuchus aff. *puncticollis*	5	0.22	Dweller
Genieridium bidens (Balthasar, 1942)	329	14.37	Dweller
Trichillum externepunctatum Preudhomme de Borre, 1886	998	43.58	Dweller
Coprini			
Canthidium aff. *pinotoides*	2	0.09	Burrower
Dichotomius bos (Blanchard, 1843)	719	31.40	Burrower
Dichotomius glaucus Harold, 1869	6	0.26	Burrower
Dichotomius nisus (Olivier, 1789)	3	0.13	Burrower
Dichotomius opacipennis Luederwaldt, 1931	1	0.04	Burrower
Dichotomius sexdentatus (Luederwaldt, 1925)	9	0.39	Burrower
Ontherus appendiculatus (Mannerheim, 1829)	82	3.58	Burrower
Ontherus digitatus Harold, 1868	6	0.26	Burrower
Deltochilini			
Canthon chalybaeus Blanchard, 1843	4	0.17	Roller
Onthophagini			
Digitonthophagus gazella (Fabricius, 1787)	9	0.39	Burrower
Onthophagus aff. *hirculus*	113	4.93	Burrower
Phanaeini			
Coprophanaeus spitzi (Pessôa, 1935)	2	0.09	Burrower
Number of individuals	2,290	100.00	
Number of species	16		

The dominance of *T. externepunctatum* may be related to the small size of the beetles (~ 3.5 mm) (Vaz-de-Mello 2008), which enables that a greater number of individuals can share the resources available. Because *D. bos* was the second most abundant species in the present study using sheep dung as bait, and has been abundant in many Brazilian pasturelands utilized for cattle production (*e.g.*, Louzada & Carvalho e Silva 2009; Rodrigues *et al.* 2010; Abot *et al.* 2012), we believe that its dominance may be associated to adaptation to Neotropical pastures (Abot *et al.* 2012) and not just the food resource.

The dominance of dwellers may be related to the small size of species collected. This probably permits that a greater number of individuals can share the resources since resource availability in these areas is reduced. In this case, small individuals are at an advantage when competing with larger ones for the resource, because a greater number of small individuals can likely share the same resource. In richness, the dominance of burrowers in pastures may be associated to the constant availability of manure, since individuals of this guild are generally larger and able to colonize a greater number of dung pads (Flechtmann *et al.* 1995).

In conclusion, we demonstrated that dung beetles are attracted to sheep dung. Because the production of both cattle and sheep in the same area is common in tropical pastures, the presented results highlight the need to investigate the actual role of dung sharing (cattle dung + sheep dung) by dung beetles. On one hand, the dung beetles may benefit from the diversification of the trophic resource present in these landscapes but the effects of potential losses to the agroecosystem by cattle must be investigated. In intensive grazing systems, where the cattle remain in the same pasture for a long period of time, the movement of these animals reduces vegetation cover. Trampling can kill young plants or damage mature plants, compact and destabilize the soil surface and increase the area of bare soil (*e.g.*, Vzzoto *et al.* 2000). These effects may increase soil erosion and consequently the degradation of grasslands, negatively impacting the dung beetles assemblage. The lack of pressure from cattle production enables an increased growth of exotic grasses and native herbs, changing the microclimate characteristics of the areas (*e.g.*, Halffter 1991). In environments with higher humidity, as in the case of pastures with more plant biomass, sheep dung can be rehydrated with dew or rain and become more attractive to dung beetles for a longer period (*e.g.*, Lumaret & Kirk 1987). This probably favors the dung beetles assemblage, which can use the sheep dung as a resource. An alternative would be to manage the animals in these areas, leaving only the sheep, which would ensure the supply of resources to the beetles for a determined period. Thus, exotic grasses and native vegetation would be able to grow, altering microclimatic conditions of the area, which potentially favor the dung beetles. With these strategies, farmers may conserve the elevated abundance and diversity of dung beetles in their pastures and thus benefiting from these organisms and also the doubled revenue from creation of both animals. In addition, experiments for evaluation of the ecological functions performed by dung beetles should be carried out, as proposed by Braga *et al.* (2012). This will provide information on the contribution of dung beetles in the removal of dung and bioturbation when using sheep dung.

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