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Inventory

Dung beetles (Coleoptera: Scarabaeidae: Scarabaeinae) of Serra do Divisor National Park, Brazil

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Abstract: Serra do Divisor National Park (SDNP) is a protected area located in the western Brazilian Amazon that is threatened by a pending bill proposing to downgrade its status and to build a road that would effectively slice the park in half. The biodiversity of SDNP is poorly understood and no dung beetle inventories have been conducted within the park to date, despite being one of the most studied insect groups in the Neotropics. We sampled dung beetles with flight interception traps (FITs) and pitfall traps baited with human faeces to provide the first comprehensive dung beetle species list for SDNP. In total, we collected 4,909 dung beetle individuals belonging to 83 species. Of these, 18 were new species records for the state of Acre and two for Brazil. We also found species with Andean affinity and five species new to science. This study contributes to our understanding of dung beetle assemblages in the western Brazilian Amazon, showing that SDNP is a unique locality due to the proximity of the Andes, and highlighting that biodiversity in many Amazonian protected areas remains severely under sampled.
***Keywords*:** *Amazon; Flight interception traps; Pitfall; Species list.*

Os besouros rola-bostas (Coleoptera: Scarabaeidae: Scarabaeinae) do Parque Nacional da Serra do Divisor, Brasil

Resumo: O Parque Nacional da Serra do Divisor (PNSD) é uma unidade de conservação localizada no sudoeste da Amazônia brasileira. O parque é extremamente biodiverso, mas está ameaçado por um projeto de lei que propõe diminuir sua categorização para Área de Proteção Ambiental (APA) e construir uma rodovia que cortaria o parque ao meio. Contudo, a biodiversidade do PNSD ainda é pouco estudada. Um exemplo disso é que nenhum inventário de besouros rola-bostas havia sido realizado nesta área até então, mesmo tratando-se de um dos grupos de insetos mais estudados na região Neotropical. Os besouros foram amostrados usando armadilhas de interceptação de voo (*Flight Interception Traps* – FIT) e armadilhas *pitfall* iscadas com fezes humanas para compor a primeira lista de espécies de besouros rola-bostas do PNSD. Nós coletamos um total de 4.909 indivíduos de 83 espécies, sendo 18 espécies novos registros de ocorrência para o estado do Acre e duas

para o Brasil. Também capturamos espécies com afinidade Andina e cinco espécies novas para a ciência. Este trabalho amplia o conhecimento atual das assembleias de rola-bostas no sudoeste amazônico, mostra que PNSD é uma localidade singular devido à sua proximidade com os Andes e evidencia que muitas áreas de proteção na Amazônia ainda são pouco estudadas.

Palavras-chave: *Amazônia; Armadilha de interceptação de voo; Lista de espécies; Pitfall.*

Introduction

The Neotropical region is estimated to host at least a third of the world's biodiversity (Raven et al. 2020), with the majority found in the Amazon rainforest (Antonelli et al. 2018). However, this high-biodiversity region is under immense threat from deforestation (Hoang & Kanemoto 2021) largely driven by agribusiness expansion (Pereira et al. 2020, Seymour & Harris 2019). Protected Areas (PAs) have therefore become increasingly important to mitigate deforestation and safeguard biodiversity (Soares-Filho et al. 2010, Barber et al. 2014, Gonçalves-Souza et al. 2021). In fact, 47% of Amazonia lies within a PA (IUCN categories I – VI), collectively spanning 198 million hectares (Soares-Filho et al. 2023) and deforestation rates are much lower inside PAs than outside (Qin et al. 2022).

Serra do Divisor National Park (SDNP) is an ~0.84 Mha PA located in the extreme western Brazilian Amazonia in the state of Acre, adjacent to the border with Peru (Brazil 1989, 2000, ISA 2023). SDNP and its contiguous sister-park (the ~1.35 Mha *Sierra del Divisor National Park*) in Peru, form a substantial transnational biological corridor spanning more than two million hectares across the Brazil-Peru border (MMA 2024, SERNANP 2024). SDNP is extremely biodiverse, hosting at least 43 species of large mammals and more than 100 amphibian, 30 reptile, 480 bird, and 55 bat species (UNESCO 2024). Less than 1% of the park's primary forest has been altered since its creation (Koga et al. 2022) and SDNP is therefore an important refuge for biodiversity including many species of high conservation value (Gonzalez & Acuy 2017, MMA 2024).

Despite its importance, SDNP is under increasing pressure (Ruaro & Laurance 2021, Koga et al. 2022). The PA is currently threatened by a pending bill (n. 6024/2019) that proposes to downgrade its status to an Environmental Protection Area (*Área de Proteção Ambiental* in Portuguese – APA) and extend the BR-364 highway through its territory (Brazil 2019). These proposed actions would allow activities prohibited within a National Park, leading to economic exploitation, accelerated deforestation and habitat degradation with significant environmental and societal impacts (Ruaro & Laurance 2021, Koga et al. 2022). The highway could also intensify illegal logging, promote illegal settlements, mining, and hunting, and benefit drug trafficking and criminal factions (Laurance & Balmford 2013, Faleiro 2023). For a map of the proposed highway through the contiguous PAs in Brazil and Peru, refer to Koga et al. (2022).

Research on the biodiversity of SDNP has increased in recent years, particularly for vertebrates (Calouro 1999, Lopes & Rehg 2003, Whitney et al. 2004, Lemos et al. 2018, Almeida et al. 2022b) and insects including butterflies (Dolibaina et al. 2012, 2015, 2016, Kaminski 2020), leafhoppers (Creão-Duarte et al. 2023), wasps (Azevedo et al. 2002, Morato et al. 2008), and termites (Ferreira et al. 2023). However, invertebrate biodiversity inventories generally remain insufficient, and, to the best of our knowledge, no comprehensive inventory of dung beetles (Coleoptera: Scarabaeidae: Scarabaeinae) has been conducted in the park, even though dung beetles are among the most studied insect groups in the Neotropics, especially South America (Arellano et al. 2023, 2024).

The Neotropical realm harbours the greatest dung beetle diversity and richness in the world (Favila et al. 2023), with Brazil alone hosting at least 787 species (Vaz-de-Mello & Bordin 2024). These beetles portray a wide range of feeding habits which have undoubtedly contributed to their high species richness in this region (Gill 1991). While dung beetles are commonly known for being coprophagous, feeding mainly on mammal faeces (Filgueiras et al. 2009, Tsuji et al. 2021), there are also species that are partially or strictly necrophagous (feeding on carrion) or saprophagous (consuming decaying fruit or fungi; Halffter & Matthews 1966, Halffter & Halffter 2009), and a few may even be predators (Vaz-de-Mello et al. 1998, Oliveira et al. 2022).

Many dung beetles are known for their reproductive and feeding behaviour, which involves rolling some of the food and building nests underground (Cambefort & Hanski 1991). Although this behaviour varies among species (Halffter & Edmonds 1982), dung beetles play a crucial role in nutrient recycling and increasing soil nutrient concentrations (*e.g.* including phosphorus, ammonia, and nitrogen; Maldonado et al. 2019) by burying decaying organic matter. They also contribute to soil aeration, secondary seed dispersal, and parasite suppression (Louzada 2008, Nichols et al. 2008, Almeida et al. 2022a). Furthermore, dung beetles are a high-performance group in biodiversity assessment and monitoring (Gardner et al. 2008) and can be used to evaluate changes in the habitat integrity (Verdú et al. 2011, Viegas et al. 2014, Carvalho et al. 2020, Noriega et al. 2021).

In this study, we present a checklist of dung beetle species from Serra do Divisor National Park in the state of Acre, Brazil. This is a fundamental first step in monitoring biodiversity and establishing further conservation practices (Jones et al. 2013). By providing information on the occurrence of dung beetle species, we contribute to the broader understanding of biodiversity in this region. We also discuss our findings in relation to the park's geographic location, sampling methods used, and the proposed actions of bill 6024/2019.

Material and Methods

1. Study area

Serra do Divisor National Park (SDNP) is situated in the upper Juruá River basin in the state of Acre, westernmost Brazilian Amazonia. Encompassing an area of 837,554 ha, the park spans five municipalities: Cruzeiro do Sul, Mâncio Lima, Marechal Thaumaturgo, Porto Walter, and Rodrigues Alves (MMA 2024). The average elevation is 300 m, and

the main primary vegetation is open ombrophilous forest, accounting for 84.99% of the park, followed by dense ombrophilous forest, making up the remaining 15.01% (ISA 2023). Annual precipitation in the park is 2,200 mm, with average temperatures ranging between 23–26°C throughout the dry and rainy seasons (ISA 2023).

2. *Sampling design*

Dung beetle sampling was carried out during December 2019 in *terra firme* forest sites in the northern sector of SDNP as part of our 3rd Amazon Biodiversity & Carbon (ABC) expedition (www.abc-expeditions.com/). The permanent license for zoological material collection was authorized by *Ministério do Meio Ambiente* (MMA), *Instituto Chico Mendes de Conservação e Biodiversidade* (ICMBio), and *Sistema de Autorização e Informação em Biodiversidade* (SISBIO) process n. 72874, on November 4, 2019.

Sampling was conducted along three 1-kilometer transects referred to as plot A (07°24'44"S 73°39'49" W), B (07°29'26"S 73°39'06" W), and C (07°25'46"S 73°37'39" W; Figure 1). In each plot, four flight interception traps (FIT) of 2 × 1.5 m were installed 250 m apart and left open for 12 days (the spatial configuration of sampling along each plot is shown in Figure 1). Samples were collected every four days, resulting in a total of 12 FIT samples per plot. Additionally, for each of the same transects, 10 pitfall traps baited with human faeces were installed 100 m apart, filled with a mixture of water, salt, and detergent. Pitfall traps were left open for 48 hours and resulted in a total of 10 samples per plot (Larsen & Forsyth 2005, Da Silva and Hernández 2015; Mora-Aguilar et al. 2023).

3. *Dung beetle identification*

Collected specimens were fixed with 96% alcohol in the field and later deposited in *Coleção Entomológica de Mato Grosso Eurides Furtado* (CEMT), at *Universidade Federal de Mato Grosso*, Cuiabá, state of Mato Grosso, Brazil. Dung beetle identification was achieved using taxonomic bibliography and the identification keys therein (Génier 1996, Cook 1998, 2000, Edmonds & Zídek 2004, Génier 2009, Edmonds & Zídek 2010, Vaz-de-Mello et al. 2011, Edmonds & Zídek 2012, Génier & Arnaud 2016, Rossini & Vaz-de-Mello 2017, Cupello & Vaz-de-Mello 2018, Rossini et al. 2018, Silva & Valois 2019, Rossini & Vaz-de-Mello 2020), and by comparing with specimens previously identified and deposited at CEMT. When species identification was not possible, specimens were sorted based on external morphology.

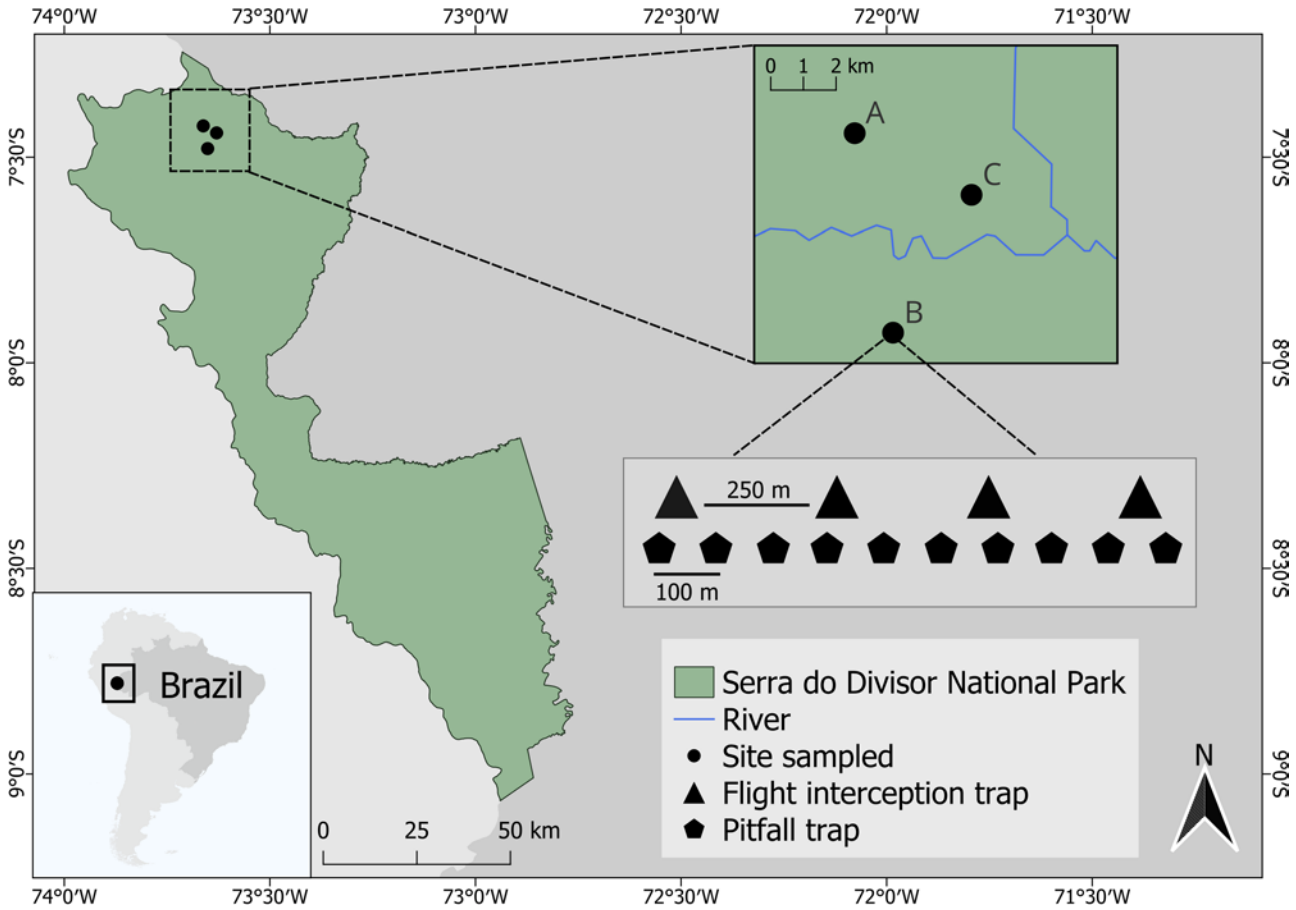

Figure 1. Serra do Divisor National Park (SDNP), state of Acre, westernmost Brazilian Amazon, where dung beetles were sampled in plots A, B, and C (inset square) in the northern portion of the park using flight interception traps and pitfall traps baited with human faeces. The spatial configuration of sampling along each plot is also shown.

4. Data analysis

To assess sampling efficiency, we performed individual-based rarefaction curves of species richness at plot-level (q = 0; Chao et al. 2014) and calculated sample coverage using the 'iNEXT' package (Hsieh & Chao 2024) and 'ggplot2' (Wickham 2016) in R (R Core Team 2023). To visualize species relative abundance sampled by FITs and pitfall traps we plotted rank abundance curves using the 'BiodiversityR' package (Kindt & Coe 2005).

Results

In total, we collected 4,909 dung beetle individuals from 83 species (Table 1): 50 were identified to species level (60.24%) and 33 were not associated to existing species names (39.76%). Among the 20 genera captured, *Canthidium* was the most species-rich with 12 species and 361 individuals, followed by *Ateuchus* with 10 species and 139 individuals, and *Eurysternus* with nine species and 1,171 individuals. The most abundant species was *Onthophagus rubrescens*

Table 1. List of 83 dung beetle species from Serra do Divisor National Park (SDNP), sampled with flight interception traps (FIT) and pitfall traps baited with human faeces (PT). Literature citations are added when the species have been previously recorded for the state of Acre. * = first species record for Acre; ** = first species record for Brazil; - = no information found; N = number of individuals captured in our study.

Species	Capture method	Literature records	Site	N
Anomiopus pictus (Harold, 1862)	FIT	*	SDNP	1
Anomiopus sp. 1	FIT	–	SDNP	3
Anomiopus sp. 2	FIT	–	SDNP	1
Ateuchus aeneomicans (Harold, 1868)	FIT; PT	*	SDNP	16
Ateuchus aff. *murrayi*	FIT; PT	–	SDNP	100
Ateuchus aff. *ovalis*	FIT	-	SDNP	2
Ateuchus aff. *pygidialis*	PT	–	SDNP	1
Ateuchus cereus (Harold, 1868)	FIT; PT	*	SDNP	4
Ateuchus columbianus (Harold, 1868)	FIT; PT	**	SDNP	4
Ateuchus connexus (Harold, 1868)	FIT	*	SDNP	4
Ateuchus globulus (Boucomont, 1928)	FIT	*	SDNP	3
Ateuchus murrayi (Harold, 1868)	FIT; PT	*	SDNP	4
Ateuchus substriatus (Harold, 1868)	PT	*	SDNP	1
Bdelyrus sp. 1	FIT	–	SDNP	1
Canthidium aff. *dohrni*	FIT; PT	–	SDNP	5
Canthidium aff. *funebre*	PT	–	SDNP	4
Canthidium aff. *lentum*	FIT; PT	–	SDNP	16
Canthidium aff. *melanocephalum*	FIT; PT	–	SDNP	5
Canthidium aff. *onthophagoides*	FIT	–	SDNP	4
Canthidium aff. *orbiculatum*	FIT; PT	–	SDNP	132
Canthidium aff. *rufinum*	PT	–	SDNP	2
Canthidium sp. 1	PT	–	SDNP	1
Canthidium sp. 2	PT	–	SDNP	4
Canthidium sp. 3	FIT	–	SDNP	1
Canthidium sp. 4	FIT; PT	–	SDNP	77
Canthidium sp. 5	FIT; PT	–	SDNP	10
Canthon aff. *angustatus*	PT	–	SDNP	78
Canthon brunneus Schmidt, 1922	PT	*	SDNP	15
Canthon luteicollis Erichson, 1847	FIT; PT	Vaz-de-Mello, 1999	SDNP; Zoobotânico Park - Universidade Federal do Acre	142

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Species	Capture method	Literature records	Site	N
Canthon quadrimaculatus Schmidt 1922	PT	*	SDNP	1
Canthon rufocoeruleus Martínez, 1948	PT	*	SDNP	5
Canthon semiopacus Harold, 1868	PT baited with human faeces or carrion (bovine liver)	Bitencourt et al. 2019a; Bitencourt et al. 2019b	SDNP; Senador Guiomard, Catuaba Experimental Reserve; Antimary State Forest	3
Canthon xanthopus Blanchard 1846	FIT; PT baited with human faeces or carrion (chicken heart)	Bitencourt et al. 2019b	SDNP; Floresta Estadual do Antimary	8
Canthonella sp. 1	FIT	–	SDNP	2
Canthonella sp. 2	PT	–	SDNP	1
Coprophanaeus sp. 1	FIT	–	SDNP	3
Coprophanaeus telamon Erichson 1847	FIT; PT baited with human faeces or carrion (chicken heart or bovine liver)	Bitencourt et al. 2019a; Bitencourt et al. 2019b; Cupello & Vaz-de-Mello, 2013; Edmonds & Zídek, 2010; Vaz-de-Mello, 1999	SDNP; Senador Guiomard, Catuaba Experimental Reserve; Antimary State Forest; Xapuri, Chico Mendes Reserve; Zoobotânico Park - Universidade Federal do Acre	34
Cryptocanthon peckorum Howden 1973	FIT; pan traps; PT baited with human faeces or carcass	Cook, 2002	SDNP; Rio Branco, Catuaba Experimental Reserve	12
Deltochilum aff. *carinatum*	FIT; PT	–	SDNP	4
Deltochilum aff. *guyanense*	FIT; PT	–	SDNP	16
Deltochilum gr. *aspericolle*	FIT; PT	–	SDNP	37
Deltochilum gr. *barbipes*	FIT; PT	–	SDNP	21
Deltochilum gr. *femorale*	FIT	–	SDNP	4
Deltochilum orbiculare Lansberge 1874	FIT; PT baited with human faeces or carrion (bovine liver)	Bitencourt et al. 2019a; Bitencourt et al. 2019b	SDNP; Senador Guiomard, Catuaba Experimental Reserve; Antimary State Forest	15
Deltochilum orbignyi amazonicum Bates, 1887	FIT; PT baited with human faeces or carrion (chicken heart)	Bitencourt et al. 2019b	SDNP; Antimary State Forest	37
Deltochilum schefflerorum Silva, Louzada & Vaz-de-Mello, 2015	FIT	*	SDNP	1
Dendropaemon lydiae Génier & Arnaud 2016	FIT	Génier & Arnaud, 2016	SDNP; Zoobotânico Park – Universidade Federal do Acre	1
Dichotomius aff. *lucasi*	FIT; PT	–	SDNP	18
Dichotomius divisor Moura et al. 2025	FIT; PT	–	SDNP	70
Dichotomius batesi (Harold, 1869)	FIT; PT	Valois, Vaz-de-Mello & Silva, 2023	SDNP; Xapuri, Chico Mendes Reserve	141
Dichotomius gandinii Rossini & Vaz-de-Mello, 2020	PT baited with human faeces or fish carrion	Rossini & Vaz-de-Mello, 2020	SDNP; Xapuri, Chico Mendes Reserve; Zoobotânico Park – Universidade Federal do Acre	2

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Species	Capture method	Literature records	Site	N
Dichotomius mamillatus (Felsche, 1901)	FIT; PT baited with human faeces or carrion (chicken heart or bovine liver)	Bitencourt et al. 2019a; Bitencourt et al. 2019b; Vaz-de-Mello, 1999	SDNP; Senador Guiomard, Catuaba Experimental Reserve; Antimary State Forest; Xapuri, Chico Mendes Reserve; Zoobotânico Park – Universidade Federal do Acre	9
Dichotomius ohausi (Luederwaldt, 1923)	FIT; PT baited with human faeces or carrion (chicken heart or bovine liver)	Bitencourt et al. 2019a; Bitencourt et al. 2019b; Vaz-de-Mello, 1999	SDNP; Senador Guiomard, Catuaba Experimental Reserve; Antimary State Forest; Zoobotânico Park - Universidade Federal do Acre	2
Dichotomius robustus (Luederwaldt, 1935)	PT baited with human faeces or carrion (chicken heart)	Bitencourt et al. 2019b; Vaz-de-Mello, 1999	SDNP; Antimary State Forest; Zoobotânico Park - Universidade Federal do Acre	3
Eurysternus caribaeus (Herbst, 1789)	FIT; PT baited with several mammal faeces (including human); several carcasses; occasionally in light traps	Bitencourt et al. 2019a; Bitencourt et al. 2019b; Génier, 2009; Vaz-de-Mello, 1999	SDNP; Senador Guiomard, Catuaba Experimental Reserve; Antimary State Forest; Cruzeiro do Sul; Zoobotânico Park - Universidade Federal do Acre	438
Eurysternus cayennensis Castelnau, 1840	FIT; PT	*	SDNP	172
Eurysternus foedus Guérin-Méneville, 1844	FIT; PT baited with several mammal faeces (including humans') or carcasses (as rotten bovine liver); rarely in light traps	Bitencourt et al. 2019a; Génier, 2009	SDNP; Senador Guiomard, Catuaba Experimental Reserve; Cruzeiro do Sul	10
Eurysternus hamaticollis Balthasar, 1939	PT	*	SDNP	9
Eurysternus hypocrita Balthasar, 1939	FIT; PT baited with human faeces or carrion (chicken heart)	Bitencourt et al. 2019b	SDNP; Antimary State Forest	226
Eurysternus plebejus Harold, 1880	FIT; PT baited with human faeces	*	SDNP	53
Eurysternus strigilatus Génier, 2009	FIT; PT baited with human faeces or carrion (chicken heart)	Bitencourt et al. 2019b	SDNP; Antimary State Forest	68
Eurysternus ventricosus Gill 1990	PT	*	SDNP	10
Eurysternus wittmerorum Martínez 1988	FIT; PT baited with human faeces, carrion (chicken heart), fish faeces or carcasses (especially snail carcasses)	Bitencourt et al. 2019b, Génier, 2009	SDNP; Antimary State Forest, Feijó	185
Isocopris rossinii Arias-Buriticá et al. 2023	FIT; PT baited with human faeces	Arias-Buriticá et al. 2023	SDNP	7
Ontherus aff. *alexis*	PT	–	SDNP	38

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Species	Capture method	Literature records	Site	N
Ontherus raptor Génier, 1996	FIT	**	SDNP	1
Onthophagus digitifer Boucomont 1932	PT	*	SDNP	4
Onthophagus onorei Zunino & Halffter 1997	PT	*	SDNP	262
Onthophagus osculatii Guérin-Méneville, 1855	FIT; PT baited with human faeces or carcass	Rossini, Vaz-de-Mello & Zunino, 2018	SDNP; Xapuri, Chico Mendes Reserve	370
Onthophagus rubrescens Blanchard, 1846	FIT; PT baited with human faeces	*	SDNP	1457
Onthophagus xanthomerus Bates 1887	FIT; PT baited with human faeces or carrion (bovine liver)	Bitencourt et al. 2019a	SDNP; Senador Guiomard, Catuaba Experimental Reserve	17
Oxysternon conspicillatum (Weber, 1801)	FIT; PT baited with human faeces or carrion (bovine liver)	Bitencourt et al. 2019a; Vaz-de-Mello, 1999	SDNP; Senador Guiomard, Catuaba Experimental Reserve; Zoobotânico Park – Universidade Federal do Acre	36
Oxysternon silenus Castelnau, 1840	FIT; PT baited with human faeces or carrion (bovine liver)	Bitencourt et al. 2019a	SDNP; Senador Guiomard, Catuaba Experimental Reserve	25
Phanaeus bispinus Bates, 1868	FIT; PT baited with human faeces or carrion (bovine liver)	Bitencourt et al. 2019a	SDNP; Senador Guiomard, Catuaba Experimental Reserve	4
Phanaeus cambeforti Arnaud, 1982	FIT; PT baited with human faeces or carrion (chicken heart)	Bitencourt et al. 2019b	SDNP; Antimary State Forest	23
Phanaeus chalcomelas (Perty, 1830)	FIT; PT baited with human faeces or carrion (bovine liver)	Bitencourt et al. 2019a	SDNP; Senador Guiomard, Catuaba Experimental Reserve	45
Phanaeus sp. 1	FIT; PT baited with human faeces	–	SDNP	20
Scybalocanthon aereus (Schmidt, 1922)	FIT; PT baited with human faeces or carcass	Silva & Valois, 2019	SDNP; Mâncio Lima; Xapuri, Chico Mendes Reserve	1
Scybalocanthon uniplagiatus (Schmidt, 1922)	FIT; PT baited with human faeces or fungi	Silva & Valois, 2019	SDNP; Rio Branco,Catuaba Experimental Reserve	27
Sylvicanthon bridarollii (Martínez, 1949)	FIT; PT baited with human faeces or carrion (bovine liver)	Bitencourt et al. 2019a	SDNP; Senador Guiomard, Catuaba Experimental Reserve	12
Sylvicanthon proseni (Martinez 1949)	FIT; PT baited with human faeces, human+pig dung, cow dung, cow spleen, banana, chicken meat or rotten bovine liver; black light traps	Bitencourt et al. 2019a; Cupello & Vaz-de-Mello, 2018	SDNP; Senador Guiomard, Catuaba Experimental Reserve; Mâncio Lima; Manoel Urbano, Chandless State Park Xapuri, Chico Mendes Reserve	235
Uroxys sp. 1	FIT; PT	–	SDNP	62
Uroxys sp. 2	FIT	–	SDNP	1

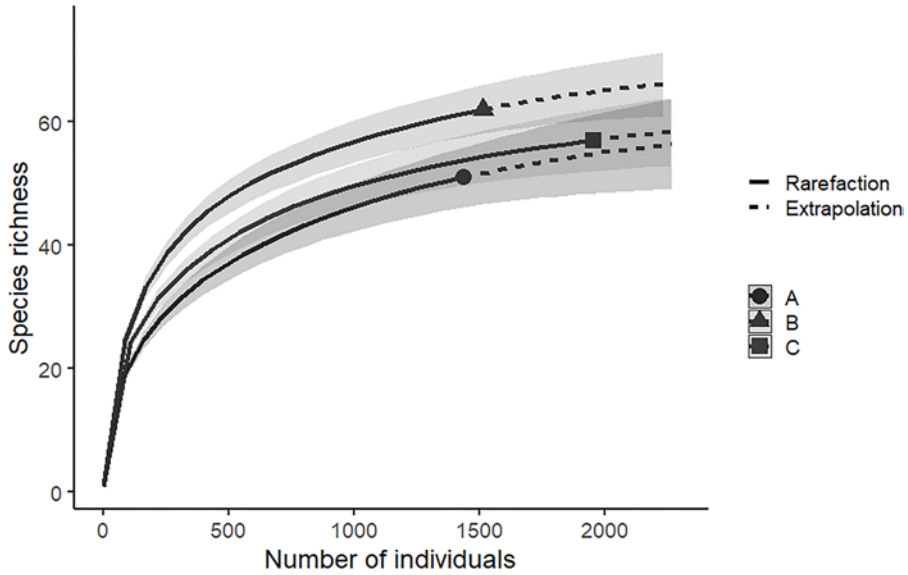

Figure 2. Individual-based rarefaction curves for dung beetle species sampled by both pitfall traps and FITs in plots A, B, and C at Serra do Divisor National Park (SDNP) in the state of Acre, Brazil. Shaded areas represent the 95% confidence intervals of each rarefaction curve.

Blanchard, 1846 with 1,457 individuals, followed by *Eurysternus caribaeus* (Herbst, 1789) with 438 individuals and *Onthophagus osculatii* Guérin-Méneville, 1855 with 370 individuals.

We sampled 1,438 individuals and 51 species in plot A (mean ± standard deviation of individuals per species: 34.65 ± 21.81); 1,516 individuals and 62 species in plot B (36.53 ± 17.11); and 1,955 individuals and 57 species in plot C (47.11 ± 27.89), with a mean sample coverage of 99.27% among plots (Supplementary Material, Table S1). Rarefaction curves also confirmed that our sampling effort was reasonable, although a few additional species may have been added with continued sampling (Figure 2). Eighteen species (21.69%) were captured solely by FITs, 20 species (24.1%) were captured only by pitfall traps, and 45 species (54.22%) were captured by both methods. Pitfall traps captured 4,415 individuals (89.94%; mean ± standard deviation of individuals per species: 106.39 ± 6.87) while FITs sampled only 494 individuals (10.06%; 11.9 ± 2.14) (Supplementary Material, Figure S1).

Our expedition uncovered 18 new dung beetle species records for the state of Acre: *Anomiopus pictus* (Harold, 1862), *Ateuchus aeneomicans* (Harold, 1868), *Ateuchus cereus* (Harold, 1868), *Ateuchus connexus* (Harold, 1868), *Ateuchus globulus* (Boucomont, 1928), *Ateuchus murrayi* (Harold, 1868), *Ateuchus substriatus* (Harold, 1868), *Canthon brunneus* Schmidt, 1922, *Canthon quadrimaculatus* Schmidt, 1922, *Canthon rufocoeruleus* (Martínez, 1948), *Deltochilum schefflerorum* Silva, Louzada & Vaz-de-Mello, 2015, *Eurysternus cayennensis* Castelnau, 1840, *Eurysternus hamaticollis* Balthasar, 1939, *Eurysternus plebejus* Harold, 1880, *Eurysternus ventricosus* Gill 1990, *Onthophagus digitifer* Boucomont, 1932, *Onthophagus onorei* Zunino & Halffter 1997, and *Onthophagus rubrescens* Blanchard, 1845; and two new records for Brazil: *Ateuchus columbianus* (Harold, 1868) and *Ontherus raptor* Génier, 1996 (Figures 3–4). *Eurysternus hamaticollis* was reported for state of Acre by Schoolmeesters (2024) without reporting the source of the data, thus we confirm the occurrence of this species in the state.

In addition, we collected five dung beetle species new to science in SDNP: *Isocopris rossinii* (already described by Arias-Buriticá et al. 2023), *Phanaeus* sp. 1 (FZVM & BRB pers. obs.), *Ateuchus* aff. *pygidialis*, *Ateuchus* aff. *murrayi*, and *Ateuchus* aff. *ovalis* (MC pers. obs.).

Discussion

This study presents the first list of dung beetle species from Serra do Divisor National Park. We documented 83 species using flight interception traps and pitfall traps baited with human faeces, of which 18 were unrecorded for the state of Acre, two were new records to Brazil, and five were new to science.

SDNP lies in the transition zone between the Ucayali and Rondônia biogeographical provinces (Morrone et al. 2022), on the border with Peru, and relatively close to the Andean piedmonts within pre-Andean Amazonia (ISA 2023). Indeed, the presence of two dung beetle species that were only previously captured in the Andes (*Onthe*. aff. *alexis* and *Onthe. raptor*) underlines this proximity. We could not unequivocally confirm the identification of the former as *Onthe. alexis*. However, this species is typically reported in the Andean region at elevations ranging from 1,100 to 2,000 m in Bolivia and over 730 m in Colombia and Peru (Génier 1996, Larsen 2004, Pulido-Herrera et al. 2007, Hamel-Leigue et al. 2008). This study presents the first record of *Onthe. raptor* in Brazil, previously found at 1,000 m in Bolivia (Génier 1996) and on the eastern slopes of the Peruvian Andes up to 3,200 m (Larsen et al. 2006). All these previous records are at elevations substantially higher than the elevations reached within SDNP (max = 650 m; mean = 300 m; ISA 2023). This supports the notion that SDNP is under some Andean

influence. We also obtained the first record of *At. columbianus* for Brazil, a species that to date has only been reported from Colombia and Peru (COL 2024).

The geographic location of SDNP may explain the high number of species recorded in the current study, as there is a high likelihood of recording elements from both biogeographical provinces (Morrone 2009). Indeed, a study from the middle section of the Juruá River, (~790 km downstream on a straight line from SDNP), detected 83 species in *terra firme* forest, of which only 21 species also occurred at our study site despite sampling the same river basin and interfluvial region (*i.e.* Juruá-Javari; Nichols et al. 2013). Other studies from Acre have registered between 36 to 58 species and have only been conducted in the eastern parts of the state (Vaz-de-Mello 1999, Bitencourt et al. 2019a, b). However, the high species richness may also be due to our use of two sampling techniques. The high proportion of species (45.79%) that we sampled exclusively by either FITs or pitfall traps shows that these two methods are complementary (Andrade et al. 2011, Mora-Aguilar et al. 2023).

In addition to the new species records, we also confirmed at least five dung beetle species new to science in SDNP: *I. rossinii*, *Phanaeus* sp. 1, *At.* aff. *pygidialis*, *At.* aff. *murrayi*, and *At.* aff. *ovalis*. The first species has already been described by Arias-Buriticá et al. (2023), the second is part of the *chalcomelas* species group currently undergoing revision (FZVM & BRB unpubl. data), and the last three are within a genus that is also under revision (Cupello et al. 2023). These three *Ateuchus* species were already known from collections elsewhere in the Amazon, but the other two species were sampled for the first time by our ABC Expedition to SDNP.

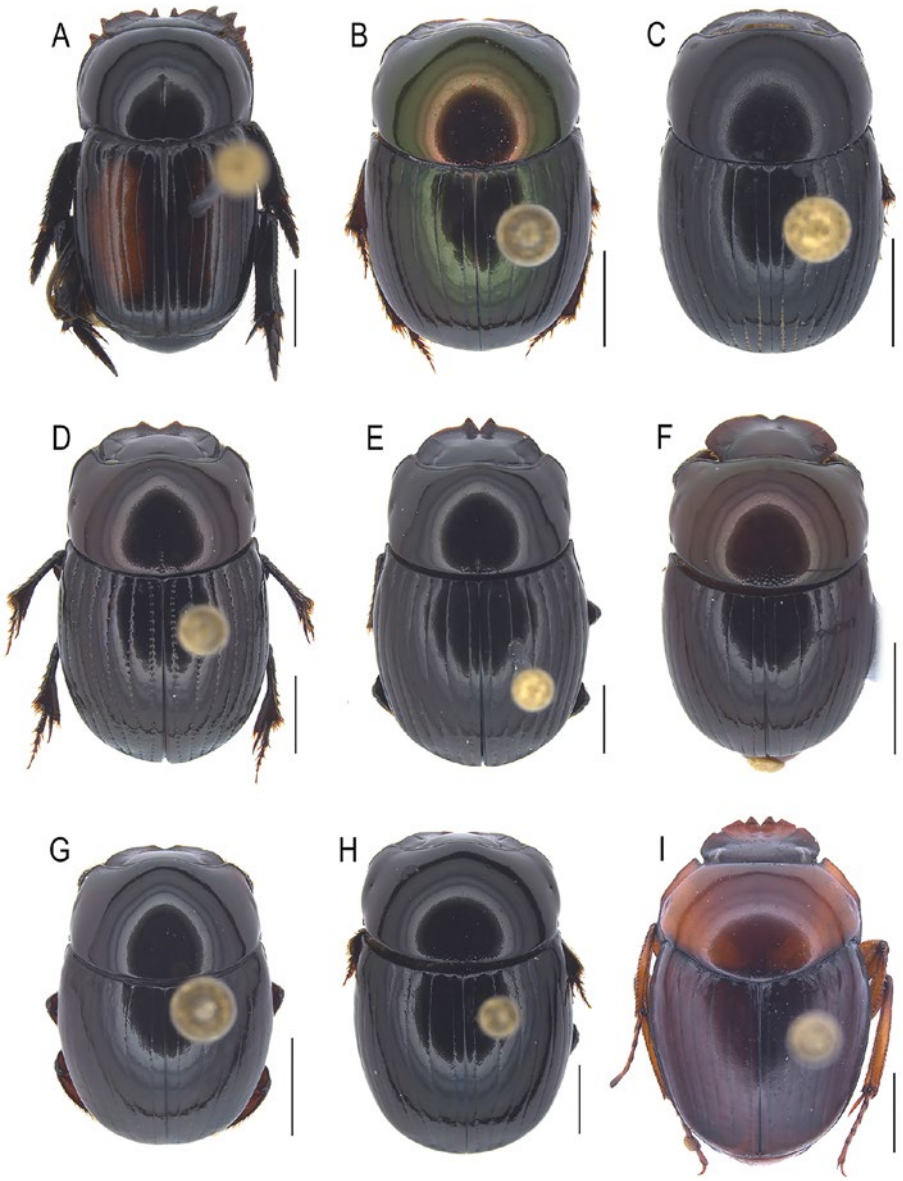

Figure 3. New dung beetle species records for the state of Acre (*) and Brazil (**) sampled during our ABC Expedition to Serra do Divisor National Park, Brazil. The bars indicate a 2 mm scale. A) *Anomiopus pictus**; B) *Ateuchus aeneomicans**; C) *Ateuchus cereus**; D) *Ateuchus columbianus***; E) *Ateuchus connexus**; F) *Ateuchus globulus**; G) *Ateuchus murrayi**; H) *Ateuchus substriatus**; I) *Canthon brunneus**.

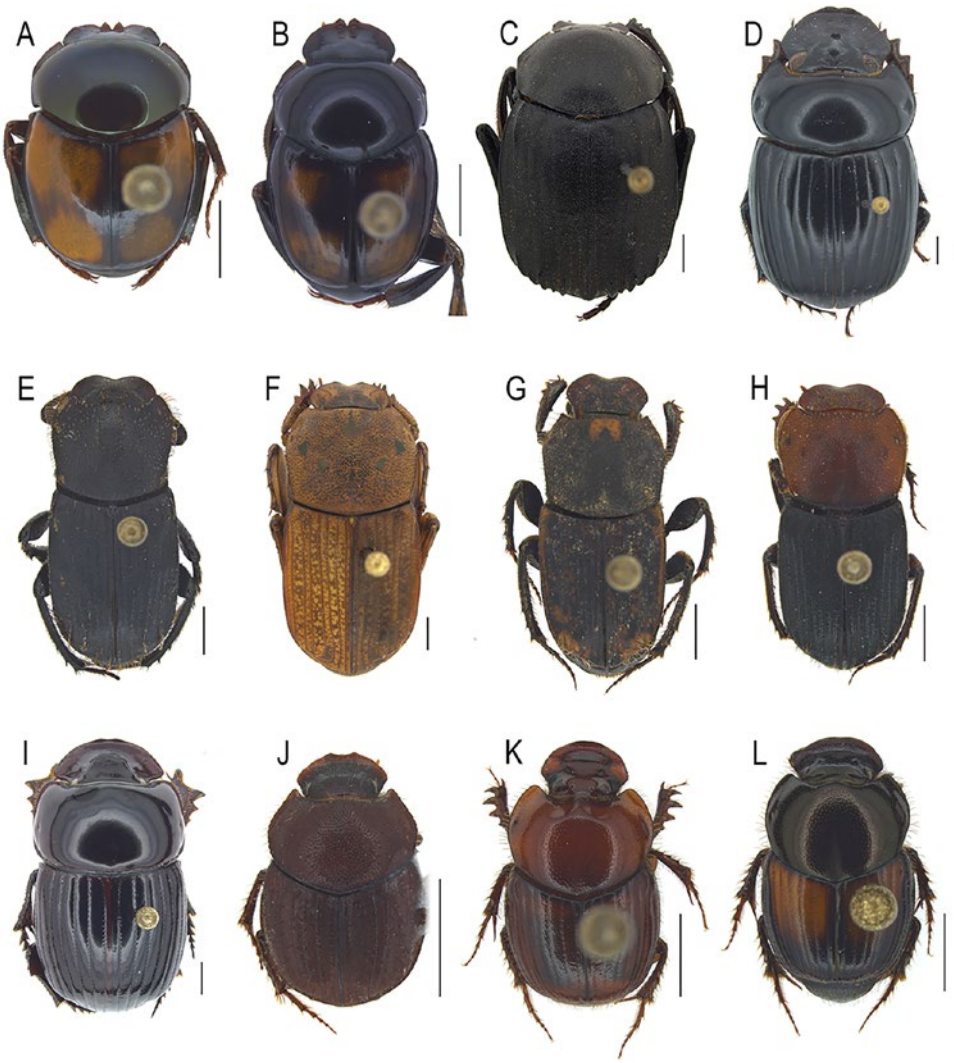

Figure 4. New dung beetle species records for the state of Acre (*) and Brazil (**) sampled during our ABC Expedition to Serra do Divisor National Park, Brazil. The bars indicate a 2 mm scale. A) *Canthon rufocoeruleus**; B) *Canthon quadrimaculatus**; C) *Deltochilum schefflerorum**; D) *Isocopris rossinii* (new species sampled in our expedition and described by Arias-Buriticá et al. 2023); E)*Eurysternus cayannensis**; F) *Eurysternus hamaticollis**; G) *Eurysternus plebejus**; H) *Eurysternus ventricosus**; I) *Ontherus raptor***; J) *Onthophagus digitifer**; K) *Onthophagus onorei**; L) *Onthophagus rubrescens**.

A new species of *Isocopris* was surprising because this genus was recently reviewed by Rossini & Vaz-de-Mello (2017), making it a focus of intense research across several scientific collections. *Isocopris rossinii* has also been sampled within the sister-park of SDNP and the Peruvian Amazon (*Sierra del Divisor National Park*; Arias-Buriticá et al. 2024). Its geographical distribution therefore ranges from SDNP to the slopes of the Andes. A new species of *Phanaeus* was similarly unexpected since they are large (10–28 mm) and well-represented in scientific collections due to their cephalic horns and iridescent metallic colors (Edmonds 1994, Hamel-Leigue et al. 2009, Edmonds & Zídek 2012).

Our results support the idea that SDNP is a particularly high-biodiversity area within the Amazon, and we are deeply concerned about the consequences of actions proposed by bill 6024/2019. These actions are part of an approach that threatens PAs called 'protected areas downsizing, downgrading and degazetting' (PADDD; Bernard et al. 2014, Ruaro & Laurance 2021). Construction of the BR-364 highway would result in 'downsizing' by effectively slicing SDNP in half and reducing its official size (Mascia & Paille 2010). The construction of roads in forested areas generally leads to ecosystem impacts like habitat loss and fragmentation, and biodiversity impacts like traffic mortality and stress (Robinson et al. 2010). Regarding dung beetles, Carpio et al. (2009) recorded that rare species vanished close to a new road in the Ecuadorian Amazon, although there is a shortage of studies that investigate these effects on dung beetles. Furthermore, the bill proposes to 'downgrade' the SDNP status of protection from a National Park to an Environmental Protection Area, flexing several legal restrictions on human activities (Brazil 2019). Both actions occur prior to 'degazetting' process, which entails the complete removal of protection from an area (Mascia & Pailler 2010). This would clearly have drastic consequences for the biodiversity of this region.

Conclusions

This study contributes to our understanding of dung beetle assemblages in the westernmost Brazilian Amazon, shows that SDNP is under Andean influence due to its proximity to these mountainous regions, and highlights that the insect fauna in many protected areas in the Amazon remains poorly known. This lack of knowledge hampers conservation actions and makes it difficult to understand the impacts of human disturbance and encroachment in remote and relatively pristine regions such as SDNP. We therefore advocate for the continued protection of SDNP and are critical of the proposed road construction and plans to downgrade the park to an Environmental Protection Area (bill 6024/2019).

Supplementary Material

The following online material is available for this article:

Figure S1 - Rank abundance curves of dung beetle species sampled with flight interception traps (FIT) and pitfall traps baited with human feces at Serra do Divisor National Park (SDNP), Acre, Brazil. Y-axis was calculated with species relative abundance on a logarithmic scale (log_{10}).

Table S1 – Sample size, species richness and sample coverage of dung beetles sampled at three transects (plots A, B, and C) with flight interception traps (FITs) and pitfall traps baited with human feces at Serra do Divisor National Park (SDNP), Brazil.

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Renato A. de Azevedo: methodology.

Fernando Z. Vaz-de-Mello: conceptualization; investigation; supervision; resources; writing – review & editing.

Conflicts of Interest

The authors declare that they have no conflict of interest related to the publication of this manuscript.

Ethics

This study did not involve human beings and/or clinical trials that should be approved by one Institutional Committee.

Data Availability

Supporting data are available at <https://doi.org/10.48331/scielodata.QT4KDV>.

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