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Can Baited Pitfall Traps for Sampling Dung Beetles Replace Conventional Traps for Sampling Ants?

KR Przybyszewski[1], RJ Silva[2], RE Vicente[3], JVG Freitas[4], MJB Pereira[1], TJ Izzo[5], D Storck-Tonon[1]

1 - Universidade do Estado de Mato Grosso (UNEMAT), Programa de Pós-Graduação em Ambiente e Sistemas de Produção Agrícola, Tangará da Serra-MT, Brazil

2 - Universidade do Estado de Mato Grosso (UNEMAT), Centro de Pesquisas, Estudos e Desenvolvimento Agroambientais (CPEDA), Coleção Entomológica de Tangará da Serra (CEnTg), Tangará da Serra-MT, Brazil

3 - Universidade do Estado de Mato Grosso (UNEMAT), Centro de Pesquisas e Tecnologia na Amazônia (CEPTAM), Laboratório de Anatomia Vegetal. Alta Floresta-MT, Brazil

4 - Universidade do Estado de Mato Grosso (UNEMAT), Bacharelado em Agronomia, Tangará da Serra-MT, Brazil

5 - Universidade Federal de Mato Grosso (UFMT), Programa de Pós-Graduação em Ecologia e Conservação da Biodiversidade, Cuiabá-MT, Brazil

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Corresponding author
Kelley Rita Przybyszewski
Entomology Laboratory / CPEDA
State University of Mato Grosso
MT-358, 7 - Jardim Aeroporto
78300-000 - Tangará da Serra -MT, Brasil.
E-Mail: kelleyritap@gmail.com

Abstract

Ants and dung beetles are widely used in monitoring biodiversity and are considered excellent environmental indicators. Although the pitfall trap is the most commonly used method to sample dung beetles and ants in ecological studies, beetles are usually sampled using dung-baited pitfall traps while ants are sampled using un-baited pitfalls. In the protocol for collecting the beetles it is necessary to have attractive baits in pitfalls. In order to minimize collection effort and costs and to facilitate logistics, it is necessary to determine if there is an effect of the baits on the biodiversity of ants collected in the same traps. Therefore, the objective of this work was to find out whether baited pitfalls could replace conventional pitfalls for the capture of ants. In a total of 42 areas of native habitat, three baited pitfall traps and three without bait were installed, all in the same transect, equidistant ten meters and in activity for 48 hours. In total, 150 species were collected, of which 131 were recorded in non-baited pitfalls and 107 in baited pitfalls. Traps without bait contributed to 28% of the total number of species captured in this study, whereas pitfalls with bait contributed only to 12% of the total species caught. However, 60% of the total species were captured regardless of the method. In addition to the loss of species among the types of traps, the effect of the method modifies the species composition. We concluded that depending on the type of study, a small decrease in the number of species and change in the composition can influence the results. Thus, we recommend that baited pitfalls should not replace conventional pitfalls.

Introduction

In biodiversity monitoring programs, insects are generally used as ecological and biodiversity indicators to highlight areas maximum diversity and the degree of disturbance of the areas (McGeogh, 2007). Among the insects with potential for use in such monitoring programs, the orders Coleoptera and Hymenoptera stand out, particularly dung beetles (Coleoptera: Scarabaeinae) and ants (Hymenoptera: Formicidae) (Barthi et al., 2016; Louzada et al., 2010). Both taxonomic groups are extremely abundant and play extremely important roles in the ecosystems where they live, such as nutrient cycling, decomposition, pollination, predation and seed dispersal (Nichols et al., 2008; Del Toro et al., 2012).

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Although these groups are well studied in terms of taxonomy and ecology, the taxonomy identification and natural history of a large proportion of the species is still unknown (Nunes et al., 2014; Prado et al., 2016; Silveira et al., 2016). Dung beetles, more than their outstanding diversity of species, play important roles in ecosystems and are sensitive to environmental changes, which affect the group's richness, distribution and abundance (Marsh et al., 2013). Ants are also diverse and act in ecosystems as predators, herbivores, saprophages, seed dispersers, directly affecting the structure and composition of vegetation (Underwood & Fisher, 2006; Del Toro et al., 2012).

An advantage for using dung beetles and ants in environmental and biodiversity monitoring is the fact that both are sampled quickly and relatively cheaply, both groups being frequently employed (Gardner et al., 2008; Ribas et al., 2012). The methods of collecting ants and dung beetles differ in the published collection protocols, and can vary according to the objective of each study (Lobo et al., 1988; Delabie et al., 2000). However, there are methods that can be used to collect both groups simultaneously, reducing costs and facilitating the fieldwork logistics. This is the case of pitfall traps, which, with some modifications, are efficient in catching both ants and dung beetles (Aquino et al., 2006).

The traps for capturing ant and dung beetles are commonly made from plastic cups, which are buried at ground level and filled with some solution to break water´s superficial tension or preserve the samples, making the cost of confection and installation relatively low (Souza et al., 2016). However, traps aiming at collecting dung beetles commonly are baited with human or pig feces, which attract beetles foraging for food resource (Stork-Tonon et al., 2020). Although some studies use baits in the collection of ants, especially pitfalls placed in the vegetation intended to capture arboreal ants, soil ant traps are preferably installed without any attraction, capturing ants foraging at random outside the colony (Alonso & Agosti, 2000). Field observations and conversations with experts indicated that the number of ants caught in dung beetle traps is often high and is often not assessed. In this way, the collected specimens are deposited without identification in collections or, in many cases, are discarded in the field. Among the main reasons for not using them is the concern of the researchers that the human feces bait may have a negative effect on some species of ants. In fact, to our knowledge, no work has been carried out to assess whether pitfalls for dung beetles are efficient for sampling the ant community in a given location. If the bait for dung beetles does not interfere in the capture of ants, the pitfall trap becomes an important tool to minimize sampling efforts in research and costs in surveys, thus optimizing the sampling protocol (Souza et al., 2012; 2016). Therefore, this work aims to evaluate whether pitfall traps with attractive lures (human feces) used in capturing dung beetles can be used, without prejudice to the capacity of environmental bio-monitoring, to capture ants. For this, we evaluated whether: i) the use of pitfall traps with bait cause any change (increase or decrease) in the number of species of ants captured? ii) the composition of ant species caught in baited and non-baited traps is different? iii) the change in capture observed at both the sample level and the site level?

Material and methods

Study area

Data collections were carried out in 42 areas (farms) of native habitat (Legal Reserves) distributed in eight municipalities (Fig 1; Table S1). These areas are inserted in a region of extensive transition between the Amazon and Cerrado biomes within the State of Mato Grosso (Marques et al., 2019).

The choice of areas was defined based on: i) Minimum distance of 3.5 km between the sample points to guarantee independence and; ii) the permission from rural producers to access property. The sites were characterized by a tropical Savanna climate, according to the Köppen-Geiger classification (Alvares et al., 2013), average temperatures ranging from 24 to 36 °C and annual precipitation of 1.700 mm (Rosa et al., 2007) with well-defined dry and rainy seasons (Marcuzzo & Melo, 2011).

Sample protocol

All samples were collected during the rainy season, when dung beetles are more abundant (Hanski & Cambefort, 1991), between November 2017 and February 2018. At each collection site, a linear transect was established within native habitats (Legal Reserve of the farm), 150 m (parallel) from the edge of agricultural crops. In each transect, three pairs of baited-unbaited pitfalls were installed 30 m equidistant, being the baited-unbaited pair separated by a distance of 10 m (Fig S1). The unbaited trap consists of a standard pitfall only containing capture solution (water, detergent and salt), and the baited trap, consisting of a standard pitfall with the capture solution plus a smaller container (coffee cup of 100ml) with about ~30 g of human feces fixed with galvanized wire inside the trap. All traps were standardized with a diameter of 14 cm and volume of 1000 ml, and with the same capture solution, only differing in the presence or absence of the baits (Agosti et al., 2000) (Fig 1). All traps were kept active for 48 hours. Therefore, we have a total sample effort of 252 baited and unbaited traps distributed in the 42 areas. The samples were transferred to the Entomology Laboratory of the State University of Mato Grosso, Campus of Tangará da Serra, where they were screened and morphotyped to the lowest possible taxonomic level. Posteriorly, the ants were identified using dichotomous keys present in literature on Neotropical ant species (Fernández, 2003; Longino, 2009; Lattke et al., 2007; Mackay & Mackay, 2010; Cuezzo & Guerrero, 2011; Baccaro et al., 2015; Feitosa & Prada-Achiardi, 2019), photo types in AntWeb (AntWeb, 2019) and the ant vouchers deposited in the collection of the Laboratório de Ecologia de Comunidades,

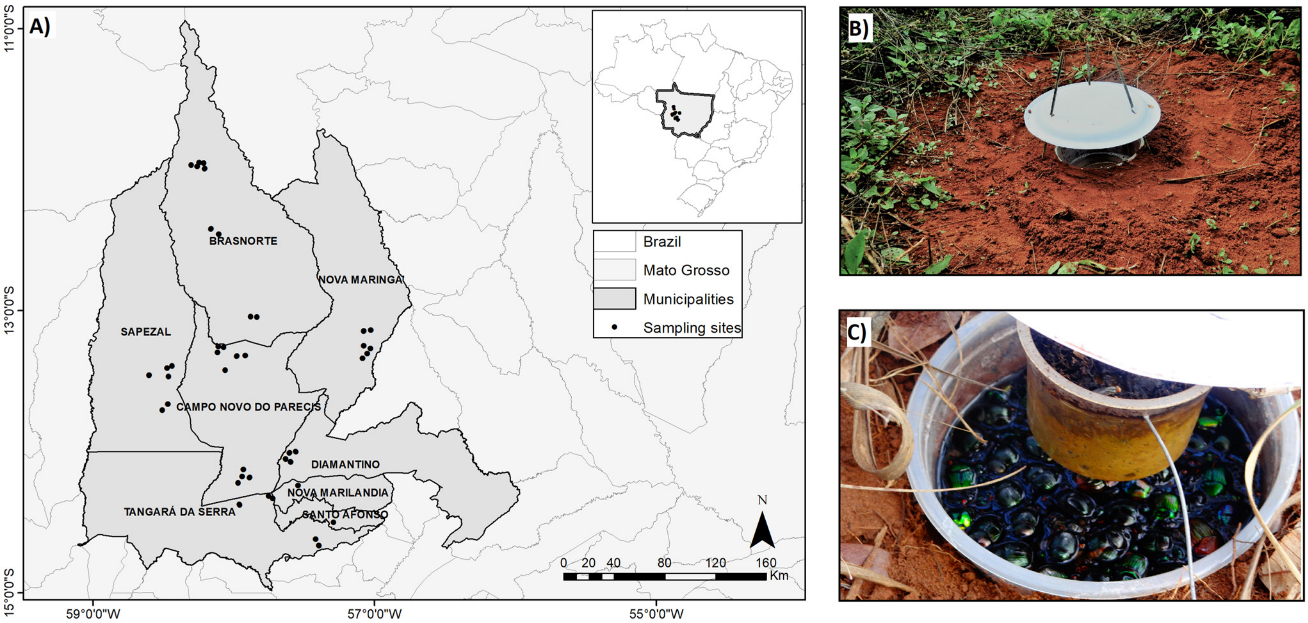

Fig 1. In (A) Spatial distribution of the 42 trapping sites in the State of Mato Grosso, Brazil (Source: bioagro network). (B) pitfall trap with capture solution (water, detergent and salt) for ant capture and (C) pitfalls with attractive baits (human feces) for capturing dung beetles.

Centro de Biodiversidade, UFMT, Cuiabá, Mato Grosso, Brazil. The vouchers are deposited in Entomological Collection of Tangará da Serra (UNEMAT-CEnTg) in Tangará da Serra-Mato Grosso, Brazil.

Data analysis

In order to compare the efficiency of the two pitfall types, species accumulation curves were generated using the *iNEXT* package (Hsieh et al., 2019) (n = 500). Extrapolation of displayed curves with 95% confidence intervals was used. To assess the effects of the trap type on the number of ant species per site, we constructed a Mixed Generalized Linear Model (GLMM) with the *glmer* function of the MuMIn package (Barton, 2009). In this model, the trap (with or without bait) was inserted as an explanatory variable and the error family used was Poisson. Since the sampling occurred in Cerrado-Amazonia transition areas, and as the objective of this work is to demonstrate the effect of the bait on the capture of ants regardless of the type of vegetation, the vegetation type of the area of the pitfall pair was inserted as a random variable in the model. To assess whether there was a difference in species composition between traps with and without baits, we used a Permutational Multivariate Analysis (PERMANOVA) (Anderson, 2001). To test the homogeneity of the dispersion within the groups formed by PERMANOVA, we used the *betadisper* function (Oksanen et al., 2018). A Principal Coordinate Analysis (PCoA) was also performed, using a Jaccard index. The first two axes of the PCoA were used to make graphs of the similarity between the points. We used a PROTEST with the *procrustes* function, from the "vegan" package, to check if the composition of the communities of both types of traps co-varied (Peres-Neto & Jackson, 2001).

Finally, the Index of Indicative Values (*IndVal*) analysis of the labdsv package (Roberts, 2016) by Dufrene and Legendre (1997) was used to assess which species were associated with baited and non-baited traps. All statistical analyzes were performed using Software R version 3.4.2 (Team R Core 2018) and the ggplot2 package was used to build the graphs (Wickham, 2016).

Results

Of the 2599 occurrences, 150 species of ants were identified, distributed in seven subfamilies and 38 genera (Table S2). Of these, 131 species were recorded in baited traps and 107 in unbaited traps. Among the species collected, 43 occurred exclusively in unbaited traps and 19 were exclusive to bait traps. Myrmicinae was the subfamily with the largest number of species (77), followed by Formicinae (25) and Ponerinae (17). The species most frequently found in unbaited traps were *Pheidole radoszkowskii* Mayr, 1884 with 47 occurrences, *Camponotus* sp1 with 45 occurrences and *Gigantiops destructor* (Fabricius, 1804) with 41 occurrences and the most frequent in baited traps were *Pheidole* sp9 with 128 occurrences, *Atta* sp2 with 108 occurrences and *Camponotus* sp1 with 98 occurrences.

The two species accumulation curves, the unbaited traps and all the traps together, had their confidence intervals overlapping regardless of the number of samples. In both cases, these curves did not overlap with the curve that represents the baited traps (Fig 2). The unbaited traps had an average of 27 species. Baited traps, on the other hand, had a significantly lower number of species, averaging 20 ($X_2 = 52.581$; $p < 0.001$) (Fig 3).

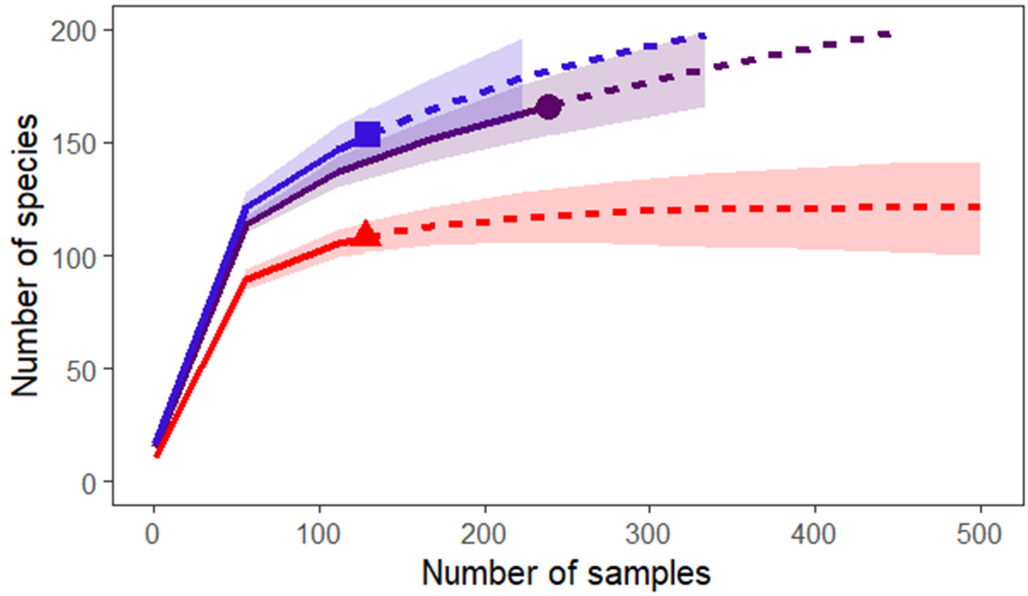

Fig 2. Accumulation curves of ant species collected in all pitfall traps (purple line), pitfall traps without bait (blue line) pitfall traps with bait (red line).

The species composition also differed between baited and unbaited traps (PERMANOVA: $R^2 = 0.04$, $p < 0.001$). Additionally, there was no difference in dispersion between these two groups (PERMDISP: $F = 0.37$; $p = 0.78$). These different communities co-vary spatially, but with an adjustment of only 0.43 (PROTEST $p < 0.01$) (Fig 4 A, B).

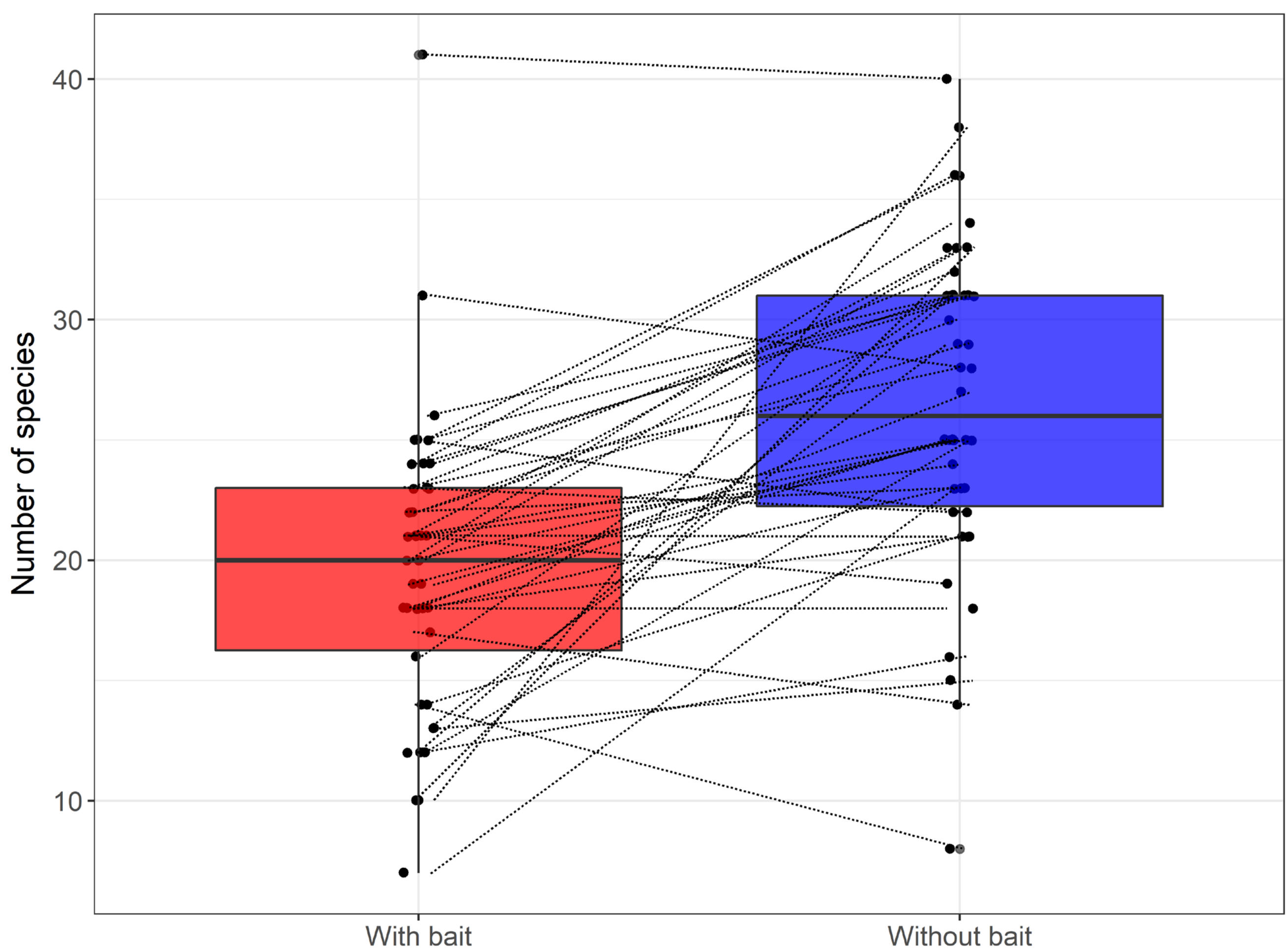

Fig 3. Number of species recorded in pitfall traps with bait (red) and without bait (blue) within the remnants of native habitat. The lines are linking the number of species caught in each type of trap at each collection point.

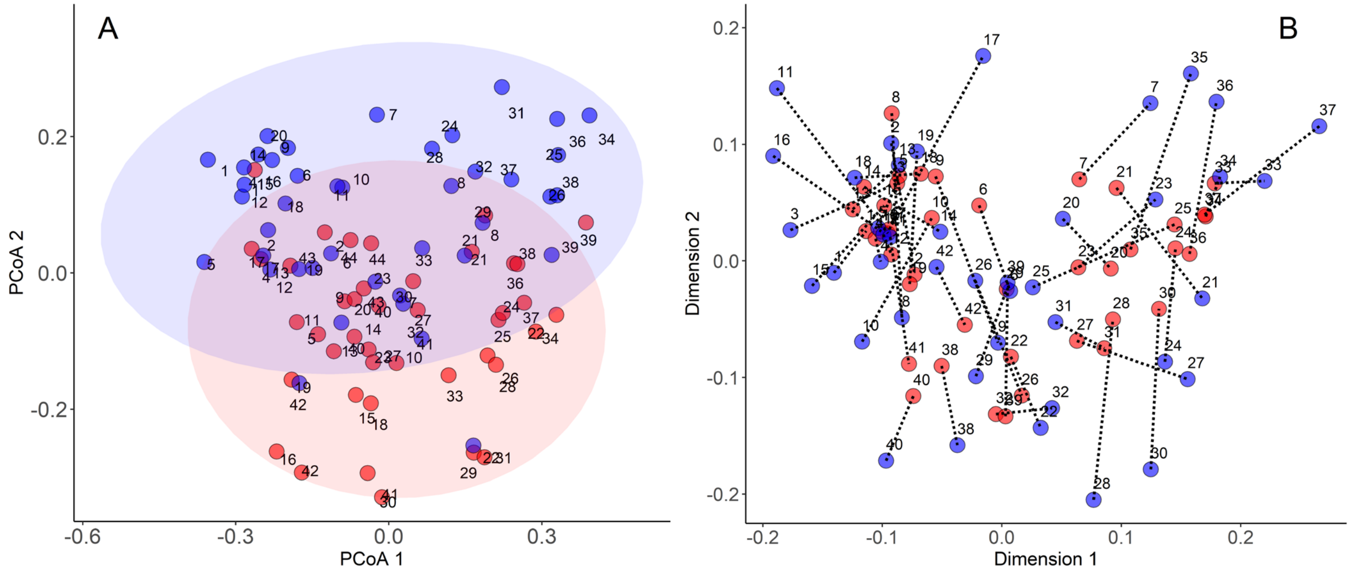

Fig 4. (A) Principal Coordinates Analysis (PCoA) ordination showing ants species composition per site sampled with pitfall traps with bait (red) and without bait (blue) in 42 sites. (B) Procrustes rotation plot of sampled sites with lines representing changes in species composition between pitfall traps with bait (red) and without bait (blue).

This difference in composition is reinforced by the difference in the most common species, as well as in the values of IndVal. Only two species, *Camponotus* sp8 and *Gnamptogenys* sp2, were associated with baited traps. However, 21 species other than those that occurred in baited pitfalls, presented significant IndVal values to unbaited traps, for example *Pheidole radoszkowskii* with 72% of association, followed by *Camponotus* sp2 with 53%, *Gigantiops destructor* (Fabricius, 1804) with 47% and *Ectatomma edentatum* (Roger, 1863) with 41%. (Table 1).

Discussion

Our results strongly suggest that the use of baited traps for dung beetles does not generate fully compatible data with a collection without bait for ants. Conventional traps, recommended in the sampling protocols and used to capture ants (Agosti et al., 2000; Bestelmeyer et al., 2000), should not be replaced by baited traps used to catch dung beetles. Baited traps capture less species and a different composition than those from unbaited ones. However, even though low (43%), there was a correlation between the communities captured by both protocols. This indicates that the communities collected in both methods can respond with some consonance to some changes, such as big disturbances, in the scale in which the sampling of this study was carried out. This correlation was insufficient to suggest that the protocols are similar and that both would capture ecological process and patterns in an equivalent way.

Approximately 26% of the species collected in the two types of traps can be considered as infrequent, as they presented a single record in this study. Some species of the genera *Labidus*, *Apterostigma*, *Cyphomyrmex*, *Myrmicocrypta* or *Strumigenys*, which were considered rare, are already considered of low occurrence in other studies using pitfall

Table 1. Species of indicator ants captured in pitfall traps with bait and without bait inside native habitats (Legal Reserve), where the frequency of occurrence represents the total occurrence in pitfalls of the types of traps.

Indicator Species	Indval	P-value	Frequency
With bait			
Camponotus sp8	39%	0.008	36
Gnamptogenys sp2	35%	0.003	28
Without bait			
Pheidole radoszkowskii	72%	0.001	46
Camponotus sp2	53%	0.033	68
Gigantiops destructor (Fabricius, 1804)	47%	0.016	54
Ectatomma edentatum (Roger, 1863)	41%	0.015	40
Solenopsis sp3	35%	0.043	39
Linepithema sp1	35%	0.011	29
Pheidole sp17	32%	0.005	22
Acromyrmex sp1	32%	0.010	27
Trachymyrmex sp2	31%	0.003	22
Pheidole sp6	31%	0.001	16
Pachycondyla harpax (Latreille, 1802)	28%	0.024	24
Pheidole sp15	24%	0.037	20
Pheidole bilimeki	23%	0.003	10
Pheidole bufo	21%	0.050	17
Pheidole sp7	21%	0.008	09
Pheidole aff transversostriata	19%	0.007	10
Camponotus sp12	19%	0.010	08
Crematogaster tenuicula (Longino, 2003)	19%	0.022	11
Ochetomyrmex neopolitus (Fernández, 2003)	16%	0.021	07
Pheidole sp11	14%	0.026	06
Odontomachus sp4	11%	0.048	05

traps (e.g.: Mcgill et al., 2007; Campos et al., 2011; Souza et al., 2012). These ones, however, have strong leverage on the number of species per site. In fact, our species accumulation curves indicated that the confidence intervals of the total number of species collected by unbaited traps and with the combined use of baited and unbaited traps overlapped, indicating that there is no difference when the same number of samples is maintained. In addition, only 19 species were added by using baited traps. Even though in other studies they are commonly collected in pitfalls without bait (Soares et al., 2010; Souza et al., 2012; Gomes et al., 2018), the 19 exclusive species of baited traps were rare or not abundant (maximum six occurrences in our samples). This result suggests that although the baited pitfalls have contributed to some increase in the number of species collected, they contribute little to the survey of species of the local myrmecofauna.

Regarding the composition of ant species, we observed differences in several species captured in both methods, demonstrating that the presence of the bait in the traps was a strong enough variable to modify the species composition pattern. This fact may be related to the great variety of habits that ants present (Hoffmann & Andersen, 2003). Also, reciprocal interference can be a factor (Hölldobler & Wilson, 1990), therefore, if some species were attracted to the bait, they could repel other species. However, our data support this hypothesis, since we observed a significant increase in the total workers frequency and number of ant species in bait traps. It is likely that ants with generalist habits are not easily affected by disturbances and resources (Baccaro et al., 2015; Barthi et al., 2016). Instead, ants with food or environmental preferences (specialists) could avoid the presence of feces, so being less captured or even absent in baited traps.

The observed decrease in the number of species in both scales using baited traps suggests negative effect of the feces bait on the capture of ants, making difficult for some species to be collected and changing the pattern of communities captured by sampling. In fact, none of the ants' species that dominated conventional traps also dominated baited traps. This demonstrates totally different conditions for the community, with relevance in the species captured by the type of sampling method. For example, an unidentified species of the genus *Camponotus* (*Camponotus* sp.8) which was associated by Indval with baited pitfall and *Pheidole radoszkowskii*, which dominated in unbaited traps and was also strongly associated by Indval with this method. However, the relevance of these species being associated with traps with and without bait, may be associated with the biology of the species, since most of the genera associated with the traps have a generalist habit and are abundant. Thus, the associated species do not provide sufficient indication for the collection methods (Longino, 2009; Baccaro et al., 2015; Barthi et al., 2016). However, previous studies have evaluated sampling techniques only in relation to the number and composition of the species sampled (Ivanov & Keiper, 2009; Tista & Fiedler, 2010) and, there was only one study in Australia by Andersen et al. (2002) that investigated whether pitfall traps used for vertebrate groups could complement surveys of larger ant species. However, to our knowledge, there has been no investigation to ascertain whether methods used for other invertebrates could complement surveys of ant species or not.

In this study, we see that the use of pitfall traps baited with feces, used in sampling dung beetles, has a negative effect on the number of species and composition of the ant community. Depending on the objective of the study, a small decrease in the number of species due to the use of baited pitfalls does not compromise the knowledge of a representative part of the ant fauna of a given region. Therefore, this difference can be revealed by the reduction in the logistical cost in fast-loading works or on a reduced budget. However, for the study of ecological patterns, studies demanding subtle differences among sites, or even for bio-indication, the use of baited traps should not be recommended. We suggest that baited pitfalls should not replace the conventional pitfalls established in collection protocols, particularly in studies with a more ecological approach. However, in order to optimize the material collected in studies of dung beetles, the ants could be used for taxonomic or biogeographic purposes and thus contribute to the species' distribution patterns.

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Author Contributions

MJB PEREIRA: Project management. MJB PEREIRA: Acquisition of research funding. MJB PEREIRA, D STORCK-TONON, TJ IZZO, RJ SILVA: Methodology. MJB PEREIRA, D STORCK-TONON, RJ SILVA: Logistics for data collection. KR PRZYBYSZEWSKI, JVG FREITAS: Laboratory processing. KR PRZYBYSZEWSKI, TJ IZZO, RE VICENTE: Species identification. KR PRZYBYSZEWSKI, D STORCK-TONON, RJ SILVA: Statistical analysis. D STORCK-TONON, TJ IZZO: Supervision. KR PRZYBYSZEWSKI, D STORCK-TONON, TJ IZZO: Writing (preparation of the original draft). KR PRZYBYSZEWSKI, D STORCK-TONON, TJ IZZO, RJ SILVA, RE VICENTE, JVG FREITAS: Writing (revision and editing).

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Supplementary Material

Table S1. Number of sampled points with their respective geographic coordinates and representative municipalities.

Locations	Longitude	Latitude	Municipalities
1	58°14’48W	11°57’01S	Brasnorte
2	58°12’54W	11°57’12S	Brasnorte
3	58°12’28W	11°59’35S	Brasnorte
4	58°18’08W	11°58’00S	Brasnorte
5	58°28’28W	13°24’26S	Sapezal
6	58°26’23W	13°23’33S	Sapezal
7	58°27’56W	13°28’05S	Sapezal
8	58°36’09W	13°27’32S	Sapezal
9	58°36’09W	13°27’32S	Sapezal
10	58°28’10W	13°39’45S	Sapezal
11	57°05’11W	13°20’21S	Nova Maringá
12	57°03’13W	13°18’22S	Nova Maringá
13	57°01’47W	13°16’09S	Nova Maringá
14	57°04’45W	13°15’02S	Nova Maringá
15	57°04’42W	13°08’40S	Nova Maringá
16	57°01’45W	13°08’21S	Nova Maringá
17	57°17’33W	14°30’05S	Santo Afonso
18	57°23’47W	14°39’58S	Tangará da Serra
19	57°43’26W	14°19’55S	Tangará da Serra
20	57°45’13W	14°18’52S	Tangará da Serra
21	57°32’40W	14°14’29S	Nova Marilândia
22	57°37’57W	14°03’09S	Diamantino
23	57°35’50W	14°04’22S	Diamantino
24	57°33’41W	13°59’58S	Diamantino
25	57°36’20W	14°00’34S	Diamantino
26	58°03’45W	13°25’17S	Campo Novo do Parecis
27	58°07’02W	13°17’45S	Campo Novo do Parecis
28	58°04’19W	13°15’39S	Campo Novo do Parecis
29	58°06’35W	13°15’22S	Campo Novo do Parecis
30	57°55’12W	13°19’09S	Campo Novo do Parecis
31	57°58’47W	13°19’22S	Campo Novo do Parecis
32	57°58’12W	14°13’19S	Campo Novo do Parecis
33	57°55’55W	14°07’38S	Campo Novo do Parecis
34	57°53’19W	14°11’05S	Campo Novo do Parecis
35	57°57’36W	14°22’35S	Tangará da Serra
36	57°52’55W	13°02’38S	Brasnorte
37	57°50’13W	13°02’46S	Brasnorte
38	58°06’27W	12°27’30S	Brasnorte
39	58°09’48W	12°25’09S	Brasnorte
40	57°25’10W	14°37’15S	Tangará da Serra
41	58°09’40W	12°25’32S	Brasnorte
42	57°25’66W	14°37’19S	Tangará da Serra

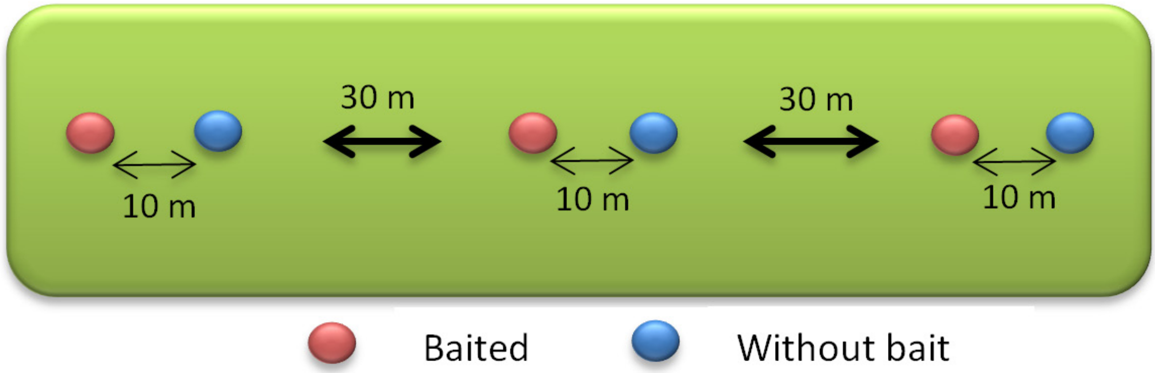

Fig S1. Sketch of the sample design of the three pairs of traps with and without bait installed inside Legias Reserves in the State of Mato Grosso.

Table S2. Occurrences of ant species captured in pitfall traps with and without bait within the native habitats sampled in the State of Mato Grosso - Brazil.

Species	Pitfalls		Total
	With bait	Without bait	
Subfamily Amblyoponinae			
Prionopelta sp1	0	1	1
Subfamily Dolichoderinae			
Azteca sp1	2	4	6
Azteca sp2	1	0	1
Dolichoderus attelaboides (Fabricius, 1775)	8	4	12
Dolichoderus decollates (Smith, F., 1858)	3	2	5
Dolichoderus ghilianii (Emery, 1894)	0	1	1
Dolichoderus imitator (Emery, 1894)	27	41	68
Dolichoderus aff *rugosus*	11	8	20
Dolichoderus sp1	1	0	1
Dorymyrmex brunneus (Forel, 1908)	12	12	24
Dorymyrmex pyramycus (Roger, 1863)	15	24	39
Dorymyrmex sp1	0	2	2
Linepithema sp1	13	49	62
Linepithema sp2	0	1	1
Tapinoma sp1	0	1	1
Subfamília Dorylinae			
Labidus sp1	1	3	4
Subfamily Ectatomminae			
Ectatomma brunneum (Smith, F., 1858)	0	1	1
Ectatomma edentatum (Roger, 1863)	29	58	87
Ectatomma lugens (Emery, 1894)	4	8	12
Ectatomma permagnum (Forel, 1908)	7	8	15
Ectatomma tuberculatum (Olivier, 1792)	27	32	59
Gnamptogenys haenschi (Emery, 1902)	0	2	2
Gnamptogenys moelleri (Forel, 1912)	13	13	26
Gnamptogenys sp1	9	3	12
Gnamptogenys sp2	27	9	36
Gnamptogenys sp3	5	13	18
Subfamily Formicinae			
Acropyga sp1	0	2	2
Brachymyrmex sp1	10	29	39
Brachymyrmex sp2	9	8	17
Camponotus burtoni (Mann, 1916)	0	1	1
Camponotus femoratus (Fabricius, 1804)	1	6	7
Camponotus aff *atriceps*	55	34	89
Camponotus sp.1	98	100	198
Camponotus sp.2	74	130	204
Camponotus sp.3	1	4	5
Camponotus sp.4	19	13	32
Camponotus sp.5	15	11	26
Camponotus sp.6	30	30	60
Camponotus sp.7	0	4	4
Camponotus sp.8	56	26	82
Camponotus sp.9	0	1	1
Camponotus sp.10	0	6	6
Camponotus sp.11	3	11	14
Camponotus sp.12	0	9	9
Camponotus sp.13	2	9	11
Camponotus sp.14	0	1	1
Camponotus sp.15	4	1	5

Table S2. Occurrences of ant species captured in pitfall traps with and without bait within the native habitats sampled in the State of Mato Grosso - Brazil. (Continuation)

Species	Pitfalls		Total
	With bait	Without bait	
Camponotus sp.16	2	0	2
Camponotus sp.17	1	0	1
Camponotus sp.18	4	0	4
Camponotus sp.19	1	0	1
Gigantiops destructor (Fabricius, 1804)	39	79	118
Nylanderia sp.1	44	54	98
Subfamily Myrmicinae			
Acromyrmex sp.1	11	35	46
Acromyrmex sp.2	44	40	84
Acromyrmex sp.3	4	0	4
Acromyrmex sp.4	0	2	2
Acromyrmex sp.5	1	0	1
Apterostigma megacephala (Lattke, 1999)	10	12	22
Apterostigma sp.1	1	6	7
Apterostigma sp.2	0	1	1
Apterostigma sp.3	0	1	1
Atta sp.1	5	5	10
Atta sp.2	108	101	209
Atta sp.3	6	1	7
Atta sp.4	0	5	5
Basiceros militaris (Weber, 1950)	1	0	1
Cephalotes atratus (Linnaeus, 1758)	3	5	8
Crematogaster brasiliensis (Mayr, 1878)	12	21	33
Crematogaster carinata (Mayr, 1862)	27	40	67
Crematogaster limata (Smith, 1858)	18	11	29
Crematogaster longispina (Emery, 1890)	2	3	5
Crematogaster nigropilosa (Mayr, 1870)	3	3	6
Crematogaster tenuicula (Longino, 2003)	2	16	18
Crematogaster sp.1	1	6	7
Cyphomyrmex sp.1	4	3	7
Cyphomyrmex sp.2	1	2	3
Cyphomyrmex sp.3	2	1	3
Cyphomyrmex sp.4	0	1	1
Cyphomyrmex sp.5	0	1	1
Cyphomyrmex sp.6	0	1	1
Cyphomyrmex sp.7	0	1	1
Cyphomyrmex sp.8	0	1	1

Species	Pitfalls		Total
	With bait	Without bait	
Cyphomyrmex sp.9	0	1	1
Daceton armigerum (Latreille, 1802)	1	0	1
Mycocepurus smithii (Forel, 1893)	0	3	3
Myrmicocrypta sp.1	0	1	1
Myrmicocrypta sp.2	0	1	1
Myrmicocrypta sp.3	0	1	1
Ochetomyrmex neopolitus (Fernández, 2003)	0	7	7
Ochetomyrmex semipolitus (Mayr, 1878)	0	1	1
Pheidole bufo (Wilson, 2003)	6	20	26
Pheidole gertrudae (Forel, 1886)	4	10	14
Pheidole nitella (Wilson, 2003)	0	2	2
Pheidole radoszkowskii Mayr, 1884	14	97	111
Pheidole aff *biconstricta*	0	2	2
Pheidole aff *bilimeki*	0	11	11
Pheidole aff *fimbriata*	0	1	1
Pheidole aff *transversostriata*	1	11	12
Pheidole sp.1	2	8	10
Pheidole sp.3	0	1	1
Pheidole sp.5	2	7	9
Pheidole sp.6	2	28	30
Pheidole sp.7	0	11	11
Pheidole sp.8	0	4	4
Pheidole sp.9	128	111	239
Pheidole sp.10	29	22	51
Pheidole sp.11	0	6	6
Pheidole sp.12	0	1	1
Pheidole sp.13	4	4	8
Pheidole sp.14	14	11	25
Pheidole sp.15	9	26	35
Pheidole sp.16	62	45	107
Pheidole sp.17	5	22	27
Pheidole sp.18	2	1	3
Pheidole sp.19	0	5	5
Pheidole sp.20	0	1	1
Pheidole sp.21	0	2	2
Pheidole sp.22	3	0	3
Rogeria sp.1	0	1	1
Sericomyrmex sp.1	41	63	104
Sericomyrmex sp.2	1	0	1

Table S2. Occurrences of ant species captured in pitfall traps with and without bait within the native habitats sampled in the State of Mato Grosso - Brazil. (Continuation)

Species	Pitfalls		Total
	With bait	Without bait	
Solenopsis sp.1	10	6	16
Solenopsis sp.2	0	5	5
Solenopsis sp.3	29	49	56
Solenopsis sp.4	0	2	2
Solenopsis sp.5	27	20	47
Solenopsis sp.6	0	1	1
Solenopsis sp.7	0	1	1
Strumigenys sp.1	1	4	5
Strumigenys sp.2	0	1	1
Strumigenys sp.3	0	1	1
Tetramorium sp.1	0	1	1
Tetramorium sp.2	1	0	1
Trachymyrmex sp.1	13	16	29
Trachymyrmex sp.2	9	46	55
Trachymyrmex sp.3	1	0	1
Wasmannia auropunctata (Roger, 1863)	1	1	2
Subfamily Ponerinae			
Anochetus sp.1	3	4	7
Anochetus sp.2	1	3	4
Hypoponera sp.1	0	1	1
Hypoponera sp.2	0	3	3
Hypoponera sp.3	0	1	1
Hypoponera sp.4	6	1	7
Leptogenys sp.1	0	2	2
Mayaponera sp.1	2	0	2
Neoponera apicalis (Emery, 1901)	19	37	56
Neoponera inversa (Smith, F., 1858)	2	2	4
Neoponera commutata (Roger, 1860)	4	14	18
Neoponera verenae (Forel, 1922)	12	18	30
Odontomachus sp.1	0	5	5
Odontomachus sp.2	3	2	5
Odontomachus sp.3	20	19	39
Odontomachus sp.4	0	6	6
Odontomachus sp.5	0	2	2
Pachycondyla crassinoda (Latreille, 1802)	31	59	90
Pachycondyla harpax (Latreille, 1802)	9	27	36
Subfamily Pseudomyrmecinae			
Pseudomyrmex gracilis (Fabricius, 1804)	3	3	6
Pseudomyrmex tenuis (Fabricius, 1804)	7	15	22
Pseudomyrmex termitarius (Smith, F., 1855)	15	31	46
Pseudomyrmex aff *peruvianus*	0	1	1
Pseudomyrmex aff *tenuis* sp.1	2	3	5
Pseudomyrmex aff *tenuis* sp.2	2	1	3
Pseudomyrmex sp.1	2	9	11
Pseudomyrmex sp.2	1	1	2
Total number of unique species	**15**	**59**	**74**
Total number of species	**107**	**150**	**157**
Total number of occurrences	**1515**	**2167**	**3682**