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Sex ratio of the coprophagous beetle community (Coleoptera: Scarabaeidae: Scarabaeinae) in the Andean Amazon, Caquetá, Colombia.

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Abstract

Objective: Our study aimed to test whether the populations of dung beetle maintain the Fisherian sexes ratio a primary forest of an Andean-Amazonian ecosystems. Scope. Promote knowledge of the diversity of Scarabaeidae: Scarabaeinae from Caquetá, Colombia. **Methodology:** Coprophagous beetles were collected using 50 Pitfall traps baited with human feces separated from each other by 10 meters. Each trap was active for 72 continuous hours. Species were classified according to the trophic guilds and three size categories. Sampling effort was explored using an accumulation curve, meanwhile, Hill numbers were calculated to measure diversity. the Fisher test was performed to analyze the sexual ratio. A Chi-Square (X2) goodness test was performed to analyze if there were significant differences between trophic guild, species, sex and sizes. **Results:** In total, 693 individuals were collected, distributed in 12 genera and 26 species. The most abundant species were *Eurysternus cayennensis* Castelnau, 1840 and *Dichotomius* (*Dichotomius*) *quinquelobatus* (Felsche, 1910). The dominant trophic guilds were Diggers. The accumulation curve showed that the sampling effort were satisfactory, meanwhile, the Hill index showed that the abundances between species are heterogeneous. Fisher's test showed a sexual ratio of 1.4:1 male-female. The X2 test showed that there were significant differences between the trophic guild, species, sex and sizes. This study is the first approximation of the sexual ratio of dung beetles in the Colombian Andean-Amazonian region. **Conclusions:** This study provides relevant information on the sex ratio and habits occurrence for 12 genera and 26 species of Scarabaeidae that occur in the Parque Nacional Natural Alto Fragua Indi Wasi, San José del Fragua, Caquetá, Colombia.

Key words: Andean Amazon, ecology, natural reserves, trophic guilds.

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Sesgo en la proporción de sexos de la comunidad de escarabajos coprófagos (Coleoptera: Scarabaeidade: Scarabaeinae) en la Amazonia Andina, Caquetá, Colombia

Resumen

Objetivo: Nuestro estudio tuvo como objetivo probar si las poblaciones de escarabajos peloteros mantienen la proporción Fisheriana de sexos en un bosque primario de un ecosistema andino-amazónico. Alcance. Promover el conocimiento de la diversidad de los Scarabaeidae, Scarabaeinae en el Departamento de Caquetá, Colombia. **Metodología:** Se recolectaron escarabajos coprófagos utilizando 50 trampas Pitfall separadas entre sí por 10 metros, cebadas con heces humanas. Cada trampa estuvo activa durante 72 horas continuas. Las especies se clasificaron según los gremios tróficos y tres categorías de tamaño. El esfuerzo de muestreo se exploró mediante una curva de acumulación, mientras que los números de Hill se calcularon para medir la diversidad. se realizó la prueba de Fisher para analizar la proporción sexual. Se realizó una prueba de bondad Chi-Cuadrado (X2) para analizar si existieron diferencias significativas entre gremio trófico, especie, sexo y tallas. **Resultados:** En total se recolectaron 693 individuos, distribuidos en 12 géneros y 26 especies. Las especies más abundantes fueron *Eurysternus cayennensis* y *Dichotomius* (*Dichotomius*) *quinquelobatus*. El gremio trófico dominante fue el de los excavadores. La curva de acumulación mostró que el esfuerzo de muestreo fue satisfactorio, mientras que el índice de Hill mostró que las abundancias entre especies son heterogéneas. La prueba de Fisher mostró una proporción sexual de 1,4:1 entre machos y hembras. La prueba X2 mostró que existían diferencias significativas entre el gremio trófico, las especies, el sexo y las tallas. Este estudio es la primera aproximación a la proporción sexual de los escarabajos peloteros en la región Andino-Amazónica colombiana. **Conclusiones:** Este estudio proporciona información relevante sobre la proporción sexual y la ocurrencia de hábitos para 12 géneros y 26 especies de Scarabaeinae que ocurren en el Parque Nacional Natural Alto Fragua Indi Wasi, San José del Fragua, Caquetá, Colombia.

Palabras clave: Amazonia Andina, ecología, gremios tróficos, reservas naturales.

Introduction

Scarabaeidae (Coleoptera) is one of the most studied families worldwide and particularly the beetles of the subfamily Scarabaeinae. Known as coprophagous beetles, Scarabaeinae is ecologically important because they participate in the removal and burial of manure, contributing to the aeration and fertilization of the soil (Nichols et al., 2007). These dung beetles are considered an excellent focal taxon to study the response of their communities' dynamics to habitat modifications, due to their susceptibility to changes in the structure of forest vegetation, the availability of resources and changes in environmental variables (Nichols et al., 2007).

Davis et al. (2004) proposed the use of coprophagous beetles as an indicator group of habitat disturbance in tropical forests, constituting a focal group to calculate the

anthropic effects concerning the alteration and fragmentation of habitats. Additionally, the Scarabaeinae has been recognized for being important indicators of the quality of ecosystems by possessing characteristics such as high diversity, functional importance, ecological fidelity and close association with other species.

The fauna of dung beetles in Colombia is represented by approximately 40 genera and about 300 species (Noriega et al., 2015), which represents about 60% of the diversity of genera and 30% of Scarabaeinae species in the Neotropical region (Camero, 2019).

In Colombia, most studies have focused on diversity (Otavo et al., 2013; Martínez and Lopera-Toro, 2014; Martínez et al., 2018; Amell-Caez et al., 2019), evaluate the response to disturbances (Rangel-Acosta et al., 2020), list of species for the country (Medina et al., 2001) and studies on their diet (Bustos-Gómez and Lopera-Toro, 2003; Noriega, 2012), but none have focused on issues relevant to the sexual ratio. Fishers (1930) postulated that the sex ratio of most species tends to be one-to-one; however, some species have been observed to deviate from this ratio, in order to maximize the evolutionary potential and long-term prospects of a population (Tabadkani et al., 2012; Wedekind, 2012). In this sense, differences in the behavior of individuals, in size or morphology, are considered the main factors that may be biasing the sexual ratio in those species that present determination at the genetic level (Tryjanowski et al., 2009; Wedekind, 2012).

The absence of an adequate ratio between the sexes can lead to the disappearance of a species due to the difficulty of finding a partner and therefore being able to reproduce. This is particularly important in beetles whose mating ritual is quite complex including parental care in many species (Escobar, 2003).

In the Andean Amazon region, specifically in the department of Caquetá, there are no studies on gender bias in dung beetles, therefore, the main objective of this study is to test whether the populations of dung beetle species can maintain the Fisherian ratio concerning the sexes in adults and if they have any relationship with the ability to remove manure in the Parque Natural Nacional (PNN) Alto Fragua Indi Wasi.

Materials and methods

The study was carried out in the Parque Nacional Natural Alto Fragua Indi Wasi (01°17'13.3" N and 76°08'32.4" W), Vereda La Peneya, Municipality of San José del Fragua, Department of Caquetá, Colombia. The study area has an elevation of 910 meters above sea level, an average temperature of 19.9 ºC, a relative annual humidity between 85% and 90% and annual rainfall of 4,281 mm (Parques Nacionales Naturales, 2012). The area corresponds to a primary forest that constitutes a corridor between the Andean and Amazonian ecosystems (SINCHI, 2011).

To obtain a representative sampling of species present in the area and considering the time available in the field, a grid was established with 50 Pitfall traps baited with human fences, separated by 10 meters, to cover a total area of 5000 m2. The minimum distance between the traps and the edge of the forest was not less than 200 m. The entire system was exposed for 72 hours without interruption.

All the specimens collected during the field phase were taken to the Universidad de la Amazonia Entomology Laboratory -LEUA-, where the entomological material was separated, fixed and identified using the keys proposed by Medina and Lopera-Toro (2000) and Vaz-de-Mello et al. (2011), under an Olympus SZ61 stereoscope and a 2x auxiliary lens. Additionally, they were sexed, measured (total length), classified into the different trophic guild and photographed using a Leica DFC450 digital camera coupled to a Leica M205A stereoscope and connected to a computer with the Leica Application Suite software, with an automatic mounting module synchronization (http://www.syncroscopy.com/syncroscopy/).

Analyzed variables:

Richness: it is the number of species present in a habitat; in this study, it will be measured by the number of species collected in the entire grid.

Abundance: it is the number of individuals of each species present in a given place, in this study, it will be measured as the total number of individuals of each species collected in the entire grid.

Size: 100% of the collected individuals were taken into account, measured individually with a digital ruler or vernier caliper, in this way, the length in millimeters (mm) of each individual defined among the three already established groups: small (<8 mm), medium (8–12 mm) and large (>12 mm) as proposed by Doube (1991).

Relocation habit: it is understood as the ability to group individuals either from the same subfamily, genus, or species and trophic group them according to a particular characteristic or behavior, in this study, it was carried out based on the eating habits of the Scarabaeinae, with, therefore, the collected individuals were grouped into three guilds: Wheelers (Paracoprids), Diggers (Telecoprids) and Residents (Endocoprids). The Wheelers form and roll spheres of excrement before burying them, while the Diggers are characterized by extracting pieces of excrement (without forming perfect balls) that they then buried near the place where they found food, the Residents prefer to nest inside the excrement or in soil (Basto-Estrella et al., 2012).

Accumulation curve: additionally, the sampling effort was explored through a species accumulation curve using the Chao1, Chao2, Jack1 and Jack2 estimators, using the

Biodiversity Pro 2.0 program. Hill numbers (N0 > N1 > N2) were used, where N0 is the diversity based on the number of recorded species, N1 is the diversity reducing the importance of species considered rare and N2 is the number of very abundant species, using the program online SpadeR (http://chao.shinyapps.io/SpadeR/). Employed analysis to measure the diversity and richness of species present in the sampling area using the Sample Completeness Curve website.

Sex: the collected individuals will be sexed depending on the species, observing the secondary sexual characteristics of each species. The sex ratio was evaluated through the Fisher test to analyze whether there were significant differences between females and males and their 1:1 ratio using the statistical program Infostat version 2020. Finally, to demonstrate whether there were significant differences between trophic guilds, species, sex ratio and size, the Chi-Square (X2) goodness test was used for two or more samples (Moreno 2001), using the free version of the PlanMaker 2010 program. For all tests, an $\alpha = 0.05$ was used.

Results

In total, 693 individuals distributed in 12 genera and 26 species were collected, 407 were males (58.7%) and 286 females (41.3%), all species with Neotropical distribution (Medina et al., 2001; Camero and Lobo, 2010; Sarmiento-Garcés and Amat-García, 2014; Cupello, 2018; Chamorro et al., 2019a; Nunes and Vaz-De-Mello, 2019); the most abundant species were *Eurysternus cayennensis* Castelnau, 1840 (n= 135 individuals, 19.5%), *Dichotomius* (*Dichotomius*) *quinquelobatus* (Felsche, 1910) (n= 121, 17.5%) and *Eurysternus lanuginosus* Génier, 2009 (n= 56, 8.1%); the less abundant species were *Dichotomius* (*Cephagonus*) *fonsecae* (Luederwald, 1925), *Scybalocanthon* sp., *Canthon* sp. and *Sylvicanthon bridarollii* (Martínez, 1949) with one individual each (0.1%) (Table 1).

The most abundant trophic guild were Diggers with 305 individuals (44%) and 14 species (53.8%), followed by the Residents with 285 individuals (41.1%) and six species (23.1%), meanwhile, the least abundant was Wheelers with 103 individuals (14.9%) and six species (23.1%) (Figure 1, Table 1). The most abundant species of the Diggers trophic guild were *Dichotomius* (*Dichotomius*) *quinquelobatus* (n= 121, 17.5%) and *Ontherus* (*Caelontherus*) *diabolicus* Génier, 1996 (n= 51, 7.4%), of the Resident group were *Eurysternus cayennensis* (n= 135, 19.5%) and *Eurysternus lanuginosus* (n= 56, 8.1%), of the Wheelers the most abundant species were *Deltochilum* (*Deltohyboma*) *crenulipes* Paulian, 1938 (n= 49, 7.1%) and *Canthon* (*Glaphyrocanthon*) *luteicollis* Erichson, 1847 (n= 33, 4.8%) (Table 1).

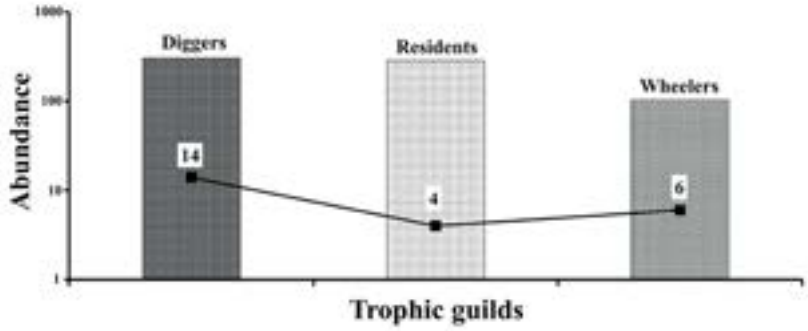

Figura 1. Trophic guilds of dung beetles present in the Parque Nacional Natural Alto Fragua Indi Wasi, Vereda la Peneya, San José del Fragua, Caquetá, Colombia

Fisher's test and X2 squared

Fisher's test showed that there are no significant differences regarding the sexual ratio of the beetles, even though the number of males was higher [n: 407 (58.7%)] compared to females [n: 286 (41, 3%)], yielding a ratio of 1.4:1 (male-female) which does not differ significantly from the expected 1:1. However reviewing the sexual ratio by species, only *D.* (*Dichotomius*) *quinquelobatus* and *Canthidium* (*Neocanthidium*) sp.2. complied with Fisherian 1:1 sex ratio, together, they belong to the trophic guild Diggers.

Onthophagus (*Onthophagus*) sp., *Dichotomius* aff. *inachus*, *Dichotomius* (*Dichotomius*) *mamillatus* (Felsche, 1901), *Deltochilum* (*Deltohyboma*) *crenulipes*, *Canthon* (*Glaphyrocanthon*) *luteicollis*, *Eurysternus cayennensis*, *Eurysternus lanuginosus*, *Eurysternus caribaeus* (Herbst, 1789) and *Eurysternus vastiorum* Martínez, 1988 presented a slight bias towards males. *Ontherus* (*Caelontherus*) *diabolicus*, *Coprophanaeus* (*Coprophanaeus*) *telamon* (Erichson, 1847), *Onthophagus* (*Onthophagus*) *xanthomerus* Bates, 1887, *Deltochilum* aff. *barbipes* and *Eurysternus hypocrita* Balthasar, 1939 presented a slight bias towards females (Table 1).

The X2 test carried out on the trophic guild showed that there is a significant difference between trophic guilds (P= 0.0001, gl= 2), likewise, it was carried out for the 26 species examined (P= 0.0001, gl= 25), presenting significant differences. Regarding sex ratio, significant differences were evidenced between males and females (P value = 0.0001, gl=). For the size (small, medium and large) it showed a significant difference for each of the assigned categories (P value = 0.0001, gl= 2).

Regarding size, 320 individuals (46.2%) measured more than 12 mm and were considered large, of which 159 were males (39.1%) and 161 were females (56.3%), followed by medium-sized beetles with 260 individuals (37.5%), of which 177 were males (43.5%) and 83 were females (29.0%). Finally, the small beetles (<8mm) with 113 individuals (16.3%), of which 71 were males (17, 4%) and 42 were females (14.7%) (Table 1).

Table 1. Species of coprophagous beetles collected in the Parque Nacional Natural, Alto Fragua Indi Wasi, Vereda La Penaya, San José del Fragua, Caquetá, Colombia.

Species	Abundance	Male	Female	Male-Female ratio	Trophic guild	Size
Ateuchus sp.	2 (0.2%)	0 (0%)	2 (100%)	-	Diggers	Small (5 mm)
Canthidium aff. gerstaeckeri	7 (1%)	0 (0%)	7 (100%)	-	Diggers	Medium-large (8–9.9 mm)
Canthidium (Neocanthidum) sp.1	4 (0.5%)	4 (100%)	0 (0%)	-	Diggers	Small-medium (7.5–9 mm)
Canthidium (Neocanthidum) sp.2	8 (1.1%)	4 (50%)	4(50%)	1:1	Diggers	Small (5–6 mm)
Coprophanaeus (Coprophanaeus) telamon	19 (2.74%)	5 (26.3%)	14 (73.7%)	1:2.8	Diggers	large (16–24.5 mm)
Dichotomius aff. inachus	26 (3.8%)	15 (56.7%)	11 (42.3%)	1.3:1	Diggers	Medium-large (12–17 mm)
Dichotomius (Cephagonus) fonsecae	1 (0.1%)	1 (100%)	0 (0%)	-	Diggers	Large (19.2 mm)
Dichotomius (Dichotomius) quinquelobatus	121 (17.5%)	62 (51.2%)	59 (48.7%)	1:1	Diggers	Large (16–21.5mm)
Dichotomius (Dichotomius) mamillatus	18 (2.6%)	10 (55.6%)	8 (44.4%)	1.2:1	Diggers	Large (19–22.5 mm)
Dichotomius (Dichotomius) ohausi	2 (0.3%)	2 (100%)	0 (0%)	-	Diggers	Large (17–18 mm)
Ontherus (Caelontherus) diabolicus	51 (7.4%)	20 (39.2%)	31 (60.1%)	1:1.5	Diggers	Medium-large (9–12.2 mm)
Onthophagus (Onthophagus) sp.	30 (4.3%)	16 (53.3%)	14 (46.7%)	1.1:1	Diggers	Small (5–7.8 mm)
Onthophagus (Onthophagus) xanthomerus	14 (2%)	4 (28.6%)	10 (71.4%)	1:2.5	Diggers	Small-medium (5–9 mm)
Oxysternon (Oxysternon) silenus smaragdinum	2 (0.3%)	2 (100%)	0 (0%)	-	Diggers	Large (16.5 mm)
Canthon (Glaphyrocanthon) luteicollis	33 (4.7%)	25 (75.8%)	8 (24.2)	3.1:1	Wheelers	Medium (8–9.8 mm)

Canthon sp.	1 (0.1%)	1 (100%)	0 (0%)	-	Wheelers	Small (6.5 mm)
Canthon sp.	1 (0.1%)	1 (100%)	0 (0%)	-	Wheelers	Small (6.5 mm)
Deltochilum aff. barbipes	18 (2.6%)	8 (44.4%)	10 (55.6%)	1:1.2	Wheelers	Small-large (9.5–11 mm)
Deltochilum (Deltohyboma) crenulipes	49 (7.1%)	28 (57.1)	21 (42.9%)	1.3:1	Wheelers	Large (12–14 mm)
Sylvicanthon bridarollii	1 (0.1%)	1 (100%)	0 (0%)	-	Wheelers	Medium (8.5 mm)
Scybalocanthon sp.	1 (0.1%)	0 (0%)	1 (100%)	-	Wheelers	Medium (9 mm)
Eurysternus caribaeus	30 (4.3%)	17 (56.7%)	13 (43.3%)	1.3:1	Residents	Medium-large (12–20 mm)
Eurysternus cayennensis	135 (19.5%)	95 (70.4%)	40 (29.6%)	2.3:1	Residents	Small-medium (7.5–11 mm)
Eurysternus foedus	3 (0.1%)	3 (100%)	0 (0%)	-	Residents	Large (17–18 mm)
Eurysternus hypocrita	54 (7.8%)	21 (38.9%)	33 (61.1%)	1:1.5	Residents	Large (16,5–21.5)
Eurysternus lanuginosus	56 (8.1%)	44 (75.6%)	12 (21.4%)	3.6:1	Residents	Small-medium (5.5–10 mm)
Eurysternus vastiorum	7 (1%)	5 (71.4)	2 (28.6)	2.5:1	Residents	Small-medium (7.5–9 mm)

Species accumulation curve

In sampling unit four, the collection was 15 species, reaching 56.8% of the total species recorded, meanwhile for the Chao 1 and Jack 1 estimators, a concordance of 69.3% and 65.3% of the species expected was found for the same sampling unit. In sampling unit 20, 22 species were collected, reaching 84.8% of the total species, coinciding with the Chao 2 and Jack 2 estimators, which had a concordance of 88.5% and 87.5%, respectively. Finally, in sampling unit 40, 25 species were collected, corresponding to 96.5% of the total species recorded in this study, reaching a concordance of 99% and 97% according to the Chao 1 and Jack 1 estimators, which suggests that the sampling effort was ideal (Figure 2).

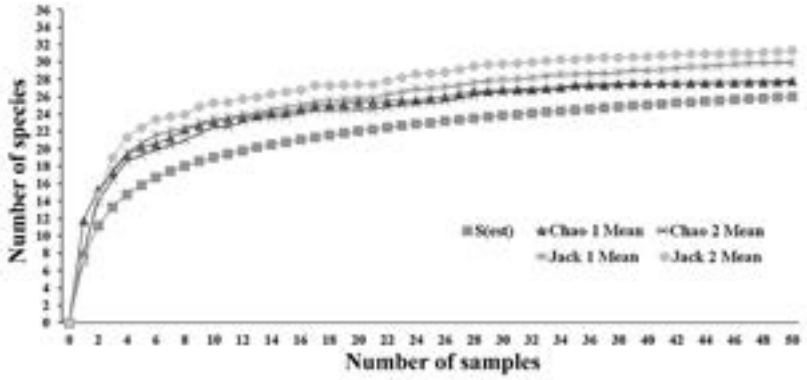

Figure 2. Accumulation curve of dung beetle species present in the Parque Nacional Natural Alto Fragua Indi Wasi, Vereda La Penaya, San José del Fragua, Caquetá, Colombia.

Hill diversity index indicated that 26 species were recorded, where there are 9.8 species considered very abundant (N2=9.8) and 13.4 species considered abundant (N1=13.4), likewise the slope of the curve of the Hill index slope was not so pronounced, which is attributed to the high number of abundant and very abundant species (Figure 3).

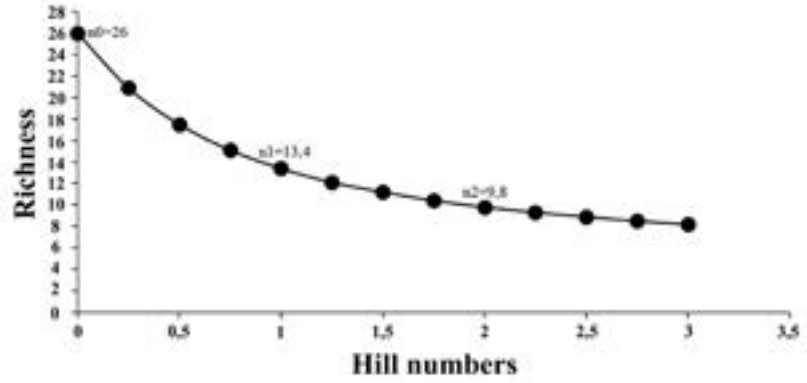

Figure 3. Hill diversity numbers for the dung beetle species present in the Parque Nacional Natural Alto Fragua Indi Wasi, Vereda La Penaya, San José del Fragua, Caquetá, Colombia.

Discussion

In this study, the most abundant species were *Eurysternus cayennensis*, *Dichotomius* (*Dichotomius*) *quinquelobatus*, meanwhile, *Canthon* sp., *Dichotomius* (*Cephagonus*) *fonsecae*, *Scybalocanthon* sp. and *Sylvicanthon bridarollii* were the least abundant. These results agree with those reported by Chamorro et al. (2019b). *Dichotomius* (*D.*) *quinquelobatus*, *E. cayennensis* and *Deltochilum (Deltohyboma) crenulipes* were the most abundant species of the Wheelers, Diggers and Residents trophic guilds, which also coincide with that found by Chamorro et al. (2019b).

The most abundant trophic guilds were Wheelers (Paracoprids), with 305 individuals (14 species, 53.8%), followed by Residents (Endocoprids) with 285 individuals (six species, 23.1%), meanwhile, the least abundant was Diggers (Telecoprids) with 105 individuals (six species, 23.1%). The composition of trophic guilds agrees with what was reported by Basto-Estrella et al. (2012) and Chamorro et al. (2019b) who report that in deep and slightly rocky soils and tropical humid forests, Wheelers tend to have a greater abundance. Additionally, Halffter (1991) mentions that the structure of the soil is essential to understand the diversity of Scarabaeinae since this is their habitat during much of their life cycle.

In this study, a greater abundance of males was observed, however, the Fisher test showed that there is a sexual ratio of 1.4:1 (male-female), which does not represent a significant difference over that postulated by Fisher (1930) as a 1:1 ratio, agreeing with what was obtained by Barreto et al. (2021). However, according to González-Vainer et al. (2003) the sexual ratio varies according to the annual climatic seasonality. Additionally, Onore et al. (2003) established that the sex ratio can vary depending on the community of beetles and the locality, according to this, it must be taken into account that the biological efficacy must be stable in the ratio of males and females. In this context, differences in behavior, size or morphology must be considered as factors that may be biasing the sexual ratio in those species that present determination at the genetic level (Tryjanowski et al., 2009; Wedekind 2012).

Regarding the sampling effort, the species accumulation curve showed that a 99% concordance was obtained according to the Chao 1 and Chao2 estimators and 97% and 97.8% with the Jack 1 and Jack 2 estimators, respectively. These results coincide with those recorded by Ferrer-Paris et al. (2013), who suggests that if the number of traps is low, it will be necessary for them to work for several days, but if the number of traps is high, the effect of the sampling days is not as important as it happened with the samplings. In this study or considering more samplings at different seasonal times (high rains and low rains), the diversity of beetles could be close to 100%.

Hill diversity numbers are increasingly used for studies of diversity, taxonomy, phylogeny and trophic groups (Chao et al. 2014), in this study the slope of the curve of Hill numbers reflects the unevenness of relative species abundance, the more unequal the distribution of relative abundances and the steeper the slope, the relative abundances tend to be uniform (Chao et al., 2014), contrary to what was obtained in this study, where said slope does not was so pronounced, which is attributed to the high number of abundant and very abundant species.

Conclusions

Scarabaeinae is an important subfamily of beetles found in Colombia and the Amazon region, of which despite its great progress and studies, only a few ecological and taxonomic information is available for the Andean Amazon region and the department of Caquetá. This study provides relevant information on the sex ratio and habits occurrence for 12 genera and 26 species of Scarabaeinae that occur in the Parque Nacional Natural Alto Fragua Indi Wasi, San José del Fragua, Caquetá, Colombia.

The potential of dung beetles as indicators of environmental quality proposes carrying out conservation plans in the areas where they live since these individuals are important in recycling nutrients, improving soil conditions and contributing to the secondary dispersion of seeds by providing direct and indirect many ecosystem services.

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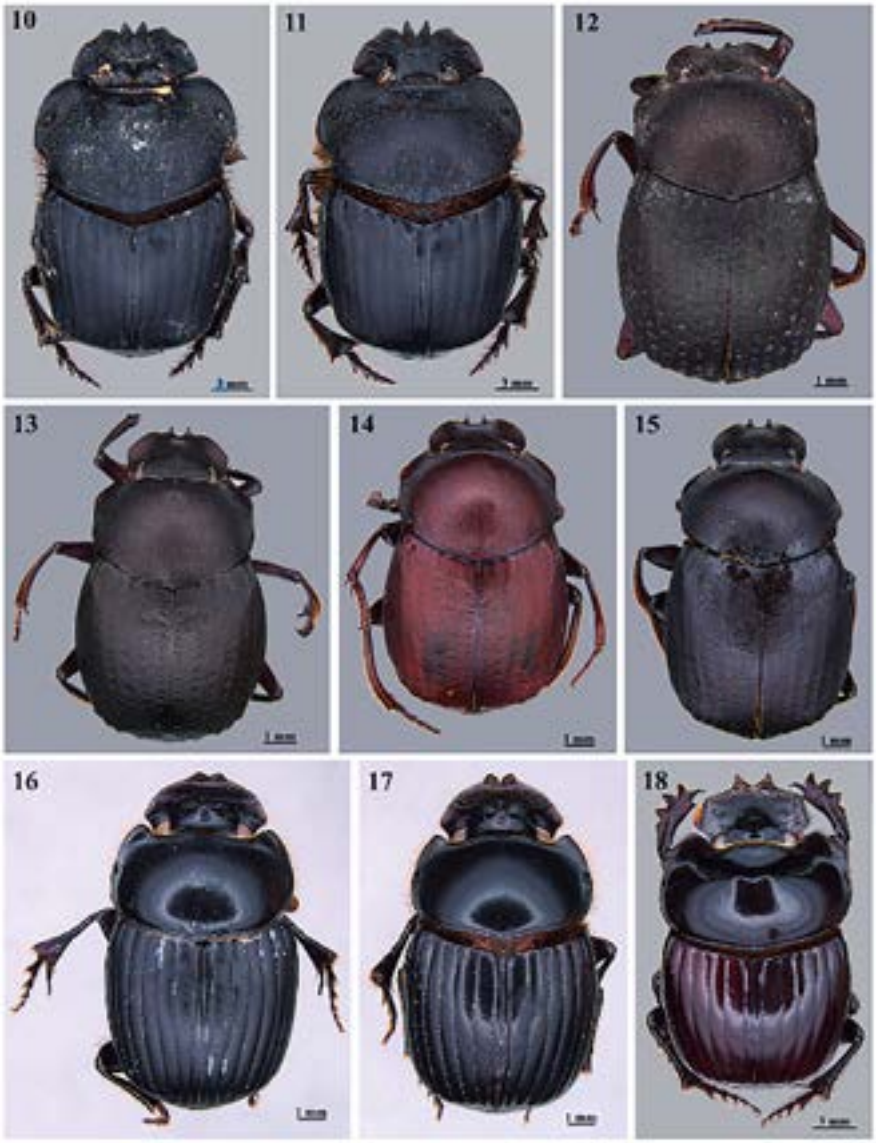
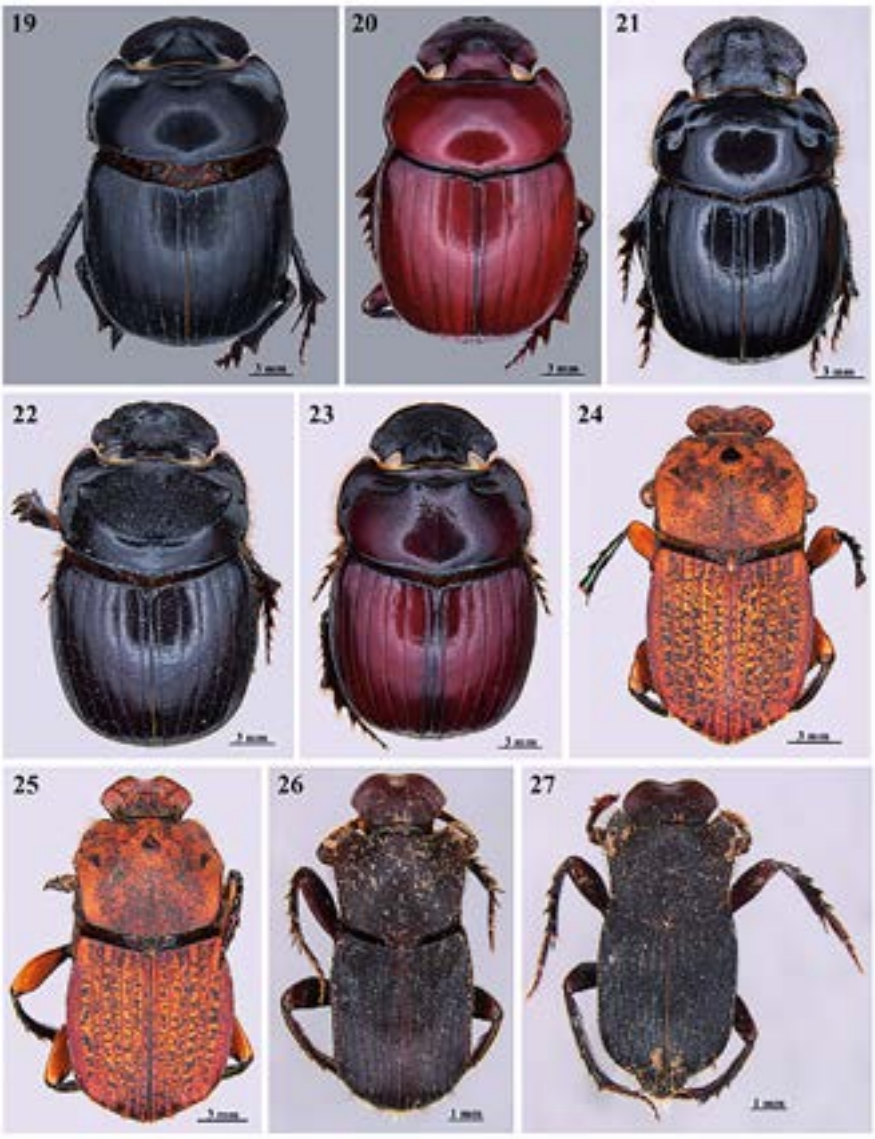
Annexed 1–9. Habitus, dorsal view, 1- *Ateuchus* sp. female; 2- *Canthidium* aff. *gerstaeckeri* male; 3- *Canthidium* aff. *gerstaeckeri* Harold, 1876 female; 4- *Canthidium* sp.1 male; 5- *Canthidium* sp.2 male; 6 *Canthidium* sp.2 female; 7- *Canthon luteicollis* Erichson, 1847 male; 8- *Canthon luteicollis* Erichson, 1847 female; 9- *Canthon* sp. male.

Annexed 10–18. Habitus, dorsal view, 10- *Coprophanaeus telamon* (Erichson, 1847) male; 11- *Coprophanaeus telamon* (Erichson, 1847) female; 12- *Deltochilum* aff. *barbipes* male; 13- *Deltochilum* aff. *barbipes* female; 14- *Deltochilum crenulipes* Paulian, 1938 male; 15- *Deltochilum crenulipes* Paulian, 1938 female; 16- *Dichotomius* aff. *inauchus* male; 17- *Dichotomius* aff. *inauchus* female; 18- *Dichotomius fonsecae* (Luederwald, 1925) male.



Annexed 19–27. Habitus, dorsal view, 19- *Dichotomius mamillatus* (Felsche, 1901) male; 20- *Dichotomius mamillatus* (Felsche, 1901) female; 21- *Dichotomius ohausi* Luederwaldt, 1923 male; 22- *Dichotomius quinquelobatus* (Felsche, 1910) male; 23- *Dichotomius quinquelobatus* (Felsche, 1910) female; 24- *Eurysternus caribaeus* (Herbst, 1789) male; 25- *Eurysternus caribaeus* (Herbst, 1789) female; 26- *Eurysternus cayennensis* Castelnau, 1840 male; 27- *Eurysternus cayennensis* Castelnau, 1840 female.



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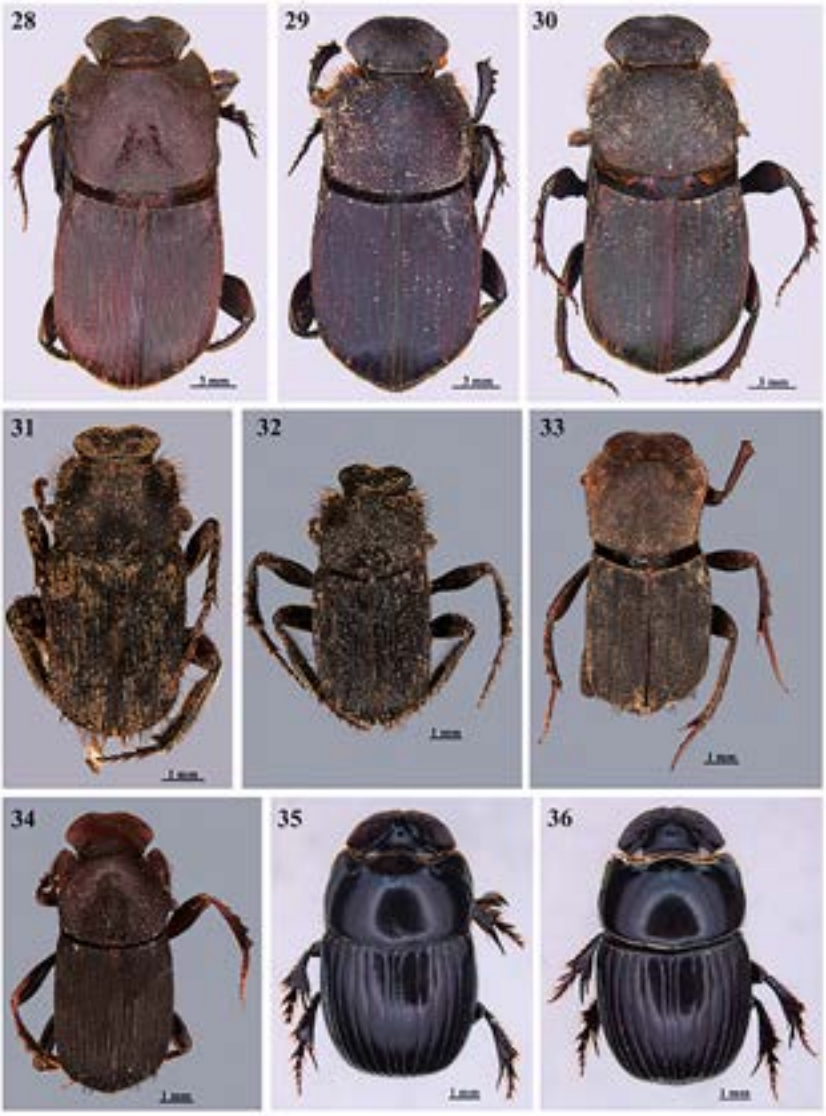
Annexed 28–36. Habitus, dorsal view, 28- *Eurysternus foedus* Guérin-Méneville, 1830 male; 29- *Eurysternus hypocrita* Balthasar, 1939 male; 30- *Eurysternus hypocrita* Balthasar, 1939 female; 31- *Eurysternus lanuginosus* Genier, 2009 male; 32- *Eurysternus lanuginosus* Genier, 2009 female; 33- *Eurysternus vastiorum* Martínez, 1824 male; 34- *Eurysternus vastiorum* Martínez, 1824 female; 35- *Ontherus diabolicus* Génier, 1996 male; 36- *Ontherus diabolicus* Génier, 1996 female.



Annexed 37–43. Habitus, dorsal view, 37- *Onthophagus* sp.1 male; 38- *Onthophagus* sp.1 female; 39- *Onthophagus* sp.1 male; 40- *Onthophagus* sp.1 female; 41- *Oxysternon silenus* Castelnau, 1840 male; 42- *Scybalocanthon imitans* Harold, 1868 male; 43- *Sylvicanthon bridarolli* (Martínez, 1949) male.