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Original Research Article

Endoparasites in the Feces of *Dasyprocta punctata* from Armenia City, Quindio-Colombia

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Abstract: The presence of endoparasites in the feces of *Dasyprocta punctata* and the comparison of their heterogeneity in terms of species diversity in two vegetation types (guadua forest and fruit areas) were evaluated in Armenia, Quindio-Colombia. Six patches (three guadua forest and three fruit areas) were randomly selected for feces collection. The methods of Kato-Katz and Ritchie were used for the identification of endoparasites at the genus level. The diversity (Shannon-Wiener index) and dominance (Simpson index) were calculated for each vegetation type and compared by a Student's t-test. A range-abundance curve was generated to determine the most abundant genus in each vegetation type. Ten genera of endoparasites were recorded. The heterogeneity and dominance of these were not different between vegetation types. However, the range-abundance curves showed that *Trichuris*, *Ascaris* and *Strongyloides* were abundant genera in the guadua forest, and *Ascaris*, *Toxocara* and *Strongyloides* were abundant in the fruit areas. Genera such as *Ascaris*, *Toxocara* and *Trichuris* are reported for the first time in *D. punctata*, which are commonly reported in domestic animals. The higher abundance of *Trichuris*, *Ascaris* and *Strongyloides* in the guadua forest suggests a relationship with microenvironmental variables. Future studies that identify the possible vectors and hosts of these endoparasites are necessary.

Keywords: Fruit areas, gastrointestinal nematodes, guadua forest, new records, urban areas, wild rodents.

INTRODUCTION

Parasitic diseases regulate the population dynamics of wild animals, and the effects of parasitic diseases can be potentially negative when hosts have poor nutrition, stress, chronic diseases and old age [1]. These effects significantly reduce the performance of individuals, their reproductive success and even cause death by immunosuppression [2, 3]. In fact, parasites can contribute to the local extinction of wild animal populations, especially when they are found in isolated and reduced habitats or where the presence of an easily transmissible parasite species exists [2]. However, in the parasite-host relationship, it has also been documented that parasites can disappear, even when their definitive hosts are present, due to changes in environmental factors caused by fragmentation, habitat loss and the disappearance of intermediate hosts or vectors [4]. Therefore, the prevalence of parasites in anthropized environments may depend on the tolerance of their hosts and vectors to the alteration of their habitat, as well as the ability of the parasite to persist under new environmental conditions, the ability to infect its hosts and its life cycle [5, 6].

In addition, in environments disturbed by activities such as livestock or urban development, the chance of wild animals coming into contact with parasites of domestic animals and vice versa also increases [7-10]. In particular, generalist parasite species represent a greater threat to vulnerable wild animal populations than specialized parasites [7]. Among these, endoparasites are of great importance since they can affect their hosts in different ways. For example, genera such as *Trichuris* and *Strongyloides* generate lesions, such as ulcers, and cause thickening of the gastrointestinal mucosa, gastritis and chronic enteritis [11]. In addition, endoparasites can be generalists of certain animal groups, as is the case with *Trichuris gracilis* which can be shared between species of the Dasyproctidae family [12]. The main routes of infection by endoparasites are oral, respiratory and dermal [13], and these diverse transmission and infection strategies can make them more successful and favor their persistence in anthropized environments, as is the case for nematodes [14].

The city of Armenia, Quindio-Colombia, has a complex and diverse system of relicts of vegetation composed of different species and plant associations [15] that functions as habitats and corridors for wild animals such as agoutis *Dasyprocta punctata*. This species has an important ecological role in ecosystems as dispersers and seed removers and is also an important element in the food chain [16-18]. In addition, it is known that they can inhabit areas with natural vegetation and anthropized environments such as crops, fruit trees and urban areas [19, 20]. Currently, there is very little information on the diversity of endoparasites in *D. punctata* and other species of the genus in this type of environment, since most of the work is carried out with free-living animals in natural areas or with animals in captivity [21-23]. Therefore, the main objectives of this study were: 1) to identify the endoparasites present in the feces of *D. punctata* in an urban area of the city of Armenia, Quindio, Colombia; and 2) to compare the heterogeneity and dominance of endoparasites in two types of vegetation present in the city (guadua forest and fruit areas).

MATERIALS AND METHODS

Study area. The study was located in the city of Armenia, Quindio-Colombia, where six patches were randomly selected with two contrasting vegetation types: natural guadua forest formed by *Guadua angustifolia* and planted fruit areas composed of species such as *Psidium guajava*, *Persea americana* and *Citrus sp*, where the presence of agoutis is common (Figure 1). Guadua forest sites corresponded to the areas known as Mercedes del Norte, Parque de la Vida and La Castellana, and the fruit areas were represented by Monteblanco 1, Monteblanco 2 and Monteblanco 2 second section (Table 1). The weather in the studied sites corresponds to Af – Tropical [24], with an annual average temperature of 18-24°C and an annual average precipitation of 2000-4000 mm [25]. In addition to the agoutis, in the sampling areas the presence of domestic species such as *Canis lupus familiaris*, *Felis silvestris catus* and *Gallus gallus* is common.

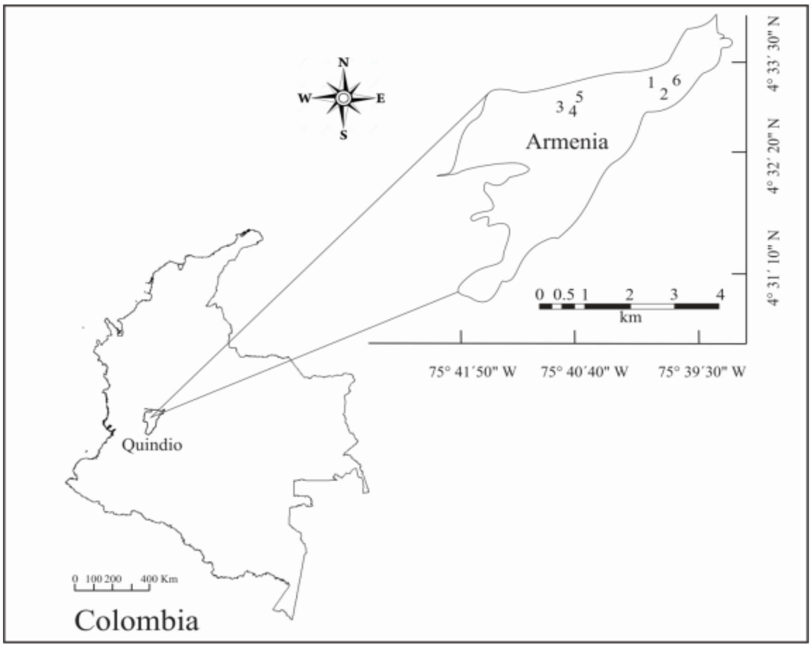

Fig-1: Map of study sites corresponding to two contrasting vegetation types in the city of Armenia, Quindio-Colombia. The guadua forest are represented by Mercedes del Norte (1), Parque de la Vida (2) and La Castellana (6). The fruit areas correspond to Monteblanco-1 (3), Monteblanco-2 (4) and Monteblanco-2 second section (5).

Table-1: Description of the study areas in the city of Armenia, Quindio-Colombia

Sites	Vegetation types	Surface (m^2)	m.a.s.l.
Mercedes del Norte	Guadua forest	58,867	1,501
Parque la Vida	Guadua forest	80,000	1,551
La Castellana	Guadua forest	763.01	1,553
Monteblanco 1	Fruit area	159	1,450
Monteblanco 2	Fruit area	970	1,453
Monteblanco 2 second section	Fruit area	106.9	1,456

Collection and transport of samples. During March-May 2016, nonsystematic sampling was conducted in the selected areas twice a month for each area. The expeditions were conducted from 7:00 a.m. to 11:00 a.m. with the objective of collecting 10 fresh feces samples from agoutis for each one of the replicas by vegetation type. The identification of *D. punctata* feces was performed according to the criteria established by Aranda-Sánchez [26]. The feces were collected with sterile forceps to avoid contact with the soil and prevent contamination of the sample. Samples were placed in sterile test tubes with 3 ml of 10% formaldehyde. The material was labeled and placed in a cooler at 4°C until transfer to the Biomedical Laboratory of the University of Quindio.

Sample processing. The identification of endoparasites was carried out by the methods of Ritchie [27] and Kato Katz [28]. Following the Ritchie method, half of each sample was placed in a falcon tube and brought to a volume of 10 ml with saline solution. Then, these were centrifuged for five minutes at 2500 rpm, the supernatant was removed, and the sample was brought to a final volume of 15 ml with saline solution. Subsequently, 10% formalin saline was added to the contents of the tube and brought to 10 ml; later, 3 ml of ether was added to each tube. The tubes were shaken for 30 seconds and centrifuged for 5 minutes at 2500 rpm. After this process, four layers were exposed: a) an upper layer of ether, b) a capful of fatty residue, c) a formalin layer and d) sediment. With a micropipette, the ether and the capful of fatty residue were removed. A small sample of the remaining liquid residue and the sediment was transferred with a dropper to a slide, and a drop of Lugol solution was added to identify eggs or larvae. The sample was observed by microscopy with a 40x objective.

For the Kato-Katz method, 1 g of fecal matter was used. It was filtered through a metal mesh towards a slide. Subsequently the feces were covered with an acetate lamella previously moistened with glycerin and malachite green to 3% for 24 hours. Subsequently, the plate was turned over on a sheet of absorbent paper and was gently compressed. It was allowed to stand for two hours, and finally, each sample was observed under the microscope with the 40x objective to identify eggs or larvae. The identification of parasites was corroborated by the help of three specialists and through the following guides: Atlas of Human Parasitology [29], Clinical Parasitology Book [30] and Guides in Veterinary Parasitology [31].

Statistical analysis. To assess differences in the parasite heterogeneity between vegetation types, we obtained the Shannon-Wiener index, which measures equity and assumes that individuals are selected at random and that all species are represented in the sample, as well as the Simpson index, which takes into account the representativity of the species with greater importance value without considering the contribution of the rest of the species [32]. A Student' t test was used to compare the index obtained between vegetation types. Given that the study is descriptive and that it is uncertain whether each sample belongs to a different individual, a range-abundance curve was made using the number of eggs or larvae by genus transformed to Log + 1.

RESULTS

Identification of the endoparasite genus. Ten taxa were recorded at the genus level of endoparasites present in feces of agoutis: nematodes (*Trichuris* sp., *Ascaris* sp., *Strongyloides* sp., *Ancylostoma* sp., *Uncinaria* sp., *Strongylus* sp., *Trichostrongylus* sp and *Toxocara* sp., trematodes, such as *Paragonimus* sp., and cestodes, such as *Taenia* sp. (Figure 2).

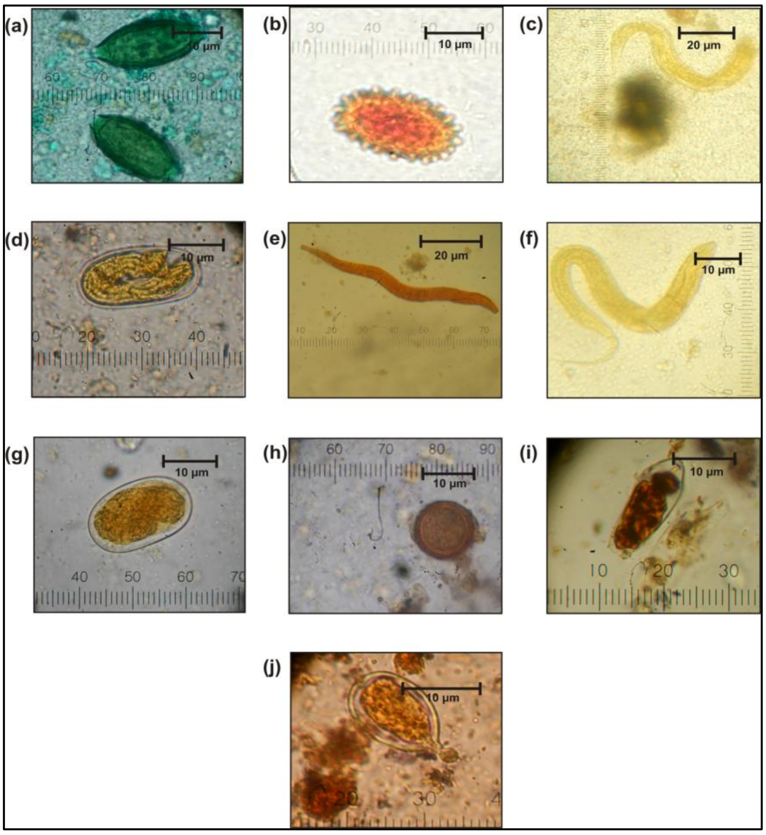

Figure 2. Endoparasites at the genus level recorded by microscopy (objective 40 X) in the feces of *Dasyprocta punctata* collected in guadua forest and fruit areas of the city of Armenia, Quindío-Colombia. Nematodes (a) Trichuris eggs; (b) Ascaris egg; (c) Strongyloides larva; (d) Ancylostoma egg; (e) Uncinaria larva; (f) Strongylus larva; (g) Trichostrongylus egg; (h) Toxocara egg; (i) Paragonimus trematode egg; (j) Taenia cestode egg.

Heterogeneity and Dominance of endoparasites between vegetation types. No differences were found in the heterogeneity of genera between vegetation types (t = - 0.30, gl = 167.66, P = 0.758), or in their dominance (t = 1.52, gl = 156.29, P = 0.12859). However, nematodes of the genera *Trichuris* sp., *Ascaris* sp. and *Strongyloides* sp. were more abundant in the guadua forest, and *Ascaris* sp. and *Toxocara* sp. Were more abundant in the fruit areas (Figure 3).

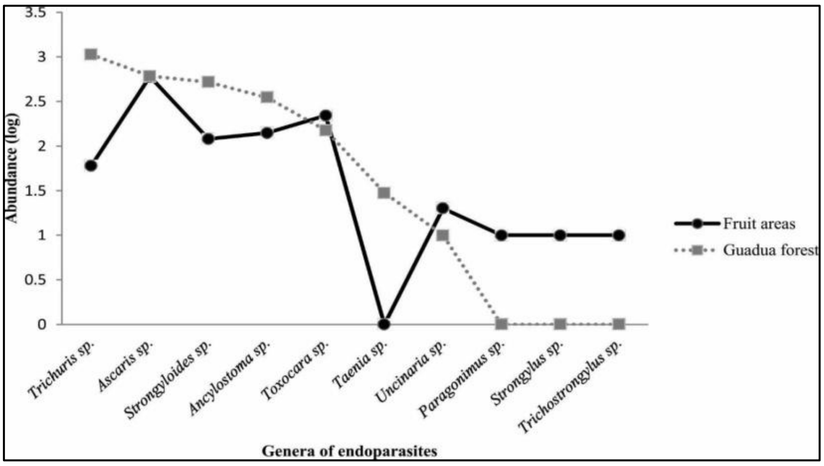

Fig-3: Range-abundance curve of the genera of endoparasites recorded in two vegetation types in Armenia, Quindio-Colombia. On the Y- axis the abundance of the genera in log +1 is shown, and on the X- axis the genera recorded for each vegetation type is shown.

DISCUSSION

Identification of the endoparasite genus. The identification process of endoparasites can be complicated due to the presence of different stages in the observed samples (larvae, eggs, cysts and oocysts). In this sense, BOWMAN [33] mentions that in studies with endoparasites, it is common to report their identification at the genus level. Although *Dasyprocta puncata* has a wide distribution from southern Mexico to northern Argentina and can inhabit natural and anthropized environments [19, 34], it has been the subject of few endoparasitological studies. For example, in Costa Rica, animals in captivity were analyzed and four different taxa of parasites was reported, among which was the nematode *Strongyloides* sp. [35]; additionally, *Eucyathostomum copulatum* was recorded in an urban area in Peru [36], and *Raillietina* sp. was recorded in natural environments of Chiapas, Mexico [37]. Unlike previous studies, this study reports a greater number of taxa for two vegetation types in a highly anthropized environment (Armenia-Quindio, Colombia), with nine taxa in fruit trees areas and seven taxa in guadua forest.

In species taxonomically similar to *D. punctata* (family Dasyproctidae), a great diversity of endoparasites has been recorded. For example, in free-living individuals of *D. leporina* up to seven species of endoparasites have been reported per location, including *Acanthocheilonema* spp., *Aspidodera binansata var. agouti*, *Durettestrongylus ojastii*, *Eimeria agouti*, *Eimeria cotiae*, *Eimeria paraenis*, *Heligmostrongylus* sp., *Helminthoxys urichi*, *Physaloptera torresi*, *Physocephalus mediospiralis*, *Pudica pudica*, *Raillietina demerariensis var. trinitatae*, *Stichorchis giganteus*, *Strongyloides agouti*, and *Trichuris gracilis var trinitatae* [23], while for captive individuals up to four different taxa have been recorded, namely, *Strongyloides* spp., *Paraspidodera uncinata*, *Eimeria* spp. and *Trichuris* spp. [23]. For both free-living and captive organisms, the endoparasite species with the highest prevalence are *Strongyloides agouti*, *Trichuris gracilis* and *Eimeria* spp.

In free-living individuals of *D. fuliginosa* captured in palm plantations, species such as *Viannella trichospicula* and *Avellaria intermedia* were reported [11]; similarly, for free-living *D. guamara*, the presence of *Physaloptera torresi* and *Trichuris gracilis* has been reported [12]. These endoparasites can generate negative effects such as lesions in the gastrointestinal tract, such as ulcers, and thickening of the mucosa, and chronic enteritis, and in turn can cause diarrhea, decreased appetite and body mass, epithelial hyperplasia, anemia and eosinophilic granuloma [38].

The genus Trichuris has been commonly reported in *Dasyprocta leporina*, *D. fuliginosa* [38, 39], *D. guamara* [12] and *Agouti paca* [40], as well as *Strongyloides* genus in species such as *Dasyprocta leporina* [21, 22] and *Agouti paca* [40]. These genera of endoparasites have a widespread distribution, so their presence is well documented even in captive agoutis [41].

Endoparasites of the genus *Ascaris* have also been reported in rodents of the genus *Dasyprocta* [42, 43], suggesting that the route of infection is through direct contact of the skin with soil contaminated by the feces of pigs, dogs and humans, as well as the ingestion of contaminated water [44]. In feces of agoutis, parasites of the genera *Toxocara*, *Taenia*, *Uncinaria* and *Paragonimus* were also recorded. These have been scarcely reported in this species but have been associated mostly with other exotic vertebrates, such as *Canis lupus familiaris*, *Felis silvestris catus* and *Rattus rattus*, as well as wild species, such as *Procyon lotor*, *Philander opossum*, *Didelphis marsupialis*, *Felis pardalis* and *Conepatus semistriatus*, and humans [45]. The presence of *Ancylostoma* sp. in the feces of the agoutis is notable, since this genus of endoparasites has been related in South America to free-range or captive wild animals such as canids (*Cerdocyon thous* and *Lycalopex vetulus*), felines (*Puma yagouaroundi*), primates (*Cacajao calvus*) and even armadillos (*Euphractus sexcinctus*) [46-48]. Its recognition is a key element to identify possible transmitters of this species, whose parasitic effect in animals of the *Dasyprocta* genus is mainly reflected in the digestive and respiratory system. The genera *Strongylus* and *Trichostrongylus*, also recorded in this study, have been reported in previous studies with caviomorphic rodents of the genus *Sigmodon* [49] but also in individuals of the genus *Dasyprocta* [50]. The development of parasitological studies with genera not well known to agoutis is essential to increase knowledge about their biology, as well as for the establishment of control and conservation policies.

Heterogeneity and dominance of endoparasites between vegetation types. The heterogeneity of species between vegetation types was not different. However, the genera *Trichuris*, *Ascaris* and *Strongyloides* were the most abundant in the guadua forest, while *Ascaris* and *Toxocara* were the most abundant in the fruit areas. The presence of genera such as *Ascaris* and *Toxocara* suggests a spatial overlap among rodents, dogs, cats and humans because they commonly move between the types of vegetation studied, and they could serve as vectors of these endoparasites [41]. According to Gállego-Berenguer [51], the displacement of parasitized fauna among different environments constitutes one of the main agents of dispersion and transmission. In parallel, other studies have shown that transmission rates increase when host population densities are high [52] and when organisms have close social interactions, such as rodents of the genus *Dasyprocta* [26].

In guadua forest, *Trichuris*, *Ascaris* and *Strongyloides* were the most abundant genera. This may be because in the undergrowth of guadua forest, there is a greater amount of biomass (rhizomes, stems, branches, leaves and foliage), which generates more moisture due to reduced aeration and limited light entry

[53]. Microclimatic conditions of higher humidity can favor the development and proliferation of a large number of parasites in stages of larvae and eggs [51], including the genera identified in this study. In addition, these endoparasites have a wide distribution in tropical and subtropical environments and present great host diversity [54]. Particularly species of the genus Trichuris, which was the most abundant in the guadua forest, naturally have high population densities, because they can deposit 2,000 to 10,000 eggs per day for 4 or 5 continuous months and are, favored by high humidity conditions (more than 80%), in addition to surviving in free-range life for several years [55].

On the other hand, the genera *Ascaris* and *Toxocara* were very abundant in the agoutis present in fruit areas, probably due to the ingestion of contaminated food and water, as well as poor sanitary conditions [51]. These endoparasites are very resistant to adverse climatic variables, have great reproductive capacity and have great metabolic resistance, which could explain their great abundance in these sites [54]. Therefore, parasites can increase their abundance and population density in this type of humid environment and generate a greater probability of transmission to wildlife and domestic animals.

CONCLUSIONS

Our results show the presence of 8 nematodes, 1 trematode and one cestode in agoutis *Dasyprocta punctata* -that inhabit areas of transformed vegetation in Armenia, Quindio-Colombia, where genera such as *Ascaris*, *Toxocara* and *Trichuris* are reported for the first time in this species. This information is potentially useful to guide studies that identify those possible vectors of endoparasites of agoutis and, consequently, to establish control strategies that diminish the transmission to these organisms. In addition, the difference in the dominance of endoparasites between different vegetation types suggests the need to evaluate how microclimatic characteristics can be an important factor for the development and proliferation of these endoparasites in the studied areas.

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