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Contribution to the knowledge on the diet of the collared peccary (*Dicotyles tajacu*) at the La Selva Biological Station, Costa Rica

Aportes al conocimiento sobre la dieta del pecarí de collar (*Dicotyles tajacu*) en la Estación Biológica La Selva, Costa Rica

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The diet of the collared peccary (*Dicotyles tajacu*) in the Neotropics is poorly known, although palm fruits are frequently reported. This study aimed to evaluate the diet of collared peccary groups at La Selva Biological Station (LSBS), Costa Rica. Between July and December 2021, 30 km of LSBS trails were traveled each month. A list of plant species consumed by peccaries was elaborated from direct visual observations. Samples of plant or fruit species collected in the field were identified at the family, genus, or species level. The diet of the collared peccary inhabiting the LSBS consisted of 38 species belonging to 18 families. The most consumed species belong to the family Arecaceae. *Socratea exorrhiza*, *Ficus colubrinae*, *Dussia macroprophyllata, Sacoglottis trichogyna, Iriartea deltoidea*, and *Dipteryx panamensis* were the predominant species in the peccary diet. The most important plant component was fruits. The dispersal mode of most species consumed was Endo-*stricto*. For 53 % of plant species consumed by peccaries have no information on their IUCN conservation status. Given the diverse diet of the collared peccary, conservation actions should consider the protection of primary forests as food sources, in addition to restoration projects of tropical ecosystems to promote tree species that provide fruits attractive to peccaries.

Key words: Eating habits; fruits; palms; saino; wet tropical forest.

La información disponible sobre la dieta del pecarí de collar (*Dicotyles tajacu*) en el neotrópico es escasa, aunque se sabe que los frutos de palma son reportados con frecuencia. El objetivo de esta investigación fue evaluar la dieta de los grupos de pecaríes de collar en la Estación Biológica La Selva (EBLS), Costa Rica. Entre julio y diciembre de 2021 se recorrieron 30 km por mes en los senderos de la EBLS. Mediante el método de observación directa se realizó un listado de especies de plantas consumidas por los pecaríes. Las muestras de las especies de plantas o frutos colectadas en campo se identificaron a nivel de familia, género y/o especie. La dieta del pecarí de collar en la EBLS estuvo conformada por 38 especies, pertenecientes a 18 familias. Las especies de la familia Arecaceae fueron las de mayor consumo. *Socratea exorrhiza*, *Ficus colubrinae*, *Dussia macroprophyllata, Sacoglottis trichogyna, Iriartea deltoidea* y *Dipteryx panamensis* fueron las especies más consumidas. El componente de mayor importancia fueron los frutos. El modo de dispersión de la mayoría de las especies consumidas fue Endo-*stricto*. El 53 % de las especies de las plantas consumidas no presenta información sobre su categoría de conservación según la UICN. Dada la diversidad en la dieta del pecarí de collar, las acciones de conservación deben considerar la protección de bosques primarios como fuentes de alimento, así como proyectos de restauración de ecosistemas tropicales en función de promover especies de árboles que brindan frutos atractivos para los pecaríes.

Palabras claves: Bosque tropical húmedo; frutos; hábitos alimentarios; palmas; saíno.

The collared peccary (*Dycotyles tajacu*) is a medium-sized, compact-bodied ungulate (Aranda 1994) belonging to the family Tayassuidae (Mammalia, Artiodactyla) and previously considered in the genus *Tayassu* (Mayer and Wetzel 1987; Torrealba-Suárez 1993; Sowls 1997). This species inhabits a wide variety of biomes and is listed as Least Concern according to the International Union for Conservation of Nature (IUCN) Red List (Gongora *et al.* 2011). Its current distribution stretches from southwestern United States of America to the northern-central area of Argentina (Gasparini *et al.* 2013; Ontiveros *et al.* 2020), with stable distribution ranges of between 38 ha and 685 ha (Torrealba-Suárez 1993; Carrillo *et al.* 2002; Beck 2006). These ungulates are components of the dynamics of Neotropical forests as key herbivores governing plant diversity, spatial distribution, and demography (Clark and Clark 1989; Torrealba-Suárez 1993; Roldán and Simonetti 2001; Beck 2005, 2007; Paine and Beck 2007; Briceño-Méndez *et al.* 2017).

The diet of collared peccaries is one of the main research topics among the scholars studying these ungulates since it plays a major role in the reproductive success and evolutionary adaptation of the species, as well as in its eco-

logical relationships with other animal and plant species (Pérez-Cortez and Reyna-Hurtado 2008). In the Neotropics, peccaries are generally frugivorous, and their diet varies according to the habitat (Beck 2005). Throughout their distribution, these ungulates consume up to 128 species of plants belonging to 38 families, preferring palm fruits of the family Arecaceae (Kiltie and Terborgh 1983; Beck 2005, 2006, 2007; Keuroghlian and Eaton 2008; Queenborough *et al.* 2012), in addition to other species of the families Fabaceae, Sapotaceae, and Moraceae, among others (Beck 2005).

In this sense, peccaries consume a wide variety of plant foods such as pulp, roots, tubers (Torrealba-Suárez 1993; Altrichter *et al.* 2000; Beck 2005, 2006; Romero *et al.* 2013), and palm seeds (Queenborough *et al.* 2012). Their diet also includes animals, including invertebrates, frogs, snakes, turtles, fish, eggs, lizards, birds, and small rodents (Romero *et al.* 2013). In places with prolonged droughts, collared peccaries have been observed consuming mainly succulents, especially prickley-pear cactus, *Opuntia lindheimeri*, to meet their water and energy needs (Gallagher *et al.* 1984; Corn and Warren 1985), as well as cactus roots and pulp (Desbiez *et al.* 2009).

The La Selva Biological Station (LSBS) is under protection, and surveillance actions have been implemented, fostering the growth of local peccary populations since the 1980s (Michel *et al.* 2014; Romero *et al.* 2013). In addition, the National Wildlife Conservation Act prohibits the wildlife hunting (MINAE 2008), contributing to the abundance of this species. In LSBS, peccaries are easily observed on forest trails and near laboratories and office areas due to the abundance of food resources such as fig (*Ficus colubrinae*), chonta or walking palm (*Socratea exorrhiza*), bombona or pona palm (*Iriartea deltoidea*) and *Philodendron* sp. (Romero *et al.* 2013). Among these resources, palm fruits have been frequently reported as part of the collared peccary diet, and although it consumes a wide variety of plant species in Neotropical forests, the abundance of each species is less well-known (Beck 2005; Queenborough *et al.* 2012). This study aimed to evaluate the diet of collared peccary groups at La Selva Biological Station (LSBS) in Costa Rica.

The LSBS is located in the province of Heredia on the Caribbean slope of northern Costa Rica and is physically connected with the Braulio Carrillo National Park (Torrealba-Suárez 1993). It comprises an area of 1,600 ha, of which 73 % is wet tropical forest (wtf–T; Hartshorn 1983), and the remaining area comprises experimental forest plantations (Figure 1; Arroyo-Arce *et al.* 2013). The temperature ranges between 24.7 ºC and 27.1 °C, with maxima

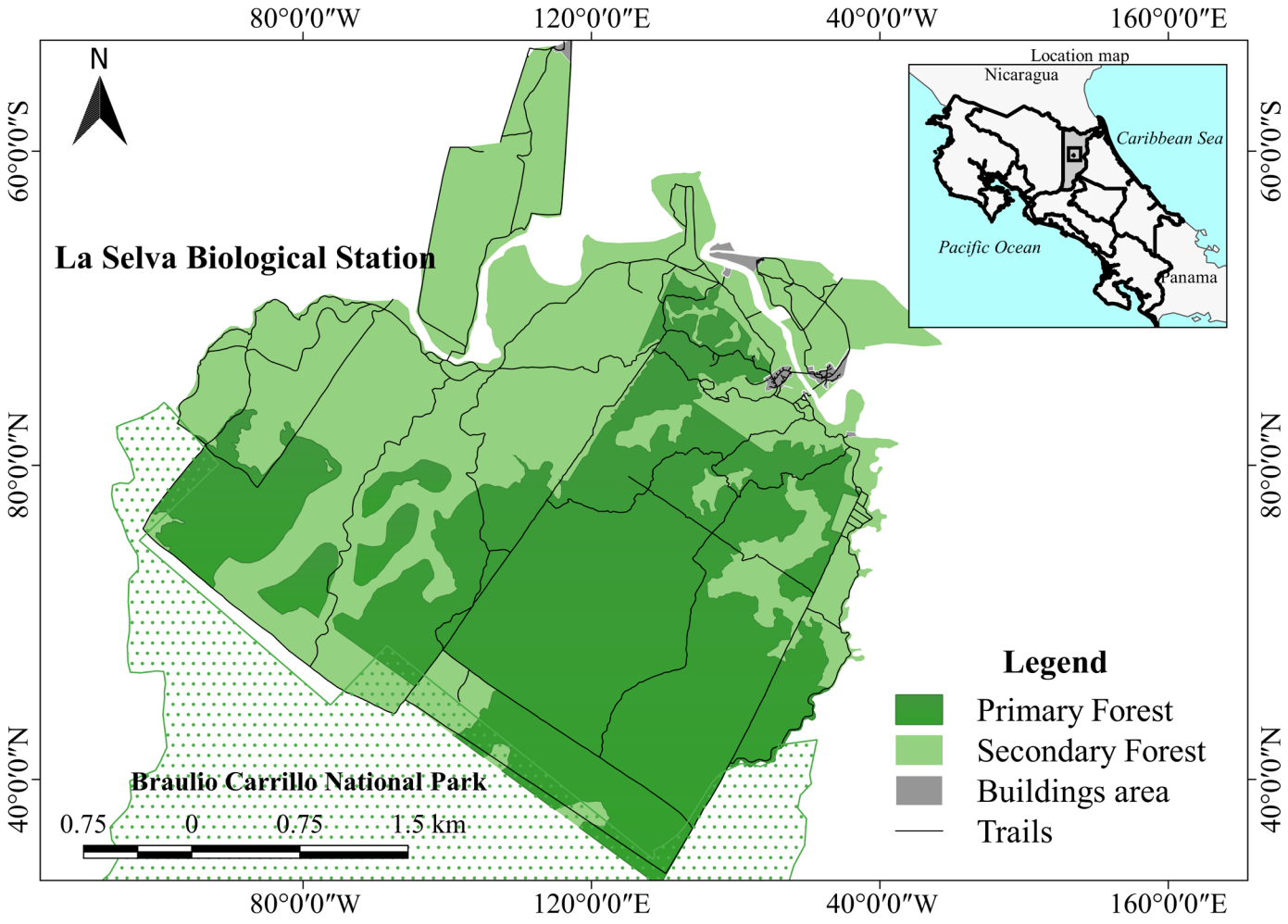

Figure 1. La Selva Biological Station, Puerto Viejo, Sarapiquí, Costa Rica.

between 30 ºC and 34 °C, and the mean annual rainfall varies between 3,800 mm and 4,000 mm (Robinson *et al.* 2018; Armstrong *et al.* 2020), with a period of low rainfall between January and April (Clark *et al.* 2013; Armstrong *et al.* 2020) and the highest precipitation between June and November (McClearn *et al.* 2016). The vegetation consists of different successional stages and the topography goes from flat to undulating (Oviedo-Pérez 2008; Arroyo-Arce *et al.* 2013; Romero *et al.* 2013; Raich *et al.* 2014).

The study on the diet of peccaries was conducted from July 9 to December 9, 2021. All the EBLS trails were traveled, with intervals of 350 m to 6 km between hikes. Trails included primary forest, secondary forest, managed forest, building areas, abandoned agroforestry, *arboretum*, clean wooded marshland, successional plots, grasslands with and without trees, forest plantations of native species, the mature forest ecological reserve, and urbanized areas. Hikes were walked over 9 hours between 8:00 and 17:00 hr, at 1 km/hr, covering an average of 30 km per month. When coming across a solitary peccary or a group of peccaries, we directly observed the nearest individual every 5 min (Figure 2a, b). We recorded the consumption of fruits, vegetative parts (leaves and stems), leaf litter or biomass in the soil, animals (invertebrates and small vertebrates), the frequency with which each food type was consumed. Samples of the species of plants or fruits consumed by peccaries were collected and identified at the family, genus, or species level with the assistance of LSBS staff.

A list of plant species consumed by peccaries was elaborated accompanied by their IUCN conservation status. Besides, the dispersal category of each was also noted, considering the 5 dispersal categories defined by Hawes *et al.* (2020): a) Endo-*stricto* or "true endozoochory", where seeds are dispersed by animals, either through seed ingestion (endozoochory) or via accumulation (synzoochory); b) Endo-*lato* or "possible endozoochory", where, in addition to dispersal by animals, this can also occur through other means such as water transport (hydrochory) or auto-dispersal (autochory); c) Synzoochory, where seeds are dispersed by animals through seed accumulation, although it also considers other means such as autochory, hydrochory, and ant dispersal (myrmecoria); d) Others: dispersal that does not involve animals, including anemochory (wind dispersal), autochory, baracory (dispersal through gravity), and hydrochory; and, e) no information available.

Finally, the most frequently consumed plant species were determined according to three categories: fruits, leaves, and flowers. The descriptive analysis was performed in Python 3.9 (Python Software Foundation 2023).

In the LSBS, the diet of the collar peccary consists of 38 species of plants belonging to 18 families (Table 1). The plant species with the highest frequency of consumption belonged to the families Arecaceae (31 %), followed by Araceae (10 %) and Moraceae, Fabaceae, Sapotaceae, Myristicaceae, Phytolaccaceae and Piperaceae (5 % each). The species consumed most frequently by peccaries were *Socratea exorrhiza* (18 observations), *Ficus colubrinae* (14 observations), *Dussia macroprophyllata, Sacoglottis trichogyna, Iriartea deltoidea* (3 observations each), and *Dipteryx panamensis* (2 observations; Table 1; Figure 3). The dominant components in the diet of collared peccaries were fruits (77 %), followed by leaves (20 %) and flowers (3 %). The fruits most consumed by peccaries in building areas were *Ficus colubrinae*.

The dispersal mode of most species consumed by peccaries was Endo-*stricto* (60.53 %), followed by synzoochory (18.42 %), Endo-*lato* (2.63 %), no information available (10.53 %), and others (7.89 %). According to IUCN conservation categories, 53 % of the plant species consumed by peccaries are not listed, 37 % are listed as Least Concern, 5 % Endangered, 2.5 % Vulnerable, and the rest are classified as Near Threatened (2.5 %).

Most of the species consumed by collared peccaries in the LSBS belong to the family Arecaceae, compared to fruits

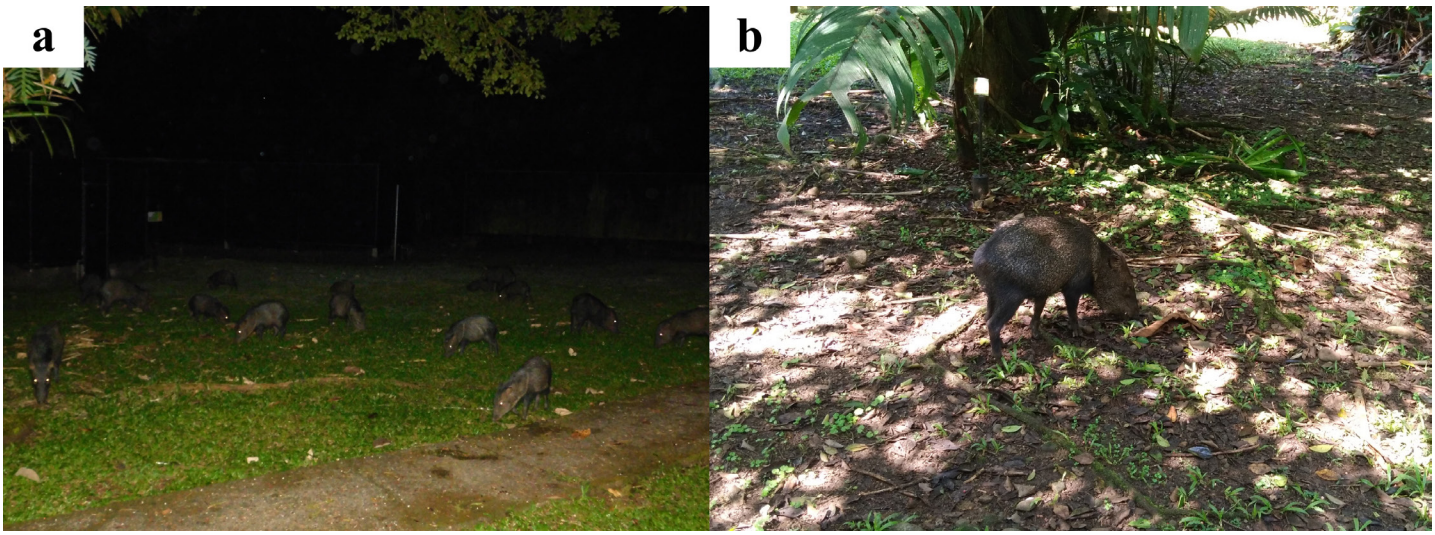

Figure 2. Collared peccaries, *Dicotyles tajacu*, feeding at La Selva Biological Station, Costa Rica. a) A group of peccaries, b) a solitary peccary.

Table 1. List of species consumed by *Dicotyles tajacu* at La Selva Biological Station, Costa Rica.

Species	Type of organism	Dispersal Category	Conservation status according to the IUCN Red List
Family Araceae			
Philodendron alliodorum	Bush	Others	No information
Philodendron jodavisianum	Creeper	Others	No information
Philodendron radiatum	Creeper	Synzoochory	No information
Philodendron sp.	Bush	Synzoochory	No information
Family Arecaceae			
Asterogyne martiana	Palm	Endo-*stricto*	No information
Astrocaryum alatum	Palm	Synzoochory	Near threatened
Astrocaryum confertum	Palm	Synzoochory	Endangered
Bactris coloradonis	Palm	Endo-*stricto*	No information
Bactris gasipaes	Palm	Endo-*stricto*	No information
Bactris longiseta	Palm	Endo-*stricto*	Endangered
Calyptrogyne ghiesbreghtiana	Palm	No information	No information
Chamaedorea pinnatifrons	Palm	Endo-*stricto*	Least concern
Iriartea deltoidea	Palm	Endo-*stricto*	Least concern
Socratea exorrhiza	Palm	Endo-*stricto*	Least concern
Synechanthus warscewiczianus	Palm	No information	No information
Welfia regia	Palm	Endo-*stricto*	No information
Family Burceraceae			
Protium pittieri	Tree	Endo-*stricto*	Vulnerable
Family Fabaceae			
Dipteryx panamensis	Tree	Endo-*stricto*	No information
Dussia macroprophyllata	Tree	Endo-*lato*	Least concern
Family Humiriaceae			
Sacoglottis trichogyna	Tree	Endo-*stricto*	Least concern
Family Lamiaceae			
Aegiphila falcata	Bush	No information	Least concern
Family Malvaceae			
Pachira aquatica	Tree	Synzoochory	Least concern
Family Menispermaceae			
Abuta panamensis	Liana	Synzoochory	No information
Family Moraceae			
Brosimum alicastrum	Tree	Endo-*stricto*	Least concern
Ficus colubrinae	Tree	Endo-*stricto*	Least concern
Family Myristicaceae			
Virola sebifera	Tree	Endo-*stricto*	Least concern
Virola koschnyi	Tree	Endo-*stricto*	Least concern
Family Nyctaginaceae			
Neea laetevirens	Bush	Endo-*stricto*	No information
Family Passifloraceae			
Passiflora arbelaezii	Liana	Synzoochory	No information
Family Phytolaccaceae			
Trichostigma polyandrum	Bush	Endo-*stricto*	No information
Phytolacca rivinoides	Bush	Endo-*stricto*	No information
Family Piperaceae			
Piper sp.	Bush	Endo-*stricto*	No information
Piper sp.	Bush	Endo-*stricto*	No information
Family Primulaceae			
Clavija costaricana	Bush	Endo-*stricto*	Least concern
Family Rubiaceae			
Faramea suerrensis	Bush	Endo-*stricto*	Least concern
Family Sapindaceae			
Paullinia granatensis	Liana	No information	No information
Family Sapotaceae			
Chrysophyllum venezuelanense	Tree	Endo-*stricto*	Least concern
Family Solanaceae			
Merinthopodium neuranthum	Bush	Others	No information

and seeds of other families (Beck 2006). This is because the fruits and seeds of palm trees are rich in carbohydrates, which provide energy, and are available throughout the year, even drought periods when fruits of other species are scarce (Beck 2005, 2006).

With regard to the species consumed, we concluded that *D. tajacu* consumes a few species when they are abundant. This was the case of *S. exhorriza*, the species most consumed by peccaries in the LSBS; in this zone, it was previously reported that peccaries consume the roots of this species, mainly when fruits are scarce (Méndez-Figueroa 2014; Ávalos *et al.* 2016).

On the other hand, *F. colubrinae*, the second most consumed species by *D. tajacu* in this study, is commonly found in areas of the LSBS with buildings. It produces fruits in all seasons so that these are readily available for consumption by peccaries throughout the year (Quesada *et al.* 1997). It should be noted that the family Araceae includes toxic species such as *Philondendron* spp. (Escobar 1972), which were consumed by peccaries in a smaller proportion. This may be related to the evolutionary adaptation of these animals, which allows feeding on plant tissues of species containing high amounts of compounds, only digestible through bacterial fermentation (Sowls 1997; Altrichter *et al.* 2000). In this sense, the number of plant species used by peccaries in the LSBS demonstrates that the collared peccary is an opportunistic species capable of using fruits and seeds across a wide morphological and taxonomic range (Sowls 1997; Keuroghlian *et al.* 2004; Beck 2005).

Our results are similar to those reported by Beck (2005) in previous studies in the Neotropics, who also found that peccaries fed preferentially on fruits of the family Arecaceae, although in a lower percentage (19 %) than the frequency reported in this note. Beck (2005) also reported the consumption of fruits of the families Fabaceae, Sapotaceae, and Moraceae in higher frequencies than those reported in the present study. With respect to the main components in the diet of the collared peccary in the LSBS, Torrealba-Suárez (1993) reported 53 % fruit consumption, while Méndez-Figueroa (2014) noted that leaves were the plant tissue most consumed (58 %), followed by fruits (31 %); these percentages differ from the figures reported herein.

As expected, endozoochory is the dispersal mode of most species consumed by peccaries in LSBS. The role of peccaries in forest regeneration in the Neotropics has been demonstrated in previous studies, both within the LSBS and elsewhere, since it has been observed that seeds of different species are resistant to the digestive process of peccaries (Beck 2005; Platt *et al.* 2014) and have successfully germinated in stool samples. For example, Beck (2005) identified seeds of *Ficus* sp., *Brosimun* spp., *Phytolacca dioica*, and *Dipteryx panamensis* in collared peccary feces. Other authors also reported the presence of seeds of *Socratea* sp. (Kiltie 1981), *Ficus* spp. (Martínez-Romero and Mandujano 1995), *Brosimum alicastrum, Piper* sp., and *Chamaedorea* sp. (Pérez-Cortez and Reyna-Hurtado 2008).

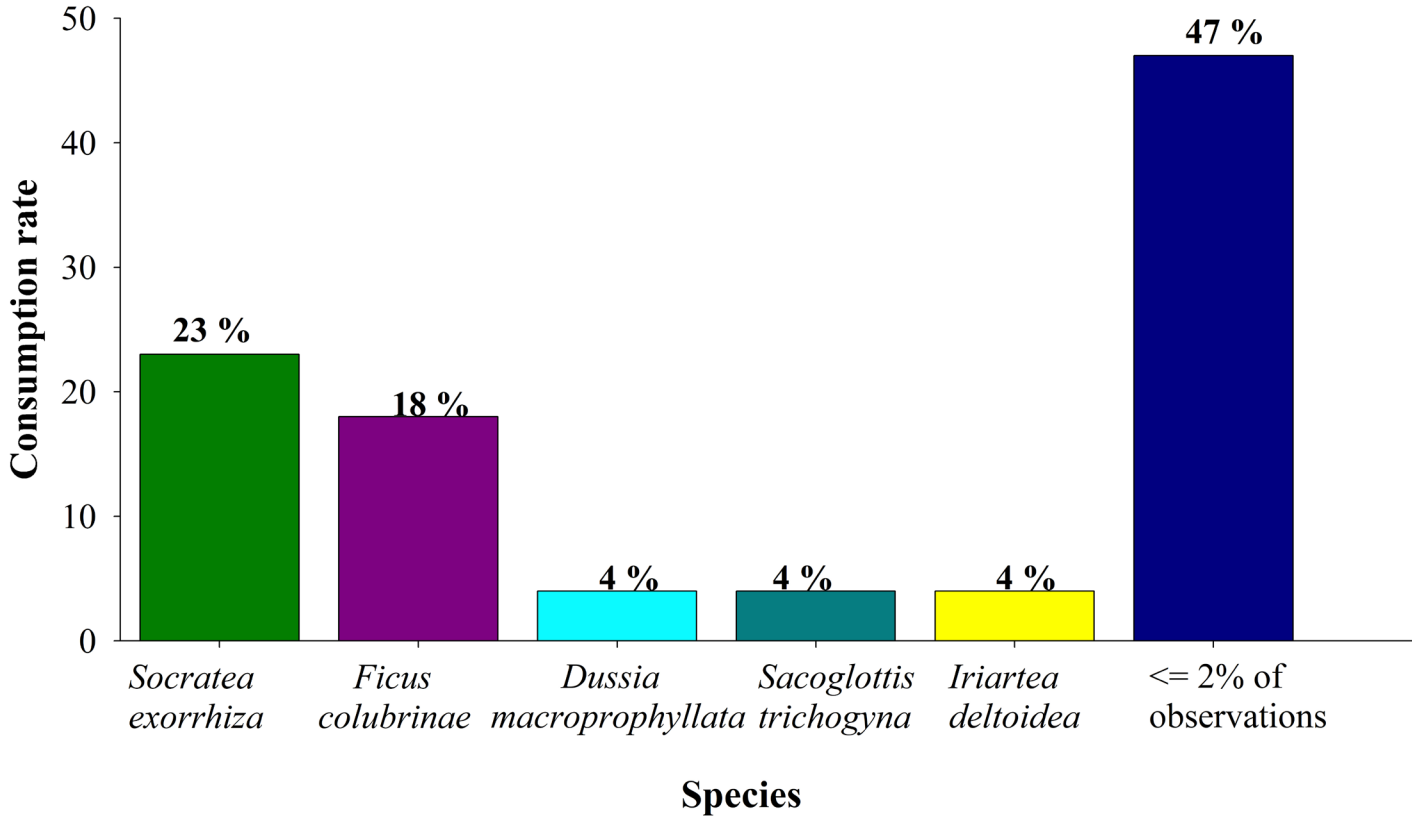

Figure 3. Number of observations for each plant species consumed by *Dicotyles tajacu* at La Selva Biological Station, Costa Rica.

Stomach analyses of collared peccaries have revealed the presence of large intact seeds of *Socratea* sp. and *I. deltoidea*, but no germination tests have been performed on them (Beck 2005). According to Kiltie (1981), peccaries thoroughly chew their food and rarely function as effective dispersers of large seeds. However, we suggest carrying out germination studies of seeds present in peccary feces to gain a better understanding of their role as seed dispersers (*e.g.,* Liu *et al.* 2004; Myers *et al.* 2004; Beck 2005). The potential of the collared peccary as a seed disperser is clear, as in the case of large seeds of *S. exhorriza, D. panamensis, B. alicastrum,* and *I. deltoidea*, and small seeds of *Phytolacca rivinoides* and *F. colubrinae*, based on the frequency of consumption reported in the present study and previous research (Kiltie 1981; Martínez-Romero and Mandujano 1995; Beck 2005; Pérez-Cortez and Reyna-Hurtado 2008).

Our results show that, in the LSBS, the diet of the collared peccary includes 38 plant species, mainly of the family Arecaceae, with fruits being the plant component most consumed in all species. Therefore, conservation actions for this ungulate species should consider restoring forest ecosystems and protecting primary forests as these represent their main food source. Finally, the connectivity between LSBS and other forest fragments should be promoted through local biological corridors to facilitate the natural restoration of plants important in the diet of peccaries, given its ecological importance in wet tropical forests.

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