

## Birds of the Grota do Angico Natural Monument in the semi-arid Caatinga scrublands of northeastern Brazil

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**Abstract:** An inventory of the avian fauna of the Grota do Angico Natural Monument in the Caatinga of northern Sergipe, Brazil, revealed the presence of at least 140 species, including nine that are endemic to the Caatinga and seasonal forest adjacent. Despite the limited scope of the study (two expeditions in July and August, 2008), the species richness recorded at the site appeared to be typical of the region and the Caatinga biome.

**Keywords:** *avian inventory, birds conservation, caatinga, protected areas, Sergipe.*

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**Resumo:** No inventário da avifauna do Monumento Natural Grota de Angico na Caatinga ao norte de Sergipe, Brasil, revelou a presença de pelo menos 140 espécies, incluindo nove endêmicas da Caatinga e florestas sazonais adjacentes. Apesar do alcance limitado do estudo (duas expedições em Julho e Agosto, 2008), a riqueza de espécies registrada no sítio aparentemente pode ser típica da região e do Bioma Caatinga.

**Palavras-chave:** *inventário de aves, conservação de aves, caatinga, unidades de conservação, Sergipe.*

## Introduction

The semi-arid scrublands of the Caatinga cover some 800,000 km<sup>2</sup> of the Brazilian Northeast. Relatively few studies of the avian fauna of this biome are available (Pacheco 2000, Olmos et al. 2005), and even basic parameters such as its overall diversity of species are poorly-defined. Estimates of the total number of bird species found in the Caatinga range from 348 (Pacheco 2004) through 460 (Major et al. 2004) to 510 (Silva et al. 2003). It nevertheless seems likely that all of these values represent underestimates, given the paucity of field studies and data.

The Caatinga has suffered extensive anthropogenic degradation, was has formed a landscape characterized by a mosaic of forest fragments and impacted vegetation within a matrix dominated by cattle ranching (Castelleti et al. 2004). This degradation of natural environments generally has deleterious effects on the diversity of a biome (Brooks & Balmford 1996, Bierregaard Junior et al. 1992), and while the Caatinga has traditionally been considered relatively immune to such impacts, a recent review (Leal et al. 2005) suggests that the Caatinga is as vulnerable as any other biome.

The creation of protected areas is a fundamental step in the conservation of natural resources, and the Sergipe state government has created a number of conservation units since 2007. One of these units is the Grota do Angico Natural Monument, which not only preserves a representative area of arboreal Caatinga on the margin of the São Francisco River, but also has considerable historic and cultural significance as the site of the death of the famous outlaw Virgulino Ferreira da Silva, known as "Lampião".

The aim of the present study was to provide an inventory of the bird species that inhabit a recently-established protected area in the Brazilian Caatinga, and contribute to the understanding of the biological diversity of this biome. As Farias & Pereira (2009) have pointed out, the avian fauna of the Caatinga is poorly-known, and any addition to the knowledge of biodiversity can provide information to develop strategies for conservation of bird species recorded.

## Materials and Methods

The present study was conducted in the Grota do Angico Natural Monument (GANM), which is located on the right margin of the lower São Francisco River in the northern extreme of the Brazilian state of Sergipe (09° 39' S; 37° 40' W). The 2138 ha reserve is located within the Caatinga morphoclimatic domain, as defined by Ab'Saber (1974), and straddles the border between the municipalities of Poço Redondo and Canindé de São Francisco (Figure 1).

The climate of the region is characterized by relatively reduced and infrequent rainfall, with annual precipitation of approximately 500 mm, distributed mainly between April and August, the period known locally as the winter (*inverno*). Rainfall is minimal during the remaining months, although the quantity and distribution of precipitation may vary considerably among years. Santos & Andrade (1992) classified the region as marginally arid (Köppen's BShw category), although local humidity levels may be influenced by the proximity of the area to the São Francisco River (Figure 1). Temperatures are relatively high throughout the year, with means of around 30 °C during the dry season, but there is also an accentuated diurnal temperature range.

The present study was based on two excursions in 2008, between the 14<sup>th</sup> and 18<sup>th</sup> of July, and the 4<sup>th</sup> and 7<sup>th</sup> of August, 2008. This period corresponds to the late wet season at the study site.

### 1. Mist-netting

Birds were captured using 100 m-long mist nets with a 35 mm mesh, which were set along existing trails during morning (5:00-

12:00 AM) and afternoon/evening sessions (4:00-10:00 PM). The specimens were removed carefully from the nets and placed in cloth bags for removal to the field laboratory for processing, where they were identified according to the field guides of Major et al. (2004) and Sigrist (2007), weighed and measured (standard parameters), see Brasil (1994), and then released at the capture sites. Specimen collection was authorized by the Brazilian Environment Institute (IBAMA), through special license number 15900-1, issued by SISBIO. Specimens were collected only when the animal died during capture. All specimens were taxidermized and deposited in the ornithological collection being established at the Federal University of Sergipe in São Cristóvão.

### 2. Observation

Additional records were collected using the active search procedure (Ambrose 1989), for the identification of large, conspicuous or aquatic birds. Observations were conducted using a pair of 8 × 40 binoculars, and the field guides of Sigrist (2007) and Major et al. (2004). This procedure was conducted during the earliest daylight hours, when birds tend to be most active. Species nomenclature followed the Brazilian Committee for Ornithological Records (Comitê... 2010).

## Results and Discussion

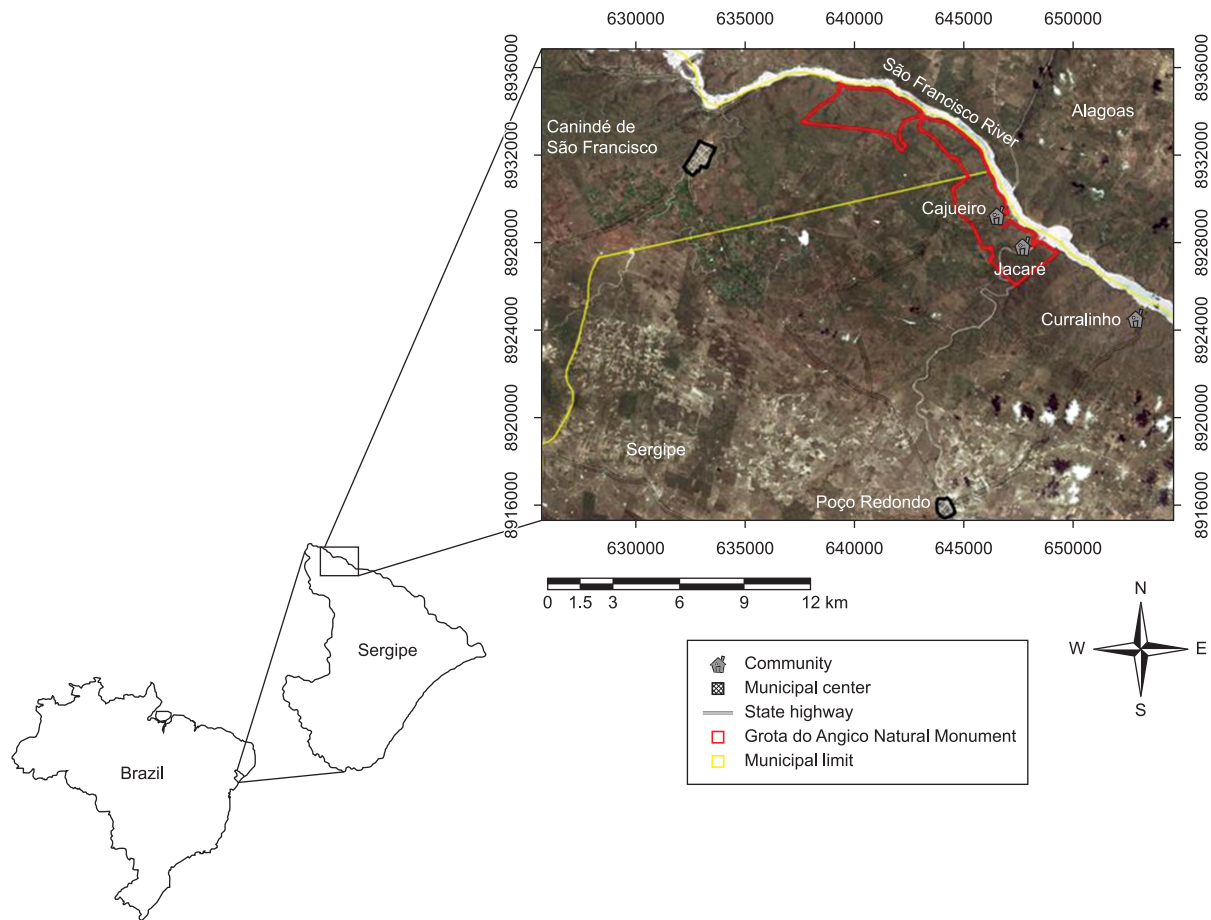
A total of 140 bird species belonging to 42 families were recorded during the course of the study (Table 1). This total corresponds to almost half (42%) of the species recorded for the state of Sergipe by Sousa (2009). The Tyrannidae was represented by the largest number of species (17), followed by the Thraupidae (nine species) and the Columbidae, Furnariidae and Emberizidae, each with eight species. Fourteen of the species recorded here are endemic to Brazil, and nine are endemic to the Caatinga (Figure 2), according to Stotz et al. (1996). One of these endemic species, the Pectoral Antwren (*Herpsilochmus pectoralis*), is listed as vulnerable to extinction by the IUCN (International... 2009).

While July is part of the peak period of bird migrations in the Caatinga (Lima et al. 2003, Ruiz-Esparza 2010), nine migratory species (*Zenaida auriculata*, *Coccyzus melacoryphus*, *Elaenia chilensis*, *Euscarthmus meloryphus*, *Empidonomus varius*, *Tyrannus melancholicus*, *Tyrannus savana*, *Turdus amaurochalinus* and *Sporophila lineola*) was recorded during the present study (based on the classification of Stotz et al. 1996). This single species contrasts with the nine and six migratory species recorded, respectively, in July and August, 2009, at the Serra da Guia, some 40 km south of the present study site, by (Ruiz-Esparza 2010). While more migratory species were recorded at this site, no waterbirds (e.g. *Anhinga anhinga*, *Egretta thula*, *Jacana jacana*, and *Phalacrocorax brasilianus*) were observed, presumably because of the absence of aquatic habitats at this higher altitude location. Despite these differences in taxonomic composition, and the much longer study period at Serra da Guia (one year), the two studies recorded the same number of species (140).

Other inventories within the same geographical region have returned similar numbers of taxa. Roos et al. (2006) recorded 145 bird species at the Sobradinho Reservoir (Caatinga), for example, located further upstream on the São Francisco River in Bahia state, whereas D'Horta et al. (2005) recorded 123 species in the Serra de Itabaiana National Park (mixed Caatinga), in southern Sergipe. At Raso da Catarina, Bahia, west and north of the present study site, Lima et al. (2003) recorded a total of 191 bird species in caatinga scrub and semideciduous forest.

Further afield, while the results of some surveys in the Caatinga were similar to those of the present study, others have reported

## Avian inventory of the Grota do Angico Natural Monument, Brazil



**Figure 1.** Location of the Grota do Angico Natural Monument in the Brazilian state of Sergipe.

**Table 1.** Bird species recorded during the present study at the Grota do Angico Natural Monument in northern Sergipe, Brazil. Nomenclature follows the Brazilian Committee for Ornithological Records (Comitê... 2010). R = resident; M = migratory; E = endemic; SV = seasonal visitor from southern South America; \* = specimen collected.

Bird family/species	Common name	Observation
<b>TINAMIDAE (5)</b>		
<i>Crypturellus parvirostris</i> (Wagler, 1827)	Small-billed Tinamou	R
<i>Crypturellus tataupa</i> (Temminck, 1815)	Tataupa Tinamou	R
<i>Rhynchotus rufescens</i> (Temminck, 1815)	Red-winged Tinamou	R
<i>Nothura boraquira</i> (Spix, 1825)	White-bellied Nothura	R
<i>Nothura maculosa</i> (Temminck, 1815)	Spotted Nothura	R
<b>PHALACROCORACIDAE (1)</b>		
<i>Phalacrocorax brasilianus</i> (Gmelin, 1789)	Neotropic Cormorant	R
<b>ANHINGIDAE (1)</b>		
<i>Anhinga anhinga</i> (Linnaeus, 1766)	Anhinga	R
<b>ARDEIDAE (3)</b>		
<i>Butorides striata</i> (Linnaeus, 1758)	Striated Heron	R
<i>Bubulcus ibis</i> (Linnaeus, 1758)	Cattle Egret	R
<i>Egretta thula</i> (Molina, 1782)	Snowy Egret	R
<b>CATHARTIDAE (4)</b>		
<i>Cathartes aura</i> (Linnaeus, 1758)	Turkey Vulture	R
<i>Cathartes burrovianus</i> (Cassin, 1845)	Lesser Yellow-headed Vulture	R
<i>Coragyps atratus</i> (Bechstein, 1793)	Black Vulture	R
<i>Sarcoramphus papa</i> (Linnaeus, 1758)	King Vulture	R
<b>ACCIPITRIDAE (5)</b>		
<i>Elanus leucurus</i> (Vieillot, 1818)	White-tailed Kite	R

Table 1. Continued...

Bird family/species	Common name	Observation
<i>Geranospiza caerulescens</i> (Vieillot, 1817)	Crane Hawk	R
<i>Heterospizias meridionalis</i> (Latham, 1790)	Savanna Hawk	R
<i>Rupornis magnirostris</i> (Gmelin, 1788)	Roadside Hawk	R
<i>Geranoaetus albicaudatus</i> (Vieillot, 1816)	White-tailed Hawk	R
FALCONIDAE (4)		
<i>Caracara plancus</i> (Miller, 1777)	Southern Caracara	R
<i>Milvago chimachima</i> (Vieillot, 1816)	Yellow-headed Caracara	R
<i>Herpetotheres cachinnans</i> (Linnaeus, 1758)	Laughing Falcon	R
<i>Falco sparverius</i> (Linnaeus, 1758)	American Kestrel	R
RALLIDAE (1)		
<i>Laterallus viridis</i> (Statius Muller, 1776)	Russet-crowned Crake	R
CARIAMIDAE (1)		
<i>Cariama cristata</i> (Linnaeus, 1766)	Red-legged Seriema	R
CHARADRIIDAE (1)		
<i>Vanellus chilensis</i> (Molina, 1782)	Southern Lapwing	R
RECURVIROSTRIDAE (1)		
<i>Himantopus melanurus</i> (Vieillot, 1817)	White-backed Stilt	R
JACANIDAE (1)		
<i>Jacana jacana</i> (Linnaeus, 1766)	Wattled Jacana	R
COLUMBIDAE (8)		
<i>Columbina passerina</i> (Linnaeus, 1758)	Common Ground-Dove	R
<i>Columbina minuta</i> (Linnaeus, 1766)	Plain-breasted Ground-Dove	R
<i>Columbina talpacoti</i> (Temminck, 1811)	Ruddy Ground-Dove	R
<i>Columbina squammata</i> (Lesson, 1831)	Scaled Dove	R
<i>Columbina picui</i> * (Temminck, 1813)	Picui Ground-Dove	R
<i>Patagioenas picazuro</i> (Temminck, 1813)	Picazuro Pigeon	R
<i>Zenaida auriculata</i> (Des Murs, 1847)	Eared Dove	M
<i>Leptotila verreauxi</i> (Bonaparte, 1855)	White-tipped Dove	R
PSITTACIDAE (4)		
<i>Aratinga aurea</i> (Gmelin, 1788)	Peach-fronted Parakeet	R
<i>Aratinga cactorum</i> * (Kuhl, 1820)	Cactus Parakeet	R, E
<i>Forpus xanthopterygius</i> * (Spix, 1824)	Blue-winged Parrotlet	R
<i>Amazona aestiva</i> (Linnaeus, 1758)	Blue-fronted Parrot	R
CUCULIDAE (6)		
<i>Micrococyx cinereus</i> (Vieillot, 1817)	Ash-colored Cuckoo	R
<i>Piaya cayana</i> (Linnaeus, 1766)	Squirrel Cuckoo	R
<i>Coccyzus melacoryphus</i> (Vieillot, 1817)	Dark-billed Cuckoo	M
<i>Crotophaga ani</i> (Linnaeus, 1758)	Smooth-billed Ani	R
<i>Guira guira</i> (Gmelin, 1788)	Guira Cuckoo	R
<i>Tapera naevia</i> (Linnaeus, 1766)	Striped Cuckoo	R
TYTONIDAE (1)		
<i>Tyto alba</i> (Scopoli, 1769)	Barn Owl	R
STRIGIDAE (2)		
<i>Megascops choliba</i> (Vieillot, 1817)	Tropical Screech-Owl	R
<i>Athene cunicularia</i> (Molina, 1782)	Burrowing Owl	R
NYCTIBIIDAE (1)		
<i>Nyctibius griseus</i> (Gmelin, 1789)	Common Potoo	R
CAPRIMULGIDAE (4)		
<i>Hydropsalis albicollis</i> (Gmelin, 1789)	Pauraque	R
<i>Hydropsalis parvulus</i> (Gould, 1837)	Little Nightjar	R
<i>Hydropsalis hirundinaceus</i> (Spix, 1825)	Pygmy Nightjar	R, E
<i>Chordeiles pusillus</i> (Gould, 1861)	Least Nighthawk	R
TROCHILIDAE (4)		
<i>Eupetomena macroura</i> (Gmelin, 1788)	Swallow-tailed Hummingbird	R

Table 1. Continued...

Bird family/species	Common name	Observation
<i>Chrysolampis mosquitus</i> (Linnaeus, 1758)	Ruby-topaz Hummingbird	R
<i>Chlorostilbon lucidus</i> (Shaw, 1812)	Glittering-bellied Emerald	R
<i>Helimaster squamosus</i> (Temminck, 1823)	Stripe-breasted Starthroat	R, E
ALCEDINIDAE (3)		
<i>Megaceryle torquata</i> (Linnaeus, 1766)	Ringed Kingfisher	R
<i>Chloroceryle amazona</i> (Latham, 1790)	Amazon Kingfisher	R
<i>Chloroceryle americana</i> (Gmelin, 1788)	Green Kingfisher	R
BUCCONIDAE (1)		
<i>Nystalus maculatus</i> * (Gmelin, 1788)	Spot-backed Puffbird	R
PICIDAE (1)		
<i>Colaptes campestris</i> (Vieillot, 1818)	Campo Flicker	R
THAMNOPHILIDAE (6)		
<i>Taraba major</i> (Vieillot, 1816)	Great Antshrike	R
<i>Thamnophilus capistratus</i> (Lesson, 1840)	Caatinga Antshrike	R, E
<i>Thamnophilus pelzelni</i> (Hellmayr, 1924)	Planalto Slaty-Antshrike	R, E
<i>Myrmorchilus strigilatus</i> (Wied, 1831)	Stripe-backed Antbird	R
<i>Herpsilochmus pectoralis</i> (Sclater, 1857)	Pectoral Antwren	R, E
<i>Formicivora melanogaster</i> (Pelzelin, 1868)	Black-bellied Antwren	R
DENDROCOLAPTIDAE (1)		
<i>Lepidocolaptes angustirostris</i> (Vieillot, 1818)	Narrow-billed Woodcreeper	R
FURNARIIDAE (8)		
<i>Furnarius leucopus</i> (Swainson, 1838)	Pale-legged Hornero	R
<i>Furnarius rufus</i> (Gmelin, 1788)	Rufous Hornero	R
<i>Synallaxis frontalis</i> (Pelzelin, 1859)	Sooty-fronted Spinetail	R
<i>Synallaxis albescens</i> (Temminck, 1823)	Pale-breasted Spinetail	R
<i>Cranioleuca semicinerea</i> (Reichenbach, 1853)	Gray-headed Spinetail	R, E
<i>Certhiaxis cinnamomeus</i> (Gmelin, 1788)	Yellow-chinned Spinetail	R
<i>Phacellodomus rufifrons</i> (Wied, 1821)	Rufous-fronted Thornbird	R
<i>Pseudoseisura cristata</i> (Spix, 1824)	Caatinga Cacholote	R, E
RHYNCHOCYCLIDAE (3)		
<i>Tolmomyias flaviventris</i> (Wied, 1831)	Yellow-breasted Flycatcher	R
<i>Hemitriccus striaticollis</i> (Lafresnaye, 1853)	Stripe-necked Tody-Tyrant	R
<i>Hemitriccus margaritaceiventer</i> (d'Orbigny & Lafresnaye, 1837)	Pearly-vented Tody-tyrant	R
TYRANNIDAE (17)		
<i>Myiopagis viridicata</i> (Vieillot, 1817)	Greenish Elaenia	R
<i>Elaenia flavogaster</i> (Thunberg, 1822)	Yellow-bellied Elaenia	R
<i>Elaenia chilensis</i> (Hellmayr, 1927)	Chilean Elaenia	SV
<i>Camptostoma obsoletum</i> (Temminck, 1824)	Southern Beardless-Tyrannulet	R
<i>Serpophaga subcristata</i> (Vieillot, 1817)	White-crested Tyrannulet	R
<i>Euscarthmus meloryphus</i> (Wied, 1831)	Tawny-crowned Pygmy-Tyrant	M
<i>Sublegatus modestus</i> (Wied, 1831)	Southern Scrub-Flycatcher	R
<i>Fluvicola albiventer</i> (Spix, 1825)	Black-backed Water-Tyrant	R
<i>Fluvicola nengeta</i> (Linnaeus, 1766)	Masked Water-Tyrant	R
<i>Arundinicola leucocephala</i> (Linnaeus, 1764)	White-headed Marsh-Tyrant	R
<i>Machetornis rixosa</i> (Vieillot, 1819)	Cattle Tyrant	R
<i>Pitangus sulphuratus</i> (Linnaeus, 1766)	Great Kiskadee	R
<i>Megarynchus pitangua</i> (Linnaeus, 1766)	Boat-billed Flycatcher	R
<i>Empidonomus varius</i> (Vieillot, 1818)	Variegated Flycatcher	M
<i>Tyrannus melancholicus</i> (Vieillot, 1819)	Tropical Kingbird	M
<i>Tyrannus savana</i> (Vieillot, 1808)	Fork-tailed Flycatcher	M
<i>Myiarchus tyrannulus</i> (Statius Muller, 1776)	Brown-crested Flycatcher	R
TITYRIDAE (3)		
<i>Pachyramphus viridis</i> * (Vieillot, 1816)	Green-backed Becard	R



Table 1. Continued...

Bird family/species	Common name	Observation
<i>Pachyrhamphus marginatus</i> (Lichtenstein, 1823)	Black-capped Becard	R
<i>Pachyrhamphus validus</i> * (Lichtenstein, 1823)	Crested Becard	R
VIREONIDAE (2)		
<i>Cyclarhis gujanensis</i> (Gmelin, 1789)	Rufous-browed Peppershrike	R
<i>Hylophilus amaurocephalus</i> (Nordmann, 1835)	Gray-eyed Greenlet	R, E
CORVIDAE (1)		
<i>Cyanocorax cyanopogon</i> (Wied, 1821)	White-naped Jay	R, E
HIRUNDINIDAE (1)		
<i>Tachycineta leucorrhoa</i> (Vieillot, 1817)	White-rumped Swallow	R
TROGLODYTIDAE (2)		
<i>Troglodytes musculus</i> (Naumann, 1823)	Southern House-Wren	R
<i>Cantorchilus longirostris</i> (Vieillot, 1819)	Long-billed Wren	R, E
POLIOPTILIDAE (1)		
<i>Poliophtila plumbea</i> (Gmelin, 1788)	Tropical Gnatcatcher	R
TURDIDAE (3)		
<i>Turdus rufiventris</i> (Vieillot, 1818)	Rufous-bellied Thrush	R
<i>Turdus leucomelas</i> (Vieillot, 1818)	Pale-breasted Thrush	R
<i>Turdus amaurochalinus</i> * (Cabanis, 1850)	Creamy-bellied Thrush	M
MIMIDAE (1)		
<i>Mimus saturninus</i> (Lichtenstein, 1823)	Chalk-browed Mockingbird	R
COEREBOIDAE (1)		
<i>Coereba flaveola</i> (Linnaeus, 1758)	Bananaquit	R
THRAUPIDAE (9)		
<i>Saltatricula atricollis</i> (Vieillot, 1817)	Black-throated Saltator	R
<i>Compsothraupis loricata</i> (Lichtenstein, 1819)	Scarlet-throated Tanager	R, E
<i>Nemosia pileata</i> (Boddaert, 1783)	Hooded Tanager	R
<i>Thlypopsis sordida</i> (d'Orbigny & Lafresnaye, 1837)	Orange-headed Tanager	R
<i>Tachyphonus rufus</i> (Boddaert, 1783)	White-lined Tanager	R
<i>Lanio pileatus</i> (Wied, 1821)	Pileated-Finch	R
<i>Tangara sayaca</i> (Linnaeus, 1766)	Sayaca Tanager	R
<i>Tangara palmarum</i> (Wied, 1823)	Palm Tanager	R
<i>Paroaria dominicana</i> (Linnaeus, 1758)	Red-cowled Cardinal	R, E
EMBERIZIDAE (8)		
<i>Zonotrichia capensis</i> (Statius Muller, 1776)	Rufous-collared Sparrow	R
<i>Sicalis flaveola</i> (Linnaeus, 1766)	Saffron Finch	R
<i>Sicalis luteola</i> (Sparman, 1789)	Grassland Yellow-Finch	R
<i>Emberizoides herbicola</i> (Vieillot, 1817)	Wedge-tailed Grass-Finch	R
<i>Volatinia jacarina</i> (Linnaeus, 1766)	Blue-black Grassquit	R
<i>Sporophila lineola</i> (Linnaeus, 1758)	Lined Seedeater	M
<i>Sporophila nigricollis</i> (Vieillot, 1823)	Yellow-bellied Seedeater	R
<i>Sporophila albogularis</i> (Spix, 1825)	White-throated Seedeater	R, E
PARULIDAE (1)		
<i>Parula pitiayumi</i> (Vieillot, 1817)	Tropical Parula	R
ICTERIDAE (6)		
<i>Icterus cayanensis</i> (Linnaeus, 1766)	Epaulet Oriole	R
<i>Icterus jamaicai</i> (Gmelin, 1788)	Campo Troupial	R, E
<i>Chrysomus ruficapillus</i> (Vieillot, 1819)	Chestnut-capped Blackbird	R
<i>Agelaioides fringillarius</i> (Vieillot, 1819)	Bay-winged Cowbird	R, E
<i>Molothrus bonariensis</i> (Gmelin, 1789)	Shiny Cowbird	R
<i>Sturnella militaris</i> (Linnaeus, 1758)	Red-breasted Blackbird	R
FRINGILLIDAE (2)		
<i>Euphonia chlorotica</i> (Linnaeus, 1766)	Purple-throated Euphonia	R
<i>Euphonia violacea</i> (Linnaeus, 1758)	Violaceous Euphonia	R
PASSERIDAE (1)		
<i>Passer domesticus</i> (Linnaeus, 1758)	House Sparrow	R



**Figure 2.** Some species endemic to the Caatinga and seasonal forest adjacent recorded during the present study: a) *Pseudoseisura cristata*, b) *Paroaria dominicana*, c) *Herpsilochmus pectoralis* (male and female), and d) *Hydropsalis hirundinaceus*.

larger numbers of species. For example, Santos (2004) recorded only 115 bird species in the caatinga of Piauí, while Telino-Júnior et al. (2005) recorded 145 species in Santa Terezinha, Paraíba. Similarly, Nascimento (2000) recorded only 116 species at the Seridó Ecological Station in Rio Grande do Norte, and 154 species at the Ajuba Ecological Station in Ceará, while Farias et al. (2010) found 162 species in the Negreiros National Forest in Pernambuco. By contrast, Nascimento et al. (2000) reported a total of 193 species from the Araripe Plateau, located in the contact zone between the states of Pernambuco, Ceará, and Piauí, Olmos (1993) recorded 208 in the Serra da Capivara National Park in Piauí, and Farias et al. (2006) found a total of 249 species in areas of caatinga habitat in Pernambuco, Paraíba, and Ceará considered to be high priority for conservation.

While it seems likely that the full complement of species found in the Grota do Angico Natural Monument was not recorded here, due primarily to the relatively short duration of the study, this comparison among studies suggests that the estimate of species richness was relatively reliable, by regional standards.

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