Nest support plants of the Araripe Manakin *Antilophia bokermanni*, a Critically Endangered endemic bird from Ceará, Brazil

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O soldadinho-do-Araripe *Antilophia bokermanni* é uma ave endêmica da floresta úmida da Chapada do Araripe, 'Criticamente em Perigo' e nidifica ao longo de cursos d'água naturais e artificiais. O objetivo desta pesquisa foi verificar quais plantas são utilizadas para suporte de seus ninhos. Esta pesquisa foi conduzida durante quatro estações reprodutivas do soldadinho-do-Araripe. Foram documentados 28 ninhos que tinham como suporte 11 espécies vegetais, pertencentes a oito famílias, sendo 21 deles encontrados em Melastomataceae (n=11), Rubiaceae (n=7) e Piperaceae (n=3). Os ninhos do soldadinho-do-Araripe são construídos entre as estações seca e chuvosa, quando as plantas são removidas indiscriminadamente das margens dos cursos d'água. Recomendamos a interrupção da retirada de plantas que margeiam os cursos d'água, especialmente durante o período reprodutivo desta ave.

The Araripe plateau is located at the junction of the north-east Brazilian states of Pernambuco, Piauí and Ceará, and presents several distinct habitats, including evergreen forest[9]. Evergreen forest in this region, where the Araripe Manakin *Antilophia bokermanni* is endemic[2] is restricted to north-east-facing hillsides, in Ceará, due to the many springs in the area and the high cloud-borne moisture between 600 and 800 m elevation[4].

A. bokermanni is Critically Endangered[7,10] and is included on the National List of Species of Brazilian Fauna on the Brink of Extinction[16]. For at least a century, the natural watercourses on the slopes of the Araripe plateau have been partially deviated for agricultural use, mainly sugarcane plantations[17]. As a consequence of such intervention, most of the native riparian vegetation has been drastically reduced or totally removed[17]. Sugarcane agriculture is scarce now[17], but canals and their forested banks still exist in some areas, with the water being used by the local population for other purposes[2].

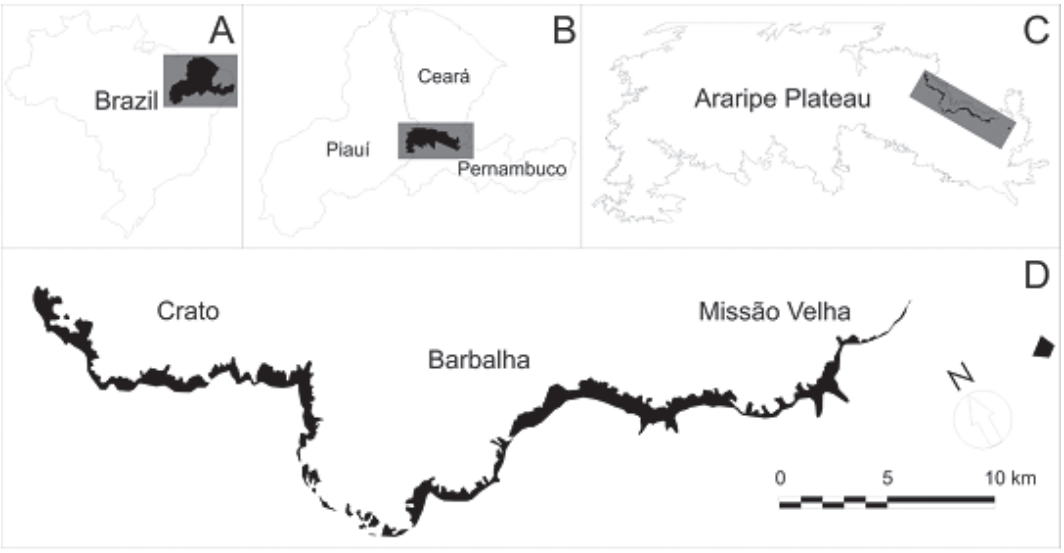

Figure 1. Location of Ceará, Piauí and Pernambuco, in north-east Brazil (A), on whose borders the Araripe plateau is located (B); evergreen forest occurs only on the north-east slopes (C) in the municipalities of Crato, Barbalha and Missão Velha (D), Ceará.

A. bokermanni has probably adapted to the modified forest structure, because females construct their nests on plants both at natural and artificial edges of riparian vegetation[2,7]. Nests are slung between tree forks at heights of up to two metres, and are constructed of dry vegetable fibres, spider webs and lichens, 'decorated' with leaves, and the nesting season is November–January[2].

Nesting, including nest construction, egg laying and incubation, is a critical phase for birds[21]and disturbance in this period can compromise the survival of a species[21]. The few studies on nest support preferences[15,18,20] have revealed patterns in the types of plants used[6]. This characteristic reinforces the theory that effective conservation depends on knowledge of nesting substrates, because removal of nesting plants can negatively affect breeding success[21].

Araripe Manakin is the most threatened species of Pipridae mainly because of habitat destruction due to loss of riparian vegetation and adjacent evergreen forest[8]. Here we identify those plants used as nest supports and provide guidelines for habitat management to conserve the Araripe Manakin.

Study area and Methods

Our study was conducted on the north-east slope of the Araripe plateau, in southern Ceará, in evergreen forest at 600–800 m, in the municipalities of Crato (07°16'36"S 39°26'41"W and 07°16'55"S 39°26'24"W), Barbalha (07°19'59"S 39°24'46"W and 07°21'52"S 39°19'52"W) and Missão Velha (07°24'31"S 39°13'36"W and 07°24'46"S 39°13'37"W) (Fig. 1). The study area has two very well-defined seasons, dry (0–60 mm of precipitation), in May–November, and wet (>60 mm), in December–April, with maximum rainfall in February–March, and mean annual precipitation of 1,033 mm. Mean annual temperature is 25.7°C, the coldest months being June–July (24.1°C) and the warmest November (27.4°C)[5].

Data collection

Field work was conducted during the nesting period (November–January), in 2004–07, totaling c.160 hours along watercourses in the forest interior and covering c.1.8 km. When nests were found, the supporting plant was photographed or collected, preferably with the plant's reproductive structures intact, for herbarium specimen preparation. Nest height and placement in relation to the supporting plant and the watercourses were noted. Nests were not collected. The phenology of nest support plants was studied during two years, data being complemented using herbarium specimens. Plant species utilised as support for nests of *A. bokermanni* were classified according to habitat: (1) arboreal: woody individuals at least 3 m tall; (2) shrubs: between 1 and 3 m tall; (3) sub-shrubs: a maximum of 1 m tall with a woody main stem and secondary ramifications; and (4) herbs: plants without an above-ground woody stem[22]. Plant species were identified by specialists and deposited in the Herbarium EAC of the Federal University of Ceará, Fortaleza, being classified according to the APG II[1].

Results

Eleven plant species, belonging to eight families, were utilised by Araripe Manakin as nest supports.

Table 1. Families (*n*=8) and species (*n*=11) of plants used as nest support by Araripe Manakin *Antilophia bokermanni*, and their categorisation (HB: Arboreal = Arb, Shrub = Sh and Sub-shrub = Sub), number of nests per plant species (Nest / sp.) and its fruiting period on the hillsides of the Araripe plateau, Ceará, Brazil.

Families	Species	HB	Nest / sp.	Fructification
Burseraceae	*Protium heptaphyllum* (Aubl.) Marchand	Arb	1	September–January
Chrysobalanaceae	*Hirtella glandulosa* Spreng.*	Arb	3	September–January
Cyatheaceae	*Cyathea pungens* (Willd.) Domin	Sh	1	May
Melastomataceae	*Henriettea succosa* (Aubl.) DC.*	Arb	7	October–April
	Miconia ibaguensis (Bonpl.) Triana*	Sh	4	July–April
Nyctaginaceae	*Guapira opposita* (Vell.) Reitz	Arb	1	October
Picramniaceae	*Picramnia sellowii* Planch.	Arb	1	March, May–June, September
Rubiaceae	*Psychotria colorata* (Willd. ex Roem. & Schult.) Müll. Arg.*	Sh	6	Jan–May, July, September
	Cordiera myrciifolia (Spruce ex K. Schum) C. Persson & Delprete	Sh	1	December, January
Piperaceae	*Piper arboreum* var. *arboreum* Aubl.	Sub	2	September
	Piper arboreum var. *hirtellum* Yunck.	Sub	1	March, May–June, September

*Plant species utilised both as nest support and food.

Melastomataceae, Rubiaceae and Piperaceae were most commonly used, with two species each, corresponding to 75% of the total; other families were represented by one species each (Table 1).

Twenty-eight nests of *A. bokermanni* were found on the following species: *Henriettea succosa* (*n*=7, 25%) and *Miconia ibaguensis* (*n*=4, 14.29%), Melastomataceae; *Psychotria colorata* (*n*=6, 21.43%) and *Cordiera myrciifolia* (*n*=1, 3.57%), Rubiaceae; *Piper arboreum* var. *arboreum* (*n*=2, 7.14%) and *P. arboreum* var. *hirtellum* (*n*=1, 3.57%), Piperaceae; *Hirtella glandulosa* (*n*=3, 10.72%), Chrysobalanaceae, followed by *Cyathea pungens* (*n*=1, 3.57%), Cyatheaceae; *Protium heptaphyllum* (*n*=1, 3.57%), Burseraceae; *Guapira opposita* (*n*=1, 3.57%), Nyctaginaceae; and *Picramnia sellowii* (*n*=1, 3.57%), Picramniaceae (Table 1).

Most nests were sited below 2 m (93.2%), except two (6.8%), one 2.5 m and the other 5 m above ground, built on *Protium heptaphyllum* and *Henriettea succosa*, respectively. All nests were sited at the extremity of branches and above watercourses.

Six plant species used by Araripe Manakin as nest supports (*Miconia ibaguensis*, *Henriettea succosa*, *Hirtella glandulosa*, *Psychotria colorata, Cordiera myrciifolia* and *Protium heptaphyllum*) were in fruit during the nesting period (Table 1). The first four mentioned plant species were utilised both as support for nests and by the manakins to feed[12], or 71.44% of the nest support plants recorded (Table 1). The other two plant species in fruit did not feature in the bird's diet (Table 1). Some plant species fruited two months prior to nesting (September–October) and others were in fruit after the nesting period (February–July) (Table 1).

Plants used as nest supports were arboreal (45.45%), shrubs (36.36%) and sub-shrubs (18.19%). Although tree species represent almost half these plants, only two individuals were in the adult phase (*Protium heptaphyllum* and *Henriettea succosa*).

Discussion

The use of Melastomataceae and Rubiaceae by the Araripe Manakin for nest support mirrors the observations of Marini[15] who studied the breeding biology of Helmeted Manakin *A. galeata*, the sole congeneric.

That 71.44% of nests were constructed on just four plant species—*Henriettea succosa*, *Miconia ibaguensis*, *Psychotria colorata* and *Hirtella glandulosa*—indicates a clear preference for these substrates, either due to their structure, their location beside watercourses, or even their fructification, which coincides with the manakin's nesting season. Foster[6], in her Costa Rican study of Long-tailed Manakin *Chiroxiphia linearis*, observed that 43.6% of monitored nests were sited on just four plant species: *Eugenia* sp. (Myrtaceae), *Terminalia lucida* (Combretaceae), *Ardisia revoluta* (Myrsinaceae) and *Psychotria* sp. (Rubiaceae). *C. linearis* selects plants based on their form and fructification, which factors might also be the case in Araripe Manakin.

An overlap in fructification and nidification was also observed by Marini[14] for *A. galeata*; he reported that *A. galeata* nest construction coincided with peak fructification of one of the nest support plants (*Miconia hirtella*, Melastomataceae).

According to Lack[11], hatching of the offspring must coincide with a peak in food resources, to maximise survival, which finding was further corroborated by this study. Indeed, if *A. bokermanni* breeds in January, for instance, the final month in which nest construction was observed, whilst the young hatch in three weeks[2] and take another three weeks to fledge, this coincides with the fructification of *Henriettea succosa* and *Miconia ibaguensis*.

Araripe Manakin's preference for young arboreal and shrub species might be related to the fact that these plants present structures sufficiently strong to support the female and two young, but not to withstand the additional weight of potential predators. This strategy is reinforced by siting nests at the extremities of the branches, usually beside or above watercourses. Brosset[3] monitored 550 nests of 110 bird species in a tropical forest in central Africa, and found that 337 were predated. He demonstrated that predation varied according to habit, and that nests on trees were more vulnerable to predation (70%) than those sited on bushes (50%) and that levels of predation decreased in nests above watercourses (35%).

Foster[6] observed that Long-tailed Manakin also prefers to construct its nest at the extremity of branches, and believed that such sites are less accessible to lizards and mammals, which might also be true in the Chapada do Araripe. Although White-eared Opossum *Didelphis albiventris* and White-tufted Marmoset *Callithrix jacchus* have been observed in the study area, and are considered predators of eggs and young birds[13,19], we did not record them predating Araripe Manakin eggs or chicks. Reidy[19] used video cameras to identify one mammalian and four avian nest predators of Lance-tailed Manakins *Chiroxiphia lanceolata*, two of them present in the Araripe Manakin's range (Roadside Hawk *Buteo magnirostris* and *Didelphis albiventris*). Because predation is responsible for a large percentage of nest failures in tropical forests[19] it is important to make systematic observations to identify predators of the nests of *Antilophia bokermanni*.

Nonetheless there are disadvantages to siting nests close to a branch's terminus and at the margins of artificial watercourses, as such situations are more vulnerable to human disturbance. Mainly in the period immediately prior to the wet season

(September–November), these areas are managed with the purpose of increasing the water supply to part of the human population, in lieu of natural watercourses, and require maintenance to prevent erosion. Because of this, branches and / or plants present at their margins are removed, including those used as nest support by *A. bokermanni*, during the early construction phase. Similar types and effects of disturbance have been observed for Blue-fronted Parrot *Amazona aestiva* in Mato Grosso do Sul, Brazil[20]. It is necessary, therefore, to manage both natural and artificial watercourses and their vegetation within the range of *A. bokermanni*, to ensure that extraction and / or clearance of vegetation, especially during the bird's nesting period during the transition between the dry and wet seasons, is minimised.

Enforcement of legislation protecting evergreen forest and Permanent Preservation Areas on hillsides, and around springs and watercourses, would greatly aid the Araripe Manakin's conservation. However, such mechanisms are ineffective in Brazil, despite that the area lies within the buffer zone of the Araripe National Forest and the Environmental Protection Area of the Chapada do Araripe plateau, both of which are conservation units subject to sustainable use. Preventing the extinction of *A. bokermanni* will involve halting the loss of evergreen forest on north-east hillsides and the loss of natural vegetation atop the plateau, as the latter serves as the recharging zone for aquifers. Deviating watercourses within evergreen forests must be curbed and the recovery of riparian vegetation encouraged using plant species favoured by the manakins both as food[12] and nest substrates.

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