

Papéis Avulsos de Zoologia

Museu de Zoologia da Universidade de São Paulo

Volume 57(21):275-285, 2017

www.mz.usp.br/publicacoes
www.revistas.usp.br/paz

ISSN impresso: 0031-1049
ISSN on-line: 1807-0205

NEW RANGE LIMIT OF THE *ANOPETIA GOUNELLEI* (AVES: TROCHILIDAE): STATE OF ART AND A REVIEW ON THE UPDATED AREA

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ABSTRACT

New technologies and the rapid amount of data help to improve and update the distribution of the species. Anopetia gounellei (Broad-tipped Hermit, Trochilidae) is a poorly known hummingbird and has been recorded outside its formal range since 2009. Here we reviewed the records of the Broad-tipped Hermit, proposing new range limits and discussing the species ecoregional endemism. The species was recorded in a variety of vegetation, including caatinga and humid forest. Our updated range-limit suggest an increase of 80% from the previous range, exceeding the Caatinga limits, calling into question the endemism of the species to this biome, but confirming a close relationship with dry ecoregions in Brazil. Basic information about its biology is needed, and further studies about breeding and ecological requirements are recommended.

KEY-WORDS: Biome; Caatinga; Distribution; Endemism; Hummingbird-plant interaction.

INTRODUCTION

Species distribution and distributional range are popular topics in ecology today, helping to understand from community patterns to species biology (Collevatti *et al.*, 2013; Peischl *et al.*, 2015). In recent years, many studies have been developed to predict the consequences of climate and its impact on species range limits (Sunday *et al.*, 2012; Lenoir & Svenning,

2013). To address those studies, range limit information is commonly accessible through open databases such as BirdLife [www.birdlife.org], eBird [www.ebird.org] and GBIF [www.gbif.org]. These databases provide easy access to a large volume of data, and help to explore and understand global ecological patterns (Elith & Franklin, 2013; Silva *et al.*, 2014). However, due to the rapid pace of technological development and the increasing number of biological surveys, it is

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difficult to keep data on species distributional range updated and verified. This can affect studies that use these data, such as data on species diversity based on distribution models (Maldonado *et al.*, 2015).

The range limit of the hummingbird *Anopetia gounellei* (Boucard, 1891) is part of a large compilation of distribution maps and an example of the aforementioned problem. The species seems to be restricted to the northeastern Brazil, based on its range limits (BirdLife International, 2015). However, in 2002, the species was recorded in southeastern Brazil (16°23'S, 43°24'W) (Vasconcelos *et al.*, 2006), and in 2009 Araujo recorded the species in northeastern areas outside its range (07°28'15"S, 36°52'51"W). Additionally, the current conservation status of *A. gounellei* is least-concern, which could be a consequence of the lack of information about its population size, range size, or habitat quality (Hinkelmann *et al.*, 2015).

Anopetia gounellei is the only species representative of the subfamily Phaethornitinae restricted to the dry region of northeastern Brazil (Silva *et al.*, 2003; Hinkelmann *et al.*, 2015). Although not well-known (Hinkelmann *et al.*, 2015), the species may be the major pollinator of semiarid plants (*see* Demetrio, 2008; Neves *et al.*, 2011) and may contribute to floral maintenance (Ashman *et al.*, 2004; Aguilar *et al.*, 2006).

Considering available information about *A. gounellei* we are concerned about the consequences of the obsolete information available about its distribution. Therefore, our main objective is to conduct a review about this species and its distribution range limits. Further, this review discusses the species' endemism to the Caatinga ecoregion as commonly mentioned in the literature (*e.g.*, Cracraft, 1985; Stotz *et al.*, 1996; Pereira *et al.*, 2014).

MATERIAL AND METHODS

Data searching and literature review

We did an extensive literature review to update the distribution and ecological information of *A. gounellei*. The review process involved searching academic databases such as Google Scholar, Periódicos CAPES, Scielo, Science Direct and Scopus, using the following keywords, "*Phaethornis gounellei*", "*Anopetia gounellei*", "Broad-tipped Hermit" and "Rabobranco-de-cauda-larga". The search period ranged from 1891 to 2015. We also included literature that was not identified through the database search, but of which we had previous knowledge. All records were

examined and divided according to subject groups: bird surveys, the hummingbird-plant relationship – including pollination, taxonomy/phylogeny, reproduction, and 'other'. We searched these studies for information about reproduction, taxonomy and phylogeny, feeding behavior, plants visited, recorded climate and altitude, seasonality, and tolerance to human disturbance.

The records were gathered from the literature as well as from Centro Nacional de Pesquisa e Conservação de Aves Silvestres (CEMAVE), eBird (eBird, 2015) – only data approved by the eBird quality process –, from senior birdwatchers, and from the following scientific collections: Heretiano Zenaide (Universidade Federal da Paraíba), Museu Paraense Emilio Goeldi, Universidade Federal de Pernambuco, Museu de Zoologia da Universidade Estadual de Campinas, Fonoteca Neotropical Jacques Vielliard, Museu de Zoologia da Universidade de São Paulo, Museu de Zoologia da Universidade Estadual de Feira de Santana.

Data analysis

Based on the coordinates obtained from the database search and literature review we built a new range map for the species using the Geographic Information System (GIS) approach; analyses were performed in ArcGis 10.1 (ESRI, 2012). The GIS consisted of the political delimitation of Caatinga biome (MMA, 2015), the terrestrial ecoregions of the world (Olson *et al.*, 2001), the range limit of *A. gounellei* (BirdLife International, 2015) and the coordinates where the presence of *A. gounellei* was recorded. First, we generated buffers with 30 km for each recorded presence, as this is the maximum flight distance recorded for hummingbirds in a day (Sick, 1997); after that, we created a minimum convex polygon (MCP) using the same presence records. The MCP was then smoothed and approached the presence buffers to create the updated range limit (UR).

The UR area was compared with the old range limit (OR) area, and then the Caatinga ecoregion and biome. Further, we examined the ecoregion category of each presence record, and calculated the preponderance of presences according to each ecoregion using the bootstrapping resample technique (10,000 replicates) to avoid bias. The ecoregions were then classified as dry (Atlantic dry forest, Caatinga, Campo rupestre, Cerrado) or humid (Bahia coastal forest, Bahia interior forest, Caatinga enclaves moist forest, Maranhão babaçu forest, Pernambuco interior forest) to analyze the frequency of *A. gounellei* records.

RESULTS AND DISCUSSION

We identified 80 documents mentioning *A. gounellei*. However, 15 did not contain any specific information about *A. gounellei*. Of the 65 remaining documents (Appendix 1), 47 were research articles, 10 book chapters and eight thesis. When examined by subject area, the documents identified were categorized as bird surveys (36), hummingbird-plant relationship – including pollination (11), taxonomy/phylogeny (nine), reproduction (two), and other (seven).

Taxonomy and Phylogeny

Anopetia gounellei was discovered by Edmond Gounelle (Pacheco, 2003) and described as a new species by Boucard in 1891; synonyms for the species are *Phaethornis gounellei* and *Threnetes longicauda* (Cory, 1915; Hellmayr, 1929). The relation between *A. gounellei* and its sister taxon *Phaethornis* were the subject of some studies (Hinkelmann & Schumammn, 1997; Hinkelmann & Van den Elzen, 2003; Piacentinni, 2011). In 1921, Eugène Simon described *gounellei* as part of the new genus *Anopetia*. Thereafter, the taxon *gounellei* was moved between *Phaethornis* and *Anopetia* (Peters, 1945; Hinkelmann & Schumammn, 1997; Hinkelmann & Van den Elzen, 2003; Piacentinni, 2011). Among recent publications, we found a phylogeny in which *A. gounellei* is shown to be closest to *Phaethornis*, but not inside the genus (Hinkelmann & Van den Elzen, 2003). Years later, *gounellei* was recognized again as *Phaethornis* (Piacentinni, 2011). The most recent article about hummingbird phylogeny did not include *A. gounellei* (McGuire *et al.*, 2009; McGuire *et al.*, 2014), but it is considered a member of the Hermits hummingbird (Phaethornitinae (McGuire *et al.*, 2009). On main bird lists – South America Classification Committee (SAAC, Remsen *et al.*, 2016), Brazilian Committee of Ornithological Records (Piacentinni *et al.*, 2015), and International Union for Conservation of Nature and Natural Resources red list (IUCN, 2015) the species is named as *Anopetia gounellei*.

The Hummingbird-plant relationship

Similar to other hummingbirds, *A. gounellei* requires a great amount of energy to accommodate its high metabolism, and this energy comes from plant nectar (Sick, 1997). Of the 11 studies on the hummingbird/plant relationship, nine described the

plants which *A. gounellei* visits (Table 1). The visited plants consisted of 13 families and 25 species, four of them not recognized on the species level – Acanthaceae, Bignoniaceae, *Capparis* sp. and *Pavonia* sp. (Vasconcelos *et al.*, 2006; Machado, 2009). The majority of plant species presented the pollination syndrome of ornithophily (12) followed by entomophily (six), chiropterophily (four) and sphingophily (one). The total nectar volume and sugar concentration ranged from 53-1997 µl and 11-50% respectively (Vogel *et al.*, 2005; Lucena, 2007). The phenology and flowering regime varied from continuous to short annual periods (Machado, 2009; Machado, 2014).

All the visits reported were legitimate visits in which the bird contacted the fertile parts of the flowers, and *A. gounellei* can be considered as the effective pollinator of *Camptosema pedicellatum* Benth, *Jatropha mutabilis* Benth and *Helicteres velutina* K. Schum. (Demetrio, 2008; Neves *et al.*, 2011). *Anopetia gounellei* was reported foraging as traplining (17 studies) and low reward traplining (Moura, 2012), flying large routes on its search for nectar (Feinsinger & Colwell, 1978). Intraspecific agonistic interaction was reported only once while feeding (Moura, 2012). The plant species as well as the floral traits can be found in Table 1; *Capparis* sp. (Capparaceae) was reported by Vasconcelos *et al.* (2006) with no further information.

The frequency of visits was reported for 22 plant species, but with different calculation methods. However, low frequency (equal or less than three visits per hour) seemed to be a pattern and is reasonable for trapliner hummingbirds such as *A. gounellei*. Therefore, we believe that plants with regular visits during one day, such as *Camptosema pedicellatum* (Demetrio, 2008), or visited with a relative frequency above 20% (*see* Table 1) are used as food sources.

A tube-like shape and conspicuous colors are traits commonly associated with the flowers that *A. gounellei* uses as a feeding source (Table 1) and these traits are normally related to the pollination syndrome of ornithophily (Faegri & Pijl, 1980). *Anopetia gounellei* showed no restriction concerning pollination syndromes, visiting and feeding in a large number of plant species and behaving as generalist (*see* Floral Traits on Table 1). We found no information about arthropod consumption by *A. gounellei*, which seems to be an important aspect of other hummingbird species in arid and semi-humid areas (Remsen *et al.*, 1986; Stiles, 1995).

In contrast to its traplining generalist behavior, *A. gounellei* acted as a legitimate visitor in all reported visits as well as for species exclusively pollinated by

TABLE 1: Reported plants visited by *Anopetia gounellei*, floral traits, and references. NA – states for no data.

FAMILY	SPECIES	FLORAL TRAITS	AUTHOR
Acanthaceae	<i>Anisacanthus brasiliensis</i> Lindau	Infundibular, red	Machado, 2009
Apocynaceae	<i>Prestonia coalita</i> (Vell.) Woodson	Tubular, yellow	Machado, 2009
Asteraceae	<i>Lychmophora salicifolia</i> Mart.	Campanulatete, blue	Machado, 2014
Bignoniaceae	<i>Piriadacus erubescens</i> (DC.) Pichon ^F	Tubular, red	Machado, 2009
	<i>Pyrostegia venusta</i> (Ker Gawl.) Miers	Tubular, orange	Machado, 2009
	Bignoniaceae sp.	Infundibular, pink	Machado, 2009
	<i>Setilobus simplicifolius</i> K. Schum. ^F	Campanulatete, yellow	Machado, 2009
Bromeliaceae	<i>Neoglaziovia variegata</i> (Arruda) Mez ^F	Pseudotubular, purple/red	Moura, 2012
Cactaceae	<i>Melocactus bahiensis</i> (Britton & Rose) Luetzelb. ^H	NA	Olmos & Albano, 2012
	<i>Pilosocereus catiingicola</i> (Gürke) Byles & G.D. Rowley	Campanulate, white	Lucena, 2007
	<i>Pilosocereus gounellei</i> F.A.C. (Weber) Byles & G.D. Rowley	Tubular, white	Lucena, 2007
	<i>Pilosocereus pachycladus</i> F. Ritter ^F	Tubular, white	Lucena, 2007; Moura, 2012
	<i>Micranthocereus flaviflorus</i> Buining & Brederoo	Tubular, orange	Moura, 2012
Euphorbiaceae	<i>Jatropha mutabilis</i> Benth	Disk, red	Neves <i>et al.</i> , 2011
Fabaceae	<i>Camptosema pedicellatum</i> Benth ^F	Tubular, red	Demetrio, 2008
	<i>Mimosa lewisii</i> Barneby	Capitulate, green/white	Vogel <i>et al.</i> , 2005
	<i>Calliandra sessilis</i> Benth.	Paintbrush, white/red	Machado, 2014
Malvaceae	<i>Pavonia glazioviana</i> Gürke	NA	Olmos & Albano, 2012
	<i>Pavonia</i> sp. ^F	Pseudotubular, red	Machado, 2009
	<i>Helicteres velutina</i> K. Schum. ^H	Tubular, red	Demetrio, 2008; Machado, 2009
Passifloraceae	<i>Passiflora luetzelburgii</i> Harms ^{H,F}	Tubular, red	Moura, 2012
Rubiaceae	<i>Manettia cordifolia</i> Mart.	Tubular, red	Machado, 2014
Sapindaceae	<i>Serjania coradinii</i> Ferrucci & Somner	Disk, white	Machado, 2009

^H – Species exclusively pollinated by hummingbirds.

^F – Feeding resource: species visited regularly during one day or having relative frequency of visit above 20%.

hummingbirds, *Passiflora luetzelburgii*, *Helicteres velutina* and *Melocactus bahiensis* (Machado & Lopes, 2004). However, its role in the vegetation community is not clear and *A. gounellei* could be an important key to the semiarid ecological community, including human systems, since it plays a role closely related to vegetal reproduction.

Reproduction and associations

Information about reproduction of *A. gounellei* is scarce, consisting of only two nest reports and one description (Lima *et al.*, 2008; Lima *et al.*, 2010; Moura, 2012). The nest reports dated from February (Lima *et al.*, 2008; Lima *et al.*, 2010) and December (Moura, 2012). In a similar period other studies reported no molting or brood patch (November to December), and males were reported vocalizing at the same time, reminiscent of a reproductive display (December) (Roos *et al.*, 2006; Olmos & Albano, 2012). This information suggests a likely breeding season between December and February, since the nest reports are restricted to these months.

The nests were described as elongated and spindle shaped, and both of them had two eggs (Lima *et al.*,

2008; Lima *et al.*, 2010). The nest structures were attached beneath a leaf of *Cnidocolus urens* (L.) Arthur (Euphorbiaceae) – a stinging plant; families such as Heliconiaceae and Arecaceae are also used in the same way (Ruschi *apud* Lima *et al.*, 2008; Lima *et al.*, 2010). The nest descriptions, as well as the nest position, were similar to *Phaethornis* one, where the structure attached to the leaf underside causes a fold protecting the nest (Sick, 1997); this accounts for yet another characteristic that relates *A. gounellei* to the genus *Phaethornis* and could help in the discussion of genus.

Lima *et al.* (2010) also reported a parental behavior of *A. gounellei*: the male inspected the nest during the incubation period and also after hatching. An association with *Allodectes* mites was reported by Silva (2013) and once *A. gounellei* was reported use for hunting game (Teixeira *et al.*, 2014).

Human disturbances and forest dependency

The sensitivity to human disturbances and forest dependency of *A. gounellei* are mainly based on Stotz *et al.* (1996) and Silva *et al.* (2003). Stotz *et al.* (1996) does not address any of these issues in relation to *A. gounellei*, and Silva *et al.* (2003) report the

species as forest-dependent, with a high sensitivity to human disturbance. On the other hand, some studies recorded the species occurrence in open or semi-open areas, as well as, with medium sensitivity and forest-independent (Willis, 1992; Roda & Carlos, 2004; Albano & Girão, 2008; Santos, 2008). Three studies reported *A. gounellei* flying in intermediate vegetation stratum, or understory (Stotz *et al.*, 1996; Machado, 2009; Silveira & Machado, 2012), and many others in areas close to human disturbance (Olmos *et al.*, 2005; Vasconcelos *et al.*, 2006; Farias, 2007; Dornelas *et al.*, 2012; Silva *et al.*, 2012). Three research articles discussed human disturbance specifically: two registered *A. gounellei* only in undisturbed areas and one recorded the species in both undisturbed and disturbed areas (Silva, 2009; Lyra-Neves *et al.*, 2012; Nunes & Machado, 2012).

None of the main references to sensitivity or forest dependency has a judicious source of knowledge or sufficient field observations to draw conclusions about the preferences of *A. gounellei*. Only Silva *et al.* (2003) provided a description of the levels of forest dependency, but how they assigned sensitivity is unclear. Thus, we considered the forest dependency description of Silva *et al.* (2003) and adapted it for sensitivity so that (1) high sensitivity: species that only occur in human-undisturbed environments; (2) low sensitivity: species that commonly occur in human-disturbed environments; (3) medium sensitivity: species that occur in a mix of human-disturbed and undisturbed environments.

High sensitivity and forest dependence are commonly assigned to *A. gounellei*, but recent field observations recorded the species on open and semi-open areas as well as on disturbed habitats. However, these presence records were always near forest or native vegetation patches (*see* Roda & Carlos, 2004; Albano & Girão, 2008; Nunes & Machado, 2012). Therefore, further studies must address this question, but at our best knowledge *A. gounellei* has medium sensitivity to human disturbances and it is semi-dependent on the forests.

Environmental conditions

In general, the studies reported a regional climatic condition; only two studies reported climatic conditions where *A. gounellei* is resident (Machado, 2009; Moura, 2012). They reported an annual mean temperature from 18°C to 22°C, and mean annual rainfall ranging from 700 mm to 1.300 mm. The climate classification varied among authors, field areas

and classification systems. For the Köppen system we were able to find presence records on dry semiarid (Bsh), tropical with dry winter (Aw), tropical with dry summer (As) and humid tropical with dry winter and temperate summer (Cwb) (Sick *et al.*, 1987; Dornelas *et al.*, 2012; Machado, 2014; Ruiz-Esparza *et al.*, 2015) areas, and for the IBGE system the climate varied among semiarid, subtropical with moderate humidity and tropical with rainy summer (Neves *et al.*, 2011; Nunes & Machado, 2012; Las-Casas *et al.*, 2012a, b; Ruiz-Esparza *et al.*, 2012; Silva *et al.*, 2012; Silveira & Machado, 2012).

Anopetia gounellei was reported at many altitudes, from lowlands, 40-50 m high, to 1000-1191 m high (Olmos, 1993; Stotz *et al.*, 1996; Roda & Carlos, 2004; Vasconcelos & D'Angelo, 2007; Silva *et al.*, 2012; Sousa *et al.*, 2012; Pereira *et al.*, 2014). At the highest altitudes many studies reported more humid vegetation such as seasonal semi-deciduous forest and ombrophilous forest (Parrini *et al.*, 1999; Pacheco, 2003; Farias *et al.*, 2005; Albano & Girão, 2008; Demetrio, 2008; Santos *et al.*, 2012). Humid vegetation also appeared in lowlands (Silva, 2009; Silva *et al.*, 2012; Ruiz-Esparza *et al.*, 2015). However, the majority of vegetation recorded belongs to the caatinga type, ranging from shrubby caatinga to dense arboreal caatinga (Silva *et al.*, 2003; Olmos *et al.*, 2005; Leal *et al.*, 2006; Vasconcelos *et al.*, 2006; Farias, 2007; Araujo *et al.*, 2012; Olmos & Albano, 2012); cerrado and rocky fields were also reported but in a small number (Dornelas *et al.*, 2012; Machado, 2014; Pereira *et al.*, 2014).

Studies concerning seasonality of *A. gounellei* reported the species on caatinga and humid vegetation in both dry and rainy seasons, as well as resident and occasional (Olmos, 1993; Santos, 2004; Leal *et al.*, 2006; Santos *et al.*, 2012; Silva *et al.*, 2012; Silveira & Santos, 2012; Ruiz-Esparza *et al.*, 2015). We found only one seasonality record for cerrado-like vegetation which reported *A. gounellei* as occasional on an area close to caatinga, and during a severe drought (Machado, 2014).

The authors did not report weather conditions specifically of the field area or period, but instead reported general aspects of the region. Further, many studies reported *A. gounellei* as occasional and did not discuss the climatic aspect in detail, nor did they reveal the true climatic conditions when the record was made. For this reason, we were not able to determine the climatic conditions that limit *A. gounellei* occurrence. Detailed studies, such as niche modeling and natural history, are still necessary to explore the climate and altitude conditions that *A. gounellei* can endure.

Species range and ecoregions

A century after its discovery *A. gounellei* has been registered in the states of Piauí, Ceará, Bahia, and Minas Gerais (Cory, 1915; Simon, 1921; Sick *et al.*, 1987). In 2003 a new state was added, Pernambuco (Pacheco, 2003), and in the XXI century other states of northeastern Brazil were reported – Sergipe, Paraíba, Alagoas and Rio Grande do Norte (Araujo *et al.*, 2012; Diniz *et al.*, 2012; Lyra-Neves *et al.*, 2012; Silva *et al.*, 2012; Fernandes-Ferreira *et al.* 2014).

Only two attempts to update information on the range limit of *A. gounellei* were made: by Araujo in 2009 and by Piacentinni in 2011. However, there were no discussion or new limits traced for the range limit in their work. Our UR (data available upon request) expanded the occurrence area 76% (OR area 535,970 km², UR area 944,051 km²), and occurrences from 2010 to 2015 were spread over the north-south and east-west limits (Fig. 1). When overlapped with the Caatinga biome and ecoregion limits, the UR revealed no restriction to these areas and surpasses them by 116,809 km² and 212,217 km², respectively (Fig. 2).

No information was found on *A. gounellei* population size, though it is considered uncommon de-

spite its great number of records (Hinkelmann *et al.*, 2015). The species is resident and endemic of Brazil (Piacentinni *et al.*, 2015), but has been described as endemic of caatinga (Cracraft 1985; Grantsau, 1988; Stotz *et al.*, 1996; Parrini & Pacheco, 1997; Parrini *et al.*, 1999). Our analysis reveals that *A. gounellei* can be found beyond the ecoregion and biome Caatinga limit and in a variety of vegetation, and therefore can no longer be considered endemic of any Caatinga, whether biome, vegetation or ecoregion (Fig. 1 and Fig. 2) as accepted today.

The maps and analysis revealed that *A. gounellei* occurs mainly in dry ecoregions (bootstrap confidence interval: 178-186 records, $N = 192$ and $P = 0.05$), with the majority of records and range within Caatinga ecoregion (Fig. 2) – bootstrap confidence interval: 156-169 records, $P = 0.05$. It demonstrates that the reported caatinga endemism of *A. gounellei* is in fact a result of its close relationship with dry areas, and may have been misled due to the species' abundance inside the Caatinga limits or due to biased sample effort. Further, we want to stress here that the relationship to dry areas may not be restricted only to naturally dry areas, but also to dry areas caused by deforestation (Chakravarty *et al.*, 2012), where *A. gounellei* could act as an opportunist resulting in range expansion.

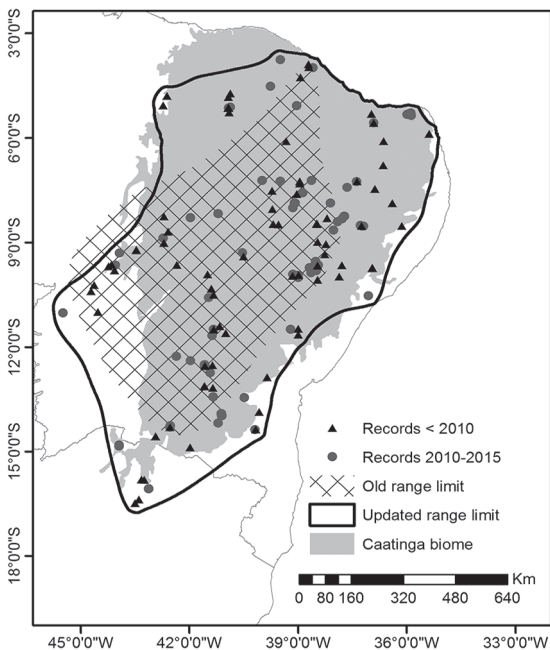


FIGURE 1: Updated distributional range of *Anopetia gounellei* overlaid with the older range limit, the Caatinga biome (by Ministério do Meio Ambiente, Brazil) and the presence records. The occurrence was expanded over 400,000 km² and records from 2010 to 2015 (the year after the first record outside the range limit) are spread over the north-south and east-west limits. It is possible to observe on the south and southwestern areas of the range many records outside the Caatinga biome limit

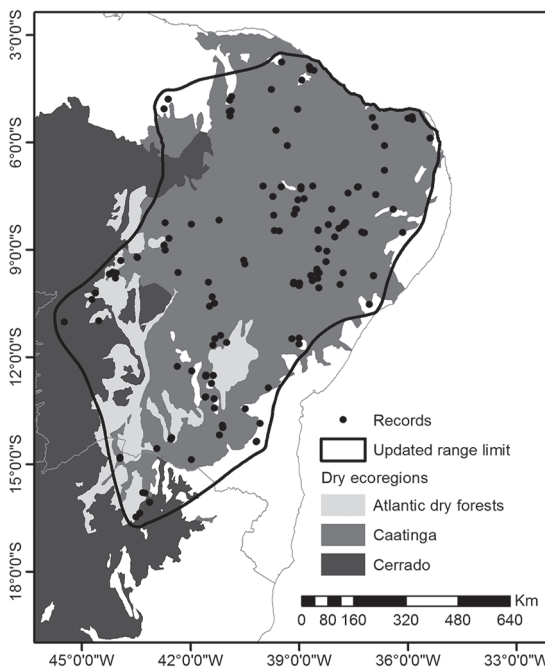


FIGURE 2: Updated distributional range limit of *Anopetia gounellei* overlapped with the dry ecoregions; others ecoregions were avoided for the sake of clarity. The range is not restricted to the Caatinga ecoregion, going beyond it by more than 212,000 km². However, few records are outside the dry ecoregion limits, and even they are close to their limits

However, this relation, as well as any climatic constrain of *A. gounellei*, requires further examination to be better understood.

The expansion of *A. gounellei* range limits reported here may be caused by the same reason the species was assigned as endemic – sample effort concentrated in easy access areas or bird hotspots (great richness and easy observation of birds). However, the majority of records date from 2000, and the expansion could also be a result of species' dispersion due to environmental suitability or stress (see Machado, 2014), climate change (e.g., Henry, 2012; Ławicki, 2014) or population increase (e.g., Guevara *et al.*, 2011). Further, the broad range and expansion, the variety of vegetation registered, and feeding on plant species with various traits all support the hypothesis that *A. gounellei* is a generalist and, potentially, a winner species (McKinney & Lockwood, 1999), which facilitates expansion. Detailed studies on species niche and historical records should be accessed to better understand the reasons for the expansion and the biological responses of *A. gounellei*, clarifying the main drivers of *A. gounellei* population dynamics and the true plant-hummingbird relation.

RESUMO

Devido ao rápido avanço da tecnologia e informação, é difícil manter dados sobre as espécies e suas áreas de ocorrência atualizados. O beija-flor *Anopetia gounellei* (rabo-branco-de-cauda-larga) tem sido registrado fora dos seus limites de distribuição conhecidos desde de 2009. Fizemos aqui uma ampla revisão da literatura com o objetivo de atualizar sua área de ocorrência, com o intuito de propor um novo limite de distribuição e discutir o endemismo ecorregional. A maior parte da literatura tratava sobre levantamentos de Aves. Os principais aspectos abordados na revisão da literatura foram a taxonomia e as plantas visitadas. Diversos tipos de vegetações foram reportadas, incluindo tanto caatinga quanto vegetações úmidas. A área de ocorrência atualizada excedeu em 80% da área de ocorrência antiga. *Anopetia gounellei* foi principalmente reportado em ecorregiões secas. Os resultados não sustentam o endemismo de *A. gounellei* para a caatinga e confirmam uma relação muito próxima com ecorregiões secas. As informações biológicas sobre *A. gounellei* são escassas, sendo sua reprodução e seus limitantes ambientais áreas prósperas para estudos sobre sua conservação.

PALAVRAS-CHAVE: Bioma; Caatinga; Distribuição; Ecorregião; Endemismo; Interação planta/beija-flor.

ACKNOWLEDGMENTS

We are grateful to the Universidade Estadual de Feira de Santana and to the Program in Modelagem em Ciências da Terra e do Ambiente for the infrastructure and software processing support, and to Fundação de Amparo a Pesquisa do Estado da Bahia for the master's scholarship. In addition, we would like to thank the ornithologists Jean Júnior Barcik, Reinaldo Brito, Sérgio Cedraz, Pablo Cerqueira, Dira Coutinho, Fernando Flores, Marcelo Holderbaum, Jeremy Minns, Jefferson Bob, Marcos Crozariol, John Medcraft, Alex Mesquita, Sérgio Leal, Almir Távora and Francisco Sagot-Martins, the Grupo Ornitológico Potiguá and to the Centro Nacional de Pesquisa e Conservação de Aves Silvestres.

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Aceito em: 23/04/2017

Publicado em: 12/06/2017

Editor Responsável: Luís Fábio Silveira



APPENDIX 1

Table: Literature review of *Anopetia gounellei* by source and subject.

SOURCE	SUBJECT (QUANTITY)	REFERENCES
Authors	bird survey (4)	Sick <i>et al.</i> , 1987; Sick, 1997; Olmos & Albano, 2012; Araujo, 2009
	taxonomy/phylogeny (6)	Hartert, 1897; Cory, 1915; Simon, 1921; Hellmayr, 1929; Peters, 1945; Grantsau, 1988
	hummingbird-plant relation (2)	Moura, 2012; Machado, 2014
	reproduction (1)	Lima <i>et al.</i> , 2008
	other (1)	Stotz <i>et al.</i> , 1996
Periódicos CAPES	bird survey (1)	Santos <i>et al.</i> , 2012
	hummingbird-plant relation (1)	Las-Casas <i>et al.</i> , 2012a
Google Scholar	bird survey (31)	Stone & Roberts, 1934; Olmos, 1993; Parrini <i>et al.</i> , 1999; Pacheco, 2003; Silva <i>et al.</i> , 2003; Santos, 2004; Roda & Carlos, 2004; Farias <i>et al.</i> , 2005; Olmos <i>et al.</i> , 2005; Roos <i>et al.</i> , 2006; Vasconcelos <i>et al.</i> , 2006; Farias, 2007; Vasconcelos & D'Angelo, 2007; Albano & Girão, 2008; Santos, 2008; Farias, 2009; Pereira & Azevedo-Júnior, 2011; Araujo <i>et al.</i> , 2012; Diniz <i>et al.</i> , 2012; Dornelas <i>et al.</i> , 2012; Lyra-Neves <i>et al.</i> , 2012; Nunes & Machado, 2012; Paixão, 2012; Ruiz-Esparza <i>et al.</i> , 2012; Schunck <i>et al.</i> , 2012; Silva <i>et al.</i> , 2012; Silveira & Machado, 2012; Silveira & Santos <i>et al.</i> , 2012; Sousa <i>et al.</i> , 2012; Pereira <i>et al.</i> , 2014; Ruiz-Esparza <i>et al.</i> , 2015
	taxonomy/phylogeny (3)	Hinkelmann & Schuchmann, 1997; Hinkelmann & Van den Elzen, 2003; Piacentinni 2011
	hummingbird-plant relation (6)	Machado & Lopes, 2004; Vogel <i>et al.</i> , 2005; Leal <i>et al.</i> , 2006; Lucena, 2007; Demetrio, 2008; Las-Casas <i>et al.</i> , 2012b
	reproduction (1)	Lima <i>et al.</i> , 2010
	other (6)	Cracraft, 1985; Willis, 1992; Silva, 2009; Silva, 2013; Fernandes-Ferreira <i>et al.</i> 2014; Teixeira <i>et al.</i> , 2014
Scielo	hummingbird-plant relation (2)	Machado, 2009; Neves <i>et al.</i> , 2011

Number in parentheses indicates the number of studies by subject.