Breeding aspects of the Sunbittern (*Eurypyga helias*) in Brazil, based on citizen science data

Aspectos reproductivos de la garza del sol (*Eurypyga helias*) en Brasil, basados en datos de ciencia participativa

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Abstract

The breeding of the Sunbittern remains scarcely studied in South America. We examined here aspects of the breeding of the Sunbittern in Brazil through citizen science platforms. We searched for photographs in the eBird, iNaturalist and WikiAves databases in November 2020 and June 2021. Eighteen records showing evidence of breeding activities were obtained by citizens. They showed copulations, nests, and young outside the nests, and were obtained in the Amazon, the Cerrado and the Pantanal. Nests were built with leaves, roots, stems, moss and mud, and were on branches over the water. Nests had an incubating adult (n=9), a single egg (n=3), or 1-2 nestlings being cared or not by an adult (n=2). Records obtained by citizen scientists in Brazil indicate that breeding activities of the Sunbittern occur mainly during the rainy season, although records involving copulations and incubation suggest that some individuals might breed during periods of less intense rainfall.

Key words: Amazonia, Cerrado, Citizen Science, Eurypygidae, Pantanal

Resumen

La cría de la garza del sol (*Eurypyga helias*) sigue siendo poco estudiada en América del Sur. El objetivo de este estudio fue examinar aspectos de la cría de *E. helias* en Brasil. Búsquedas de fotografías fueron hechas a través de las bases de datos de eBird, iNaturalist y WikiAves en noviembre del 2020 y junio del 2021. Los registros mostraban cópulas, nidos o jóvenes fuera de los nidos, y ocurrieron en la Amazonia, en el Cerrado y en el Pantanal. Dieciocho registros que mostraban evidencia de actividades de reproducción fueron publicados por científicos ciudadanos. Los nidos estaban constituidos de hojas, raíces, tallos, musgo y barro, y estaban en ramas sobre el agua. Los nidos tenían un adulto en incubación (n=9), un solo huevo (n=3) o 1-2 polluelos bajo cuidado o no de un adulto (n=2). Los registros obtenidos por los voluntarios de plataformas de ciencia participativa en Brasil indican que las actividades de reproducción de *E. helias* ocurren principalmente durante la temporada de lluvias, aunque los registros de copulaciones e incubación sugieren que algunos individuos pueden reproducirse durante períodos de lluvias menos intensas.

Palabras clave: Amazonia, Cerrado, ciencia ciudadana, Eurypygidae, Pantanal

The Eurypygiformes order comprises two families in the world (Hunt *et al.* 2020, Winkler et al. 2020). Rhynochetidae family is composed of only the Kagu Rhynochetos jubatus–flightless birds measuring about 55 cm in height that feed mainly on invertebrates gathered in soil and litter of tropical forests in New Chaledonia (Hunt *et al.* 2020). Also, Eurypygidae family includes only the Sunbittern *Eurypyga helias*, that refers to medium -sized birds able to fly, and that are found in fresh water and adjacent forests in the Neotropics (Winkler *et al.* 2020). The Sunbittern is widely distributed, from Guatemala to Bolivia and central Brazil (Stotz *et al.* 1996, MacLean 2020). These heron-like birds have small head, thin neck, and long and thin bill (Sick 1997, Mata *et al.* 2006,

Winkler *et al*. 2020). They inhabit mainly wooded streams and marshes in lowlands, where they capture a wide range of invertebrates and small vertebrates through a slow feeding search in the water or on river banks (Riggs 1948, Sick 1997, Antas 2004, Winkler *et al*. 2020). They are often found solitary or in groups of 2–3 individuals (Sick 1997, Antas 2004, MacLean 2020).

The breeding of the Sunbittern has been examined in detail in Costa Rica (Lyon & Fogden 1989) and Venezuela (Thomas & Strahl 1990). According to a review by MacLean (2020), additional information on its breeding is available in general references about national or regional avifaunas (*e.g*., Haverschmidt 1968, Stiles & Skutch 1989, Sick 1997, Antas 2004), or in short communications (*e.g*., Bartlett 1866, Skutch 1947). Sunbittern is a monogamous species, and nest-building, incubation, and the care and feeding of chicks are taken by both parents (Stiles & Skutch 1989, Thomas & Strahl 1990). Typically, their nests are platforms built on horizontal or inclined branches of trees, over the water or land (Skutch 1947, Lyon & Fogden 1989, Antas 2004). Nests are built with a range of vegetal material including leaves, roots, grasses, stems and mud (Skutch 1947, Sick 1997, Antas 2004). Clutches are of 1–2 eggs (Lyon & Fogden 1989, Sick 1997, Dubs 1992). Incubation lasts for about 30 days, and nestlings remain in the nest for a comparable period (Bartlett 1866, Thomas & Strahl 1990, Sick 1997, Antas 2004). After fledging, young remain living with the parents for additional 30 days (Lyon & Fogden 1989, Thomas & Strahl 1990). Parents defend clutches by suddenly opening their fully colored wings (Riggs 1948, Thomas & Strahl 1990, Sick 1997, Antas 2004). Regarding to Brazil, several aspects of the breeding of Sunbittern have been briefly described in general references about the country or regions such as the Pantanal (*e.g*., Dubs 1992, Sick 1997, Antas 2004). Additionally, avian inventories provided brief information on its geographic distribution, habitat use, and seasonal occurrence in localities or regions, but not on its breeding (*e.g*., Olmos *et al*. 2011, Lopes *et al*. 2016, Dornas 2019). Despite occurring widely in Amazonia, the Cerrado and the Pantanal (MacLean 2020, WikiAves 2020), its breeding has not been investigated in detail in Brazil.

We expected that the use of data gathered by citizens, and available in on-line databases such as eBird, WikiAves and iNaturalist, could help to reduce knowledge gaps on the breeding biology of the Sunbittern, as recently occurred for the Horned Screamer *Anhima cornuta* and the Orinoco Goose *Neochen jubata* (Tubelis 2020, Tubelis *et al*. 2020). The objective of this study was to investigate the breeding of the Sunbittern in Brazil. We focused on the breeding season, and characteristics of nests and clutches. Results were discussed in relation to its breeding in Brazil and other Neotropical regions.

Brazil comprises six major ecosystems within its 8,510,296 km2 (Ab'Saber 1977, Rizzini 1997, IBGE 2020 - to see the map). Amazonia covers about 50% of the territory, occurring mainly in its northern portion, and being bordered by the Cerrado. Amazonian landscapes are dominated by tropical forests and a wide range of humid areas, that harbor an extraordinary biodiversity (Cunha *et al*. 2015, ICMBio 2020, MMA 2020). The Cerrado is the savanna province that dominates central Brazil, covering about 2 million km^2 (Oliveira & Marquis 2002). Its high biodiversity is influenced by four bordering ecosystems–the Atlantic Forest, the Amazon, the Caatinga and the Pantanal (Eiten 1972, Ab'Saber 1977, Rizzini 1997). The Pantanal wetland is one of the most important and diverse humid areas of the world, occurring in Paraguay, Bolivia, and covering about 140,000 km^2 in southwestern Brazil (Godoi 1986, Cunha *et al*. 2015, MMA 2020). Climate in

the Cerrado and the Pantanal is tropical and marked by two well-defined periods: the rainy season occurs between October and April, and the dry season occurs between May and September, when precipitation can be absent during some months. Annual precipitation usually ranges between 1,500 and 2,000 mm. In both biomes, the mean annual temperature is about 26°C, with daily values ranging between 10°C in the Austral winter (June–July) and 40°C in the Austral summer (January–February) (Assad 1994, ANA 2002). Amazonia has a warmer climate, with a mean annual precipitation between 2,400 and 2,800 mm; with a dry season occurring also between May and September (Sombroek 2001). Due to its low elevation and declivity, the Pantanal experiences a remarkable alternance of dry and flood periods (Hamilton *et al.* 1996, Paz *et al.* 2014, Guimarães *et al*. 2018). Inundations also occur extensively in the Amazon basin, being less intense and spread in the Cerrado. In these three ecosystems, the water level of the rivers rises locally during the rainy period, but also during the dry season in southern Pantanal (ANA 2002, Cunha *et al.* 2015).

Records (photographs) included in this study were obtained through searches in three databases. The WikiAves (https://www.wikiaves.com.br) and eBird Brasil (https://ebird.org/brasil/home) databases were searched during November 2020 and June 2021. The search in WikiAves was done by typing "*Eurypyga helias*" in the species field. The search in eBird Brasil was done by typing the same term in the "Explorar espécies" field, and then using the filter "Brazil". In the iNaturalist database (https://www.inaturalist.org/), the search was done in June 2021 by typing the term "Pavãozinho-do-Pará" or "*Eurypyga helias*" in the field "ESPECIE" using the filter "Brasil, país".

All resulting photographs were carefully examined, and those having evidences of breeding activities of the Sunbittern were selected. These evidences involved copulation, nest, egg, incubating adult, or young. When we could note that two or more photographs taken in a given municipality referred to the same nest or bird in a given year, we randomly selected only one of the records to avoid replicates of a unique fact. We contacted authors of the selected photographs to ask if the nest was or not over a water body. For some records, this information was already available in the section of comments by authors. The temporal distribution of records was examined by dividing each month in three periods–(I): days 1–10, (II): days 11–20, and (III): days 21–31.

Eighteen records involving breeding activities of the Sunbittern were obtained by citizens between 2003 and 2021 in Brazil (Table 1). The sixteen records obtained in WikiAves represented 1.1% of the 1407 photographs of the Sunbittern available in this database. The only photograph obtained in the eBird database corresponded to 0.2% of the 447 records of this species gathered in Brazil. In the iNaturalist database, only one photograph was obtained, corresponding to 1.1% of the 90 records from Brazil. These 18 records were obtained mainly in Mato Grosso state, but also occurred in Tocantins, Pará and Goiás. These records involved copulations (n=2), nests with eggs, nestlings and/or incubating adults (n=14), or young outside the nests (n=2) (Fig. 1, Table 1).

Considering the three biomes together, most (72%) of the photographs were taken during periods of more intense rainfall, while a minor portion (28%) was obtained during drier months. In Amazonia, where nine records were obtained, the late period with more intense rainfall had records showing nests with egg, incubating adult or a solitary nestling (January–February), and those documenting solitary young with moderately developed plumage outside the nest

Table 1. Records (*n* = 18) involving breeding activities of the Sunbittern (*Eurypyga helias*) obtained by citizens between 2003 and 2021 in Brazil, with information on the type of evidence, location and date of the records, and brief comments on nests, birds and behavior. Biome: Amazonia (Am), Cerrado (Ce), Pantanal (Pa). The sing "?" indicates uncertain. The sign "*" indicates that the information was provided by the author of the photograph. Data was gathered in the WikiAves (W), eBird (S) and iNaturalist (iN) databases in early November 2020 and in mid-June 2021. the author of the photograph. Data was gathered in the WikiAves (W) and eBird (S) databases in early November 2020.

Evidence/ Code	Biome	State	Municipality	Date	Brief comments on nests, birds, and behavior
Copulation					
WA1063991	Pa	MT	Barão de Melgaço	09 Aug 2013	Adults copulating on the ground.
WA1712902	Pa	MT	Barão de Melgaço	10 May 2015	Adults copulating on the ground.
Nests with eggs					
WA880429	Am	MT	Paranaitá	07 Feb 2013	1 egg in the nest; nest built with leaves, roots, stems and mud; nest on a horizontal branch; nest 1.0 m over the water of Rio Teles Pires*.
WA966098	Am	MT	Alta Floresta	02 May 2013	Incubating adult; nest built with leaves, roots, stems and mud; nest on a horizontal branch; nest 1.5 m over the water of Rio Teles Pires*.
WA2458117	Am	MT	Alta Floresta	15 Jan 2017	Incubating adult; nest built with leaves, roots, moss and mud; nest on an inclined branch; nest over the water*.
S57070460	Am	MT	Alta Floresta ?	18 Sep 2018	Incubating adult; nest built with leaves, stems and mud; nest on an inclined branch; position of the nest unknown.
WA3290033	Am	MT	Alta Floresta	25 Feb 2019	Incubating adult; nest built with moss, roots and stems; nest on a horizontal branch; nest over the water of Rio Cristalino*.
WA230371	Ce	MT	Cuiabá	30 Dec 2003	1 egg in the nest; nest built with leaves, mud and stems; nest on an inclined branch; nest over the water of Rio Coxipo.
WA1213872	Ce	GO	Diorama	10 Jan 2014	Incubating adult; nest built with leaves, stems, roots and mud; nest on an inclined branch; position of the nest unknown.
WA3680706	Ce	TO	Pium	30 Jan 2019	1 egg in the nest; nest built with leaves, roots, stems and mud; nest an horizontal part of a branch; nest on the meeting of two branches; nest over the water.
WA3870404	Ce	TO	Pium	19 May 2020	Incubating adult; nest built with leaves, roots, stems and mud; nest on a horizontal branch; position of the nest unknown.
WA1921140	Pa	MT	Poconé	20 Nov 2015	Incubating adult; nest built with leaves, stems and mud; nest on an inclined branch; position of the nest unknown.
WA2888442	Pa	MT	Poconé	16 Feb 2018	Incubating adult; nest built with leaves, stems and mud; nest on an inclined branch; nest over the water*.
iN113977538	Am	MT	Alta Floresta	15 Feb 2021	Incubating adult; nest built with leaves, roots, moss and mud; nest on an inclined branch; position of the nest unknown.
Young					
WA1649409	Am	PA	Vitória do Xingu	20 Mar 2015	1 young with a plumage dominated by downy feathers; young outside the nest, at an *açaizal*.
WA2101461	Am	MT	Alta Floresta	22 Apr 2016	1 juvenile with a moderately developed plumage on a branch adjacent to Rio Cristalino*.
WA561759	Pa	MT	Barão de Melgaço	12 Mar 2007	2 nestlings in the nest being protected by an adult; nest built with leaves, roots and mud; nest on a horizontal branch; nest over the water*.
WA4220655	Am	MT	Alta Floresta	28 Feb 2021	1 nestling in the nest; nest built with leaves, roots, moss and mud; nest on a horizontal branch; position of the nest unknown.

Figure 1. Records of breeding activities of the Sunbittern (*Eurypyga helias*) obtained by citizens in Brazil **(A)** a pair copulating in May at Barão de Melgaço, MT **(B)** a nest built with plenty of moss, and an incubating adult, in February at Alta Floresta, MT **(C)** a nest with an egg in January at Pium, TO **(D)** a juvenile outside the nest in April at Alta Floresta, MT. Photographs **(A)** Bruno Carvalho/WA1712902 **(B)** Sidnei Dantas/WA3290033 **(C)** Túlio Dornas/WA3680706 and **(D)** Francisco Luiz Vicentini Neto/WA2101461.

(March–April) (Fig. 2). Also, two records showing an incubating adult were gathered during the period with less intense rainfall (May and September). In the Pantanal wetland, two copulations were recorded in the dry season (May and August), while the other three records occurred in the rainy season; there were two incubation records (November and February), and a nest with two nestlings being protected by an adult in March (Table 1). The four records obtained in the Cerrado involved only nests with an egg or incubating adult. Three of them occurred in the mid-rainy season (December–January), while another was obtained in the early dry season (May) (Fig. 2).

Nests (n=14) were platforms built on horizontal or inclined portions of branches of trees, in equal proportions (Table 1). The examination of photographs, and comments provided by authors led to know that eight nests (57%) were over the water surface of rivers or streams, including that found at Pium (Fig. 3). This nest was about 2.5 m over the water, in a tree of an igapó forest. It was over the section of the stream that is not flooded during the dry season (T. Dornas, pers. com.). We

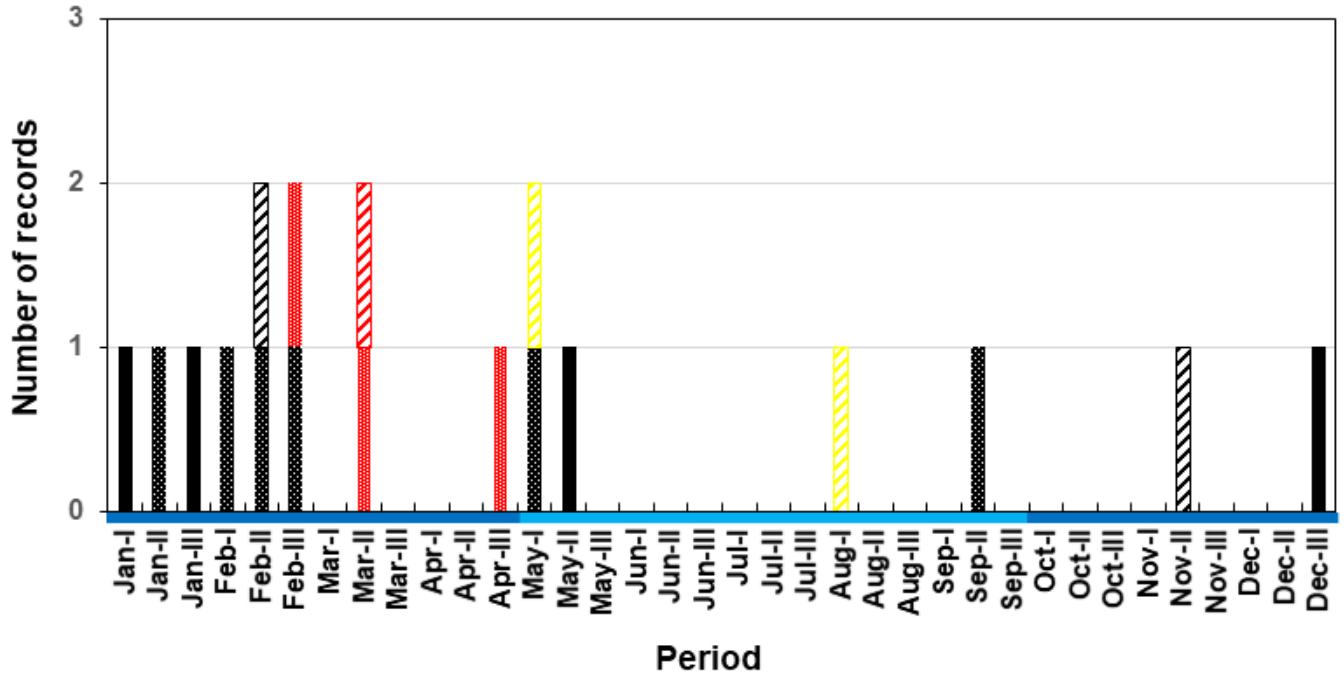

Figure 2. Seasonal distribution of photographic records showing evidence of breeding activities of the Sunbittern (*Eurypyga helias*) in three Brazilian biomes – Amazonia (bars with dots), Pantanal (bars with strips) and Cerrado (solid bars). Record types are: copulation (yellow), incubation and nest with egg (black) and young (red). Records were gathered in the WikiAves, eBird and iNaturalist databases in November 2020 and June 2021. Lines in light and dark blue colors indicate periods with less and more intense rainfall, respectively.

could not obtain this type of information for the other six (43%) nests found by citizens.

Nests were built with leaves, steams, roots, moss and mud (Fig. 1). Leaves and mud were present on all nests, while other material was less frequent. Nine nests (64%) had an incubating adult, and thus the clutch size could not be known. Other three nests had an only egg, a solitary nestling, or two nestlings being protected by an adult. Eggs were cream-pinkish with numerous black and brown dots. An egg found at Pium (Fig. 1c), and measured by TD with a 20 cm rigid plastic tape, had 41 mm in width and 52 mm in length. Solitary young with moderately developed plumage were photographed while perched on branches.

This is the first study to report on the breeding season of the Sunbittern in Brazil. This is because previous reports on its reproduction (Dubs 1992, Sick 1997, Antas 2004) have not mentioned when the distinct phases of the breeding season were recorded. For the three Brazilian biomes sampled by citizens, most records occurred during the rainy season (from November to April). This agrees with the finding of 10 nests between May and August, corresponding to the rainy season in the Venezuelan Llanos (Thomas & Strahl 1990). Also, three active nests were found from March to May, during the rainy season in a forest region in Costa Rica (Lyon & Fogden 1989). It has been suggested that the breeding period is influenced by rain, that would increase the availability of food for chicks and mud for nest construction (Thomas & Strahl 1990). On the other hand, Lyon & Fogden (1989) reported a nest being damaged by the excessive water of a river flux increased during the rainy period.

Considering the records gathered by citizens during the rainy season in Brazil, the recording of nests with eggs or incubating adults appears to be in concordance with the finding of young

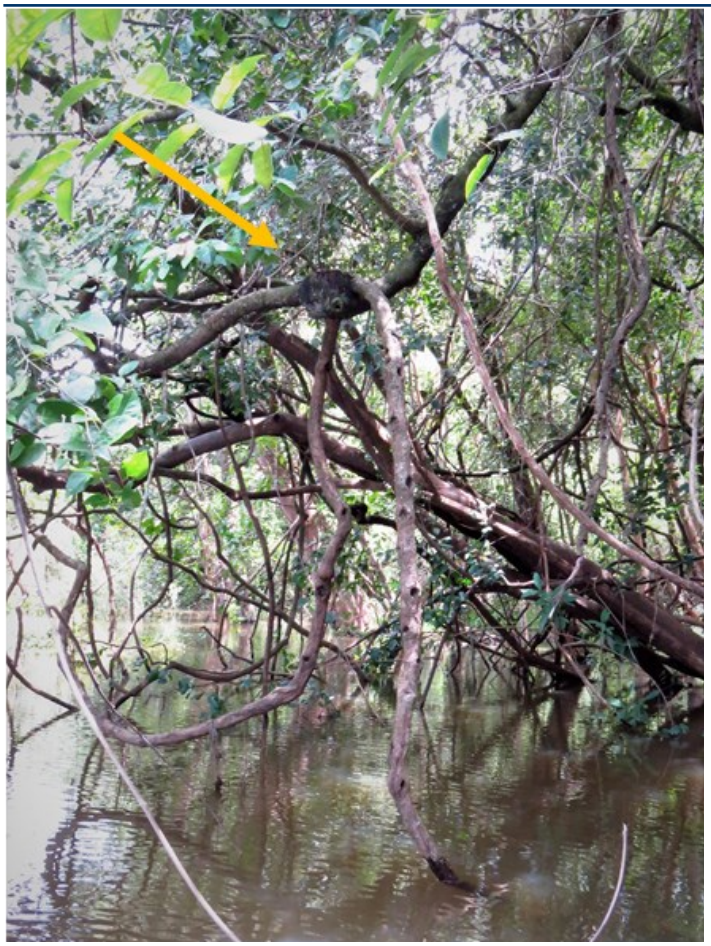

Figure 3. A nest of the Sunbittern (*Eurypyga helias*) built on a branch over the water at Pium municipality, Tocantins state, Cerrado biome, Brazil. Photo by Túlio Dornas.

some weeks later. This is because both the incubation and the period with young in the nest last for about 25_30 days (Thomas & Strahl 1990, Sick 1997, Antas 2004). With this, the occurrence of well-developed nestlings and fledglings is expected to occur from February to April, based on photographs and the literature. Considering that young rely on parents for additional 30 days (Sick 1997, Antas 2004), birds recorded during the nesting phase in the rainy season (November to February) would keep caring young until the later weeks of the rainy season in the Amazon, the Cerrado and the Pantanal. The records by citizens and the incubation period (Thomas & Strahl 1990, Sick 1997, Antas 2004) indicate that these birds had the onset of their breeding in the first half of the rainy season.

In contrast, near a third of the records of breeding Sunbittern occurred during months marked by less intense rainfall. Most (60%) of these records were gathered in May, corresponding to the early dry season in the three biomes. These records might represent a second clutch, as observed in captivity (Bartlett 1866). On the other hand, a record of a copulation in August in the Pantanal appears to agree with the finding of an incubation in September in the Amazon. These two records indicate that some Sunbittern individuals initiate their breeding season during the second half of the dry season in Brazil. The search for nests and young throughout the year would contribute to a better understanding of the breeding season of the Sunbittern. Also, future studies could verify if these distinct breeding periods vary with topography and latitude throughout the three biomes, as they might affect local climate conditions.

Nests photographed by citizens are similar in structure to those described previously for nesting Sunbittern in a range of Neotropical regions (*e.g.*, Lyon & Fogden 1989, Stiles & Skutch 1989, Thomas & Strahl 1990, Sick 1997, Antas 2004). Nest material also was comparable to that of nests examined in previous studies (Antas 2004, Winkler *et al.* 2020). However, the use of moss in a few nests found by citizens had been recorded less often (*e.g.*, Skutch 1947). Although investigations tend to inform that nests are built on horizontal branches (*e.g.*, Antas 2004, Winkler *et al.* 2020), citizens recorded nests on horizontal and inclined branches with comparable frequencies.

Also, nests accompanied by information provided by citizens were over the water, as often reported (*e.g.*, Antas 2004, Sick 1997). Thus, this study has not recorded nests built in trees over the land (*e.g.*, Skutch 1947, Thomas & Strahl 1990, Lyon & Fogden 1989), or on the ground (*e.g.*, Dubs

1992). We consider that the building of nests over the water might represented an anti-predatory behavior against terrestrial predators. However, branches such as those where nests were found are often used by arboreal lizards such as iguanas (*Iguana iguana*), besides coatis (*Nasua nasua*), tayras (*Eira barbara*) and snakes (*e.g.*, *Spilotes pulatus*) in the Cantão region. Further studies, especially those using camera traps, would be necessary to obtain information on nest predation and defense. Also, studies based on larger samples would be necessary to better examine the selection of substratum for nesting by the Sunbittern in Brazilian biomes. Future studies also could compare the abundance of nests in forests with different structure and width, in protected and modified areas, to better understand their occurrence in landscapes. Similar studies comparing different water bodies also would be welcome.

Records of nests indicate clutches of 1–2 eggs in Brazil. This agrees with reports in general references regarding Brazilian birds (*e.g.*, Dubs 1992, Sick 1997, Antas 2004). However, this study has not recorded clutches of three eggs, as reported by Riggs (1948) and MacLean (2020). The few eggs recorded in this study were cream-pinkish with some dark spots. Previous descriptions of the egg color have mentioned, for example, reddish clay-colored background with violet-gray rust-brown spots (Riggs 1948), pale pinkish-cinnamon eggs (Haverschmidt 1968), yellowish-brown eggs with irregular reddish brown and grayish lilac spots (Dubs 1992), and yellowish eggs with gray or brownish spots (Sick 1997). Thus, it appears that there is substantial variation in the color of eggs of the Sunbittern through its geographic distribution.

This study suggests that photographs obtained by citizens, and available in databases such as WikiAves, eBird and iNaturalist, can contribute to reduce knowledge gaps regarding the breeding of Brazilian birds. This is because the number of records obtained by citizens was much larger than that obtained by us. Citizen science projects have been successfully advancing scientific knowledge on birds worldwide (Bonney *et al*. 2009, Chandler *et al*. 2017, Kelling *et al*. 2019). In Brazil, the number of projects engaging numerous citizens are few, but the number of studies involving the obtention of records in databases has been increasing (Barbosa *et al*. 2021). For example, some recent studies on breeding aspects of birds have been done in the Caatinga and the Cerrado (*e.g.*, Barnett *et al*. 2014, Tubelis 2020, Tubelis *et al*. 2020). Thus, we encourage Brazilian ornithologists to make an intense use of the huge quantity of records available in data bases regarding the national avifauna. Further, we strongly suggest that photographs of nests and associated birds be taken with the maximum of worry to do not disturb parents or young. Also, we recommend abandonment of attempts of the documentation of the finding when the approach of the photographer might cause damage to the nest structure.

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