

Article

Nest support plants and breeding season of two ibis
(*Theristicus*) species in the Pantanal wetland, BrazilDárius P. Tubelis¹  & Suzana M. Salis² 

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ABSTRACT. Six species of the Family Threskiornithidae are found in the Pantanal. Despite being abundant and conspicuous birds, information on aspects of their breeding biology in this wetland remains scarce. The aim of this study was to examine breeding aspects (nest support plants and breeding season) of the two species of the genus *Theristicus* Wagler, 1832 that are found in the Brazilian wetland. Field work occurred in 2008, and a search for records (photographs) with evidences of breeding activities was done in the WikiAves and eBird databases in March 2020. A total of 49 records were obtained between 2007 and 2019 in four municipalities, mostly in Poconé. Records (n = 37) involving breeding Plumbeous Ibis, *Theristicus caerulescens* (Vieillot, 1817), were obtained between March and November, and incubation has been documented mainly between May and September. Records (n = 12) of the Buff-necked Ibis, *Theristicus caudatus* (Boddaert, 1783), occurred between April and December, and nests with an incubating adult or nestlings were mainly found between September and December. Breeding activities of *T. caudatus* were delayed in relation to those of *T. caerulescens*. Nests of both species were platforms built with large amounts of branches. Most nests of *T. caudatus* were built in palms, while nests of *T. caerulescens* were found mainly in non-palm trees. Both species nested in tree species that are commonly found in areas where they forage.

KEYWORDS. Bird, humid area, Pelecaniformes, reproduction, Threskiornithidae.

RESUMO. Uso de plantas para nidificação e estação reprodutiva de duas espécies de curicacas (*Theristicus*) no Pantanal, Brasil. Seis espécies da Família Threskiornithidae são encontradas no Pantanal. Embora sejam aves abundantes e conspícuas, informações sobre sua biologia reprodutiva nesta planície ainda são escassas. O objetivo deste estudo foi examinar aspectos da reprodução (uso de plantas para nidificação e época de reprodução) das duas espécies do gênero *Theristicus* Wagler, 1832 que ocorrem no Pantanal brasileiro. Observações de campo ocorreram em 2008, e uma busca por registros (fotografias) com evidências de atividades reprodutivas foi feita nas bases de dados de WikiAves e eBird em março de 2020. Um total de 49 registros foram obtidos entre 2007 e 2019 em quatro municípios, principalmente em Poconé. Registros (n = 37) de curicaca-real, *Theristicus caerulescens* (Vieillot, 1817), foram obtidos entre março e novembro, e a incubação foi documentada principalmente entre maio e setembro. Registros (n = 12) de curicaca, *Theristicus caudatus* (Boddaert, 1783), ocorreram entre abril e dezembro, e ninhos com um adulto incubando ou com filhotes pequenos foram encontrados principalmente entre setembro e dezembro. Assim, as atividades reprodutivas de *T. caudatus* ocorreram atrasadas em relação àquelas de *T. caerulescens*. Os ninhos das duas espécies eram plataformas feitas com grande quantidade de galhos. A maioria dos ninhos de *T. caudatus* foram construídos em palmeiras, enquanto que aqueles de *T. caerulescens* foram feitos em árvores que não eram palmeiras. As duas espécies nidificaram em espécies de árvores que são comuns em áreas próximas aos ambientes onde costumam se alimentar.

PALAVRAS-CHAVE. Ave, área úmida, Pelecaniformes, reprodução, Threskiornithidae.

The family Threskiornithidae belongs to the Order Pelecaniformes and encompasses 36 species of ibises and spoonbills that are distributed across all continents, except Antarctica (WINKLER *et al.*, 2020). They are medium-sized to large birds found in terrestrial habitats and humid areas. Their main morphological characteristics are the long legs, neck, and bill that can be broad and flat in spoonbills or thin and decurved in ibises (MATA *et al.*, 2006; WINKLER *et al.*, 2020).

Four ibis species *Theristicus* Wagler, 1832 are found in South America, and two species occur in Brazilian land (REMSEN *et al.*, 2020). The Plumbeous Ibis, *T. caerulescens* (Vieillot, 1817), is found mainly in humid areas and less

frequently in non-wetland open areas, occurring from Uruguay, northern Argentina, and southern Brazil to Paraguay, southwestern Brazil and northern Bolivia (MATHEU *et al.*, 2020a). The Buff-necked Ibis, *T. caudatus* (Boddaert, 1783), occurs mainly in northern and central South America, from Colombia to Brazil and Argentina, where it is often found in open habitats of savannas and wetlands, including grasslands, exotic pastures, marshes, and ponds (MATHEU *et al.*, 2020b).

All *Theristicus* species build platform nests (*sensu* SIMON & PACHECO, 2005). The Andean Ibis, *T. branickii* Berlepsch & Stolzmann, builds platforms for nesting at rocky walls close to waterfalls in Ecuador (LUZURIAGA *et al.*, 2021).

In Chile, it was found that the Black-faced Ibis, *T. melanopsis* (Gmelin, 1789), selects large trees, especially exotic conifers, for nesting in the urban environment (RAIMILLA *et al.*, 2015). Similarly, *T. caerulescens* and *T. caudatus* build platform nests in trees in Brazilian wetlands (ANTAS, 2004), but *T. caudatus* also nests in rocky outcrops found in open areas in Brazilian wetlands and savannas (SICK, 1997).

It is reported for Brazil that both *T. caerulescens* and *T. caudatus* nest isolated from other co-specifics (SICK, 1997), while *T. caudatus* nests in colonies in the Argentinian Patagonia (DONÁZAR *et al.*, 1994; BOULINIER, 1996). In Uruguay, breeding records of *T. caudatus* were obtained between October and December (ARBALLO, 1990; DONÁZAR *et al.*, 1994). In an originally forested landscape in southern Brazil, its breeding season occurred between July and December (DAL CORNO *et al.*, 2019). Their nests were found between August and October in the Pantanal wetland (DUBS, 1988). Despite these studies, information on the reproduction of these two *Theristicus* species remains scarce.

Theristicus caerulescens and *T. caudatus* co-exist in some regions (MATHEU *et al.*, 2020a,b), including the Pantanal wetland, where other three ibises and a spoonbill also occur (TUBELIS & TOMAS, 2003; ANTAS, 2004). The objective of this study was to investigate aspects of the breeding of two *Theristicus* species, *T. caerulescens* (Plumbeous Ibis) and *T. caudatus* (Buff-necked Ibis), in the Brazilian Pantanal wetland. More specifically, we aimed to examine mainly the breeding season and the choice of trees for nesting.

MATERIAL AND METHODS

Study area. The Pantanal wetland lies in central South America, encompassing landscapes in Brazil, Bolivia and Paraguay, where it covers about 30% of the hydrographic basin of Rio Paraguay (GODOI FILHO, 1986). The Brazilian Pantanal's extension is about 140,000 km² and it is bordered by the savanna (Cerrado), the Atlantic Forest and the Chaco (BROWN, 1986). It lies within two Brazilian states: Mato Grosso and Mato Grosso do Sul (Fig. 1). Major characteristics of its terrain are both the low altitude and declivity (GODOI FILHO, 1986; NUNES DA CUNHA & JUNK, 2015). Also remarkable are the alternance of dry and flood periods and a seasonal pattern of precipitation (HAMILTON *et al.*, 1996; PAZ *et al.*, 2014; NUNES DA CUNHA & JUNK, 2015). The rainy season usually occurs between October and April, with a peak of rainfall in the summer (January and February); the dry season occurs from May to September, with driest months in the winter (June to August) (RODELA & QUEIROZ NETO, 2007; GUIMARÃES *et al.*, 2018).

Major physiognomies in the Pantanal wetland are semideciduous and savanna forest, open savanna and, grassland. These native physiognomies have been dramatically converted to exotic pastures and forests (TOMAS *et al.*, 2019). Most plant species are the same that occur in Brazilian central western savanna (RATTER *et al.*, 2003). Major water bodies are rivers, temporary river channels (*corixos*), marshes, ponds, and lagoons (HAMILTON *et al.*, 1996; NUNES

DA CUNHA & JUNK, 2015). In the Pantanal, *T. caerulescens* occurs mainly in the flat humid areas, seasonally flooded, and *T. caudatus* occurs often in open grasslands, including exotic pastures and wetlands habitats (ANTAS, 2004).

Data set. Records of *T. caerulescens* and *T. caudatus* nests were obtained from searches for photographs in the WikiAves (<https://www.wikiaves.com.br>) and eBird (<https://ebird.org/brasil/home>) databases between 12 and 17 March 2020, and only one nest was recorded by chance encounter in the field by Suzana Salis in 2008 in southern Pantanal in Miranda municipality (20°02'47"S; 57°41'41"W).

In both database searches, records showing evidence of breeding activities by *T. caerulescens* or *T. caudatus* in the Brazilian portion of the Pantanal wetland (within municipalities of states of Mato Grosso and Mato Grosso do Sul) were selected. These records involved copulatory behavior, nest building, eggs, nestlings, juveniles and/or adults in nests, incubation, and young being fed by adults. All records were considered, except when we could note that two or more photographs referred to the same nest in a given year. When these replicates were detected, only one was randomly selected, to avoid repetition. However, these replicates were considered for the identification of the tree species, as they usually showed the parts of plants in different positions.

Ten records were not included in the examination of the breeding season due to doubts. They are: record WA153555 with uncertain date; WA2400226 could refer to an adult or a well-developed juvenile in the nest; WA2094977 could refer to incubation or nest building; WA2280776 could refer to the period of egg laying or incubation; other six records (WA357638, WA780653, WA2280772, WA1475247, WA2625892 and WA2662999) could involve incubation or young care in the nest. However, they were considered for evaluating the use of plant species for nesting, and are indicated with de sign “?” in the Appendix.

Data analysis. Based on their leaves, branches, and trunk, trees used as substrate for nesting were classified into two classes of plant type: 1) those belonging to the monocotyledons, at Family Areaceae (here called “palm trees”); 2) those belonging to the dicotyledons, several botanical families (here called “non-palm trees”). This classification was adopted due to the ease in separating these two types of plant, besides the difficulties in identifying other groups of trees. For both species, the numbers of palm and non-palm trees used as substrate for nest building were compared.

RESULTS

Overall. A total of 49 records of breeding activities of two *Theristicus* species obtained in the Brazilian Pantanal wetland between 2007 and 2019 were included in this study. One nest was recorded during our field observations, while the others were gathered in databases. WikiAves provided most records, while a single record was obtained in the eBird database. These records were obtained in four municipalities: Poconé (n = 25; 51%) in Mato Grosso, and Corumbá

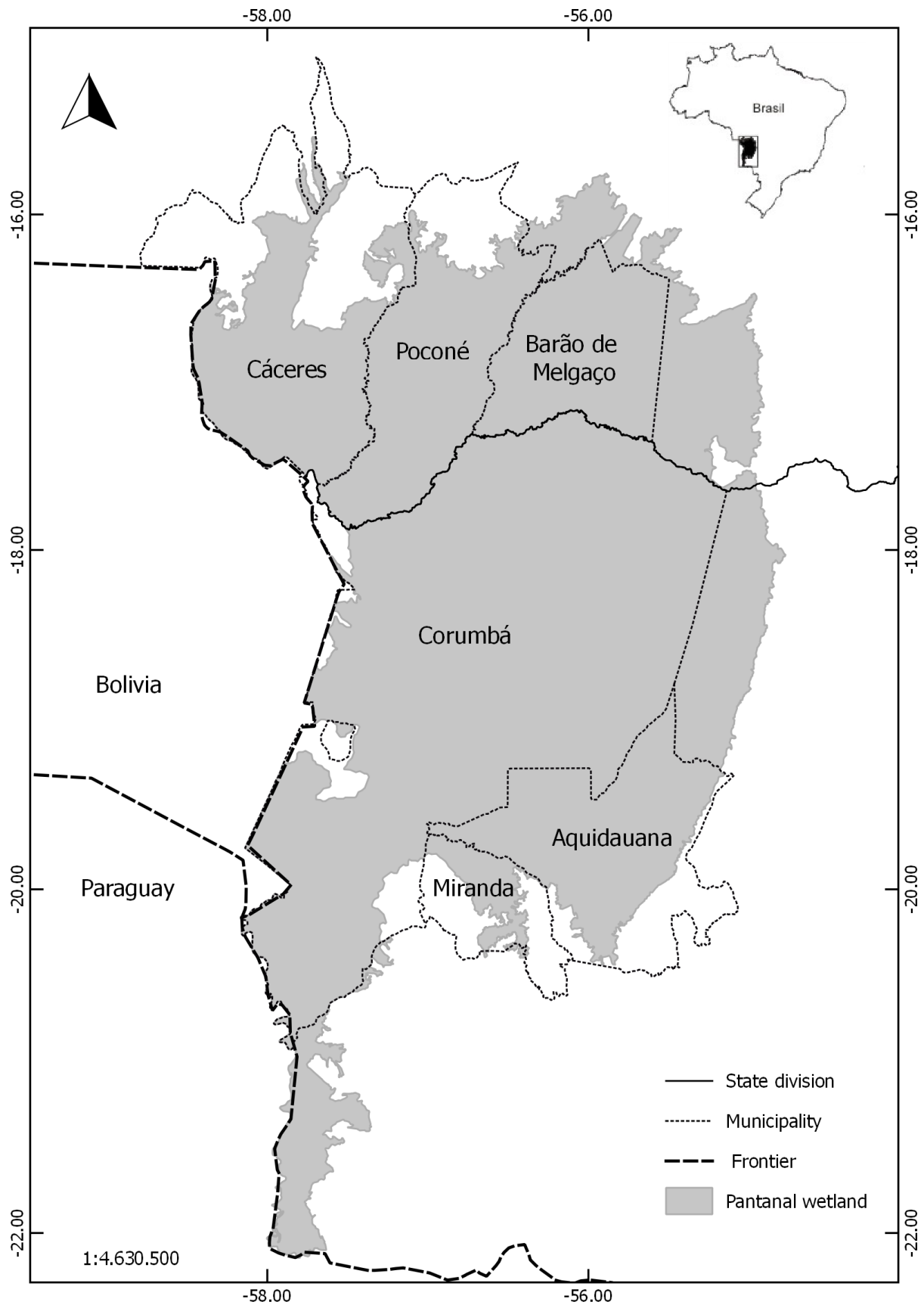


Fig. 1. Municipalities in which records (photographs) with evidences of breeding activities of two ibis species (*Theristicus caerulescens* and *T. caudatus*) were obtained by us and citizens between 2007 and 2019 in the Brazilian Pantanal (gray area). Taquari river divides this Brazilian wetland in two portions: that of Mato Grosso state (where Poconé is located) and that of Mato Grosso do Sul state (where Corumbá, Miranda and Aquidauana are located).

(n = 17; 35%), Miranda (n = 4; 8%) and Aquidauana (n = 3; 6%) in Mato Grosso do Sul (Fig. 1). The 47 records obtained in WikiAves represent 3.3% of the total number of photographs (n = 1415) of these two ibis species obtained in these four localities and available in this database during the search period. The only record found in the eBird database represents 0.6% of the 148 photographs of *T. caudatus* obtained in Mato Grosso state by citizens.

Considering the 49 records evaluated, 45 are photos of nests, of which 42 (93%) were built on plant substratum, and three (7%) on another substratum. Twenty-eight (67%) of the plant substratum were identified, of which 20 (48%) were identified as species, three (7%) to genus level, and five (12%) to family level, and 14 (33%) were unidentified. (Appendix).

***Theristicus caerulescens*.** Records (n = 37) regarding breeding activities of *T. caerulescens* were more numerous in the dry season than in the rainy season (Appendix, Fig. 2).

Copulatory behavior has not been recorded. Nest building (Fig. 3) has been recorded four times, comprising mainly the first half of the dry season (May and July), but also occurring in the late rainy season (March). Incubation (Fig. 4) has been documented by 17 records, mainly in the dry season (June to September), but also being recorded in the early rainy season (October and November). For example, an incubating adult was found in November in Corumbá, fact confirmed by Rudi Laps, the author of the photograph (WA802406) (Appendix).

Seven records documented young and were more numerous in the middle of the dry season (June-July) than in the early rainy season (October) (Appendix, Fig. 2). Five nests had two (60%) or one (40%) gray nestling(s). Some nestlings had a mix of downy and flight plumage (Fig. 5), and others had a nearly full-developed plumage. The other two records of young involved the feeding of well-developed juveniles with adult plumage on the ground (Fig. 6) in August

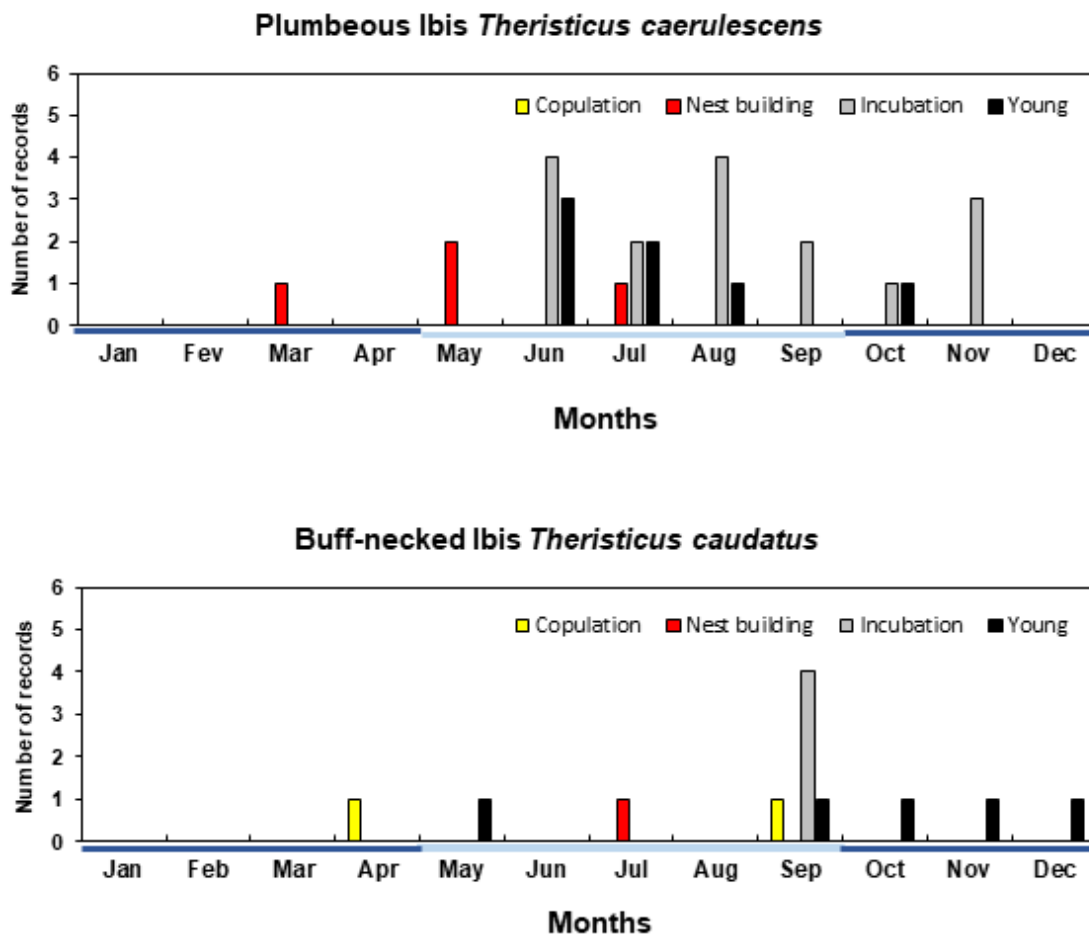


Fig. 2. Seasonal occurrence of records of breeding activities of two ibis species (*Theristicus caerulescens* and *T. caudatus*) in the Brazilian Pantanal wetland, based on records (photographs) obtained during our field observations, and by citizens, between 2007 and 2019. Data by citizens was gathered in the WikiAves and eBird databases in March 2020. The horizontal bars in light and dark blue colors indicate the length of the dry and rainy seasons in the Pantanal, respectively.



Figs 3-6. Records with evidences of breeding activities of the Plumbeous Ibis (*Theristicus caerulescens*) obtained in the Brazilian Pantanal wetland: 3, two adults building a nest at Poconé, MT (photo by Eric Gallardo); 4, an incubating adult at Poconé, MT (photo by Ademir Carletti); 5, an adult and a nestling in a nest at Corumbá, MS (photo by Leonardo Merçon/Instituto Últimos Refúgios); 6, an adult feeding a young on the ground at Poconé, MT (photo by Maria Beatriz Felgar de Toledo). Records were gathered in the WikiAves database.

and October (Appendix). As a result, records of breeding activities of *T. caerulescens* tended to be concentrated in the dry season (69%), being less numerous in the rainy season (31%) (Fig. 2, Appendix).

Nests were platforms (*sensu* SIMON & PACHECO, 2005) formed by many branches (Fig. 4). Of the 35 nests found by citizens, 33 (94%) had trees as substratum (Appendix). Of these, 32 (97%) had non-palm trees as substratum, and only one (3%) was built in a palm tree. Regarding non-palm trees nest substratum, 20 (62.5%) were identified, of which 13 (41%) were identified to species, three (9%) to genus level, and four (12.5%) to family level (Appendix). This resulted in nine species of the six families (Bignoniaceae, Cannabaceae, Fabaceae, Euphorbiaceae, Malvaceae, and Sapotaceae), with more records of Bignoniaceae. The only palm tree used for nesting could be identified to family level (Arecaceae). On other hand, two nests (6%) were built on human-made substratum: top of a pole and roof of a house (Appendix).

***Theristicus caudatus*.** Records ($n = 12$) showing evidence of breeding activities of *T. caudatus* occurred in both seasons, being more concentrated in the late dry season (September), but also occurring in the rainy season, and the

early dry season (Fig. 2, Appendix). Copulatory behavior has been documented by two records. They occurred in the late rainy season (April) and in the late dry season (September). These records showed birds copulating in the nest and on the ground. Nest building has been recorded only once (Fig. 7), in the dry season (July). Four records of incubating adults (Fig. 8) were obtained, all in the late dry season (September). Young have been recorded five times. Nestlings with a short bill and a white downy plumage (Figs 9, 10) were found in four nests between the early dry season (May) and the early rainy season (November). Half of these nests had one nestling, while the other half had two. Also, an adult was found while feeding a juvenile with adult plumage on the roof of a house in December. As a result, records of breeding activities of *T. caudatus* showed a tendency to be concentrated from the late dry season (Fig. 2, Appendix).

Nests were platforms built with large amounts of branches, similar to those of *T. caerulescens*. Of the 10 nests found, six (60%) had palm trees as substratum, while three (30%) were built in non-palm trees. One nest was built on the top of a pole with electric cables (Appendix). The palm trees used for nesting were identified, which comprised



Figs 7-10. Records with evidences of breeding activities of the Buff-necked Ibis (*Theristicus caudatus*) obtained in the Brazilian Pantanal wetland: 7, two adults and a nest being built at Poconé, MT (photo by Ronaldo Duarte); 8, an incubating adult at Poconé, MT (Photo by Antonio Carlos Iglesias); 9, a young being cared in a nest at Miranda, MS (Photo by Suzana Maria Salis); 10, two young with adults in a nest at Aquidauana, MS (Photo by Ana Aquino). Records were gathered in the WikiAves database, except for Fig. 9.

three species of the family Arecaceae (*Attalea phalerata*, *Copernia alba*, and *Cocos nucifera*).

Half of these nests were built in *Cocos nucifera*, the only exotic species used for nesting by this ibis species. Non-palm trees used for nesting involved a species of the family Fabaceae (cf. *Albizia inundata*), while the other two trees could not be identified (Appendix).

DISCUSSION

Breeding season. Results of our study indicate that *T. caerulescens* tends to concentrate their breeding activities in the dry season in the Brazilian Pantanal wetland. This is because records of incubating adults, or nestlings, tended to be more numerous between June and August, corresponding to the middle of the dry season. Also, juveniles with adult plumage were found being fed on the ground from August to October, representing the later phases of a breeding season by the end of the dry season or beginning of the rainy season. Records of adults building nests from March to May indicate that some pairs initiated their breeding activities in the early dry season or even in the later weeks of the previous rainy season. This appears to agree with a study by DUBS (1988) in southern Pantanal, that observed mating and nest building in

March-April, and hatching and rearing of chicks from mid-August to mid-October. Similarly, OLMOS (1990) recorded eggs and young near fledging of *T. caerulescens* in August-September in northern Pantanal.

Despite these similarities, DUBS (1988) and OLMOS (1990) have not recorded incubation by *T. caerulescens* in the early rainy season (October and November), as occurred in our study. These few records obtained by citizens suggest that some *T. caerulescens* start their breeding activities in the early rainy season, after a period marked by high concentration of records involving breeding activities of the species.

Breeding records of *T. caudatus* tended to be concentrated between the late dry season and the middle of the rainy season (September to December). Considering these records, the onset of the breeding season would be the late dry season, and the early rainy season. Also, as young recorded in our study were small nestlings from September to December, the occurrence of more developed nestlings and fledged juveniles are expected for later months of the rainy season (December-February). No other studies have studied the breeding season of *T. caudatus* in the Pantanal. However, a nest with grayish chicks was found in mid-December in Uruguay, but no information on rainfall was provided (ARBALLO, 1990). In agreement with our findings, the laying

dates occurred between late September and late October (dry months) in Argentinian Patagonia (DONÁZAR *et al.*, 1994).

A record by citizens of copulation in April and another of young in May indicate that some *T. caudatus* might start their breeding activities in the later months of the rainy season (March–April). These relatively scarcer records might represent a delayed breeding or second attempt of breeding after the end of a breeding in January–February. Thus, it was noted for *T. caudatus* a period with the occurrence of scarcer records after a period marked by the concentration of breeding activities, as noted for *T. caerulescens*. Further studies are necessary to know if these lesser common records represent a second attempt of breeding or simply a naturally delayed onset of the breeding season by some individuals of both species studied by us.

Therefore, in the Brazilian Pantanal, periods of higher concentration of breeding activities of both *Theristicus* species apparently coincide with periods of greater availability of their food items. This is because *T. caerulescens* usually feed on aquatic gastropods and insects that are gathered in humid areas (ANTAS, 2004). The reduction of the water levels during the dry season probably eases the capture of such preys by these ibises. Equally, *T. caudatus* are mostly insectivorous (SICK, 1997; ANTAS, 2004), and thus might face higher food availability during the rainy season, when flying arthropods become more abundant in grasslands (PINHEIRO *et al.*, 2002).

Nest substratum. Our study is the first to investigate the selection of nest substratum by *Theristicus* species in the Pantanal wetland, considering a sample of several nests. However, OLMOS (1990) reported that four of five nests of *T. caerulescens* were built on the horizontal limbs of huge fig trees in northern Pantanal. Also, ANTAS (2004) informed that it nests in large unidentified trees. Further, DUBS (1988, 1992) did not inform details on the type of trees used for nesting ibises. Thus, our study appears to be the first to identify plant species used by *Theristicus* ibises for nesting in the Brazilian Pantanal wetlands, when 67% records were identified to different levels (e.g., 48% and 12% to species and family levels, respectively).

Considering only natural substratum, all nests of both species involved in our study were built in trees. Nests of *T. caudatus* built at rocky walls or cliffs, such as reported for Uruguay, Argentina, and Brazil (ARBALLO, 1990; DONÁZAR *et al.*, 1994; SICK, 1997; MORONI *et al.*, 2017), have not been found in our study. This occurred because this rocky substratum does not occur in the Pantanal, that is a sedimentary plain region (GODOI FILHO, 1986; NUNES DA CUNHA & JUNK, 2015). Our study also did not record nests of *T. caudatus* on marsh vegetation, as found in Argentinian Patagonia (DONÁZAR *et al.*, 1994). Further sampling would be necessary to know if this species nests on similar plants in the Pantanal, as marsh vegetation is commonly found throughout the entire wetland (NUNES DA CUNHA & JUNK, 2015).

Trees used for nesting by both *Theristicus* species had a strong physical structure. Nests of *T. caerulescens* were mostly built on non-palm trees, encompassing a range of plant families and species. Although we have not measured

trees, it was possible to note that they were large, based on the width of limbs and branches used as support for the nests. The tree species used by *T. caerulescens* for nesting are all heliophyte (LORENZI, 1992, 1998), occurring as isolated trees or in borders of the natural forest patches throughout Pantanal landscapes (POTT & POTT, 1994). Half of these species occur in areas not reached by typical annual flooding, while the other half growth at landscape areas subject to eventual flooding, adjacent or close to water bodies (POTT & POTT, 1994; BASSACO & NOGUEIRA, 2019), that are humid areas often used by *T. caerulescens* for feeding (ANTAS, 2004).

On the other hand, nests of *T. caudatus* were mainly found in palm trees. The two native palms in which nests were built are typical of native grassy areas (NUNES DA CUNHA & JUNK, 2015). For example, *Copernicia alba* occurs in savanna areas (“savana estépica parque”) according to IBGE (2012), *Attalea phalerata* occurs in islands of vegetation (“capões”) in seasonally flooded grassland areas (DAMASCENO JÚNIOR *et al.*, 2014), and both can occur in remaining vegetation in exotic pastures near of farmhouses. The exotic palm *Cocos nucifera* is often planted around human habitations in ranches in the Pantanal. The native grassland areas subject to eventual flooding and exotic non-wetland grassy areas are major feeding areas of *T. caudatus*, which feed mainly on insects and other arthropods in the Pantanal (ANTAS, 2004). Interestingly, in Colombia, FIERRO-CALDERÓN (2010) found two nests of *T. caudatus*, and both were built on palms but could not examine choice of nest-site due to the low number of nests found.

A few nests of our study were built on artificial structures, comprising a house roof, a pole, and a tower. These nests referred to a minor portion of the nests found, and thus nesting associated with such structures should be considered as eventual opportunistic behavior by both species. As they usually are not disturbed by humans in the Pantanal (pers. obs.), they might be not afraid of building nests in the surroundings of human habitations, where these structures are common. Nesting on man-made structures had been reported previously for *Theristicus* species in Brazil. For example, *T. caudatus* uses towers of transmission lines for nesting in central and southern Brazil (DAL CORNO *et al.*, 2019).

Other aspects of the breeding. Nests of *T. caerulescens* and *T. caudatus* involved in this study were platforms built with numerous dry branches and twigs. This can be considered comparable with previous descriptions of their nests found in Brazil (e.g., OLMOS, 1990; ANTAS, 2004). However, as we and citizens have only observed nests from distance, we could not examine details of their chambers, that were considered to have grasses, leaves, and aquatic plants (DUBS, 1988, 1992; ANTAS, 2004). Records of our study comprised only single nests of both species, a result similar to those obtained previously for Brazil (e.g., DUBS, 1988; OLMOS, 1990; SICK, 1997; ANTAS, 2004). However, this pattern contrasts with the finding of nesting colonies of *T. caudatus* in adjacent countries, such as those found in Argentina (DONÁZAR *et al.*, 1994). As these colonial nesting

sites would be easily sighted due to their large size, it is unlikely that they occur in the Brazilian Pantanal.

The presence of 1–2 eggs or young in nests included in our study is in agreement with results of previous studies of these two ibis species in the Brazilian Pantanal, that reported clutches of 1–3 eggs or nestlings (DUBS, 1988; OLMOS, 1990). As our study involved only a few records showing eggs in nests and fully-developed young outside their nests, our study could not make adequate conclusions about breeding success, as occurred for other regions (e.g., DONÁZAR *et al.*, 1994). Thus, further studies involving the monitoring of nests since the laying period would be necessary to examine the survival of eggs and young of both species in the Pantanal wetland.

Although we have not monitored nests, a careful examination of branches led us to recognize that nests of the *T. caerulescens* shown in two photographs (WA805234 and WA818084) were built in the same tree in Corumbá. They were active in 2010 and 2012, respectively, and indicate that a given tree can be used for nesting in more than a year.

The consecutive utilization of the same nest site in different years by birds of a given species had been observed for the Jabiru, *Jabiru mycteria* (ANTAS & NASCIMENTO, 1996; OLIVEIRA & CAVALCANTI, 2000), and the Hyacinth Macaw, *Anodorhynchus hyacinthinus* (GUEDES, 2004; SCHERER-NETO *et al.*, 2019). Further studies employing banding are necessary to know if the re-utilization of a given tree for nesting by *T. caerulescens* and *T. caudatus* involves the same or different pairs. Also, banding and the monitoring of trees used for nesting along several years would allow knowing if these ibis species keep fixed pairs for several breeding seasons.

Concluding remarks. Our study suggests that the breeding of both *Theristicus* species inhabiting the Brazilian Pantanal differs substantially in relation to the type of trees used for nesting. Most nests of *T. caerulescens* were built in non-palm trees that often reaches large sizes in the Pantanal, comprising several plant families and species. Contrastingly, most nests of *T. caudatus* were found in exotic and native palm trees. In both cases, plants used for nesting are commonly found in their major habitats.

Also, we observed that the breeding season of *T. caudatus* is delayed in relation to that of *T. caerulescens*. For both species, the concentration of records involving breeding activities appeared to coincide with periods marked by higher availability of food resources. More specifically, *T. caerulescens* tended to have breeding activities mainly during the dry season, when gastropods and other preys might become more available due to the reduction of water levels in humid areas. In analogy, records of breeding *T. caudatus* were more common during the rainy season, when insects might become more abundant in low-wet grassy areas in the Pantanal.

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Appendix. Records of breeding activities of two ibis (*Theristicus*) species obtained in the Brazilian portion of the Pantanal wetland between 2007 and 2019, with information on the date and location of records, type of breeding evidence, structures used as nest substratum or where birds were found, including information on trees in which nests were built. Breeding: (Copol) copulation, (Incub) incubation, (Nestb) nest building, (Ycare) young care, (Yfeed) young feeding. Substrate: (Np) non-palm tree, (Pa) palm tree. All columns: the term “n.a.” indicates that the information is not applied, and the term “n.i.” indicates that the plant species or family could not be identified. Records were listed by species, then by the type of breeding evidence, and then chronologically according to the day and month in which the records occurred. Records from the eBird (S) and WikiAves (WA) databases were gathered in March 2020. The sign “?” indicates that the record was not included in the evaluation of the breeding season (Fig. 2) due to uncertainties (see Methods)

Species/Code	Date	Breeding	Municipality	State	Substrate	Scientific name	Botanic family
<i>T. caerulescens</i>							
WA2400226	05 Jan 2013	Young?	Miranda	MS	Np	n.i.	n.i.
WA322209	18 Mar 2011	Nestb	Miranda	MS	Np	cf. <i>Tabebuia</i> sp.	Bignoniaceae
WA2108390	05 May 2016	Nestb	Poconé	MT	Np	n.i.	cf. Fabaceae
WA974030	26 May 2013	Nestb	Poconé	MT	Np	<i>Handroanthus heptaphyllus</i> (Vell.) Mattos	Bignoniaceae
WA23220	02 Jul 2007	Nestb	Poconé	MT	Np	<i>Pouteria glomerata</i> (Miq.) Radlk.	Sapotaceae
WA2094977	18 Apr 2016	Nestb or Incub?	Poconé	MT	Np	<i>Handroanthus heptaphyllus</i> (Vell.) Mattos	Bignoniaceae
WA176752	03 Jun 2007	Incub	Poconé	MT	Np	n.i.	n.i.
WA370444	05 Jun 2011	Incub	Corumbá	MS	Np	cf. <i>Sebastiania brasiliensis</i> Spreng.	Euphorbiaceae
WA1748024	06 Jun 2015	Incub	Poconé	MT	Np	n.i.	n.i.
WA1030010	19 Jun 2013	Incub	Poconé	MT	Roof	n.a.	n.a.
WA3434741	05 Jul 2019	Incub	Corumbá	MS	Np	cf. <i>Celtis iguanaea</i> (Jacq.) Sarg.	Cannabaceae
WA2620389	13 Jul 2017	Incub	Poconé	MT	Np	n.i.	n.i.
WA3482596	01 Aug 2019	Incub	Corumbá	MS	Np	n.i.	Fabaceae
WA2648045	03 Aug 2017	Incub	Poconé	MT	Np	n.i.	n.i.

Appendix Cont.

Species/Code	Date	Breeding	Municipality	State	Substrate	Scientific name	Botanic family
WA1068307	10 Aug 2008	Incub	Poconé	MT	Np	<i>Handroanthus heptaphyllus</i> (Vell.) Mattos	Bignoniaceae
WA1066490	17 Aug 2013	Incub	Poconé	MT	Np	<i>Handroanthus heptaphyllus</i> (Vell.) Mattos	Bignoniaceae
WA1922741	02 Sep 2015	Incub	Corumbá	MS	Np	n.i.	n.i.
WA759961	10 Sep 2012	Incub	Poconé	MT	Np	n.i.	n.i.
WA783894	19 Oct 2012	Incub	Corumbá	MS	Tower	n.a.	n.a.
WA805234	03 Nov 2010	Incub	Corumbá	MS	Np	n.i.	n.i.
WA802406	06 Nov 2012	Incub	Corumbá	MS	Np	<i>Handroanthus heptaphyllus</i> (Vell.) Mattos	Bignoniaceae
WA2280776	06 Nov 2012	Incub or laying?	Corumbá	MS	Np	n.i.	n.i.
WA818084	18 Nov 2012	Incub	Corumbá	MS	Np	n.i.	n.i.
WA153555	?	Incub	Miranda	MS	Np	<i>Cordia</i> sp.	Boraginaceae
WA357638	23 May 2011	Incub or Ycare?	Corumbá	MS	Np	cf. <i>Sebastiania brasiliensis</i> Spreng.	Euphorbiaceae
WA2625892	30 Jul 2016	Incub or Ycare?	Corumbá	MS	Np	<i>Handroanthus</i> sp.	Bignoniaceae
WA2662999	15 Aug 2017	Incub or Ycare?	Poconé	MT	Np	n.i.	Fabaceae
WA1475247	11 Sep 2014	Incub or Ycare?	Aquidauana	MS	Np	<i>Sterculia</i> cf. <i>apetala</i> (Jacq.) H. Karst.	Malvaceae
WA780653	13 Oct 2012	Incub or Ycare?	Corumbá	MS	Np	<i>Handroanthus</i> cf. <i>heptaphyllus</i> (Vell.) Mattos	Bignoniaceae
WA2280772	04 Nov 2012	Incub or Ycare?	Corumbá	MS	Np	<i>Handroanthus</i> cf. <i>heptaphyllus</i> (Vell.) Mattos	Bignoniaceae
WA1777198	04 Jun 2015	Ycare	Poconé	MT	Np	n.i.	n.i.
WA1437281	22 Jul 2014	Ycare	Poconé	MT	Np	n.i.	n.i.
WA1744651	22 Jun 2015	Ycare	Poconé	MT	Np	<i>Hymenaea courbaril</i> L.	Fabaceae
WA1395225	24 Jun 2014	Ycare	Poconé	MT	Pa	n.i.	Arecaceae
WA2655758	20 Jul 2017	Yfeed	Corumbá	MS	Np	n.i.	cf. Euphorbiaceae
WA3169273	23 Aug 2018	Yfeed	Poconé	MT	n.a.	n.a.	n.a.
WA3255486	26 Oct 2018	Yfeed	Poconé	MT	n.a.	n.a.	n.a.
<i>T. caudatus</i>							
WA21801	28 Apr 2008	Copul	Poconé	MT	n.a.	n.a.	n.a.
WA1480913	27 Sep 2014	Copul	Corumbá	MS	Pa	<i>Copernicia alba</i> Morong	Arecaceae
WA1194236	24 Jul 2013	Nestb	Poconé	MT	Np	cf. <i>Albizia inundata</i> (Mart.) Barneby & J.W.Grimes	Fabaceae
WA3583848	04 Sep 2019	Incub	Poconé	MT	Pa	<i>Attalea phalerata</i> Mart. ex Spreng.	Arecaceae
WA1897369	09 Sep 2015	Incub	Poconé	MT	Np	n.i.	n.i.
Suzana Salis	11 Sep 2008	Incub	Miranda	MS	Pa	<i>Cocos nucifera</i> L.	Arecaceae
S39361892	24 Sep 2017	Incub	Poconé	MS	Np	n.i.	n.i.
WA3671406	22 May 2018	Ycare	Aquidauana	MS	Pa	<i>Cocos nucifera</i> L.	Arecaceae
WA3202330	12 Sep 2017	Ycare	Corumbá	MS	Pa	<i>Cocos nucifera</i> L.	Arecaceae
WA3171119	25 Oct 2018	Ycare	Poconé	MT	Pa	<i>Attalea phalerata</i> Mart. ex Spreng	Arecaceae
WA827156	19 Nov 2012	Ycare	Corumbá	MS	Pole	n.a.	n.a.
WA1544219	11 Dec 2014	Yfeed	Aquidauana	MS	n.a.	n.a.	n.a.